ElCoM
ELECTRICAL COMPUTER MECHATRONICS

تقدم لجنة ElCoM الاكاديمية

دفتر لمادة:

فيزياء عامة (١)

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محاضرة (1)

Subject * chapter (1) * (الفيزياء والقياس) Date 18-9-2012 No.

* physics and Measurement *

* 1.3 Dimensional Analysis * (تحليل البعد)

* dimension ⇐ the physical nature (طبيعة) of a quantity (كمية).

* Three basic quantity mechanice :-

* quantity ⇐ *	* SI unit ⇐ *	* cgs unit ⇐ *	* Dimension ⇐ *
1) length (l) (طول)	meter (m)	cm	L
2) Mass (M) (كتلة)	Kg	g	M
3) Time (T) (زمن)	second (s)	s	T

*** SI unit ⇐ International system.

*** [x] ⇐ Dimension of x Derived quantities. (كمية المشتقة)

*** X = position (الموقع)

*** XX = displacement (الإزاحة)

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*quantity	*Dimension	*SI unit	*cgs unit
1) Area (A)	$[A] = L^2$	m^2	cm^2
2) Volume (V)	$[V] = L^3$	m^3	cm^3
3) Speed (v) (velocity)	$[v] = \frac{L}{T}$	$\frac{m}{s}$	$\frac{cm}{s}$
4) Accelaration (a)	$[a] = \frac{L}{T^2}$	$\frac{m}{s^2}$	$\frac{cm}{s^2}$
5) Density (D)	$[D] = \frac{[M]}{[V]} = \frac{M}{L^3}$	$\frac{Kg}{m^3}$	$\frac{g}{cm^3}$

6) Force = $M * a$

$[F] = [M] * [a]$

$= M * \frac{L}{T^2}$

$= Kg * \frac{m}{s^2}$

$= \boxed{N}$ نيوتن

*** Any physical Equation (معادلات فيزيائية) should be dimensionally ...

$$[L.H.S] = [R.H.S]$$

(تكافؤ المعادلة)

⇒ Ex (1.1) Analysis of an Equation

Show that the expression $v = at$, where v represents speed, a acceleration and t instant of time. is dimensionally correct?

* Solution:

$v = at$

$[L.H.S]$ $\qquad$ $[R.H.S]$

$[v] = \boxed{\frac{L}{T}}$ $\qquad$ $[at] = \frac{L}{T^2} \times T = \boxed{\frac{L}{T}}$

$$[L.H.S] = [R.H.S] = \frac{L}{T}$$

(This dimensionally is correct) ✓

⇒ Ex ... $X = Vt + \frac{1}{2} at^2$

* Solution: $[L.H.S]^2$

$[x] = \boxed{L}$

$[R.H.S]$

$[Vt] = \frac{L}{T} \times T = \boxed{L}$

$[\frac{1}{2} at^2] = \frac{L}{T^2} \times T^2 = \boxed{L}$

$[Vt + \frac{1}{2} at^2] = \boxed{L}$

$$[L.H.S] = [R.H.S] = L$$

(This dimensionally is correct) ✓

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⇒ Ex 80 $X = Vt + \frac{1}{2}at$

* Solution:

[L.H.S]:

$[x] = \boxed{L}$

[R.H.S]:

$[Vt] = \frac{L}{T} \times T = \boxed{L}$

$[\frac{1}{2}at] = \frac{L}{T^2} \times T = \boxed{\frac{L}{T}}$

$[Vt + \frac{1}{2}at] \neq [X] \neq L$

$[L.H.S] \neq [R.H.S]$ (This dimensionally is not correct) X

⇒ Ex (1.2) 80 (Analysis of a power law)

Suppose we are told that the acceleration (a) of a particle moving with uniform speed (V) in a circle of radius (r) is proportional to some power of (r) say (r^n) and some power of (V) say (V^m), Determine the values of (m) and (n) and write the simplest form of an equation for the acceleration (a)?

* Solution:

$[a] = K V^m r^n \Rightarrow [L.H.S] = [a] = \frac{L}{T^2} = L^1 T^{-2}$

$[R.H.S] = K V^m r^n$

$= K (\frac{L}{T})^m (L)^n$

⇒

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$[R.H.S] = [K r^m v^m] =$

$(L)^n \left(\frac{L}{T}\right)^m = L^n \times \frac{L^m}{T^m} = \boxed{\frac{L^{m+n}}{T^m}}$

$\Rightarrow L.H.S = \frac{L}{T^2}$

$R.H.S = \frac{L^{m+n}}{T^m}$

$L.H.S = R.H.S$

$\frac{L^{(1)}}{T^{(2)}} = \frac{L^{(m+n)}}{T^{(m)}}$

$\therefore \boxed{m = 2}$ #

$m+n=1$

$2+n=1$

$\therefore \boxed{n=-1}$ #

$\therefore a = K r^{-1} v^2$ ⇒ equation

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*(1.4) Conversion of Units *
(تحويل الوحدات)

*** $1\ m = 10^2\ cm$

$1\ Km = 10^3\ m$

$1\ Kg = 10^3\ g$

$1\ Mg = 10^6\ g = 10^{-3}\ Kg$

$1\ mm = 10^{-3}\ m$

$1\ cm = 10^{-2}\ m$

$1\ \mu m = 10^{-6}\ m$ (μ: Symbol)

$1\ nm = 10^{-9}\ m$

$1\ Pm = 10^{-12}\ m$

⇒ Ex: $v = 60\ \frac{Km}{hr}$ تحويل $\Rightarrow \frac{m}{s}$

↳ Solution: $\frac{60 \times 10^3}{60 \times 60} = \frac{1000}{60} = \frac{100}{6}\ \frac{m}{s}$

⇒ Ex: $A = 10\ m^2$ تحويل $\Rightarrow cm^2$

↳ Solution: $10 \times (10^2)^2 = 10^5\ cm^2$

* Problems *

(9) Kinetic energy (K) has dimensions $(Kg.\frac{m^2}{s^2})$. It can be written in terms of the momentum (p) and mass (m) as:

$$K = \frac{p^2}{2m}$$

(a) Determine the proper units for momentum using dimensional analysis.

* Solution:

$$p^2 = K \times 2m$$
$$p^2 = 2Km$$
$$p = (2Km)^{1/2}$$
$$p = (2 \times Kg.\frac{m^2}{s^2} \times Kg)^{1/2}$$
$$p = 2(Kg^2.\frac{m^2}{s^2})^{1/2}$$

$$\boxed{p = 2\ Kg.\frac{m}{s}}$$

(b) The unit of force is the newton (N), where $1\ N = 1\ Kg.\frac{m}{s^2}$. what are the unit of momentum (P) in terms of newton and another fundamental SI unit?

* Solution:

$$[F] = N$$
$$1\ N = Kg.\frac{m}{s^2}$$
$$1\ N = Kg.\frac{m}{s \times s}$$

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$1N = Kg.\frac{m}{s} \times \frac{1}{s}$

$1N = [P] \times \frac{1}{s}$

$\boxed{[P] = N.S}$ #

10) Newton's law of universal gravition is represented by : $F = \frac{GMm}{r^2}$, where (F) is the magnitude of the gravitational force exerted by one small object on another, (M) and (m) are the (masses) of the objects, and (r) is a distance. Force has the SI units $Kg.\frac{m}{s^2}$, what are the SI units of the proportionality constant (G)?

* Solution :

$$[G] = \frac{F \times r^2}{M\,m}$$

$$[G] = \frac{Kg \times m \times m^2}{s^2 \times Kg^2}$$

$$\boxed{[G] = \frac{m^3}{s^2.Kg}}$$ #

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(13) A solid piece of lead has a (mass) of (23.94) g and a (volume) of ($210 cm^3$) from these data. Calculate the (density) of lead in SI units (Kg per cubic meter)?

* Solution:

$$[D] = \frac{[M]}{[V]} = \frac{M}{L^3}$$

(الحجم) * $210 \times (10^{-2})^3$

210×10^{-6}

$21 \times 10^{-5} m^3$

(الكتلة) * $23.94 \times 10^{-3} Kg$

$$[D] = \frac{23.94 \times 10^{-3}}{21 \times 10^{-5}} = 1.14 * 10^2$$

(114) Kg/m^3 #

* * * *

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محاضرة (٣)

Subject *chapter (2) (Motion in one Dimension)*

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2.1

*** position: location of the object with respect to a reference point. (موقع الجسم)

*** Displacement: The change in the position of the object in some time interval. (الإزاحة)

$$\Delta X = X_f - X_i$$

*** Distance (D): The total length of the path followed by the object. (المسافة)



*** average Speed: (معدل السرعة) (متوسط السرعة)

$$V_{avg} = \frac{\text{Distance (D)}}{\Delta t}$$

$$\text{(ع) Speed} = \frac{d}{\Delta t}$$

*** average velocity: (متوسط السرعة)

$$V_{x\,avg} = \frac{\Delta X}{\Delta t} = \frac{X_f - X_i}{t_f - t_i}$$

محاضرة (٤)

(2)

2.2 Instantaneous of velocity
(السرعة اللحظية)

$$v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt} = \text{(ميل المماس)}$$
(المشتقة)
(the slope of the tangent)

$$\text{speed} = \left| \frac{dx}{dt} \right|$$

$$\text{average speed} = \frac{dx}{dt}$$
(سرعة)

2.4 Acceleration

- average acceleration (التسارع) (متوسط تغاير السرعة) $a_{x,avg} = \frac{v_{xf} - v_{xi}}{t_f - t_i}$

$$a_{x,avg} = \frac{\Delta v_x}{\Delta t}$$

- Instantaneous acceleration:

$$a_x = \lim_{\Delta t \to 0} \frac{\Delta v_x}{\Delta t} = \frac{d v_x}{dt} = \text{slope of the tangent of } v_x \text{ vs } t$$

$$a_x = \frac{d^2 x}{dt^2}$$
(مشتقة الثانية) (مسافة)

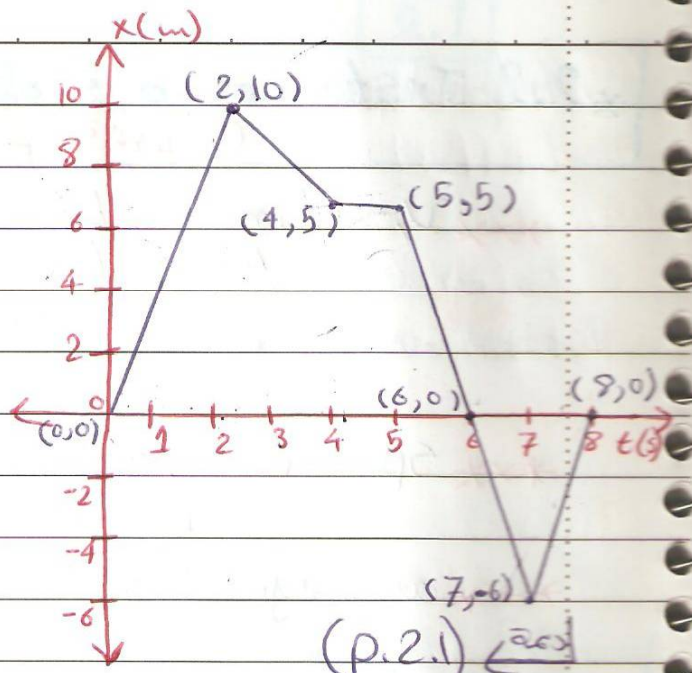
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(٢١)

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Problems

(1) The position versus time for a certain partical moving along the x axis is shown in figure p2.1. Find the average velocity in the time intervals :-



(p.2.1)

a) 0 to 2 s

- Solution :- $V_{xavg} = \frac{\Delta x}{\Delta t}$

$= \frac{10-0}{2-0} = \boxed{5 \text{ m/s}}$

b) 0 to 4 s.

- Solutions :- $V_{xavg} = \frac{\Delta x}{\Delta t}$

$= \frac{5-0}{4-0} = \boxed{\frac{5}{4} \text{ m/s}}$

c) 2 to 4 s.

- Solutions :- $V_{xavg} = \frac{\Delta x}{\Delta t}$

$= \frac{5-10}{4-2} = \boxed{\frac{-5}{2} \text{ m/s}}$

d) 4 to 7S.

- Solutions: $V_{xavg} = \frac{\Delta X}{\Delta t} = \frac{-6-5}{7-4} = \frac{-11}{3}$ m/s

e) 0 to 8s

- Solutions: $V_{xavg} = \frac{\Delta x}{\Delta t} = \frac{0-0}{8-0} = 0$ m/s

(8) Find the Instantaneous velocity of the particale described in figure (P2.1) at the following times:

a) $t = 1S$

- Solution: $V_x = \frac{dx}{dt} = slope = \left(\frac{\text{فرق المسافات}}{\text{فرق الزمن}}\right)$

(0,0) ، (2,10) ← النقط المطلوبة من النقطتين

$V_x = \frac{10-0}{2-0} = \frac{10}{2} = 5$ m/s

b) $t = 3S$

- Solution: $V_x = \frac{10-5}{2-4} = \frac{5}{-2}$ m/s

c) $t = 4.5S$

- Solution: $V_x = \frac{5-5}{5-4} = 0$ m/s

d) $t = 7.5S$

- Solution: $V_x = \frac{0--6}{8-7} = 6$ m/s

صفر ← المسافة بين النقطة: ويعود لنفس النقطة a → b
b → a

(3) A person walks first at a constant speed of (5 m/s) along a straight line from point (A) to point (b) and then back along the line from (b) to (a) at a constant speed of (3 m/s) ..

a) what is her average speed over the entire trip?

* Solution:: average speed $= \frac{dx}{dt} = \frac{D}{t}$

$$* \quad 5 = \frac{D}{t_1}$$

$$D = 5t_1$$

$$\boxed{t_1 = \frac{D}{5}}$$

$$* \quad 3 = \frac{D}{t_2}$$

$$3t_2 = D$$

$$\boxed{t_2 = \frac{D}{3}}$$

$$\text{average speed} = \frac{D_1 + D_2}{t_1 + t_2}$$

$$\frac{2D}{\frac{D}{5} + \frac{D}{3}} = \frac{2D}{\left(\frac{3\times1}{3\times5} + \frac{5\times1}{5\times3}\right) * D} = \frac{2}{\frac{8}{15}}$$

$$= 2 \times \frac{15}{8} = \boxed{3.75 \text{ m/s}}$$

b) what is her average velocity over the entire trip?

- Solution:: average velocity $= \frac{\Delta X}{\Delta t} = \frac{X(A) - X(A)}{\Delta t}$

$= 0$ m/s

(17) A particle moves along the x axis according to the equation $(X = 2 + 3t - t^2)$, where X is in meters and t is in seconds. At $t = 3$ s, find:

a) the position of the particle.

* $X(3) = 2 + (3*3) - (3*3)$

$X(3) = 2$ m

b) its velocity.

* $V_{x,avg} = \frac{\Delta x}{\Delta t} = \frac{dx}{dt} = (3 - 2t)$ ⇒ المشتقة ... (X) لـ

$= 3 - 2*3 = 3 - 6 = -3$ m/s

c) its acceleration.

* $a_{x,avg} = \frac{\Delta V_x}{\Delta t} = \frac{dV_x}{dt} = \frac{d^2x}{dt^2} = -2$ m/s^2

← المشتقة الثانية ... (X) لـ

d) average velocity between 1s to 3s.

* $V_{x,avg} = \frac{\Delta x}{\Delta t} = \frac{X(3) - (1)}{3 - 1} = \frac{2 - 4}{2} = -1$ m/s

e) average acceleration between 1 s to 3s.

* $a_{x,avg} = \frac{V_x(3) - V_x(1)}{3 - 1} = \frac{-3 - 1}{2} = -2$ m/s^2

(السرعة) المشتقة الأولى

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(1.5)

(2.5 + 2.6) Motion in one dimension with constant acceleration (تسارع ثابت)...

a_x = constant...

$$\Rightarrow a_x = a_{x,avg} = \frac{\Delta v_x}{\Delta t} = \frac{v_{xf} - v_{xi}}{t_f - t_i}$$

between $t_i = 0$

$t_f = t$

$$a_x = \frac{v_{xf} - v_{xi}}{t - 0} = \frac{v_{xf} - v_{xi}}{t}$$ (ضرب تبادلي)

$$v_{xf} - v_{xi} = a_x t$$

$$\boxed{v_{xf} = v_{xi} + a_x t} \Rightarrow (1)$$

* أول معادلة من معادلات الحركة وهي:

$(x_f = x_i + v_{xi} t)$

$\Rightarrow$ من المعادلة (1): $v_{xf} = v_{xi} + a_x t$

$$v_x = v_{xi} + a_x t$$

$$\frac{dx}{dt} = v_{xi} + a_x t$$

(بالتكامل) $$\int_{x_i}^{x_f} dx = \int_0^t v_{xi}\, dt + \int_0^t a_x t\, dt$$

$$\boxed{x_f - x_i = v_{xi} t + \frac{1}{2} a_x t^2} \Rightarrow (2)$$

* ثاني معادلة من معادلات الحركة وهي:

$(\Delta x = x_f - x_i = v_{xi} t + \frac{1}{2} a_x t^2)$

⟹ (نعوض معادلة رقم ① في معادلة رقم ② ينتج أن)

$$v_{xf} = v_{xi} + a_x t$$

$$a_x = \frac{v_{xf} - v_{xi}}{t}$$

$$x_f - x_i = v_{xi} t + \frac{1}{2} a_x t^2$$

$$x_f - x_i = v_{xi} t + \frac{1}{2} \frac{v_{xf} - v_{xi}}{t} t^2$$

$$x_f - x_i = v_{xi} t + \frac{1}{2} (v_{xf} - v_{xi}) t$$

(جميع المقادير)

$$x_f - x_i = v_{xi} t + \frac{1}{2} v_{xf} t - \frac{1}{2} v_{xi} t$$

$$x_f - x_i = \frac{1}{2} v_{xi} t + \frac{1}{2} v_{xf} t$$

$$x_f - x_i = \frac{1}{2} t (v_{xi} + v_{xf})$$

$$\boxed{x_f - x_i = \frac{1}{2} (v_{xi} + v_{xf}) t} \quad \rightarrow (3)$$

$$\boxed{x_f = x_i + \frac{1}{2} (v_{xi} + v_{xf}) t} \quad \rightarrow (3)$$

* ثالث معادلة من معادلات الحركة:

(لا تحتوي على التسارع)

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⟹ (من معادلة رقم ① وبالتعويض في معادلة ② ينتج:)

$$v_{xf} = v_{xi} + a_x t$$
$$v_{xf} - v_{xi} = a_x t$$
$$t = \frac{v_{xf} - v_{xi}}{a_x}$$

$$x_f - x_i = \frac{1}{2}(v_{xf} + v_{xi})t$$
$$x_f - x_i = \frac{1}{2}(v_{xf} + v_{xi})\frac{(v_{xf} - v_{xi})}{a_x}$$
$$x_f - x_i = \frac{1}{2}\frac{(v_{xf}^2 - v_{xi}^2)}{a_x}$$

(بالضرب بالمتبادل)
$$x_f - x_i \times 2a_x = \frac{1}{2}(v_{xf}^2 - v_{xi}^2)$$
$$v_{xf}^2 - v_{xi}^2 = 2a_x(x_f - x_i)$$

④ ⟸
$$\boxed{v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)}$$

* رابع معادلة من معادلات الحركة ∴

$(v_f^2 = v_i^2 + 2as)$

ملخص القوانين

1) $v_{xf} = v_{xi} + a_x t$
2) $x_f - x_i = v_{xi} t + \frac{1}{2} a_x t^2$
3) $x_f - x_i = \frac{1}{2}(v_{xf} + v_{xi})t$
4) $v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$

problems

(21) An object moving with uniform acceleration has a velocity of (12 cm/s) in the positive direction when its x coordinate is (3 cm). if its x coordinate (2 s) later is (-5 cm), what is its acceleration?

* Solution

$v_{x_i} = 12$ cm/s
$t = 2$ s
$x_i = 3$ cm
$x_f = -5$ cm
$a_x = ???$

$$x_f - x_i = v_{x_i} t + \frac{1}{2} a_x t^2$$
$$-5 - 3 = (12 * 2) + \left(\frac{1}{2} * a_x * 2 * 2\right)$$
$$-8 = 24 + 2a_x$$
$$\frac{-32}{2} = \frac{2a_x}{2}$$

$$a_x = -16 \text{ cm/s}^2$$ #

(28) A partical moves along the x axis. Its position is given by the equation $x = 2 + 3t - 4t^2$, with x in meters and t in seconds. Determine (a) its position when it changes direction and (b) its velocity when it returns to the position it had at $t = 0$???

⟹ Solution:-

(a) position (موضع) — $v = 3 - 8t = 0 \Rightarrow t = \frac{3}{8} \Rightarrow x = 2 + 3 * \frac{3}{8} - 4(\frac{3}{8})^2$

$x = -2.56\,m$

(b) velocity $= \frac{dx}{dt} = 3 - 8t = 3 - 8 * 0 = 3\,m/s$

(29) Ex (page 37) ***

⟹ a car (سيارة) traveling at a constant (ثابتة) speed of 45.0 m/s passes a trooper on a motorcycle hidden behind a billboard. One second after the speeding car passes the billboard, the trooper sets out from the billboard to catch the car, accelerating at a constant rate of $3\,m/s^2$. How long does it take her to overtake the car?

⟹ Solution: $x_f - x_i = v_{x_i} t + \frac{1}{2} a t^2$

$x_f - 0 = v_{x_i} * 0 + \frac{1}{2} a_x t^2$

trooper ⟸ $x_B = \frac{1}{2} a_x t^2$ ⟹ =

car ⟸ $x = x_B + v_x t$

Ex:

At $t=0s$ a car is at $x_i=120m$ and at $t=3s$ $x_f=270m$, find its:

a) speed... $[s]=\frac{\Delta x}{\Delta t}=\frac{270-120}{3-0}=$ **50 m/s**

b) average velocity... $[v]=\frac{\Delta x}{\Delta t}=$ **50m/s**

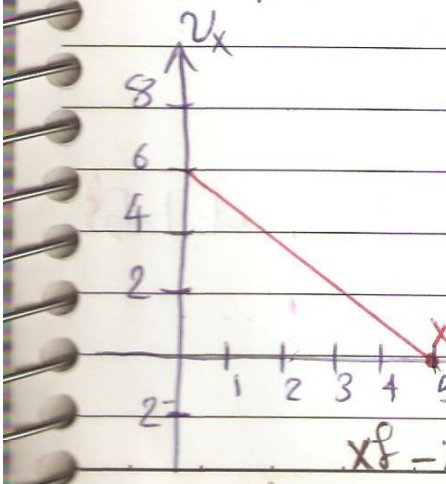
Ex:

IF $x=(2t^2-3t+4)m$, find the Average velocity From $t_i=1s$ to $t_f=3s$?

⟹ Solution: $v_{,avg}=\frac{\Delta x}{\Delta t}=\frac{x(3)-x(1)}{3-1}$

$=\frac{(2(3)^2-3(3)+4)-(2-3+4)}{2}=$ **5m/s**

Ex: v_x is the velocity of a particle moving along the x-axis as shown, if $x=2m$ at $t=0s$, what is the position of the particle at $t=5s$?



$*\Delta x=x_f-x_i=\int_{t_i=0}^{t_f=5} v_x\cdot dx=$ area

$x_f-2=\frac{1}{2}(5-0)*(6-0)$

$x_f=15+2=$ **17 m**

$x_f-x_i=$ area$_1$ − area$_2$ ⟸ عندما الزمن = آ ث *

$x_f-2=17-\frac{1}{2}*1*2$

$x_f=16m$

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Ex $x = 2t^2 - 3t + 4$

find the intantanous velocity :. at $t = 1$ s ?

$\Rightarrow [v] = \frac{dx}{dt} = 4t - 3 = (4*1) - 3 = \boxed{1 \text{ m/s}}$

Ex $x = 2 + 3t - t^2$ at $t = 3$ s, find the position when $t = 3$ s and the velocity and the acceleration.

*Solution :. position $= 2 + 3*3 - 3*3 = \boxed{2 \text{ m}}$

$$\text{velocity} = \frac{dx}{dt} = 3 - 2t = 3 - 6 = \boxed{-3 \text{ m/s}}$$

$$\text{acceleration} = \frac{dx^2}{d^2t} = \boxed{-2 \text{ m/s}^2}$$

عجلة السالبة

Q $x = 3t^2 - 2t + 3$

(a) find the average acceleration from $t = 2$ s to 3 s

- Solution :. $[a_{x,avg}] = \frac{d^2x}{dt^2} = \frac{v_{xf} - v_{xi}}{t_f - t_i}$

$x = 6t - 2 \Rightarrow \frac{16 - 10}{3 - 2} = \boxed{6 \text{ m/s}^2}$

(b) find the instantanous acceleration at $t = 5$ s

- Solution :. $[a_{x,avg}] = \frac{dv}{dx} = \boxed{6 \text{ m/s}^2}$

$x = 6t - 2$ مشتقة

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Ex $x = 2 + 3t - 4t^2$

Find the position of an object when it changes direction?

$v = x = 3 - 8t$

$v = 3 - 8t = 0$

$8t = 3$

$t = \frac{3}{8} s$

$x = 2 + 3 * \frac{3}{8} - 4 * (\frac{3}{8})^2$

$x = -2.56\ m$

$v_f > v_i \leftarrow a_x^{(+)}$

$v_f = v_i \leftarrow a_x = 0$

$v_i > v_f \leftarrow a_x^{(-)}$

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Ex (A jet plane) طيارة تهبط
فتتوقف بتباطؤ (-) ثابت
(as it comes to rest)
تهبط بسرعة
$v_f = 0$ m/s
$v_i = 100$ m/s
$a = -5$ m/s²

a) $\Delta t = ?? \Rightarrow a_x = \frac{\Delta v_x}{\Delta t} \Rightarrow \Delta t = \frac{\Delta v_x}{a_x} = \frac{-100}{-5}$

$\Delta t = 20$ s

(نوجد بالقانون) $(v_f = v_i + a_x t)$

b) The Runway = 0,8 K.m = 800m find Δx ?

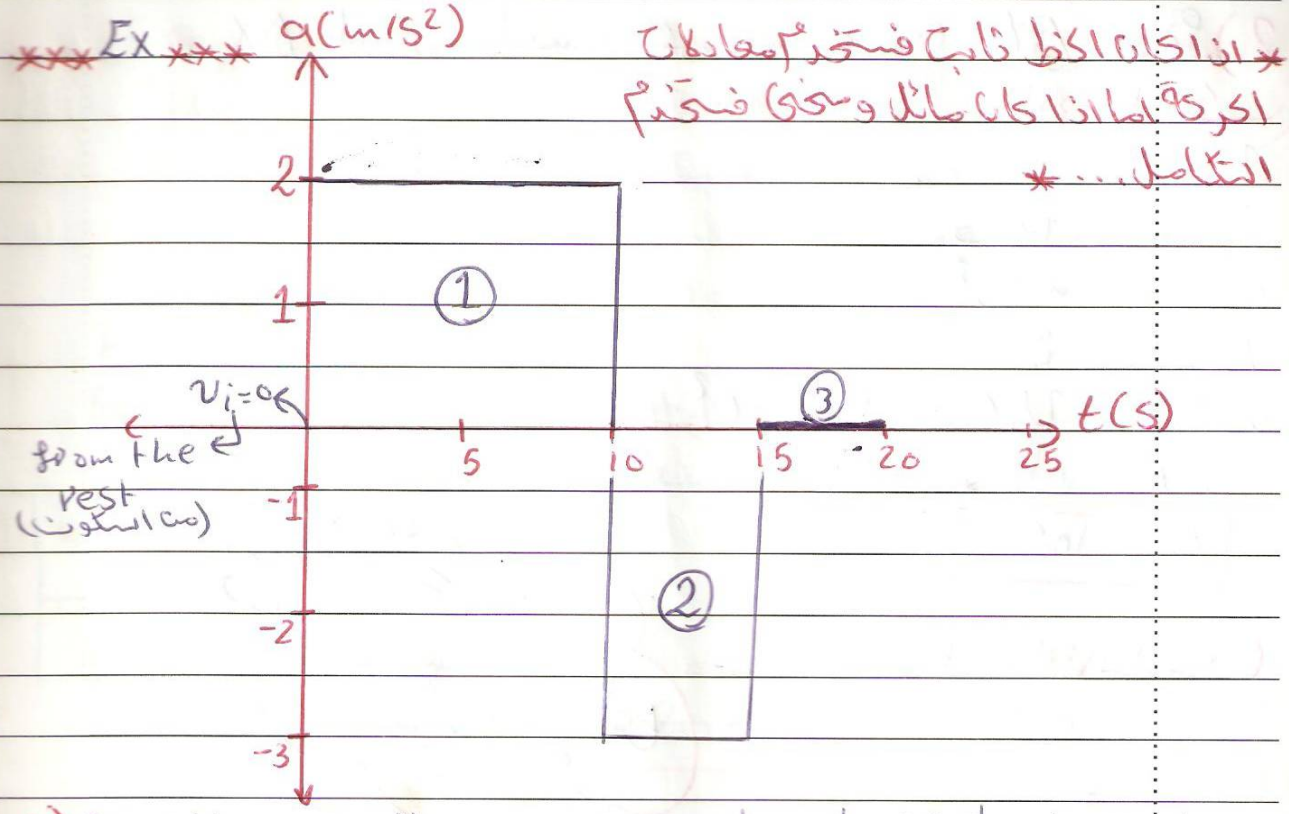
* $\Delta x = v_i t + \frac{1}{2} a_x t^2$

$\Delta x = (100 * 20) + (\frac{1}{2} * -5 * 20^2)$

$\boxed{\Delta x = 1000 \text{ m}}$

(نحول لكم 1 Km = 1000 طول المدرج ...)

*** Ex ***



* اذا كان الخط ثابت فنستخدم معادلات الحركة اما اذا كان مائل ومنحنى فنستخدم التكامل... *

1) Find the velocity at $t=10S$, $t=15S$, $t=20S$

$t=10S \Rightarrow v_f = v_i + a \times t$

$v_f = 0 + 2 * 10$

$v_f = 20\ m/s$ ⇒ كتلة المرحلة الأولى تساوي السرعة الابتدائية للمرحلة الثانية.

$t=15S \Rightarrow v_f = v_i + a \times t$

$v_f = 20 + 5 * -3$

$v_f = 20 + -15$

$v_f = 5\ m/s$ ⇒ كتلة المرحلة الثانية تساوي السرعة الابتدائية للمرحلة الثالثة.

$t=20S \Rightarrow v_f = 5 + (0 * 5)$

$= 5\ m/s$

2) find (ΔX) (المرحلة الثالثة) and total ΔX ...

(المرحلة الأولى)

$v_i = i$

$v_f = 20\ m/s$

$a_x = 2\ m/s^2$

$\Delta t = 10\ s$

$* \Delta X = v_i t + \frac{1}{2} a_x t^2$

$\Delta X = \frac{1}{2} * 2 * 100$

$\Delta X = 100\ m$

total $\Delta X = X_1 + X_2 + X_3$

$= 2.5 + 100 + 25 +$

$= 187.5\ m$

(المرحلة الثانية)

$v_i = 20\ m/s$

$v_f = 5\ m/s$

$a_x = -3\ m/s^2$

$\Delta t = 5\ s$

$* \Delta X = v_i t + \frac{1}{2} a_x t^2$

$= (20 * 5) + (\frac{1}{2} * -3 * 5 * 5)$

$= 62.5\ m$

(المرحلة الثالثة)

$v_i = 5\ m/s$

$v_f = 5\ m/s$

$a_x = 0\ m/s^2$

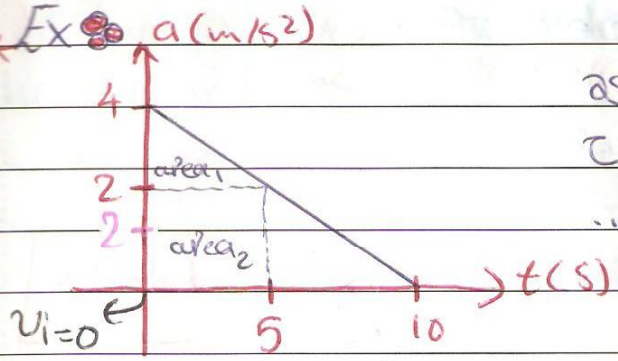
$\Delta t = 5\ s$

$\Delta X = v_i t + \frac{1}{2} a_x t^2 = (5 * 5) + (\frac{1}{2} * 0 * (5)^2)$

$= 25\ m$

Subject Date No.

*** Ex



* لايجاد قوانين الكرة
في الثانية وبيانيا
فنستخدم التكامل..

- find the velocity at t=10S ???
and t=5S ???

t = 10 S

$\rightarrow v_f - v_i = \text{area}$

$v_f - 0 = \frac{1}{2} * 10 * 4 = 20 \text{ m/s}$

t = 5 S

$\rightarrow v_f - v_i = \text{area}_1 + \text{area}_2$

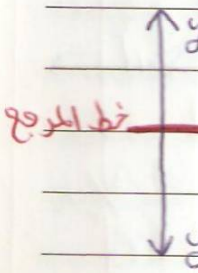
$v_f - 0 = (5*2) + (\frac{1}{2} * 5 * 2)$

$= 10 + 5$

$= 15 \text{ m/s}$

2.7 Freely falling objects :: سقوط الاجسام الحرة (من ارتفاع عودي على الارض)

$a_x = 9.8 \text{ m/s}^2 \approx 10 \text{ m/s}^2$



* المعادلات :

① $v_{xf} = v_x - g\Delta t$

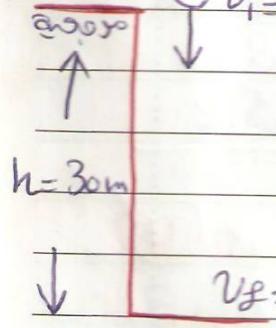
② $x_f - x_i = v_i t - \frac{1}{2} g t^2$

③ $v_f^2 = v_i^2 - 2g(x_f - x_i)$

ملاحظة: هنرمز للاتجاه لأسفل بـ down ward
للاتجاه لأعلى up ward

Problems

*



السرعة سالبة (down ward) :: لأنها

* $v_f^2 = v_i^2 - 2g(x_f - x_i)$

$v_f^2 = (-8)^2 - (2 \times 10 \times -30)$ (عكس الاتجاه)

$v_f^2 = 64 - -600$

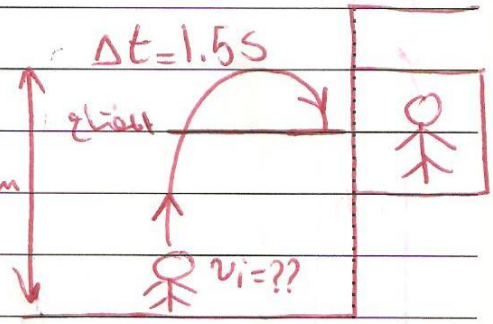
$v_f = \sqrt{664}$

$v_f = \pm 25.7$ m/s

(عكس الاتجاه)

Subject Date No.

(43) A student throws a set of keys vertically (upward) to her sorority sister, who is in a window 4,00 m above. The second student catches the key 1.50 s later.
(a) with what initial velocity were the keys thrown?
(b) what was the velocity of the keys just before they were caught?



→ Solution: (a)

$\Delta X = v_i t - \frac{1}{2} g t^2$

$4 = (v_i * 1.5) - (\frac{1}{2} * 10 * (1.5)^2)$

$4 = v_i * 1.5 - 11.25$

$\frac{15.25}{1.5} = v_i$

$v_i = 10,1$ m/s → (+) upward

(b) $v_f = v_i - g\Delta t$

$v_f = (10) - (10 * 1.5)$

$v_f = -5$ m/s

H.W → Δt = ?? when $v = 0$

$\Delta X = v_i \Delta t - \frac{1}{2} g \Delta t^2$

$\Delta X = 0 - \frac{1}{2} g \Delta t^2$

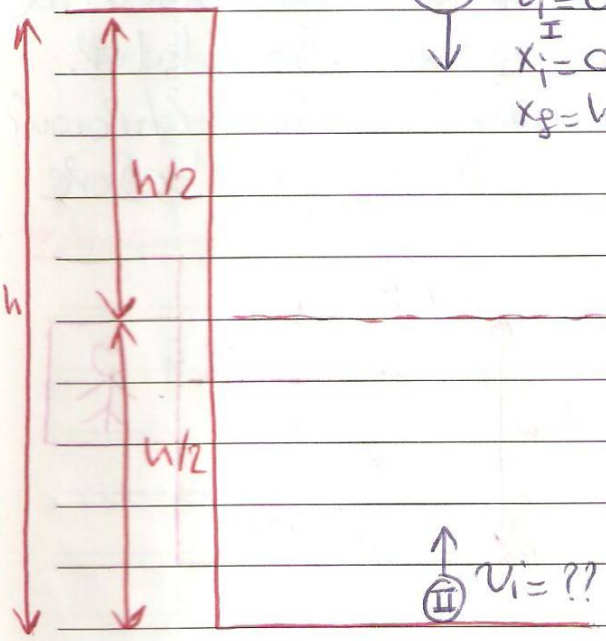
$4 = +\frac{1}{2} g \Delta t^2$

$+\frac{8}{10} = \frac{10}{10} \Delta t^2$

$+0,8 = \Delta t^2$

$0,8 = t$

Ex From the rest



Find $v_i(h, g)$ per-wise

* (I) $x_f - x_i = v_i t - \frac{1}{2} g t^2$

since $-\frac{h}{2} = -\frac{1}{2} * g * t^2$

$$\sqrt{\frac{h}{g}} = t$$

* (II) $x_f - x_i = v_i t - \frac{1}{2} g t^2$

$$\frac{h}{2} = v_i * \frac{\sqrt{h}^2}{\sqrt{g}} - \left(\frac{1}{2} * g * \frac{h}{g}\right)$$

$$\frac{h}{2} = \frac{v_i \sqrt{h}}{\sqrt{g}} - \frac{1}{2} h$$

$$\therefore h = \frac{v_i \sqrt{h}}{\sqrt{g}} \Rightarrow v_i = \frac{h\sqrt{g}}{\sqrt{h}} = \sqrt{hg} \text{ m/s}$$

Ex: The position of a pinewood derby car was observed at various times; the result are summarized in the following table. Find the average velocity of the car for
(a) the first second.
(b) the last 3 second.
(c) the entire period of observation.

t(s)	0	1	2	3	4	5
x(m)	0	2.3	9.2	20.7	36.8	57.5

Solution: average velocity $= \frac{\Delta x}{\Delta t}$

(a) 2.3 m/s

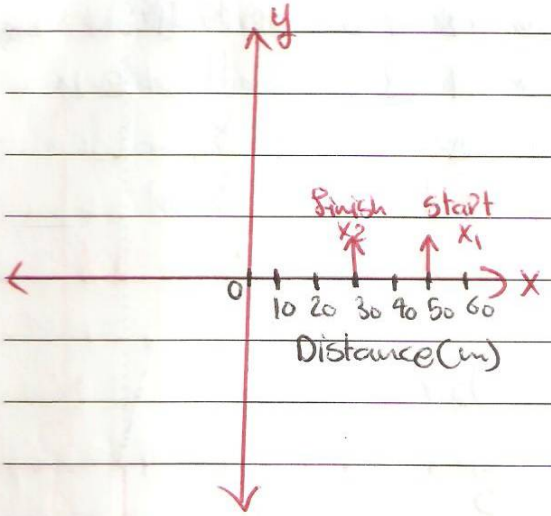
(b) $\frac{57.5 - 9.2}{5 - 2} = \frac{48.3}{3} =$ **16.1 m/s**

(c) $\frac{57.5 - 0}{5 - 0} =$ **11.5 m/s**

Ex: The position of a runner as a function of time is plotted as moving along the x-axis of a coordinate system. During a(3s) time interval, the runners position changes from $x_1 = 50.0$ m to $x_2 = 30.5$ m, as shown in the figure. what was the runner's average velocity? what was the average speed?

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*Solution:



* average velocity $= \frac{\Delta x}{\Delta t}$

$= \frac{30.5-50}{3} = \frac{-19.5}{3} = \boxed{-6.5}$ m/s

* average speed $= \frac{d}{\Delta t}$

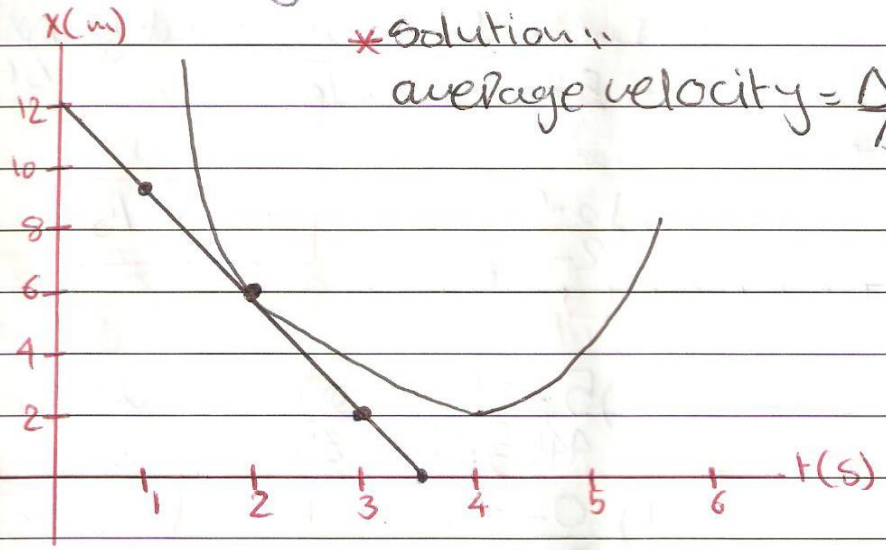
$\frac{50-30.5}{3} = \frac{19.5}{3} = \boxed{6.5}$ m/s

*** Ex: *** A particle moves according to the equation $(x=10t^2)$ where x is in meters and t is in second. (a) Find the average velocity for the time interval from (2s) to (3s). (b) Find the average velocity for the time interval from (2s to 2.10s).

- Solution: (a) average velocity $= \frac{\Delta x}{\Delta t} = \frac{90-40}{3-2} = \boxed{50}$ m/s

(b) average velocity $= \frac{\Delta x}{\Delta t} = \frac{94.1-40}{2.10-2} = \frac{4.1}{0.1} = \boxed{41}$ m/s

Ex 8 A position-time graph for a particle moving along the x-axis is shown in figure, find the average velocity in the time interval ($t=1.5s$ to $t=4s$)



*Solution:

$$\text{average velocity} = \frac{\Delta x}{\Delta t} = \frac{2-8}{4-1.5}$$

$$= \frac{-6}{2.5}$$

$$= -2.4 \text{ m/s}$$

(b) Determine the Instantaneous velocity at $t=2s$ by measuring the slope of the tangent lines shown in the graph? -Solution:

(number line (3.5, 0) (0, 12))

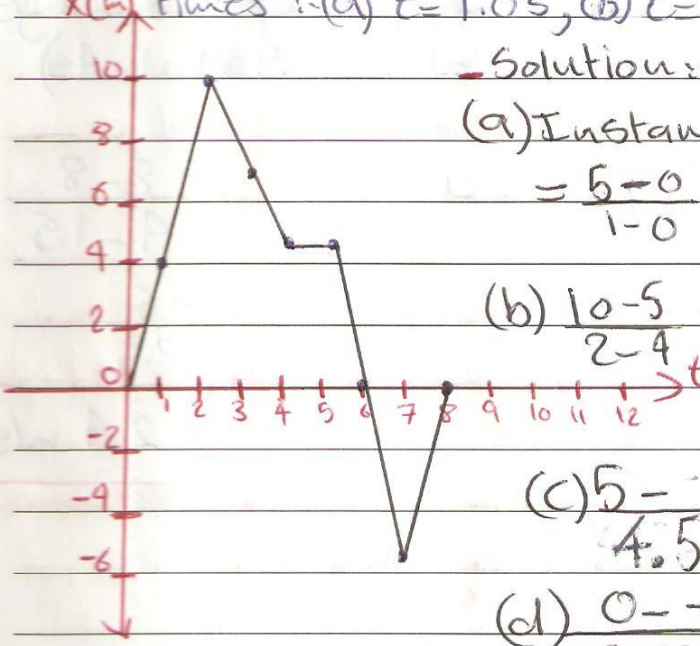
$$\text{Instantaneous velocity} = \frac{dx}{dt} = \text{slope} = \frac{\Delta y}{\Delta x} = \frac{0-12}{3.5-0} = \frac{-12}{3.5}$$

$$= -3.4 \text{ m/s}$$

(c) At what value of time (t) is the velocity zero?

-Solution: The velocity is zero when x is minimum. This is at ($t=4$)...

*Ex: Find the Instantaneous velocity at the following times :- (a) $t = 1.0\,s$, (b) $t = 3.0\,s$, (c) $t = 4.5\,s$, (d) $t = 7.5\,s$



- Solution:-

(a) Instantaneous velocity $= \frac{\Delta x}{\Delta t}$ = slope

$= \frac{5-0}{1-0} = \boxed{5\ m/s}$

(b) $\frac{10-5}{2-4} = \frac{5}{-2} = \boxed{-2.5\ m/s}$

(c) $\frac{5-5}{4.5-4} = \boxed{0\ m/s}$

(d) $\frac{0--5}{8-7} = \frac{5}{1} = \boxed{5\ m/s}$

***Ex: A 50-g superball traveling at -25 m/s bounces off a brick wall and rebounds is at 22.0 m/s. A high-speed camera records this event. if the ball is in contact with the wall for (3.50 ms), what is the magnitude of the average acceleration of the ball during this time interval? (Note: $1\ ms = 10^{-3}\ s$) ?

- Solution:- $v_{xf} = v_{xi} + a_x t$

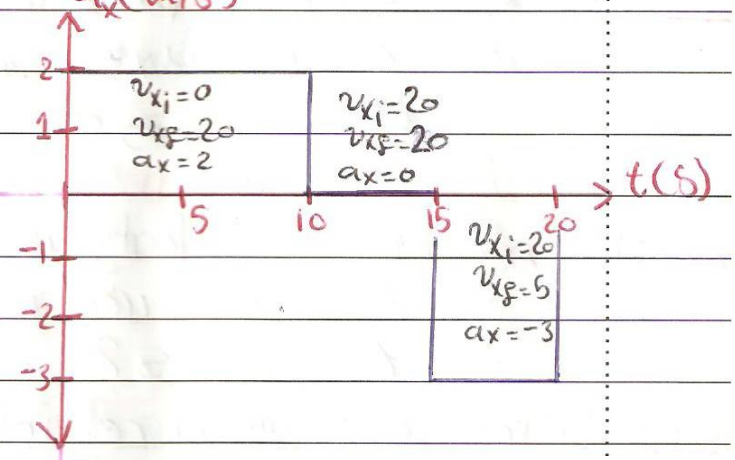
$22 = -25 + (a_x * 3.5 * 10^{-3})$

$\frac{47}{3.5 * 10^{-3}} = a_x$

$\boxed{a_x = 13.4 * 10^3\ m/s^2}$ → Digital Tools Used: $a_x = \frac{\Delta v_x}{\Delta t}$

Subject Date No.

Ex A particale starts from rest and accelerates as shown in the figure. Determine (a) the particle's speed at $t=10\,s$ and $t=20\,s$ and (b) the distance traveled in the first 20.0 s.



- Solution: (a)

$v_{xf}=v_{xi}+a_x t$

$v_{xf}=0+2*10$

$\boxed{v_{xf}=20\ m/s}$ → طبق (1)

$v_{xf}=v_{xi}+a_x t$

$v_{xf}=20+0$

$\boxed{v_{xf}=20\ m/s}$ → طبق (2)

$v_{xf}=v_{xi}+a_x t$

$v_{xf}=20+(-3*5)$

$=20-15$

$=\boxed{5\ m/s}$ #

(b) $x_f-x_i=v_{xi}t+\frac{1}{2}a_x t^2$ → طبق (1)

$x_f-0=0*t+\frac{1}{2}*2*(10)^2=\boxed{100\ m}$ → x_f → تصبح x_i للمرحلة التالية

$x_f-x_i=v_{xi}t+\frac{1}{2}a_x t^2$ → طبق (2)

$x_f-100=(20*5)+(\frac{1}{2}*0*(5)^2)=\boxed{200\ m}$ → تصبح x_i للمرحلة التالية

$x_f-x_i=v_{xi}t+\frac{1}{2}a_x t^2$ → طبق (3)

$x_f-200=(20*5)+(\frac{1}{2}*-3*25)$

$=300-37.5$

$=\boxed{262.5\ m}$ → distance #

Subject Date No.

Ex A car accelerates along a straight road from rest to (21 m/s) in (5.0 s). what is the magnitude of its average acceleration?

⇒ Solution: $v_{xf} = v_{xi} + a_x t$

$21 = 0 + a_x * 5$

$\frac{21}{5} = a_x \Rightarrow a_x = \boxed{4.2\ m/s^2}$

Ex Given the velocity as: $v_x(t) = (40 - 5t^2)$ m/s find average acceleration in time interval, $t = 0$ to $t = 2.0$ s?

⇒ Solution: average acceleration $= \frac{\Delta v_x}{\Delta t}$

$a_{x,avg} = \frac{v_x(2) - v_x(0)}{2 - 0} = \frac{20 - 40}{2} = \boxed{-10\ m/s^2}$

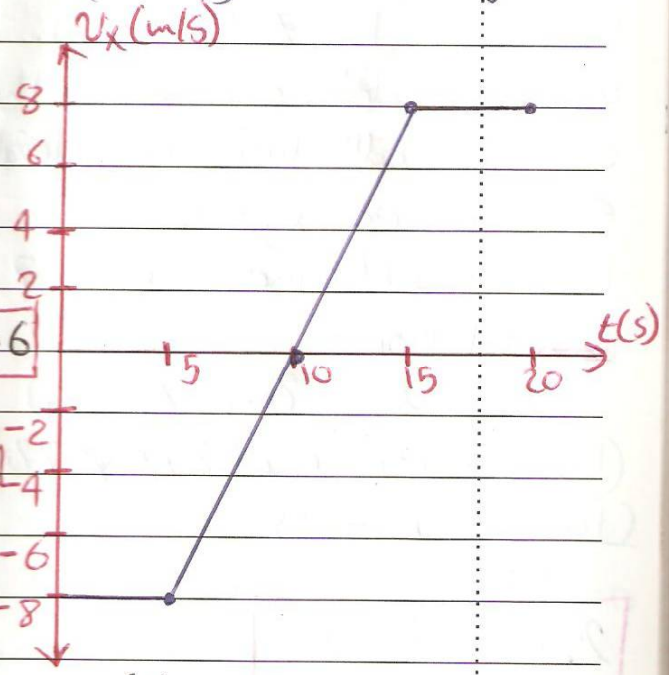
(b) find Instantaneous acceleration at any time (t) and ($t = 2.0$ s)?

⇒ Solution: Instantaneous acceleration $= \frac{dv_x}{dt}$

$= -10t$

$a_x(2) = -10 * 2 = \boxed{-20\ m/s^2}$ #

* Ex: A velocity-time graph for an object moving along the x-axis is shown in the figure. (a) Plot a graph of the acceleration versue time. (b) Determine the average acceleration of the object in the time intervals ($t=5\,s$) to ($t=15\,s$) and ($t=0$) to ($t=20\,s$).



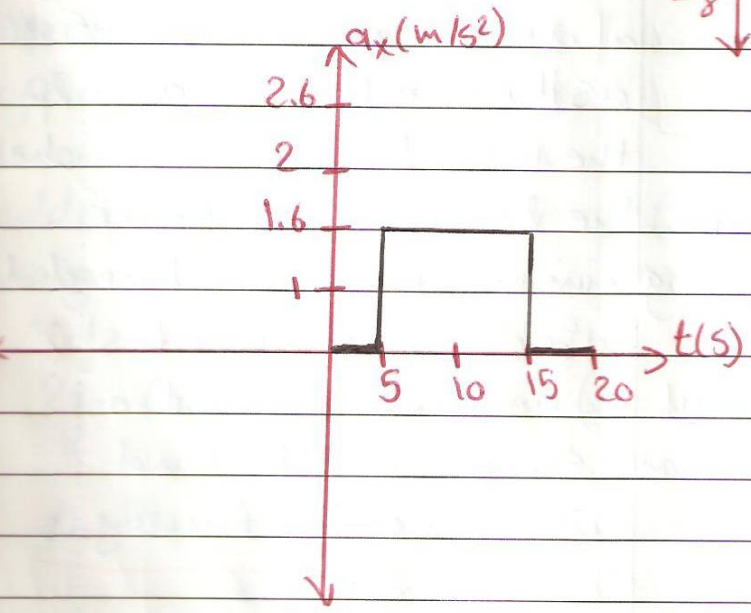
⇒ Solution: (a)

For $0<t<5 \rightarrow a_x = \frac{\Delta v_x}{\Delta t}$

$a_x = \frac{-8+8}{5-0} = \boxed{0}$

For $5<t<15 \rightarrow a_x = \frac{8--8}{15-5} = \boxed{1.6}$

For $15<t<20 \rightarrow a_x = \frac{8-8}{20-15} = \boxed{0}$



(b) average acceleration $= \frac{\Delta v_x}{\Delta t} = \frac{8--8}{15-5} = \boxed{1.6}$ (m/s²)

$\frac{\Delta v_x}{\Delta t} = \frac{8--8}{20-0} = \boxed{0.8}$ (m/s²)

Subject Date No.

أسئلة على معادلات الحركة

Ex8 Jules verne in 1865 suggested sending people to the Moon by firing a space capsule from 220m long cannon with a launch speed of $(10.97 \times 10^3 \text{ m/s})$. what would have been the unrealistically large acceleration experienced by the space travelers during launch?

⟹ solution:

$$v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$$

$$(10.97\times10^3)^2 = 0 + (2 * a_x * 220)$$

$$\frac{(10.97\times10^3)^2}{440} = a_x$$

$$2.79\times10^5 \text{ m/s}^2 = a_x$$

Ex8 A truck covers 40m in 8.50s, while smoothly slowing down to a final speed of 2.80 m/s. (a) find its original speed. (b) find its acceleration

- Solution: $x_f - x_i = 40\text{m}$

$t = 8.50\text{s}$

$v_{xf} = 2.80 \text{ m/s}$

$v_{xi} = ??$

$$x_f - x_i = \frac{1}{2}(v_{xi} + v_{xf})t$$

$$40 = \frac{1}{2}(v_{xi} + 2.80)8.50$$

$$9.411 = v_{xi} + 2.80$$

$$v_{xi} = 6.61 \text{ m/s}$$

(b) $v_{xf}^2 = v_{xi}^2 + 2a_x(x_f - x_i)$

$(2.80)^2 = (6.61)^2 + 2a_x(40)$

$7.84 = 43.6921 + 80\,a_x$

$a_x = -0.448 \text{ m/s}^2$

بطيء

Ex9 A jet plane lands with a speed of 100m/s and can accelerate at a maximum rate of -5 m/s^2 as it comes to rest. (a) from the instant the plane touches the runway, what is the minimum time interval needed before it can come to rest? (b) can this plane land on a small tropical island airport where the runway is 0.8 Km long?

- Solution (b): (NO)

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- Solution (a):
speed = 100 m/s
$a_x = -5\ m/s^2$
t = ???
$v_{xf} = v_{xi} + a_x t$
$0 = 100 - 5t$
$5t = 100$
$t = 20\ s$

* Ex: A truck on a straight road starts from rest, accelerating at $2.00\ m/s^2$ until it reaches a speed of 20.0 m/s. Then the truck travels for 20.0 s at constant speed until the brakes are applied, stopping the truck in a uniform manner in an additional 5.00 s. (a) How long is the truck in motion?

- $v_{xf} = v_{xi} + a_x t$
$\frac{20}{2} = 0 + \frac{2}{2}t \Rightarrow t = 10\ s$

$t = 10 + 20 + 5 = 35\ s$

(b) what is the average velocity of the truck for the motion described?

- Solution:
average velocity $= \frac{\Delta x}{\Delta t}$

$t = 10 + 20 + 5 = 35\ s$
Δt

* $t = 10 \rightarrow v_i = 0 \rightarrow v_f = 20\ m/s$
$\Delta x = \frac{(v_i + v_f)}{2} * t$
$\Delta x = \frac{(0 + 20)}{2} * 10 = 100\ m$

* $t = 20 \rightarrow v_i = 20\ m/s \rightarrow a_x = 0$
$\Delta x = v_{xi} t + \frac{1}{2} a_x t^2$
$= 20 * 20 = 400\ m$

* $t = 5 \rightarrow v_i = 20 \rightarrow v_f = 0$
$\Delta x = \frac{1}{2}(20 + 0) * 5 = 50\ m$

$\Delta x = x_1 + x_2 + x_3 = 550\ m$

average velocity $= \frac{550}{35} = 15.7$ #

Subject Date No.

أمثلة على السقوط الحر

*** Ex: A golf ball is released from rest from the top of a very tall building. Neglecting air resistance calculate (a) the position and (b) the velocity of the ball after (1s), (2s) and (3s).

- Solution: (a)

$y_f - y_i = v_{y_i} t - \frac{1}{2} g t^2$

$y_f - 0 = 0 - \frac{1}{2} \times (9.8)(1)^2$

$y_f = \boxed{-4.90\ m}$

$y_f - y_i = v_{y_i} t - \frac{1}{2} g t^2$

$y_f = -\frac{1}{2} * (9.8) * (2)^2$

$y_f = \boxed{-19.6\ m}$

$y_f - y_i = v_{y_i} t - \frac{1}{2} g t^2$

$y_f = -\frac{1}{2}(9.8)(3)^2 = \boxed{-44.1\ m}$

(b) $v_{y_f} = v_{y_i} - gt$

$v_{y_f} = 0 - (9.8)(1)$

$v_{y_f} = \boxed{-9.8\ m/s}$

$v_{y_f} = v_{y_i} - gt$

$v_{y_f} = -9.8 * 2$

$v_{y_f} = \boxed{-19.6\ m/s}$

$v_{y_f} = v_{y_i} - gt$

$v_{y_f} = 0 - 9.8 * 3$

$v_{y_f} = \boxed{-29.4\ m/s}$

* Ex: A ball is thrown directly downward, with an initial speed of (8 m/s) from a height of (30 m). After what time interval does the ball strike the ground?

- Solution: $v_{y_i} = 8\ m/s$

$g = 9.8\ m/s^2$

$y_i = 30\ m$

$y_f = 0\ m$

$t = ??$

$y_f - y_i = v_{y_i} t - \frac{1}{2} g t^2$

$0 - 30 = 8t - \frac{9.8}{2} t^2$

$-30 = 8t - 4.9\,t^2$

$-4.9t^2 + 8t + 30 = 0$

$t = \frac{8 \pm \sqrt{64 + 588}}{-9.8} \rightarrow \boxed{t = 1.79\ s}$

نأخذ الزمن الموجب

$(b^2 - 4ac) \in$ المميز (40)

Subject Date No.

***Ex: A baseball is hit so that it travels straight upward after being struck by the bat. A fan observes that it takes (3s) for the ball to reach its maximum height find (a) its initial velocity and (b) the height it reaches.

-Solution: $t = 3s$ (a)

$v_f = 0$

$v_i = ??$

$g = 9.8\ m/s^2$

$v_f = v_i - gt$

$0 = v_i - 9.8 * 3$

$\boxed{v_{y_i} = 29.4\ m/s}$

(b)

$y_f - y_i = \frac{1}{2}(v_{y_i} + v_{y_f})t$

$y_f - y_i = \frac{1}{2}(29.4)(3)$

$= \boxed{44.1\ m}$

∴ أو باستخدام العلاقة

$\left(y_f - y_i = v_{y_i}t - \frac{1}{2}gt^2\right)$

***Ex: At NASA's John H. Glenn research center in Cleveland, Ohio, free-fall research is performed by dropping experiment packages from the top of an evacuated shaft (145m) high. Free fall imitates the so-called microgravity environment of a satellite in orbit. (a) what is the maximum time interval for free fall if an experiment package were to fall the entire 145 m? (b) Actual NASA specification allow for a (5.18s) drop time interval. How far do the packages drop and (c) what is their speed at (5.18s) (d) what constant acceleration would be required to stop an experiment pakege in the distance remaining in the shaft after its (5.18s) fall?

-Solution (a) ??? $t = ???$

$y_i = 0$

$g = 9.8\ m/s^2$

$y_f = -145$

$v_i = 0$

NOTEBOOK (41)

$y_f - y_i = v_i t - \frac{1}{2} g t^2$

$-145 = 0 - \frac{1}{2} 9.8 (t^2)$

$-145 = -4.9 t^2$

$29.5 = t^2$

$t = 5.44\,s$

- Solution (b): $t = 5.18\,s$

$y_f = ???$

$y_i = 0$

$g = 9.8$

$y_f - y_i = v_i t - \frac{1}{2} g t^2$

$y_f = -\frac{1}{2}(9.8)(5.18)^2$

$y_f = -131.5\,m$

$|y_f| = 131.5\,m$

(distance fallen)

Solution (c): $v_{y_f} = v_{y_i} - gt$

$v_{y_f} = 0 - 9.8 \times 5.18$

$v_{y_f} = -50.764$

|speed| = 50.764 m/s

- Solution (d): $a_x = ???$

Remaining distance =

$145 - 131.5 = 13.5\,m$

$v_{y_f} = 0$

$v_{y_i} = 50.8\,m/s$

$v_{x_f}^2 = v_{x_i}^2 + 2a_x(x_f - x_i)$

$0 = (-50.8)^2 + (2a_x * (0 - 13.5))$

$0 = 2580.64 - 27 a_x$

$a_x = 95.5\,m/s^2$

* Ex: An inquisitive physics student and mountain climber climbs a (50 m) cliff that overhangs a calm pool of water. He throws two stones vertically downward, (1 s) apart and observes that they cause a single splash. The first stone has an initial speed (2 m/s). (a) How long after release of the first stone do the two stones hit the water? (b) what initial velocity must the second stone have if they are to hit simultaneously? (c) what is the speed of each stone at the instant the two hit the water?

Subject Date No.

- Solution (a): $t = ???$

$v_i = 2\ m/s$

$y_f = 50\ m$

$y_i = 0$

$y_f - y_i = v_i t + \frac{1}{2} g t^2$

$50 - 0 = 2t + \frac{1}{2} \times 9.8 \times t^2$

$50 = 2t + 4.9t^2$

$2t^2 + 4.9t^2 - 50 = 0$

$\boxed{t = 3\ s}$

- Solution (b):

$t = 3 - 1 = 2\ s$

$y_f - y_f = v_i t + \frac{1}{2} a_x t^2$

$50 = v_i * 2 + \frac{1}{2} \times 9.8 * 4^2$

$50 = 2v_i + 19.6$

$\boxed{v_{i_2} = 15.2\ m/s}$

- Solution (c):

$v_{i_1} \Rightarrow v_f = v_i + a_x t$

$v_f = 2 + (9.8 * 3)$

$v_f = 2 + 29.4$

$\boxed{v_f = 31.4\ m/s}$

$v_{i_2} \Rightarrow v_f = v_i + a_x t$

$= 15.2 + (9.8 * 2)$

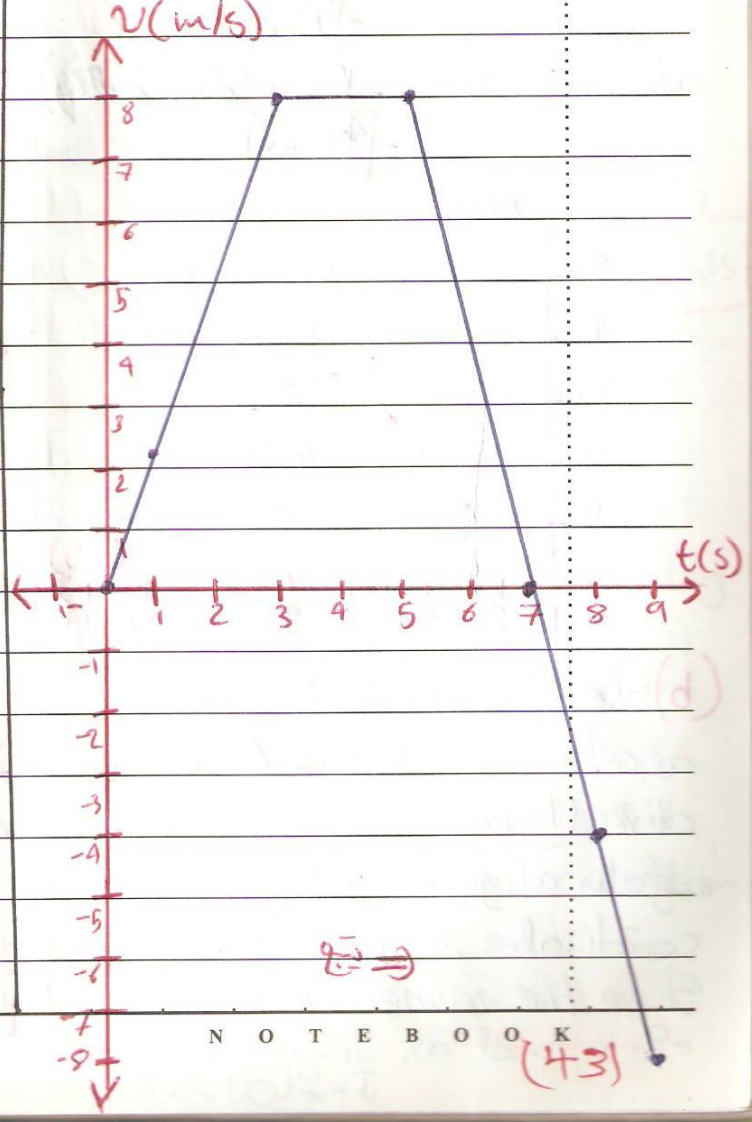
$= \boxed{34.8\ m/s}$

(position - time graph)

(velocity - time)

(velocity - time)

Ex 30



NOTEBOOK

(43)

Subject Date No.

(a) Directly above your graph sketch a graph of the position versus time, aligning the time coordinates of the two graphs.

- Solution:

at $t=3 \rightarrow x_1 = \frac{1}{2} \times 3 \times 8$

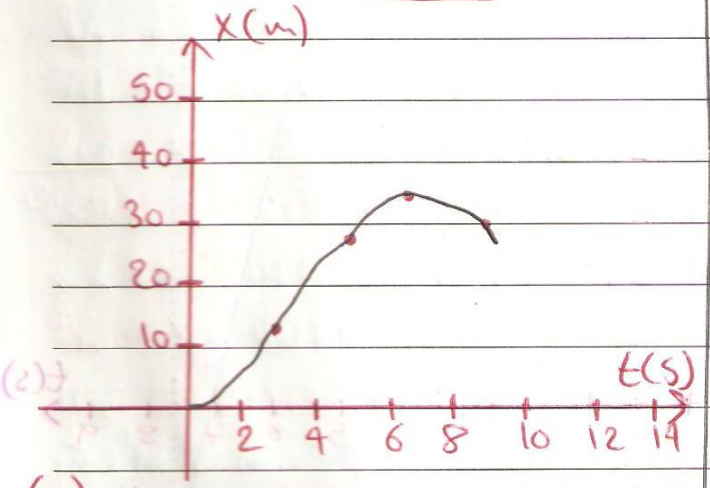
$= 12\ m$

at $t=5 \rightarrow x_2 = 12 + (2 \times 8)$

$= 28\ m$

at $t=7 \rightarrow x_3 = 28 + (\frac{1}{2} \times 2 \times 8)$

$= 36\ m$



(b) Sketch a graph of the acceleration versus time directly below the x-t graph again aligning the time coordinates. On each graph, show the numerical values of x and ax for all point of Inflection?

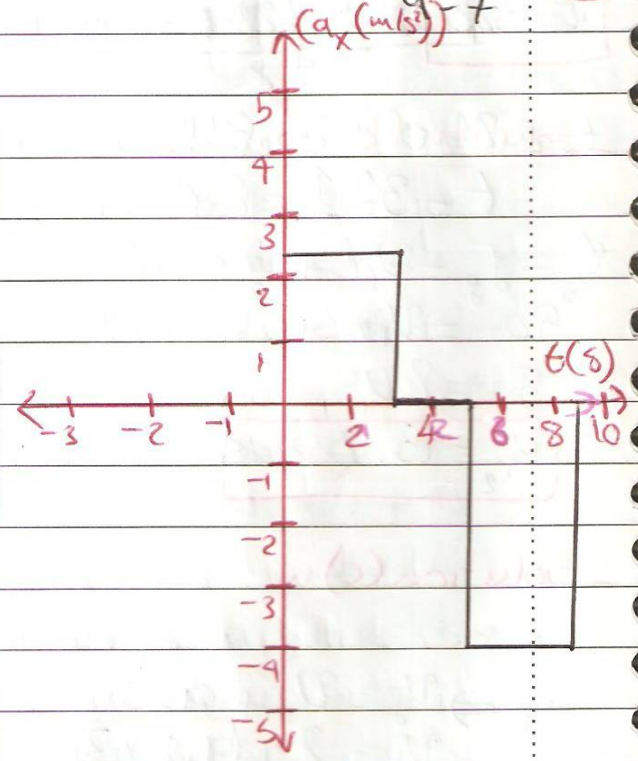
- Solution:

at $0<t<3 \rightarrow a = \frac{8}{3} = 2.67$

at $3<t<5 \rightarrow a = 0$

at $5<t<7 \rightarrow a = \frac{8-0}{5-7} = -4$

at $7<t<9 \rightarrow a = \frac{-8-0}{9-7} = -4$



(c) what is the acceleration at $t=6$?? $a_x = -4\ m/s^2$

$\left(\frac{8-8}{5-9}\right) = \frac{\Delta x}{\Delta t}$ ميل المماس

(d) Find the position at $t=6s$?

$x = 34\ m$ ← المسافة عن الصفر

يمكن الإجابة من خلال ① في الرسم $(v_x - t)$ ...

Subject - Date No.

e) what is the moped's final position at $t=9$?

$x = 28\,m \Rightarrow 36 + (\frac{1}{2} \times -8 \times 2)$

(at $t=9$ s) (at $t=2$ s)

(distance is a function of time $\rightarrow x = f(t)$)

$v_x - t$

*** Ex 8 *** A partical that is moving along a straight line decelerates uniformly from (40 cm/s) to (20 cm/s) in (5 s) and then has a constant acceleration of ($20\,cm/s^2$) during the next (4.0 s). The average speed over the whole time interval is:

a) 57 cm/s b) 40 cm/s

c) 86 cm/s d) 43 cm/s

e) 97 cm/s

- Solution: average speed $= \frac{\Delta x}{\Delta t}$

* $v_1 = 40\,cm/s$

$v_2 = 20\,cm/s$

$t = 5\,s$

$v_{x_2} = v_{x_1} + a_x t$

$a_x = \frac{20 - 40}{5} = -4\,cm/s^2$

$x_f - x_i = v_{x_i} t + \frac{1}{2} a_x t^2$

$x_f - x_i = (40 \times 5) + (\frac{1}{2} \times -4 \times 25)$

$= 150\,cm$

* $v_i = 20\,m/s$

$a_x = 20\,cm/s^2$

$t = 4\,s$

$x_f - x_i = v_{i_x} t + \frac{1}{2} a_x t^2$

$= (20 \times 4) + (\frac{1}{2} \times 20 \times 16)$

$= 240\,cm$

average Speed $= \frac{\Delta x}{\Delta t} = \frac{x_1 + x_2}{t_1 + t_2}$

$= \frac{240 + 150}{4 + 5} = 43.3\,cm/s$

* Ex 8 * a partical has an intail velocity of (4.8 m/s) toward the South and a final velocity of (7.1 m/s) toward the east. The particle was subject to a constant acceleration for (0.25 s). The magnitude and the direction of the acceleration must have been:

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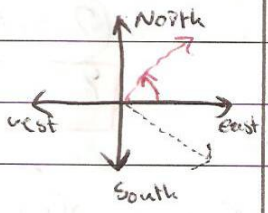
a) $8.6\ m/s^2$ at 37.1 north of east
b) $260\ m/s^2$ at 37.1 north of east
c) $37\ m/s^2$ at 37.1 north of east
d) $37\ m/s^2$ at 37.1 south of east
e) $8.6\ m/s^2$ at 37.1 south of east

- Solution: $v_i = 4.8\ m/s$ South ↓

$v_f = 7.1\ m/s \rightarrow$ east

$t = 0.25\ s$

$a_x = ???$



$v_{x_f} = v_{x_i} + a_x t$

$7.1 = 4.8 + a_x * 0.25$

$\frac{2.3}{0.25} = a_x \Rightarrow a_x = 9.2 \approx 8.6$

* Ex 8: A particle moves from $X_1 = -50\ cm$ to $X_2 = 30\ cm$. The displacement of this particle is:

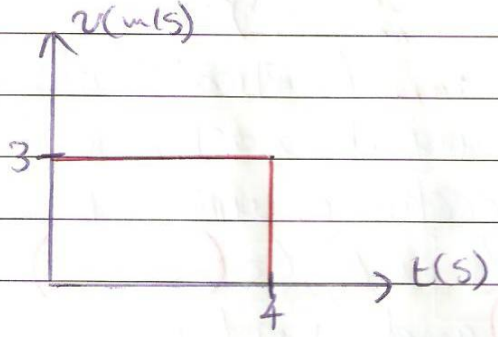
a) $-5\ cm$ c) $80\ cm$
b) $30\ cm$ d) $-30\ cm$
e) $-80\ cm$

- Solution: $d = X_f - X_i$

$d = 30 - -50$

$d = 80\ cm$

* Ex 9: The velocity-Time graph for a particle is given by the following figure find the acceleration?



- Solution: $a_x = ???$

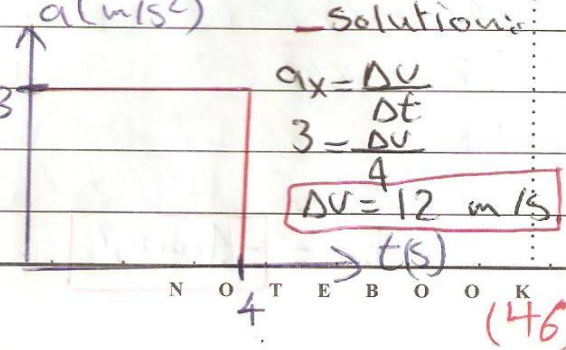
$a_x = \frac{\Delta v}{\Delta t} = \frac{3-0}{4-0} = 0.75\ m/s^2$

(or) $v_{x_f} = v_{x_i} + a_x t$

$3 = 0 + (a_x * 4)$

$0.75 = \frac{3}{4} = a_x$ //

* Ex 10: The acceleration-Time graph for a particle is given by the following figure find the velocity?



- Solutions:

$a_x = \frac{\Delta v}{\Delta t}$

$3 = \frac{\Delta v}{4}$

$\Delta v = 12\ m/s$

Subject Date No.

*Ex: A train starts from rest (at position zero) and moves with constant acceleration. On first observation the velocity is (20 m/s) and (80s) later the velocity is (60 m/s). At 80s, calculate the position and average velocity, and the constant acceleration over the interval?

- Solution: $v_f = v_i + a_x t$

$60 = 20 + a_x * 80$

$\frac{40}{80} = a_x$

$a_x = 0.5\ m/s^2$

$x_f - x_i = \frac{1}{2}(v_{x_i} + v_{x_f})t$

$= \frac{1}{2}(20+60) * 80$

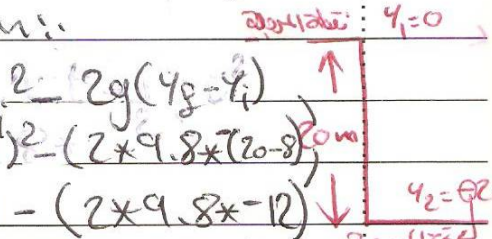
$= 3200\ m$

average velocity $= \frac{20+60}{2}$

$= 40\ m/s$

*Ex: A stone is thrown vertically upward with a velocity of 8 m/s from the top of a building that is (20 m high). Find the speed of the stone when it is (8 m) above the ground?

- Solution:



$v_{y_f}^2 = v_{y_i}^2 - 2g(y_f - y_i)$

$v_{y_f}^2 = (8)^2 - (2 * 9.8 * (20-8))$

$v_{y_f}^2 = 64 - (2 * 9.8 * -12)$

$v_{y_f}^2 = 64 - (-235.2)$

$v_{y_f}^2 = 299.2$

$v_{y_f} = 17.3\ m/s$

*Ex: A ball is thrown directly downward with an initial velocity of (8 m/s) from a height (25 m) find the time it take to strike the ground?

- Solution: $x_f - x_i = v_{x_i} t - \frac{1}{2} g t^2$

$25 = -8 * t - \frac{1}{2} * 9.8 * t^2$

$25 = -8t - 4.9 t^2$

$4.9t^2 + 8t + 25 = 0$

$\Rightarrow t = 3.95$

(3)

8 MARCH
THURSDAY

آذار
الخميس

15 Rabia II 1433 H

68 - 298

١٥ ربيع الثاني ١٤٣٣ هـ

Ex: The relationship between the velocity of abody moving along x-axis and time is given by :

$(v = 3t^2 - 2t)$

where the units ar SI units. Find the total distance the body travels between the times $t=2$ and $t=4$???

⇒ Solution: $v = \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$

$dx = v.dt$

$\int dx = \int v.dt$

$x = \int 3t^2 - 2t . dt$

$x = t^3 - t^2$

$x(4) = (4)^3 - (4)^2 = 48$

$x(2) = (2)^3 - (2)^2 = 4$

*total distance $= 48 - 4 = \boxed{44\ m}$ //

(48)

MARCH 2012

SAT		3	10	17	24	31
SUN		4	11	18	25	
MON		5	12	19	26	
TUE		6	13	20	27	
WED		7	14	21	28	
THU	1	8	15	22	29	
FRI	2	9	16	23	30	

WEEK 10

ملاحظات :

(49)

Ex In (2S) a particle moving with constant acceleration along x-axis goes from (X=10m) to (X=50m). The time interval (10m/s). Find the acceleration of the particle?

- Solution:, $t = 2s$

$x_f = x_2 = 50m$

$x_i = x_1 = 10m$

$v_{x_f} = 10 m/s$

$v_{x_i} = ???$

$a_x = ???$

$* v_{x_f} = v_{x_i} + a_x t$

$v_{x_i} = 10 - 2a_x$

$* x_f - x_i = v_{x_i} t + \frac{1}{2} a_x t^2$

$50 - 10 = (10 - 2a_x) * 2 + (\frac{1}{2} * a_x * 4)$

$40 = 20 - 4a_x + 2a_x$

$40 = 20 - 2a_x$

$2a_x = -20 \Rightarrow a_x = \boxed{-10 \ m/s^2}$

13 MARCH TUESDAY — آذار الثلاثاء

20 Rabia II 1433 H — ٢٠ ربيع الثاني ١٤٣٣ هـ

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Ex A particle moving along the X-axis has a position given by $(X = 24t - 2t^3)$ m, where t is measured in s, what is the magnitude of the acceleration at time t = 2 s?

⟹ Solution: $a_x = \frac{\Delta V_x}{\Delta t}$

$\Delta V_x = \frac{dx}{dt} = 24 - 6t^2$

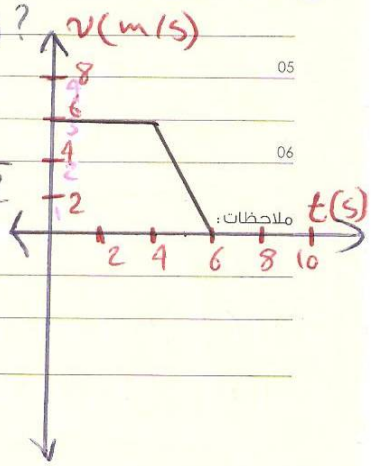
$= 24 - (6 * 4)$

$= 24 - 24 = 0$

$a_x = \frac{\Delta V_x}{\Delta t} = \frac{0}{\Delta t} = 0 \ m/s^2$ ⟹ Zero

Ex Find the acceleration of the particle at (t = 5 s)?

- Solution:



$a_x = \text{Slope} = \frac{6 - 0}{4 - 6} = \frac{6}{-2}$

$a_x = -3 \ m/s^2$

≠

(50)

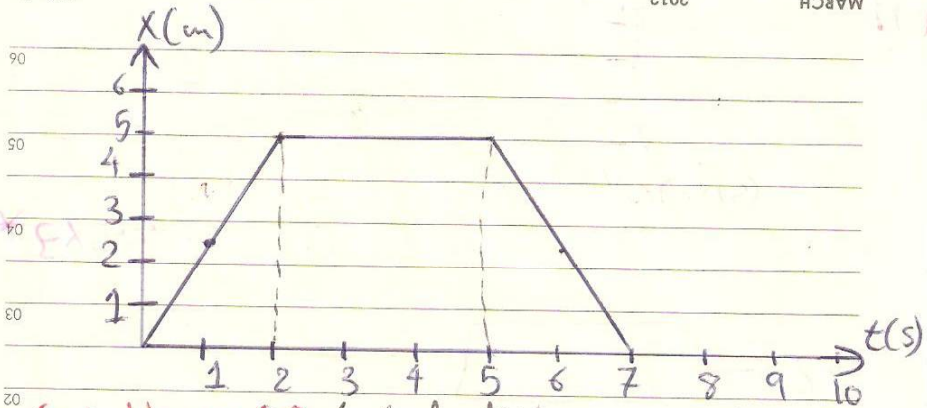
MARCH 2012

SAT		3	10	17	24	31
SUN		4	11	18	25	
MON		5	12	19	26	
TUE		6	13	20	27	
WED		7	14	21	28	
THU	1	8	15	22	29	
FRI	2	9	16	23	30	

WEEK 11

(51)

Ex Find (a) total distance travelled between t=0,s and t=7s (b) The displacement between t=0 and t=6?



- Solution: (a) total distance $= X_1 + X_2 + X_3$

$X_1 \approx 6$ m

$X_2 = 3$ m

$X_3 \approx 6$ m

total distance = 13 m

- Solution (b): zero

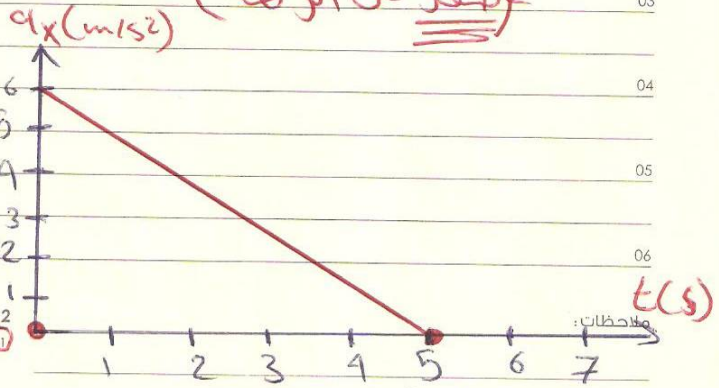
Ex At ($t=0$), a particle is located at ($X=25\,m$), and has a velocity of ($15\,m/s$) in the positive x direction. The acceleration of the particle varies with time as shown in the diagram. What is the velocity of the particle at ($t=5.0\,s$)?

- Solution: $v_f = v_i + a_x t$

$v_f = 15 + (5 * 0)$

$v_f = \boxed{15\ m/s}$

(صفر من الرسمة)



$a_x = 0$ ← ثانية $t = 5$ عند

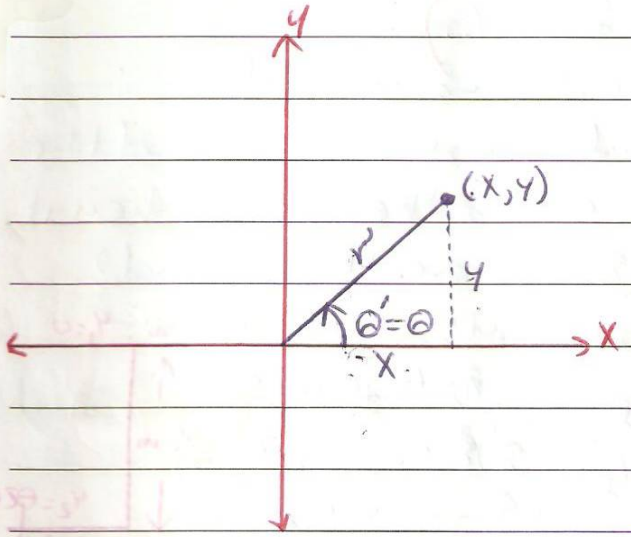
Subject *chapter (3) Go to index *محاضرة ①*

Date *3-10-2012* No.

vectors المتجهات

***polar coordinate (r, θ) الإحداثيات القطبية أو الزاوية

***cartesian coordinate (x, y) الإحداثيات الديكارتية أو المتعامدة



* مثلاً r يعبر عن طول الخط و θ الزاوية المحصورة بين r ومحور السينات الموجب...

*polar ← تحويل → cartesian

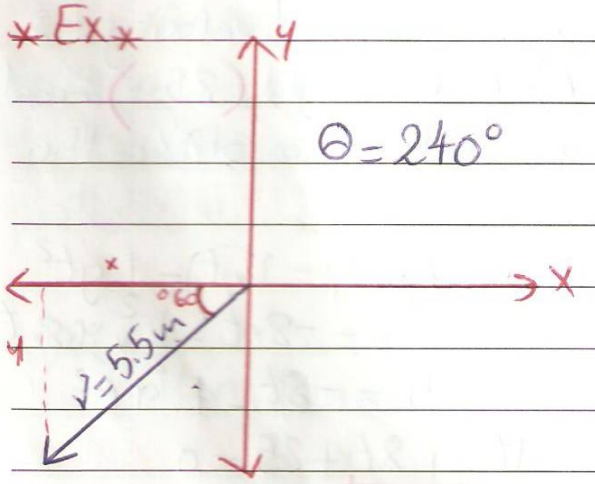
(r, θ) → (x, y)

$\sin\theta = \frac{y}{r} \Rightarrow y = r\sin\theta \Rightarrow y = r\cos\theta$

$\cos\theta = \frac{x}{r} \Rightarrow x = r\cos\theta \Rightarrow x = r\sin\theta$

(الزاوية بخطها من ... لـ)

Ex



Solution: (240 - 180)

$x = r\cos\theta = 5.5\cos 60^\circ$ (θ في الربع الثالث اذن)

$= -2.75$

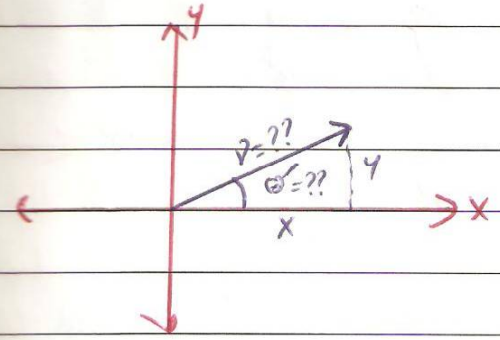
$y = r\sin\theta = 5.5\sin 60^\circ$ (θ في الربع الثالث اذن)

$= -4.4$

$(5.5m, 240^\circ) \rightarrow (-2.75, -4.4)$

*** $(x,y) \longrightarrow (r,\theta)$ ***

* حالة (1) × في الربع الأول ...



$\Rightarrow r = \sqrt{y^2 + x^2}$

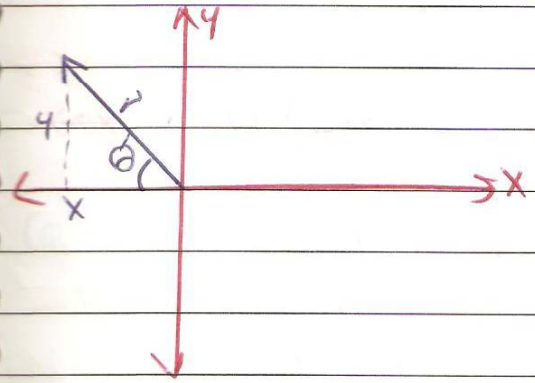
$\Rightarrow \tan\theta = \frac{y}{x}$

$\Rightarrow \theta = \theta' = \tan^{-1}\left(\left|\frac{y}{x}\right|\right)$

from ^+x-axis

above ^+x-axis

* حالة (2) × في الربع الثاني ...



$\Rightarrow r = \sqrt{y^2 + x^2}$

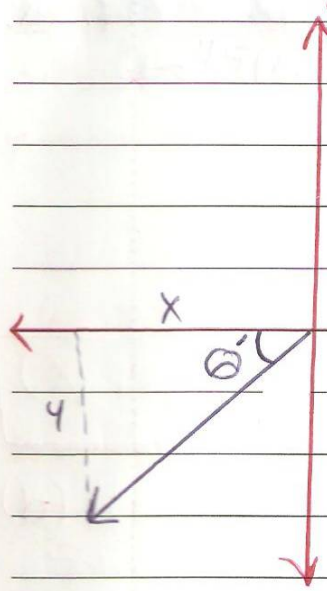
$\Rightarrow \tan\theta = \frac{y}{x}$

$\Rightarrow \theta' = \tan^{-1}\left(\left|\frac{y}{x}\right|\right)$

above ^-x-axis

$\Rightarrow \theta = 180 - \theta'$

from ^+x-axis



حالة (٣) في الربع الثالث...

$$\Rightarrow r = \sqrt{y^2 + x^2}$$

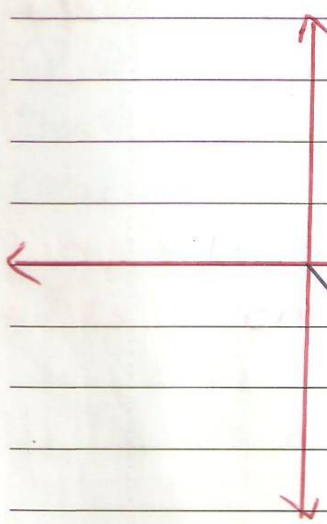
$$\Rightarrow \tan\theta' = \frac{y}{x}$$

$$\Rightarrow \theta' = \tan^{-1}\left(\left|\frac{y}{x}\right|\right)$$

above -x-axis

$$\Rightarrow \theta = 180 + \theta'$$

from +x-axis



حالة (٤) في الربع الرابع...

$$\Rightarrow r = \sqrt{y^2 + x^2}$$

$$\Rightarrow \tan\theta = \frac{y}{x}$$

$$\Rightarrow \theta' = \tan^{-1}\left(\left|\frac{y}{x}\right|\right)$$

above -x-axis

$$\Rightarrow \theta = 360 - \theta'$$

from +x-axis

Subject Date No.

*** Ex ***: The polar coordinates of a point are ($r = 5.50$ m) and $\theta = 240°$. What are the cartesian coordinates of this point?

→ Solution:: $X = r\cos\theta = 5.50 * \cos 60$

$= -2.75$ m

$y = r\sin\theta = 5.50 * \sin 60°$

$= -4.76$

$(-2.75, -4.76)$

دائماً الزاوية هتستخدمها
لازم تكون في الربع الأول
مع مراعاة الزاوية
الأصلية في الربع
مع الأخذ في الإشارة
اكتب واكتب وذكر
في الربع اللي تواجد
فيه الزاوية المراد حساب
الإحداثيات لها...

*** Ex ***: Two points in a plane have polar coordinate (2.50 m, $30.0°$) and (3.80 m, $120.0°$). Determine::

(a) the cartesian coordinates of these points?

- Solution:: $(x_1, y_1) \Rightarrow x_1 = r\cos\theta$

$= 2.50 * \cos 30°$

$= 2.50 * 0.8$

$= 2.16$ m

$y_1 = r\sin\theta$

$= 2.50 * \sin 30°$

$= 1.25$ m

$\Rightarrow \boxed{(x_1, y_1)} \rightarrow (2.16, 1.25)$

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$(x_2, y_2) \Rightarrow x_2 = r\cos\theta$

$= 3.80 * \cos 60^\circ$

$= -1.90\ m$

$y_2 = r\sin\theta$

$= 3.80 * \sin 60^\circ$

$= 3.29$

$(x_2, y_2) \Rightarrow (-1.90, 3.29)$

(b) the distance between them?

Solution: $(-1.90, 3.29)$

$(2.16, 1.25)$

$d = \sqrt{(\Delta x)^2 + (\Delta y)^2}$

$= \sqrt{(4.06)^2 + (-2.04)^2}$

$= \sqrt{16.48 + 4.1616}$

$= \sqrt{20.6416} = 4.54\ m$ #

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xxx Scalar Quantites (كميات قياسية)
such as: (your age, speed, Mass).
xxx vectors quantites (كميات متجهة)
such as: (Acceleration, velocity).

المتجه له قيمة مطلقة دائما "$\vec{A}$" له ذيل (tail) وله رأس (Head) اذا كان داخل الصفحة يرمز له برمز ⊗ واذا كان خارج من الصفحة يرمز له ⊙

(خصائص المتجهات)

xxx Some properties of vectors xxx

1) Equality of two vectors ... (المساواة بين المتجهات)
- متساوي المتجهين اذا كان لهما نفس المقدار والاتجاه أو اذا كان ينقل متجه معين اي مكان اخر دون تغيير مقداره واتجاهه فإن هذا المتجه في المكان الاول يساوي المتجه في المكان الثاني.

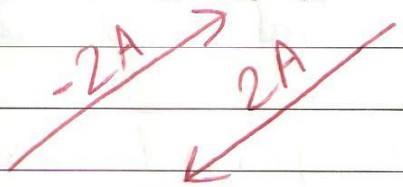
2) Adding vectors ... (جمع المتجهات)
- نقوم برسم اي متجه في نفس المقدار ونفس الاتجاه ومن ثم نرسم المتجه الثاني بحيث يكون ذيل الثاني على رأس الاول ثم نصل بين ذيل الاول ورأس الثاني فيكون هذا الخط هو ناتج المتجهين.. وينتج خاصية تبديلية (Commutative law) وخاصية التوزيع (Associative law)...

3) Subtracting vectors ... (طرح المتجهات)
- حيث انه القيمة السالبة للمتجه تعني المعاكسة في الاتجاه أي انه $A = -A$ مقداراً ويكون معاكس الاتجاه فعملية الطرح نفس عملية الجمع ولكن الاتجاه يختلف فإن $A + -B = A - B$ اي انه B معاكس في الاتجاه ثم نجمع..

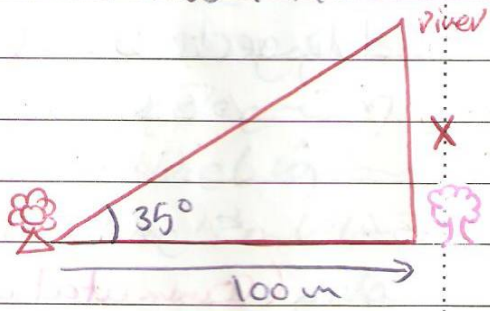
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4) (مزيد الاتجاه في مستوى)

- لو مزيد الاتجاه في مستوى موجبة غير صفر من الاختار فقط ولكن لو نقص الإزاحة وإذا مزيد الاتجاه في مستوى سالبة غير صفر من الاختار والإزاحة ...



***Ex A surveyor (مساح) measures (امتار) the distance across a straight river by the following (متابعة) method (الطريقة): Starting directly across from (من) a tree on the opposite (نقيض) bank, she walk 100 m along the riverbanks to establish a baseline. Then she sights across to the tree. The angle from her baseline to the tree 35°. How wide (عرض) is the river?



⇒ Solution: $\tan 35^\circ = \frac{X}{100}$

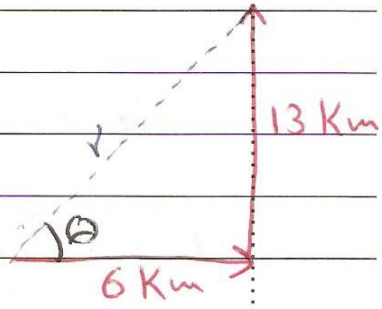
$X = 100 * \tan 35^\circ$

$\boxed{X = 70.0 \text{ m}}$

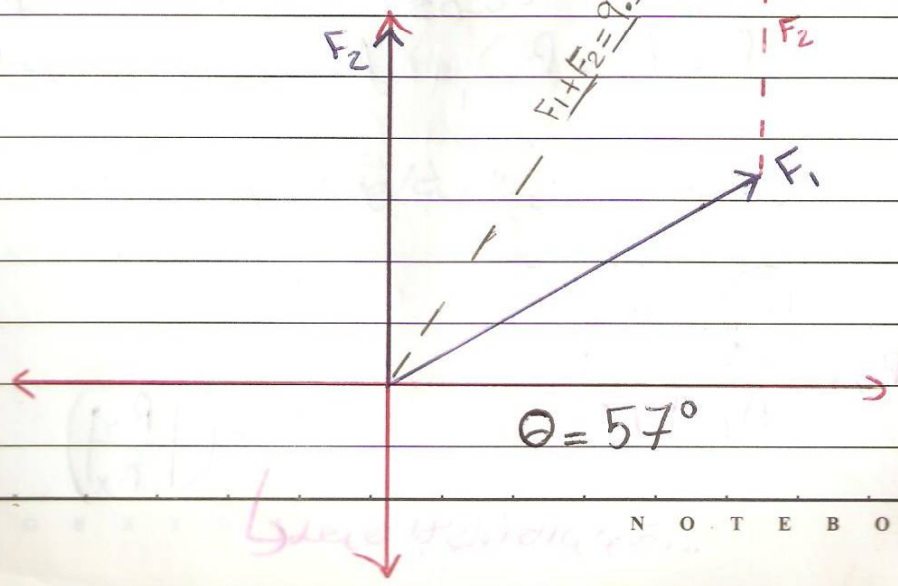
*** Ex: A pedestrain moves 6.00 Km east and then 13.0 Km north. find the magnitude and direction of the resultant displacement vectors using the graphical method.

- Solution:: $R = \sqrt{(6)^2 + (13)^2} = 14$ Km

$\theta \Rightarrow \tan^{-1}\left(\left|\frac{13}{6}\right|\right) = 65°$



*** Ex: A force F_1 of a magnitude 6.00 units acts at the origin in a direction 30° above he positive x axis. A second force F_2 of magnitude 5.00 units acts at the origin in he direction of the positive y axis. find graphically the magnitude and direction of he resultant force $F_1 + F_2$?



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(متجه الوحدة)

***Unit vectors ***

متجه الوحدة مقداره (1)..

يرمز لمتجه الوحدة باتجاه محور X بالرمز $\hat{i}$ ويرمز لمتجه الوحدة باتجاه Y بالرمز $\hat{j}$ ويرمز لمتجه الوحدة باتجاه محور Z بالرمز $\hat{k}$..

المتجه عبارة عن مجموع مركباته مثلاً المتجه A:

$$A = A_x\hat{i} + A_y\hat{j}$$

اذا كان هناك ثلاث مركبات فإن قيمة المتجه A:

$$A = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

واذا كانت مركبة المتجه (أو أحد المحاور السالبة نضع علامة السالب مثلاً:

$(A = 3\hat{i} - 6\hat{j})$

المتجه A له مركبة سينية (على محور X+ مقداره 3 وحدات

المتجه A له مركبة صادية (على محور Y- مقداره 6 وحدات..

حساب محصلة المتجهات

نقوم بجمع معاملات متجهات الوحدة المتشابهة مع بعضهم، يعني نجمع السينية مع بعضها (X)(i) والصادية مع بعض (Y)(j) والزينية مع بعض (Z)(K) فتكون المحصلة:

$$R = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j} + (A_z + B_z)\hat{k}$$

مقدار المحصلة هو الجذر التربيعي لمجموع كل مركبة مربعة بعيني:

$$R = \sqrt{R_x^2 + R_y^2}$$

$A_x + B_x$ ، $A_y + B_y$

$$\tan^{-1} = \left(\left|\frac{R_y}{R_x}\right|\right)$$

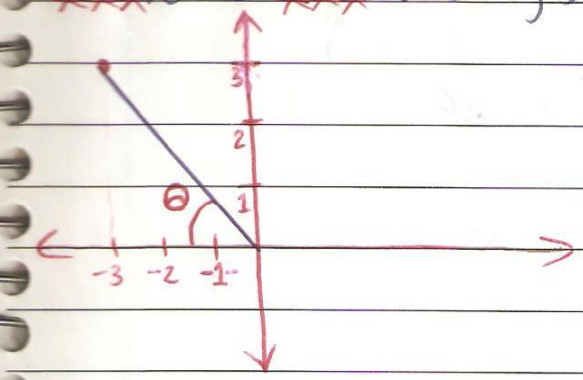
لمعرفة اتجاه أو الزاوية..

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Ex (-3m, 3m) Find (r, θ)



— Solution:

$r = \sqrt{(-3)^2 + (3)^2} = \sqrt{18} = 4.2\,m$

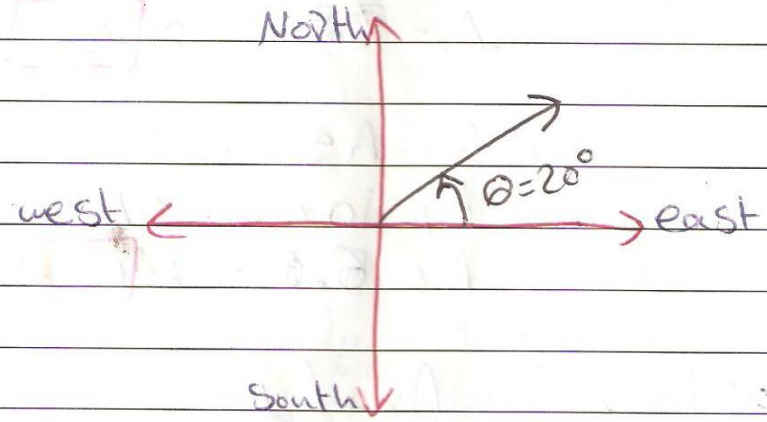
$\tan^{-1}\left(\left|\frac{-3}{3}\right|\right) = \tan^{-1}(1) = 45°$

above ⊖ x-axis

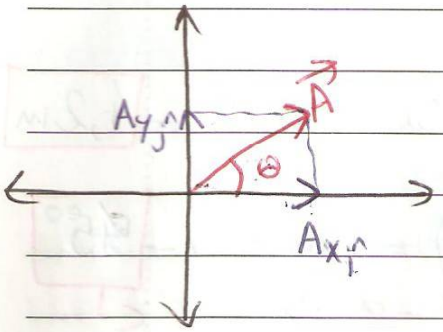
$\theta = 180 - 45 = 135°$

from ⊕ x-axis

θ = 20° North of east



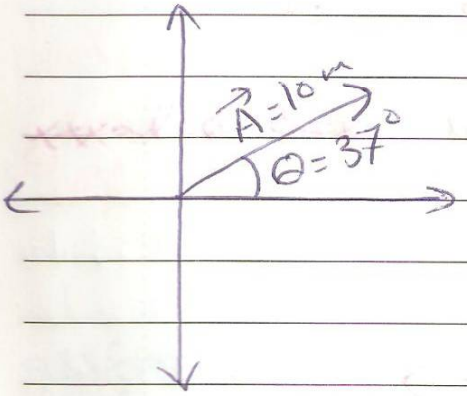
*** Components vectors ***



$$\Rightarrow A_{x\hat{i}} = A\cos\theta$$

$$A_{y\hat{j}} = A\sin\theta$$

*** Exso find the components vectors A ???



* Solution:

$A_x = A\cos\theta$

$A_x = 10 * \cos 37$

$A_x = 7.98\ m \approx \boxed{8\ m}$

$A_y = A\sin\theta$

$A_y = 10 * \sin 37$

$A_y = 6.0\ m \approx \boxed{6\ m}$

vectors: $\vec{A} = A_x + A_y$

$\vec{A} = 8\hat{i} + 6\hat{j}$

above ⊕ x-axis

from ⊕ y-axis

*** قوانين الإشعاع ***

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$$

1) $\vec{A}+\vec{B} = (A_x\hat{i}+B_x\hat{i}) + (A_y\hat{j}+B_y\hat{j}) + (A_z\hat{k}+B_z\hat{k})$

2) $\vec{A}-\vec{B} = (A_x\hat{i}-B_x\hat{i}) + (A_y\hat{j}-B_y\hat{j}) + (A_z\hat{k}-B_z\hat{k})$

3) $a\vec{A} = aA_x\hat{i} + aA_y\hat{j} + aA_z\hat{k}$ (a ثابت)

*** Ex (مثال توضيحي) *** (إيجاد محصلة $\vec{A}+\vec{B}$)

$\vec{A} = (4\hat{i} - 2\hat{j})$ m

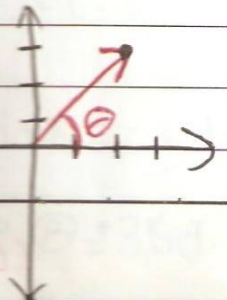
$\vec{B} = (-2\hat{i} + 5\hat{j})$ m

Find the magnitude (مقدار) and direction (اتجاه) the following cases? - Solution:

magnitude $\Rightarrow (\vec{A}+\vec{B})_x\hat{i} = 4-2 = 2$ m

$(\vec{A}+\vec{B})_y\hat{j} = -2+5 = 3$ m $\Rightarrow (2,3)$ الإحداثيات

$|\vec{A}+\vec{B}| = \sqrt{(2)^2+(3)^2} = \sqrt{13} = 3.6$ m



direction $\Rightarrow \tan^{-1}\left(\frac{3}{2}\right) = 56.3^{\circ}$

***Ex (الحالة الثانية) *** (ايجاد قيمة $\vec{a}$)

$$\vec{A} = (4\hat{i}_x - 2\hat{j}_y)\,m$$

$$\vec{B} = (-2\hat{i}_x + 5\hat{j}_y)\,m$$

Find the magnitude and direction the following cases? _ Solution:

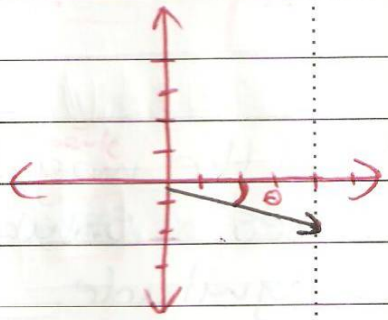
magnitude $\Rightarrow A\hat{i}_x = 4\ m$ (المركبة) $\Rightarrow (4, -2)$

$A\hat{j}_y = -2\ m$

$$\vec{A} = \sqrt{(4)^2 + (-2)^2} = \sqrt{20} = 4.4721\ m$$

direction $\Rightarrow \theta' = \tan^{-1}\left(\frac{2}{4}\right)$

$= 26.5°$



$\theta = 360 - 26.5 = 333,5°$

*** Ex: (الحالة الاولى) *** ($\vec{A}-\vec{B}$ ايجاد قيمة)

$\vec{A} = (4\hat{i}_x - 2\hat{j}_y)\,m$

$\vec{B} = (-2\hat{i}_x + 5\hat{j}_y)\,m$

Find the magnitude and direction the following cases?

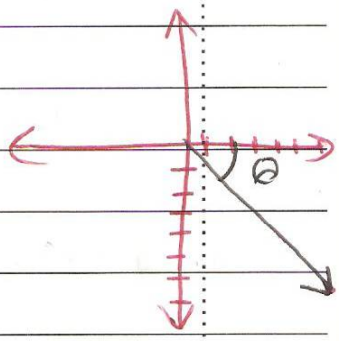
* Solution:: magnitude $\Rightarrow (A-B)\hat{i}_x = 4-(-2) = 6\,m$

$(A-B)\hat{j}_y = -2-5 = -7\,m$

الاتجاه $\Rightarrow (6,-7)$

$(\vec{A}-\vec{B}) = \sqrt{(-7)^2+(6)^2}$

$= \sqrt{85} = 9.2\,m$



direction $\Rightarrow \theta' = \tan^{-1}\left(\frac{-7}{6}\right) = -49.38$

$\theta' = 360 - 49.38 = 280.6$ from $+x$-axis

above $-x$-axis

*** Ex: (الحالة الثانية) *** ($3\vec{A}$ ايجاد قيمة)

$\vec{A} = 4\hat{i}_x - 2\hat{j}_y$

$\vec{B} = -2\hat{i}_x + 5\hat{j}_y$

Find the magnitude and direction the following cases?

* Solution:: magnitude $\Rightarrow 3\vec{A}\hat{i}_x = 3*4 = 12\,m$

$3\vec{A}\hat{j}_y = 3*-2 = -6\,m$

$\sqrt{(12)^2+(-6)^2} = \sqrt{180} = \boxed{13.41\,m}$

direction $\Rightarrow \tan^{-1}\left(\frac{-6}{12}\right) = -26.5$

$\theta = 360 - 26.5 = 333.5$

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***Ex (مثال محلول) (-5B يعني عكس اتجاه B)

$\vec{A} = (4\hat{i}_x - 2\hat{j}_y)\,m$

$\vec{B} = (-2\hat{i}_x + 5\hat{j}_y)\,m$

Find the magnitude and direction the following cases?

- Solution:: magnitude $\rightarrow -5B$ ::

$B\hat{i}_x = -5 * -2 = 10\,m$

$B\hat{j}_y = -5 * 5 = -25\,m$

$\sqrt{(10)^2 + (-25)^2} = \sqrt{725} = 26.925\,m$

$\theta' = \tan^{-1}\left(\frac{-25}{10}\right) = -68.19859 + 180 = 111.8014095^\circ$

(-5B في الربع الثاني)

$\theta = 360 - 68.19859 = 291.8014095 + 180 = 471.8014095^\circ$

(-5B في الربع الثاني)

Ex $\vec{A} = 2\hat{i}_x + 3\hat{j}_y$

$\vec{B} = -\hat{i}_x + \hat{j}_y + 3\hat{k}_z$

Find: (a) $\vec{A}.\vec{B}$ (b) Find θ???

- Solution:: $(A.B)_x = -2$

$(A.B)_y = 3$

$(A.B)_z = 0$

$(A.B)_x + (A.B)_y + (A.B)_z = 1$

- Solution::

$A = \sqrt{x^2 + y^2} = \sqrt{(2)^2 + (3)^2}$

$B = \sqrt{(-1)^2 + (1)^2 + (3)^2}$

$A.B = AB\cos\theta$

$1 = \sqrt{13} * \sqrt{11} * \cos\theta$

$\cos\theta = 0.085 \Rightarrow \theta = 85.1^\circ$

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*** Ex 8 *** $\vec{A} = -8.7\,\hat{i}_x + 15\,\hat{j}_y$

$\vec{B} = 13.2\,\hat{i}_x - 6.6\,\hat{j}_y$

find the vectors $\vec{C}$ if $\vec{A} - \vec{B} + 3\vec{C} = 0$?

*Solution :: $3\vec{C} = \vec{B} - \vec{A}$

$$\vec{C} = \frac{\vec{B} - \vec{A}}{3}$$

$\vec{B} - \vec{A} \Rightarrow (B-A)\,\hat{i}_x = 13.2 - -8.7 = 21.9$

$(B-A)\,\hat{j}_y = -6.6 - 15 = -21.6$

$(B-A)\,\hat{i}_x + (B-A)\,\hat{j}_y = 21.9 + -21.6 = 0.3$

$\vec{C} = \frac{\vec{B} - \vec{A}}{3} = \frac{0.3}{3} = 0.1$ #

*** Ex *** $\vec{A} = 6\hat{i}_x - 8\hat{j}_y$

$\vec{B} = -8\hat{i}_x + 3\hat{j}_y$

$\vec{C} = 26\hat{i}_x + 19\hat{j}_y$

$a\vec{A} + b\vec{B} + \vec{C} = 0$, find a and b?

* Solution:

$a\vec{A} = a6\hat{i}_x - a8\hat{j}_y \rightarrow (1)$

$b\vec{B} = -b8\hat{i}_x + 3b\hat{j}_y \rightarrow (2)$

$\vec{C} = 26\hat{i}_x + 19\hat{j}_y \rightarrow (3)$

$(a6\hat{i}_x - b8\hat{i}_x + 26\hat{i}_x) + (-a8\hat{j}_y + 3b\hat{j}_y + 19\hat{j}_y) = 0$

$8/\; a6\hat{i}_x - b8\hat{i}_x + 26\hat{i}_x = 0$

$6/\; -a8\hat{j}_y + 3b\hat{j}_y + 19\hat{j}_y = 0$

$48a - 64b + 208 = 0$

$+ \quad -48a + 18b + 114 = 0$

$-46b = -322$

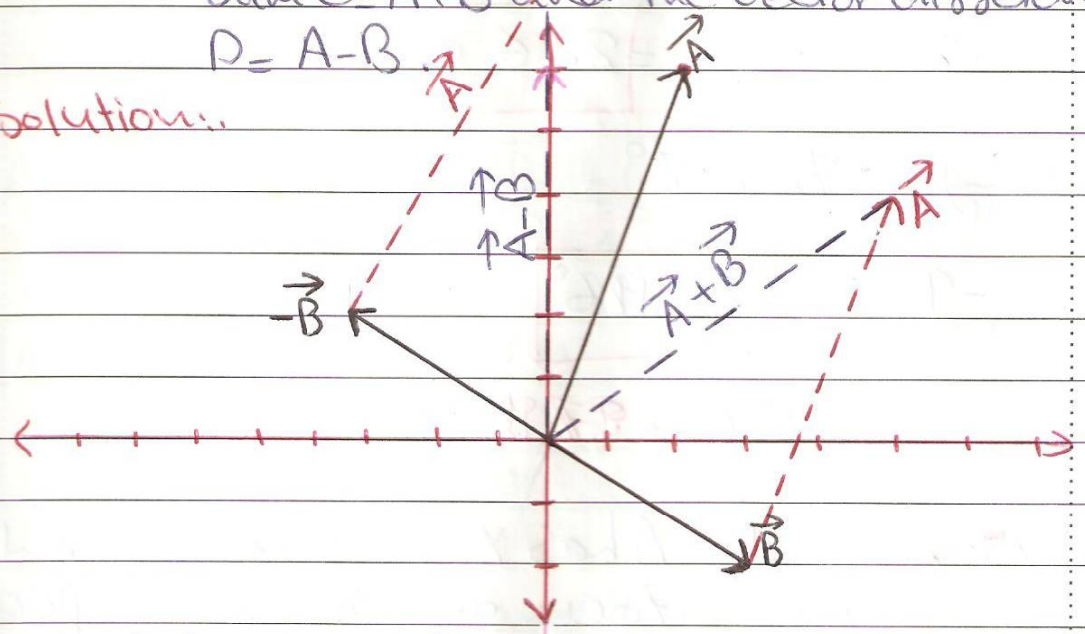
$b = 7$ → $a6 - 7*8 + 26 = 0$

$a6 - 56 + 26 = 0$

$a = 5$

Ex Given the vectors $A = 2\hat{i}_x + 6\hat{j}_y$ and $B = 3\hat{i}_x - 2\hat{j}_y$, (a) Draw the vectors Sum $C = A + B$ and the vector difference $D = A - B$

- Solution..



(b) calculate C and D, first in terms of unit vectors and then in terms of polar coordinates, with angles measured with respect to the +x-axis?

- Solution.. $C = \vec{A} + \vec{B}$

$(A+B)_x = 2 + 3 = 5\ m$

$(A+B)_y = 6 + (-2) = 4\ m \Rightarrow (5,4) \Rightarrow (5\hat{i}_x + 4\hat{j}_y)$

$\sqrt{(5)^2 + (4)^2} = \sqrt{41} = \boxed{6.403\ m}$

$\tan^{-1}\left(\frac{4}{5}\right) = \boxed{38.65^\circ}$

$(6.40, 38.65^\circ)$

$\vec{D} = \vec{A} - \vec{B} \Rightarrow (A-B)_x = 2 - 3 = -1\ m$

$(A-B)_y = 6 - -2 = 8\ m$

$\sqrt{(-1)^2 + (8)^2} = \sqrt{65} = 8.06\ m$

$\tan^{-1}\left(\frac{8}{-1}\right) = -82.87°$

$\theta = 180 - 82.87 = 97.126°$

$(8.06, 97.126°)$

*** Ex *** vector A has x and y components of -8.70cm and 15.0cm, respectively vector B has x and y components of 13.2cm and -6.60cm, respectively. if $A - B + 3C = 0$, what are the components of (C)?

$\Rightarrow A: (-8.7, 15.0) \Rightarrow A = -8.7\hat{i} + 15.0\hat{j}$

$B: (13.2, -6.60) \Rightarrow B = 13.2\hat{i} - 6.60\hat{j}$

Solution: $A - B + 3C = 0 \Rightarrow 3C = B - A \rightarrow C = \frac{B-A}{3}$

$(B-A) \Rightarrow (B-A)_x = 13.2 - -8.7 = 21.9\ m$

$(B-A)_y = -6.60 - 15.0 = -21.6\ m$

$(B-A) = (B-A)_x + (B-A)_y$

$(B-A) = (21.9)_x + (-21.6)_y = 0.3$

$C = \frac{0.3}{3} = 0.1$ or $C = \frac{B-A}{3} \Rightarrow \left(\frac{21.9}{3}\right)_x + \left(\frac{21.6}{3}\right)_y$

$\textcircled{C} \Rightarrow (7.3)_x, (7.2)_y$

*Ex** consider the two vectors $A = 3i - 2j$ and $B = -i - 4j$. Calculate (a) $A+B$?

- Solution:: $\vec{A}+\vec{B} \Rightarrow (A+B)_i\hat{}_i + (A+B)_j\hat{}_j$

$\vec{A}+\vec{B} = \boxed{2i + -6j}$

(b) $A-B$? - Solution:: $\vec{A}-\vec{B} \Rightarrow (A-B)_i\hat{}_i + (A-B)_j\hat{}_j$

$\vec{A}-\vec{B} = \boxed{4\hat{i} + 2\hat{j}}$

(c) $|A+B|$? - Solution:: $\sqrt{(2)^2 + (-6)^2} = \boxed{6.32}$

(d) $|A-B|$? - Solution:: $\sqrt{(4)^2 + (2)^2} = \boxed{4.47}$

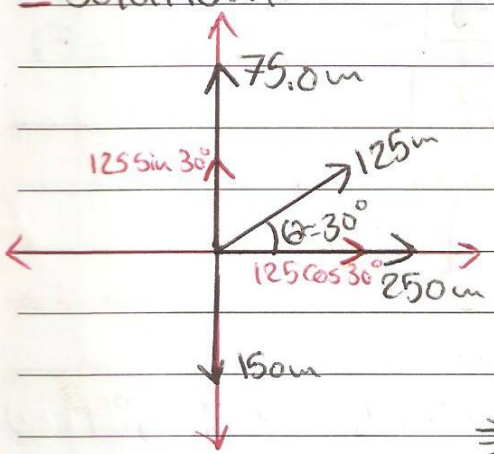
(e) directions of $(A+B)$ and $(A-B)$?

- Solution:: $(A+B) \Rightarrow \tan^{-1}\left(\frac{-6}{2}\right) = -71.5 = 288.5°$

$(A-B) \Rightarrow \tan^{-1}\left(\frac{2}{4}\right) = 26.5°$

~~Exa~~ while exploring a cave, a spelunker starts at the entrance and moves the following distance. She goes 75.0 m north, 250 m east, 125 m at angle 30.0° north of east, and 150 m south. Find the resultant displacement from the cave entrance.

Solution:



$$\Sigma x = 250 + 125\cos 30^\circ$$
$$= 250 + 108.253$$
$$= 358.25$$

$$\Sigma y = (75 + 125\sin 30^\circ) - 150$$
$$= 137.5 - 150$$
$$= -12.5$$

$$\Rightarrow \sqrt{(-12.5)^2 + (358.25)^2}$$
$$= \sqrt{128499.3125}$$
$$= 358.46806$$

$$\tan^{-1}\left(\frac{-12.5}{358.25}\right) = -1.1998$$

(358.468, 358.8)

Ex: Vector A and B have the following components:

	A	B
X components	+5 units	−3 units
Y components	−2 units	−4 units

The magnitude of the vector A−B is:

(a) 6.3 units (b) 10.0 units (c) 8.2 units (d) 16 units

Solution: $\vec{A} = 5\hat{i}_x - 2\hat{j}_y$

$\vec{B} = -3\hat{i}_x - 4\hat{j}_y$

$\vec{A} - \vec{B} \Rightarrow (A-B)_x = 5 - -3 = 8$ units

$(A-B)_y = -2 - -4 = 2$ units

$\sqrt{(8)^2 + (2)^2} = \sqrt{64+4} = \sqrt{68} = 8.2$ units ⇒ (c)

Ex: A fly crawls on one wall of a room. The lower left-hand corner of the wall is selected as the origin of a two-dimensional cartesian coordinate system. If the fly is located at the point having coordinates (2.00, 1.00 m). (a) how far is it from the corner of the room? (b) what is its location in polar coordinates?

- Solution :. (a) (2m, 1m)

$r = \sqrt{(2)^2 + (1)^2} = \sqrt{5} = \boxed{2.24\ m}$

(b) $\tan^{-1}\left(\frac{1}{2}\right) = \boxed{26.5^\circ}$

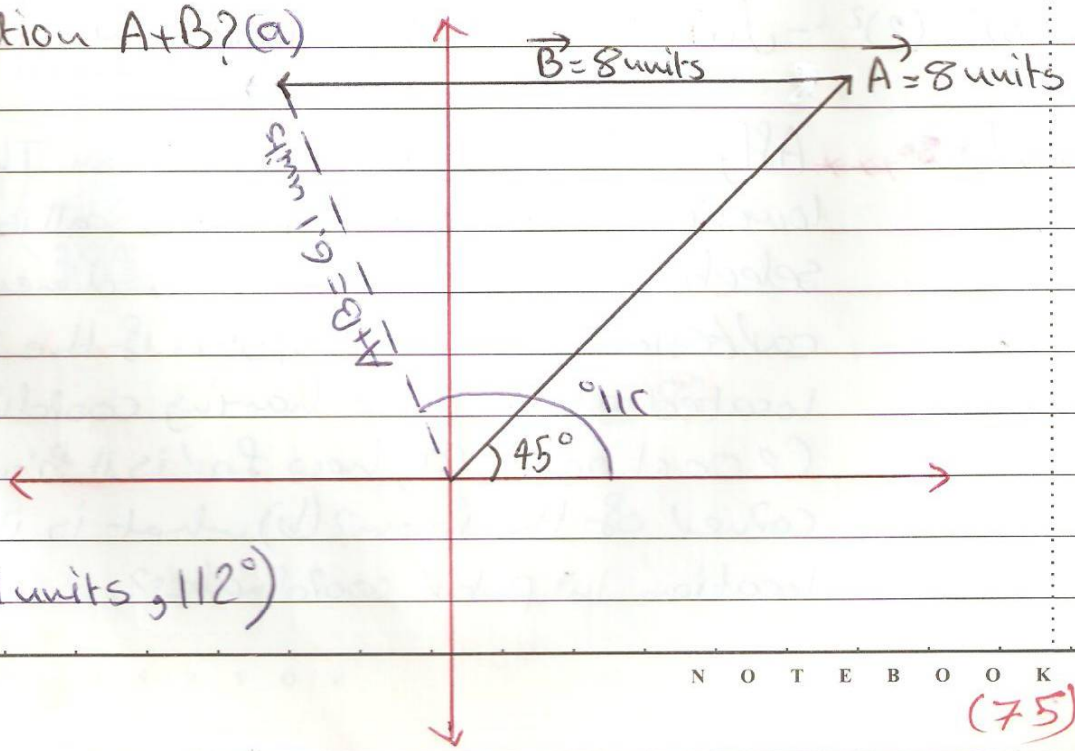
$\Rightarrow (2.24, 26.5^\circ)$ ...

*** Ex *** vector (A) has a magnitude of (8 units) and makes an angle 45° with the positive x-axis. vector (B) also has a magnitude of (8 units) and is directed along the negative x-axis. Using graphical methods, find:

(a) the vector sum (A+B).

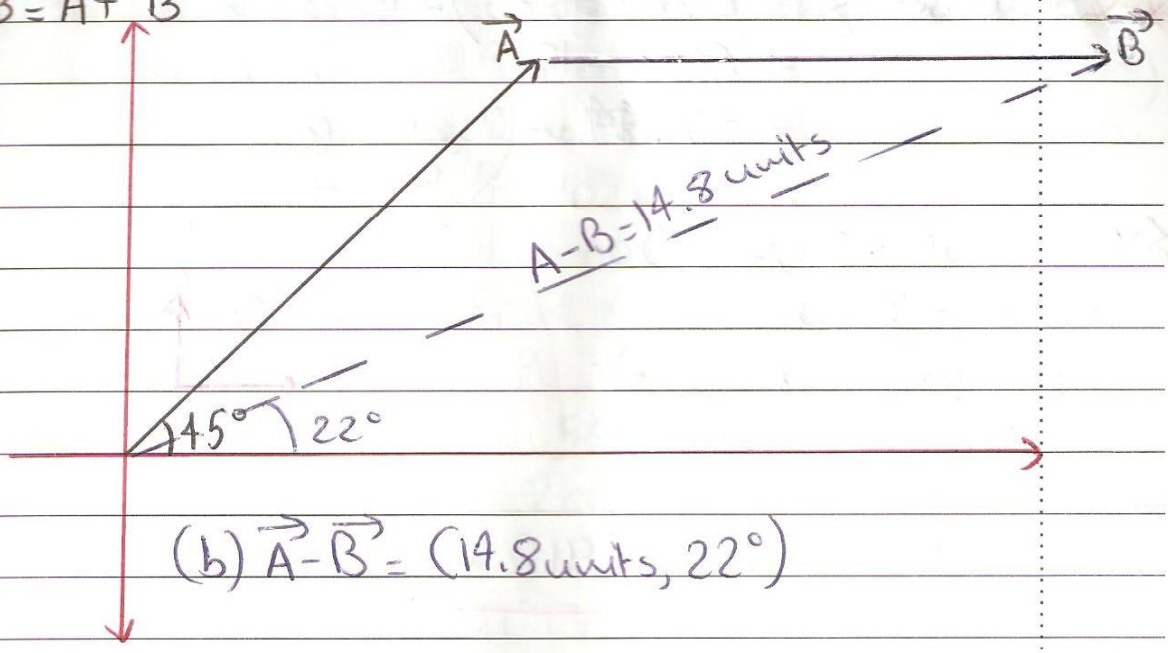
(b) the vector difference (A-B).

* Solution A+B? (a)



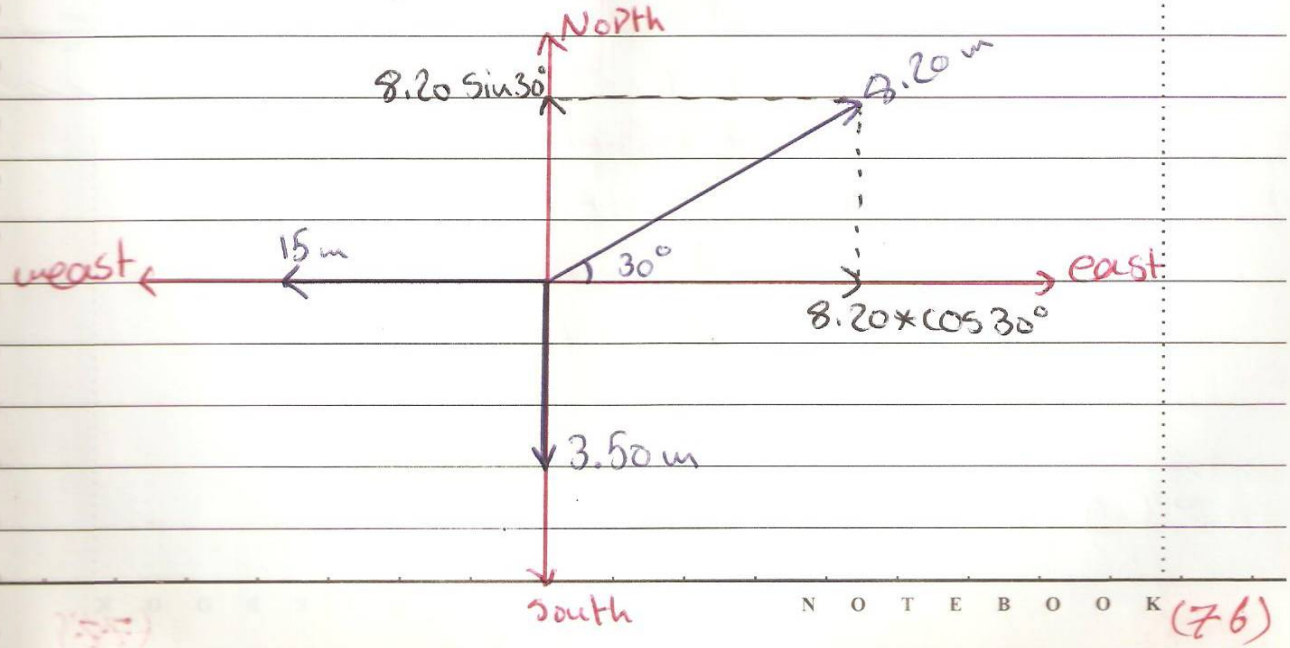
$\vec{A} + \vec{B} = (6.1\ \text{units}, 112^\circ)$

$A - B = A + -B$



(b) $\vec{A} - \vec{B} = (14.8 \text{ units}, 22°)$

Ex 8 A dog searching for a bone walks 3.50 m south, and then runs 8.20 m at an angle 30.0° north of east, and finally walks 15.0 m west. Find the dog's displacement vector?



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***Solution:: $\Sigma X = (8.20\cos 30^\circ) - 15$

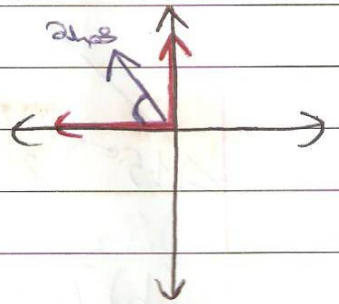
$= 5.68 - 15$

$= -7.89\ m$ (المركبة السينية السالبة)

$\Sigma Y = (8.20\sin 30^\circ) - 3.50$

$= 4.1 - 3.50$

$= 0.6\ m$ (المركبة الصادية الموجبة)

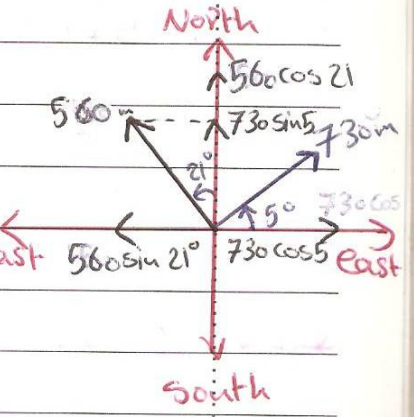


$\Rightarrow \sqrt{(-7.89)^2 + (0.6)^2} = \boxed{7.912\ m}$

$\Rightarrow \tan^{-1}\left(\frac{0.6}{-7.89}\right) = \boxed{-4.3^\circ}$ from $-x$-axis

$\theta = 180 - 4.3 = 175.7^\circ$ from $+x$-axis

Ex A map suggests that Atlanta is (730 miles in a direction of 5° north of east from Dallas). The same map shows that Chicago is (560 miles in a direction of 21° west of north from Atlantis). Modeling the Earth as flat, use this information to find the displacement from Dallas to Chicago?



$\Rightarrow$ Solution: $\sum x = 730\cos 5° - 560\sin 21°$

$= 727.2 - 200.68$

$= 527$ miles

$\sum y = 560\cos 21° + 730\sin 5°$

$= 522.8 + 63.62$

$= 586$ miles

$\sqrt{(527)^2 + (586)^2} = \boxed{788 \text{ miles}}$

$\Rightarrow \theta' = \tan^{-1}\left(\frac{586}{527}\right) = \boxed{48°}$

$\Rightarrow$ (788 miles, 48°)

Ex 8 Find the magnitude and direction of the Resultant of three displacement having rectangular components: (3m, 2m), (-5m, 3m), and (6m, 1m)?

⇒ Solution:

$$d = \sqrt{(3-5+6)^2 + (2+3+1)^2} = \sqrt{(4)^2 + (6)^2} = \boxed{7.21\ m}$$

$$\Rightarrow \tan^{-1}\left(\frac{6}{4}\right) = \boxed{56.3^\circ}$$

Ex 8 Consider the three displacement vectors $A = (3i - 3j)m$, $B = (i - 4j)m$, and $C = (-2i + 5j)m$. Use the component method to determine:

(a) The magnitude and direction of the vector $D_1 = A - B - C$ and $D_2 = A + B + C$?

(b) The magnitude and direction of $E = -A - B + C$?

⇒ Solution: (a) $D_1 = A - B - C$

$(A - B - C)_x = 3 - 1 + 2 = 4i$

$(A - B - C)_y = -3 + 4 - 5 = -4j$

$(A - B - C) = 4i - 4j$

$$\sqrt{(4)^2 + (-4)^2} = \boxed{5.65\ m}$$

$$\tan^{-1}\left(\frac{-4}{4}\right) = \boxed{-45^\circ} = \boxed{315^\circ}$$

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$D_2 \Rightarrow (A+B+C)_x = 3+1-2 = 2i$

$(A+B+C)_y = -3+-4+5 = -2j$

$A+B+C = 2i-2j$

$\sqrt{(2)^2+(2)^2} = \sqrt{8} = 2.8m$

$\tan^{-1}\left(\frac{2}{-2}\right) = -45° = 315°$

(b) $E = -A-B+C = C-A-B$

$(C-A-B)_x = (-2+3+1) = -6$

$(C-A-B)_y = (5+-3+-4) = 12 \Rightarrow -6i+12j$

$\sqrt{(-6)^2+(12)^2} = 13.4$

$\tan^{-1}\left(\frac{12}{-6}\right) = -63.43° = 116.57°$

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*** Ex ... *** Are related to the following information:

Given the two vector:

$\vec{A} = 4i - 3K$

$\vec{B} = i + 2j + 2K$

Q1 ... The vector $A - 3B$ is:

⇒ Solution: $3B = 3i + 6j + 6K$

$(A - 3B) = (4 - 3)_i + (0 - 6)_j + (-3 - 6)_K$

$(A - 3B) = \boxed{1i - 6j - 9K}$ ⇒ (d)

Q2 ... The angle between B and the positive Z-axis is:

a) $\cos^{-1}(-2/3)$ (b) $\cos^{-1}(2/3)$ c) $\cos^{-1}(-3/2)$

Q3 ... The vector C such that $A - 4B + C = 0$ is:

a) $8j - 11K$ b) $8i + 5K$ (c) $8j + 11K$ d) $8i + 8j + 5K$

⇒ Solution: $C = 4B - A$

$4B = 4i + 8j + 8K$

$A = 4i - 3K$

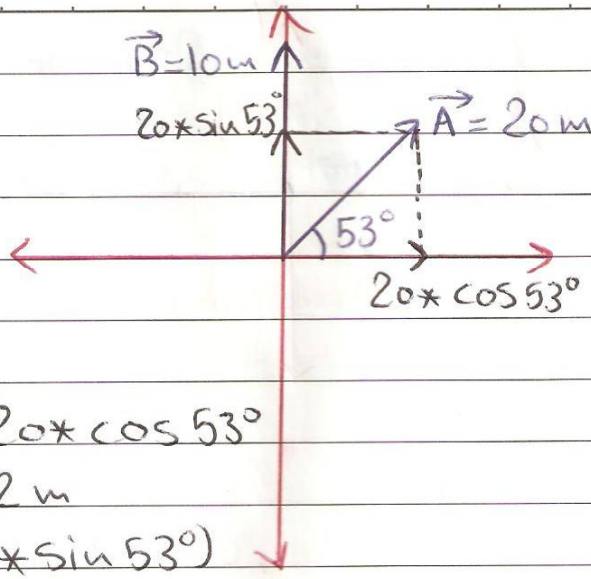
$(4B - A)_x = (4 - 4)_i + (8 - 0)_j + (8 - -3)_K$

$4B - A = 0i + 8j + 11K$

$= \boxed{8j + 11K}$ ⇒ (c)

*** Ex ***

Find $\vec{A}+\vec{B}$?



*** Solution ***

$\vec{A}+\vec{B} \Rightarrow (A+B)_x = 20*\cos 53°$

$= 12$ m

$(A+B)_y = 10+(20*\sin 53°)$

$= 10+15.9$

$= 25.97$ m

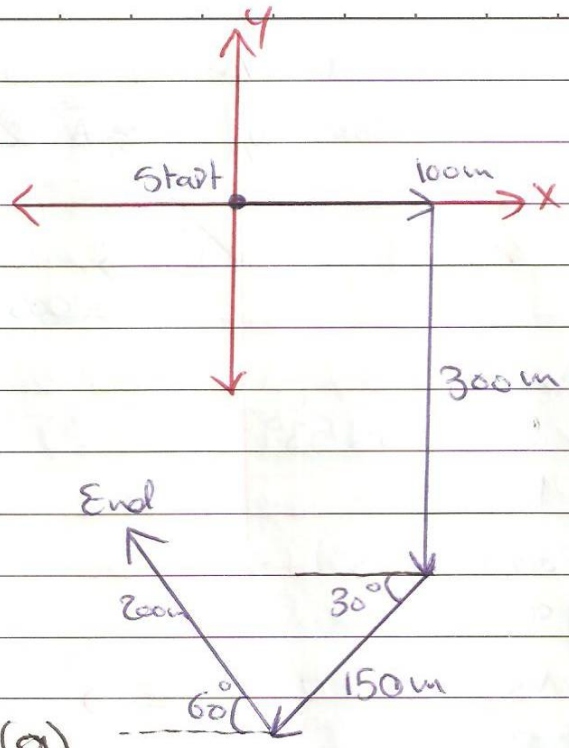
$\Rightarrow \tan^{-1}\left(\frac{25.97}{12}\right) = 65.2°$

$\sqrt{(12)^2+(25.97)^2} = 28.6$ m

*** Q47 *** A person going for a walk follows the path shown in figure (P3.47). The total trip consists of four straight-line paths. At the end of the walk, what is the person's resultant (displace-ment) measured from the starting point?

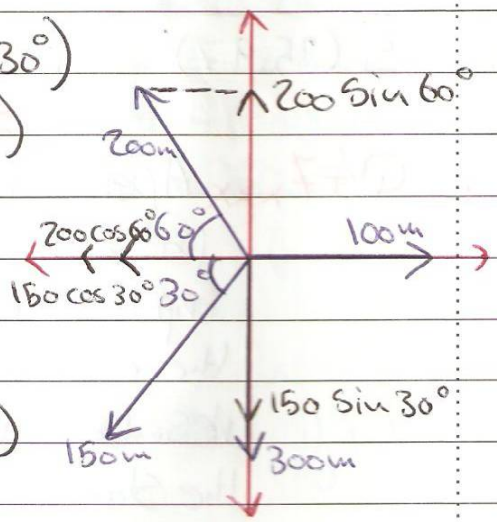
(يتبع الورقة) ⟵

(الإجابة على السؤال)
(Figure P3.47)



⟹ Solution :- (a)

$\Sigma x = 100 - (200\cos 60° + 150\cos 30°)$
$= 100 - (200*0.5 + 150*0.86)$
$= 100 - (100 + 129.9)$
$= 100 - 229.9$
$= -129.9 \approx \boxed{-130\ m}\ i$



$\Sigma y = 200\sin 60° - (150\sin 30° + 300)$
$= 173.2 - (75 + 300)$
$= 173.2 - 375$
$= \boxed{-201.8} \approx \boxed{-202\ m}\ j$

⟹ displacement = $\boxed{-130\,i - 202\,j}$

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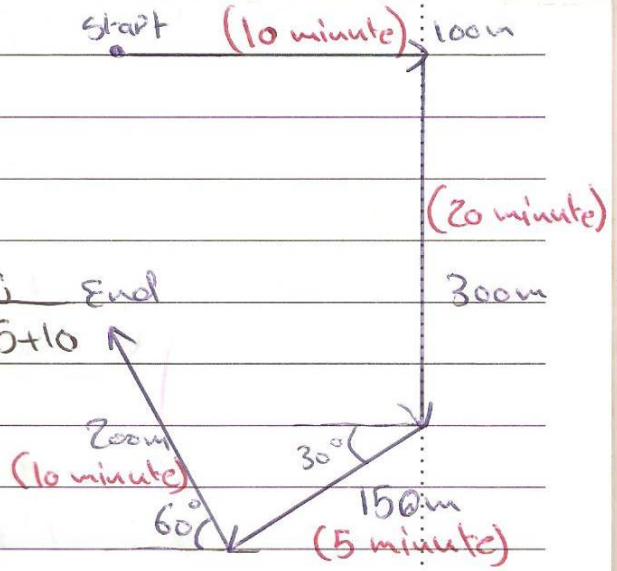
(b) Find the distance? (نجمع المسافات دون إشارات)

⇒ Solution:..

$100 + 300 + 150 + 200 = \boxed{750\ m}$ ← (distance)

(4)

c) Find the velocity?



⇒ Solution:..

$$V = \frac{\text{displacement}}{\text{time}}$$

$$= \frac{-130i}{10+20+5+10} + \frac{-202j}{10+20+5+10}$$

$$= \frac{-130i}{45} - \frac{202j}{45}$$

$$= \boxed{2.8i - 4.48j}$$

d) Find the speed?

⇒ Solution:.. $\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{750}{45} = \boxed{16.6\ m/min}$

// * * * * * *

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Motion in two dimensions

*** position vector ($\vec{r}$) متجه الموقع

$r = speed * time$

*** Displacement $(\Delta r) = r_f - r_i = \Delta x\,i + \Delta y\,j$

*** Average velocity : (السرعة المتوسطة)

$$\vec{v} = \frac{\Delta r}{\Delta t} = \frac{r_f - r_i}{t_f - t_i} = \frac{\Delta x}{\Delta t} + \frac{\Delta y}{\Delta t}$$

... Δr وتكون اتجاهاتها نفس اتجاه $\bar{v}$

*** Instantaneous velocity : (السرعة اللحظية)

$$v = \lim_{\Delta t} \frac{\Delta r}{\Delta t} = \frac{dr}{dt} = \frac{dx}{dt} + \frac{dy}{dt}$$

(مشتقة الإزاحة بالنسبة للزمن)

(اتجاه السرعة اللحظية يكون في اتجاه المماس لمسار الجسم)

*** Speed : (السرعة)

$v = |\bar{v}|$

(average velocity)

*** Acceleration velocity (متوسط التسارع) :

$$\bar{a} = \frac{\Delta v}{\Delta t}$$

*** Instantaneous Acceleration (التسارع اللحظي) :

$$a = \lim_{\Delta t} \frac{\Delta v}{\Delta t} = \frac{dv}{dt} = \frac{dv_x}{dt} + \frac{dv_y}{dt}$$

- إذا كانت السرعة Speed ثابتة وتغير الإتجاه حدث تسارع مثل الحركة الدورية "المنتظمة" لأن التسارع يحدث عند تغير السرعة إما المقدار أو الاتجاه أو كلاهما...
- إذا كانت السرعة المتجهة Velocity ثابتة فيتضح بأن المقدار والإتجاه فلا يحدث "تسارع"...

- إسم الذي يقول في السؤال (X-Y) يكون متجه الموضع لأي كائن المعادلة:

$$r = x_i + y_j$$

$$\Rightarrow v^\circ = \frac{dr}{dt} = \frac{dx}{dt} i^\wedge + \frac{dy}{dt} j^\wedge = v_x i^\wedge + v_y j^\wedge$$

- معادلات الحركة ما كان تكون الحركة في بعدين فإننا إذ كل المعادلات المتجهة مثل السرعة والتسارع إذ مركباتها السينية والصادية:

$$v_f = v_i + a\Delta t \rightarrow \begin{cases} v_{fx} = v_{ix} + a_x t \\ v_{fy} = v_{iy} + a_y t \end{cases}$$

$$v_f^2 = v_i^2 + 2a\vec{\Delta r} \rightarrow \begin{cases} v_{fx}^2 = v_{ix}^2 + 2a_x \Delta x \\ v_{fy}^2 = v_{iy}^2 + 2a_y \Delta y \end{cases}$$

$$\vec{\Delta r} = v_i \Delta t + \frac{1}{2} a \Delta t^2 \rightarrow \begin{cases} \Delta x = v_{ix} \Delta t + \frac{1}{2} a_x \Delta t^2 \\ \Delta y = v_{iy} \Delta t + \frac{1}{2} a_y \Delta t^2 \end{cases}$$

Ex 8 A golf ball is hit off a tee at the edge of a cliff. Its x and y coordinates as function of time are given by following expressions:

$$x = 18t$$
$$y = 4t - 4.9t^2$$

(a) write a vector expression for the ball's position as a function of time, using the unit vectors $\hat{i}$ and $\hat{j}$. By taking derivatives, obtain expressions for. (b) the velocity vector v as a function of time and. (c) the acceleration vector a as a function of time. Next use unit-vector notation to write expressions for. (d) the position. (e) the velocity. (f) the acceleration of the golf ball, (all at t = 3 s)

⇒ Solution (a): $\vec{r} = 18t\,\hat{i} + (4t - 4.9t^2)\,\hat{j}$

Solution (b): velocity $= \frac{dx}{dt} + \frac{dy}{dt}$

$$= 18\,\hat{i} + (4 - 9.8t)\,\hat{j}$$

Solution (c): acceleration $= \frac{dx^2}{dt^2} + \frac{dy^2}{dt^2}$

$$= 0\,\hat{i} + (-9.8)\,\hat{j} = -9.8\,\hat{j}$$

Solution (d): $\vec{r} = 18t\,\hat{i} + (4t - 4.9t^2)\,\hat{j}$ (at t = 3 s)

$$\vec{r} = (18 * 3) + (4 * 3 - 4.9(3)^2)\,\hat{j}$$
$$\vec{r} = 54\,\hat{i} + (12 - 44.1)\,\hat{j}$$
$$\boxed{\vec{r} = 54\,\hat{i} - 32.1\,\hat{j}}$$

(position)

Solution(e):. velocity $= \frac{dx}{dt} + \frac{dy}{dt}$ (at $t=3.5^s$)

velocity $= 18\,\hat{i} + (4 - 9.8t)\,\hat{j}$

$= 18\,\hat{i} + (4 - 9.8*3)\,\hat{j}$

$= 18\,\hat{i} + (4 - 29.4)\,\hat{j}$

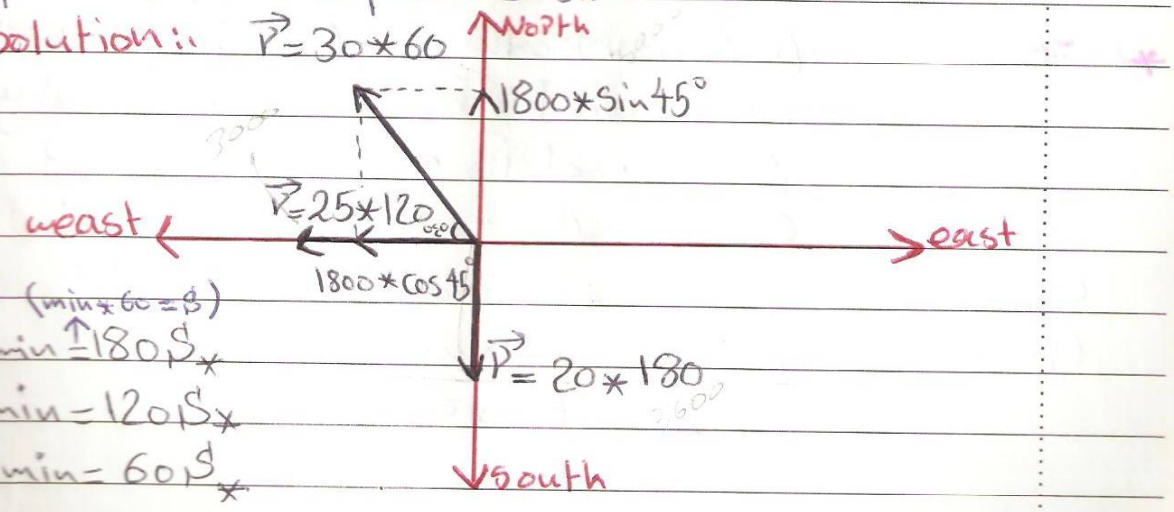
$= (18\,\hat{i} - 25.4\,\hat{j})$ m/s

Solution(f):. acceleration $= \frac{dx^2}{d^2t} \Rightarrow$ (at $t=3.5^s$)

acceleration $= -9.8\,\hat{j}$ m/s^2 (south)

*Ex: A motorist drives at (20 m/s) for (3 min), then turns west and travels at (25 m/s) for (2 min), and finally travels northwest at (30 m/s) for (1 min). For this trip, find (a) the total vector displacement (b) the average speed, and (c) the average velocity. Let the positive X-axis point east.

⇒ Solution:: $\vec{r} = 30*60$



(min*60 = s)

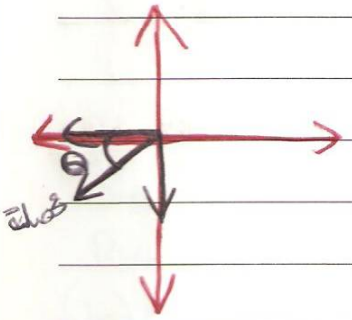
*3 min = 180 s

*2 min = 120 s

*1 min = 60 s

(a) X-axis: 0 − (3000 + 1272.8)
= −4270 m ⟹ (x-axis displacement)

y-axis: 1272.8 − 3600 = −2330 m ⟹ (y-axis displacement)



$\tan\theta = \frac{2330}{4270} = 28.6^\circ$ South of west

(b) average speed $= \frac{\Delta r}{\Delta t} = \frac{2(180) + 25(120) + 30(60)}{180+120+60}$

= 33.3 m/s

(c) average velocity $= \frac{R}{T} = \frac{\sqrt{(4270)^2 + (2330)^2}}{360}$

= 13.5 m/s

* Ex: * At (t = 0) a particle moving in the x-y plane with constant acceleration has a velocity of $v_i = 3\hat{i} - 2\hat{j}$ and is at origin at (t = 3) the particle's velocity is $v = 9\hat{i} + 7\hat{j}$, find
(a) the acceleration of the particle and ?
(b) it's coordinates at any time (t)..
$\vec{r}$ متجه الإزاحة (t) الإحداثيات

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⇒ Solution(a): $v_{fx} = v_{ix} + a_x \Delta t$

$9 = 3 + (a_x * 3)$

$9 = 3 + 3a_x$

$6 = 3a_x$

$\boxed{a_x = 2\ m/s^2}$

$v_{fy} = v_{iy} + a_y \Delta t$

$7 = -2 + (a_y * 3)$

$9 = a_y 3$

$\boxed{a_y = 3\ m/s^2}$

$* \vec{a} = (2\hat{i} + 3\hat{j})\ m/s^2$

Solution (b): $\Delta x = x_f - x_i = v_{ix} \Delta t + \frac{1}{2} a_x t^2$

$x_f - 0 = (3 * t) + (\frac{1}{2} * 2 * t * t)$

$x_f = (3t + t^2)\ m$

$\Delta y = y_f - y_i = v_{iy} t + \frac{1}{2} a_y t^2$

$y_f - 0 = -2t + \frac{1}{2} * 3 * t^2$

$y_f = (1.5t^2 - 2t)\ m$

$* \vec{r} = ((3t + t^2)\hat{i} + (1.5t^2 - 2t)\hat{j})\ m$

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*Ex The vector position of a particle varies in time according to the expression $r = (3\hat{i} - 6t^2\hat{j})$ m (a) find expressions for the velocity and acceleration as function of time. (b) Determine the particle's position and velocity at $(t = 1s)$.

⟹ Solution: (a) $\text{velocity} = \frac{dr}{dt} = (-12t\hat{j}\ \text{m/s})$

$$\text{acceleration} = \frac{dr^2}{d^2t} = (-12\hat{j}\ \text{m/s})$$

(b) $\vec{r} = (3\hat{i} - 6\hat{j})$ m

$\vec{v} = (-12\hat{j})$ m/s

*Ex A fish swimming in a horizontal plane has initial velocity $v_i = (4\hat{i} + 1\hat{j})$ m/s, at a point in the ocean where the position relative to a certain rock is $r_i = (10\hat{i} - 4\hat{j})$ m. After the fish swims with constant acceleration for (2 s), its velocity is $v = (20\hat{i} - 5\hat{j})$ m/s. (a) what are the components of the acceleration? (b) what is the direction of the acceleration with respect to unit vectors? (c) if the fish maintains constant acceleration where is it at (t = 25 s). and in what direction is it moving?

⇒ Solution (a): $v_{fx} = v_{ix} + a_x t$

$20 = 4 + (a_x * 20)$

$\frac{16}{20} = a_x$

$\boxed{a_x = 0.8 \text{ m/s}^2}$

$v_{fy} = v_{iy} + a_y t$

$-5 = 1 + (a_y * 20)$

$\frac{-6}{20} = a_y \Rightarrow \boxed{a_y = -0.3 \text{ m/s}^2}$

$\vec{a} = (0.8\hat{i} - 0.3\hat{j}) \text{ m/s}^2$

⇒ Solution (b): $\tan^{-1}\left(\frac{-0.3}{0.8}\right) = -20.6° = 360 - 20.9$

$= 339.4°$

⇒ Solution (c):

$\Delta X = X_f - X_i = v_{ix} t + \frac{1}{2} a_x t^2$

$X_f - 10 = (4 * 25) + \left(\frac{1}{2} * 0.8 * 25 * 25\right)$

$X_f - 10 = 100 + 250$

$X_f - 10 = 350$

$\boxed{X_f = 360 \text{ m}}$

$\Delta Y = Y_f - Y_i = v_{iy} t + \frac{1}{2} a_y t^2$

$Y_f - 4 = (1 * 25) + \left(\frac{1}{2} * -0.3 * 25 * 25\right)$

$Y_f + 4 = 25 - 93.75$

$\boxed{Y_f = -72.75 \text{ m}}$

$\vec{r} = (360\hat{i} - 72.75\hat{j}) \text{ m}$

- direction $= \tan^{-1}\left(\frac{v_y}{v_x}\right)$ at $t=2s$

- $v_{xf} = v_{ix} + a_x t$
  $v_{xf} = 4 + (0.8 * 2s)$
  $\boxed{v_{xf} = 24 \text{ m/s}}$

- $v_{yf} = v_{yi} + a_x t$
  $v_{yf} = (1 + -0.3 * 2s)$
  $v_{yf} = 1 - 7.5$
  $\boxed{v_{yf} = -6.5 \text{ m/s}}$

$$\vec{v} = (24\hat{i} - 6.5\hat{j}) \text{ m/s}$$

$\tan^{-1}\left(\frac{-6.5}{24}\right) = \boxed{-15.2^\circ} = 360 - 15.2 = \boxed{344.8^\circ}$ #

($v_i = v_j = 0$ عند الراحة)

Ex: A particle initially located at the origin has an acceleration of ($a = 3j \text{ m/s}^2$) and an initial velocity (of $v_i = 5\hat{i} \text{ m/s}$). Find (a) the vector position and velocity at any time t and (b) the coordinates and speed of the particle at $t = 2s$???

⇒ Solution (a): $\therefore v_{fx} = v_{ix} + a_x t$

$v_{fx} = 5 + 0$

$\boxed{v_{fx} = 5 \text{ m/s}}$

$v_{fy} = v_{iy} + a_y t$

$v_{fy} = 0 + 3t$

$\boxed{v_{fy} = 3t \text{ m/s}}$

$\Rightarrow \vec{v} = (5\hat{i} + 3t\hat{j}) \text{ m/s}$

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* position $\Rightarrow \Delta X = x_f - x_i = v_{ix} t + \frac{1}{2} a_x t^2$

$= x_f - 0 = 5t + (\frac{1}{2} * t^2 * 0)$

$\boxed{x_f = 5t \text{ m}}$

$\Delta Y = y_f - y_i = v_{iy} t + \frac{1}{2} a_y t^2$

$y_f - 0 = (0 * t) + (\frac{1}{2} * 3 * t^2)$

$\boxed{y_f = 1.5 t^2 \text{ m}}$

$\Rightarrow \vec{r} = (5t\,\hat{i} + 1.5 t^2 \hat{j})\text{ m}$

$\Rightarrow$ Solution (b): speed = magnitude of the velocity

$$\text{speed} = \sqrt{(v_i \hat{i})^2 + (v_j \hat{j})^2}$$

$$\text{speed} = \sqrt{(5)^2 + (3*2)^2}$$

$$\text{speed} = \sqrt{61}$$

$\boxed{\text{Speed} = 7.81 \text{ m/s}}$

* Ex8 * A particale starts from the origen at t=0 with velocity $(16\hat{i} - 12\hat{j})$ m/s and moues in the xy-plane with a constant acceleration $\vec{a} = (3\hat{i} - 6\hat{j})$ m/s². what is the speed of the particle at t = 3 S ???

⇒ Solution :. Speed = amagnitude of the velocity

$$= \sqrt{(v_i\hat{i})^2 + (v_j\hat{j})^2}$$

$\Rightarrow v_{fx} = v_{xi} + a_x t$

$v_{fx} = 16 + 3 * 3$

$v_{fx} = 16 + 9$

$\boxed{v_{fx} = 25 \text{ m/s}}$

$\Rightarrow v_{fy} = v_{iy} + a_y t$

$v_{fy} = -12 + (-6 * 3)$

$v_{fy} = -12 + -18$

$\boxed{v_{fy} = -30 \text{ m/s}}$

$$\vec{v} = (25\hat{i} - 30\hat{j}) \text{ m/s}$$

$$\text{Speed} = \sqrt{(25)^2 + (-30)^2} = \sqrt{1525} = \boxed{39 \text{ m/s}} \#$$

*** Ex8 • A particle starts from the origin at t=0 with initial velocity on x-components at (-20 m/s) and y-components of (10 m/s) and y-components of acceleration only zero and $a_x = 5 \text{ m/s}^2$, find the position of the particle at t = 2 S ??? find the final velocity ??? (at t = 2 S) ↵

Subject Date No.

⇒ Solution:: $\vec{v} = (-20\hat{i} + 10\hat{j})\ m/s$

$\vec{a} = (5\hat{i})\ m/s^2$

$t = 2{,}s$

$\Delta x = x_f - x_i = v_{ix}t + \frac{1}{2}a_x t^2$

$x_f - 0 = (-20 * 2) + (\frac{1}{2} * 5 * 2 * 2)$

$x_f = -40 + (10)$

$\boxed{x_f = -30\ m}$

$\Delta y = y_f - y_i = v_{iy}t + \frac{1}{2}a_y t^2$

$y_f - 0 = (10 * 2) + (\frac{1}{2} * 0 * 2 * 2)$

$\boxed{y_f = 20\ m}$

$\Rightarrow \vec{r} = (-30\hat{i} + 20\hat{j})\ m$

⇒ Solution:: $v_{fx} = v_{ix} + a_x t$

$v_{fx} = -20 + 5 * 2$

$v_{fx} = -20 + 10$

$\boxed{v_{fx} = -10\ m/s}$

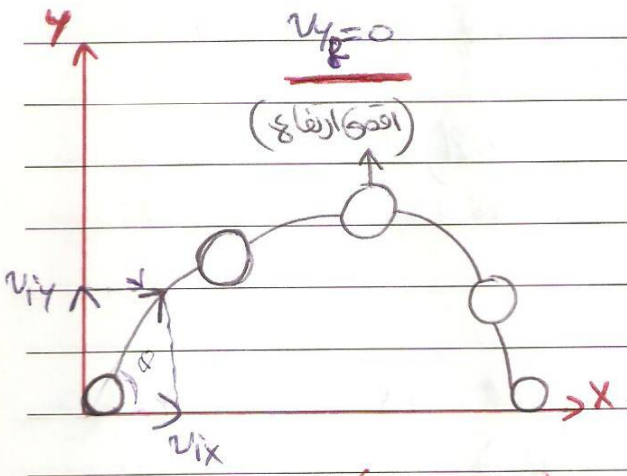
$v_{fy} = v_{iy} + a_y t$

$v_{fy} = 10 + 0$

$v_{fy} = \boxed{10\ m/s}$

$\Rightarrow \vec{v_f} = (-19\hat{i} + 10\hat{j})\ m/s$ //

Projectile Motion
(حركة المقذوفات)



* $v_{ix} = v_i \cos\theta$
* $v_{iy} = v_i \sin\theta$

* $v_{ix} = v_{fx}$
* $a_x = 0$
(constant speed)

معادلات الحركة تنقسم

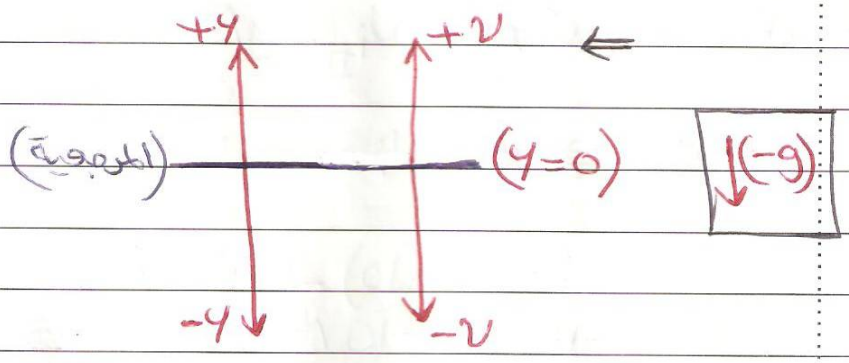
* (X-axis) ::

$v_{fx} = v_{ix}$
$v_{fx}^2 = v_{ix}^2$
$\Delta x = x_f - x_i = v_{ix}\Delta t$
$a_x = 0$

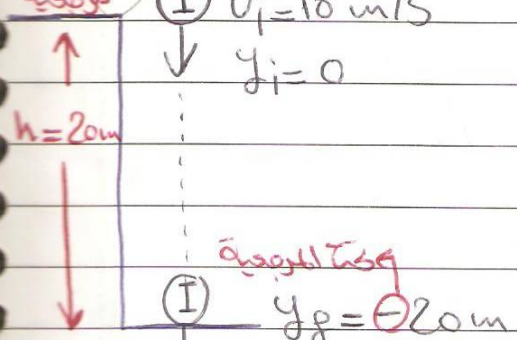
* (Y-axis) ::

$v_{fy} = v_{iy} - g\Delta t$
$v_{fy}^2 = v_{iy}^2 - 2g\Delta t$
$\Delta y = y_f - y_i = v_{iy}\Delta t - \frac{1}{2}gt^2$ ← لحساب أقصى ارتفاع

* ملاحظة (انتبه) دائماً أقصى ارتفاع تصل السرعة النهائية تساوي صفر



Ex



⟹ Solution:

$v_f^2 = v_i^2 - 2g(y_f - y_i)$

$v_f^2 = (-10)^2 - (2 * 9.8 * (-20 - 0))$

$v_f^2 = 100 - (-392)$

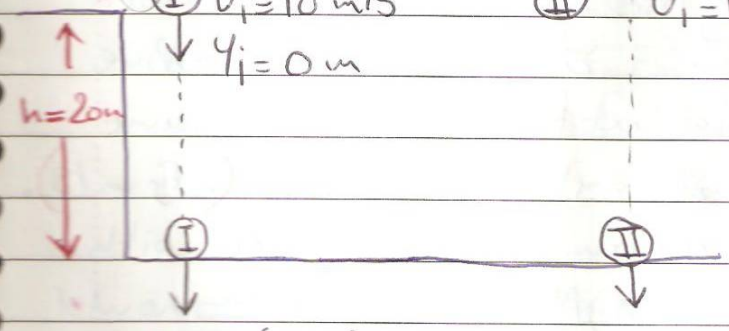
$v_f^2 = 492$

$v_f = \pm 22.18$

$v_f = \ominus 22.18$ m/s

(لأنها تتجه عكس جهة الموجبة)

Ex



⟸ لأن سرعة الطائر في الفترة الزمنية (ثانية) قبل الوصول لأعلى نقطة مساوية لسرعة الطائر في الفترة الزمنية (ثانية) بعد مغادرته لأعلى نقطة في المثال السابق وتساوي (-22.18) والسرعة الابتدائية تساوي السرعة النهائية..

- find (Δt) and y-maximum???

(أقصى ارتفاع للكرة II)

Subject Date No.

- Solution (a): $v_{f_{II}} = v_{i_{II}} - g\Delta t$

(عكس) $\Rightarrow v_f = v_i$

$(-10) = (10) - (10 * \Delta t)$

$-10 - 10 = -10\,\Delta t$

$\frac{-20}{-10} = \Delta t \rightarrow \boxed{\Delta t = 2\ s}$ #

- solution (b): $v_f^2 = v_i^2 - 2g\Delta y$

$0 = (10)^2 + (2 * 10 * \Delta y)$

$100 = 20\,\Delta y$

$\boxed{\Delta y = 5\ m}$ #

$\left(\sqrt{co} = 0 + c_1\right)$ لاحظ الرفع على الجذر التربيعي *

*Ex one strategy in a snowball fight is to throw a snow ball at a high angle over level ground. while your opponent is watching the first one, a second snowball is thrown at a low angle timed to arrive before or at the same time at the first one. Assume both a snowballs are thrown with a speed of (25 m/s). The first one is thrown at an angle of 70° with respect to the horizontal (أفقي (x)). (a) At what angle should the second snowball be thrown to arrive at the same point as the first? (b) How many seconds later should the second snowball be thrown after the first to arrive at the same time?

NOTEBOOK

Subject Date No.

→ Solution (a+b): $y_f = y_i = 0$ $(\theta = 70^\circ)$ → (first snowball)

$v_{y_i} = 25\ m/s$

$a_y = -9.8\ m/s$

(a) first snowball:

$\Delta y = y_f - y_i = v_{iy} t - \frac{1}{2} g \Delta t^2$

$0 = 0 - 0 = (v_i * \sin\theta * t) - (\frac{1}{2} g \Delta t^2)$

$0 = (25 * \sin 70 * t) - (\frac{1}{2} * 9.8 * t^2)$

$\frac{0}{t} = \frac{23.5\,t}{t} - \frac{4.9\,t^2}{t}$

$t = \frac{23.5}{4.9}$

$\boxed{t_1 = 4.79\ s}$

- second snowball:

$\Delta y = y_f - y_i = v_{iy} t_2 - \frac{1}{2} g \Delta t_2^2$

$0 = 0 - 0 = (v_i \sin\theta * t_2) - (\frac{1}{2} g \Delta t_2^2)$

$0 = (25 * \sin\theta * t_2) - (\frac{1}{2} * 9.8 * t_2^2)$

$0 = 25 * \sin\theta * t_2 - (4.9 * t_2^2)$

$4.9 t_2^2 = 25 * \sin\theta\ t_2$

$\frac{}{t_2} \qquad \frac{}{t_2}$

$t_2 = \frac{25 * \sin\theta}{4.9} = \boxed{5.1 \sin\theta}$ → $t_2 = 5.1 * \sin 20$

$t_2 = 5.1 * 0.34$

$\boxed{t_2 = 1.75\ s}$

⇒ $\theta_1 = 90 + 70 + \theta_2$

$180 = 160 + \theta_2$

$\boxed{\theta_2 = 20^\circ}$

- after the first by

$t_2 - t_1 = 4.79 - 1.75$

$= \boxed{3.05\ s}$ #

NOTE BOOK

(100)

*Ex: An astronaut on a strange planet finds that she can jumps a maximum horizontal distance of 15m if her initial speed 3 m/s. what is the free-fall acceleration on the planet?

*(قانون المدى الأفقي في أكبر قيمة له) $\Rightarrow R = \frac{\sin(2\theta_i) * v_i^2}{g}$

وإذا كانت $\theta_i = 90°$ فإن $\sin 2\theta°$ تساوي (1) يعني أن $2\theta_i = 90°$ وإذا كانت $\theta_i = 45°$ فإن $2\theta_i = 90°$ ...

-Solution: $g = \frac{\sin 2\theta_i * v_i^2}{R}$

$= \frac{1 * (3)^2}{15} = \frac{9}{15} = \boxed{0.6\ m/s^2}$

(maximum height) أقصى ارتفاع

$h = \frac{v_i^2 \sin^2\theta_i}{2g}$ ← $\frac{\sin^2\theta_i}{\sin 2\theta_i} = \frac{\tan\theta_i}{2}$ ←

*Ex: Projectile is fired in such away that is horizontal range is equal (تساوي) to three times its maximum height. what is the angle of projection?

-Solution: $R = \frac{\sin 2\theta_i * v_i^2}{g}$

$h = \frac{v_i^2 * \sin^2\theta_i}{2g}$

$3 * \frac{v_i^2 * \sin^2\theta_i}{2g} = \frac{\sin 2\theta_i * v_i^2}{g}$

$\frac{3}{2}\sin^2\theta_i = \sin 2\theta_i \Rightarrow \frac{3}{2}\sin^2\theta_i = 2\sin 2\theta_i$

$\frac{3}{2}\tan\theta_i = \frac{2\sin^2\theta_i}{\sin 2\theta_i}$

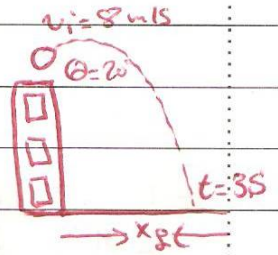
$\frac{3}{2}\tan\theta_i = \frac{2}{3}$

$\tan^{-1}\left(\frac{4}{3}\right) = \boxed{53.1°}$

* Ex: A ball is tossed (قذفت) from an upper-story window of a building. The ball is given an initial velocity of 8 m/s at an angle of 20° below the horizontal (x) (أفقي). It strikes the ground 3 S later. (a) How far horizontally from the base of the building does the ball strike the ground? (b) Find the height from which the ball was thrown? (c) How long (t) does it take the ball to reach a point (10 m) below the level of launching?

⇒ Solution: (a) $v_i = 8$ m/s $\rightarrow \theta = 20°$

$t = 3$ S



$x_f - x_i = v_{ix} t = (v_i * \cos\theta) * t$

$= (8 * \cos 20) * 3$

$= \boxed{22.6 \text{ m}}$

⇒ Solution (b): $y_f - y_i = v_{iy} t + \frac{1}{2} g t^2$

$y_f - 0 = (v_i * \sin\theta * t) + (\frac{1}{2} g t^2)$

$y_f = (8 * \sin 20° * 3) + (\frac{1}{2} * 9.8 * 3 * 3)$

$y_f = 8.208 + 44.1$

$\boxed{y_f = 52.3 \text{ m}}$

⇒ Solution (c): $y_f - y_i = v_i t + \frac{1}{2} g t^2$

$10 - 0 = (v_i \sin\theta) t + \frac{1}{2} g t^2$

$10 = (8 \sin 20) t + (\frac{1}{2} * 9.8 * t^2)$

$10 = 2.74 t + 4.9 t^2$

$4.9 t^2 + 2.74 t - 10 = 0$

$\boxed{t = 1.18 \text{ S}}$

Subject Date No.

$(y = 40m)$

Ex 8 A soccer player kicks a rock horizontally off a (40m) high cliff into a pool of water. if the player hears the sound of the splash (3S) later, what was the initial speed given to the rock? Assume (افترض) the speed of sound in air to be (343 m/s)?

- Solution:: $y_f = 40m$

$t = ???$

$\left(\text{extra time} = 3 - t\right)$ (الوقت الإضافي)

speed of sound $= 343\ m/s$

$$y_f - y_i = v_{iy}t - \frac{1}{2}gt^2$$

$$-40 - 0 = (0 * t) - \left(\frac{1}{2} * 9.8 * t^2\right)$$

$$-40 = -4.9t^2$$

$$t^2 = 8.163$$

$$\boxed{t = 2.86S}$$

* extra time $= 3 - 2.86 = \boxed{0.143S}$ (استخدم هذا)

* $r = v_i t = 343 * 0.143 = \boxed{49m} \Rightarrow r = \sqrt{x^2 + y^2}$

$$\Rightarrow 49 = \sqrt{x^2 + (40)^2}$$

$$\boxed{X = 28.3m}$$

$$x_f = x_i + v_{ix}t$$

$$28.3 = 0 + v_{ix} * 2.86 \Rightarrow v_{ix} = \frac{28.3}{2.86} = \boxed{9.91\ m/s}$$ #

O T E B O O K

(10점)

Subject Date No.

* Uniform Circular Motion *
(الحركة الدائرية المنتظمة)

⇐ تحدث عندما يتحرك الجسم بسرعة ثابتة المقدار مغيرة الاتجاه ويسار دائري فينتج عن ذلك ما يسمى بالتسارع المركزي (Centripetal Motion) وهو تسارع السرعة وهو مسار للمسار الدائري وعمودي على نصف قطر المسار الدائري

⇐ لحساب التسارع المركزي:

$$a_c = \frac{v^2}{r}$$

$$v_i = v_f = v$$

⇐ الزمن اللازم ليتم الجسم دورة واحدة

$$T = \frac{2\pi r}{v}$$

⇐ ولحساب السرعة

$$v = \frac{2\pi r}{T}$$

* Ex: An athlete Rotates a (1 Kg) discus along a circular path of Radius (1.06m). The maximum speed of the discus is (20m/s). Determine the magnitude of the maximum radial acceleration of the discus.

⇒ Solution: $a_c = \frac{v^2}{r} = \frac{20 * 20}{1.06} = 377\ m/s^2$

Subject Date No.

* Ex: A tire (0.5 m) in radius rotates at a constant rate of (200 rev/min). Find the speed and acceleration of a small stone lodged in the tread of the tire.

- Solution: $T = \frac{60}{200} = \boxed{0.3\,s}$

$$v = \frac{2\pi r}{T} = \frac{2\pi(0.5)}{0.3} = \boxed{10.5\ m/s} \#$$

$$a_c = \frac{v^2}{r} = \frac{(10.5)^2}{0.5} = \boxed{219\ m/s^2} \#$$

* Radial and tangential Acceleration: * (التسارع القطري والمماسي)

لهيكل كامل متجه التسارع إلى مركبتين هما:

1) Radial component (a_r) (مركبة قطرية)

* تكون باتجاه نصف قطر الدوران *

$a_r = -a_c = -\frac{v^2}{r}$

لـ تسبب تغير باتجاه سرعة الجسم

2) Tangential component (a_t) (مركبة مماسية)

* تكون عمودية على نصف القطر *

$a_t = \frac{d|\vec{v}|}{dt}$

لـ تسبب تغير مقدار سرعة الجسم

* مقدار التسارع *

$$a = \sqrt{a_r^2 + a_t^2}$$

Subject Date No.

* Ex: An automobile whose speed is increasing at a rate of (0.6 m/s²) travels along a circular road of radius (20 m) when the instantaneous speed of the automobile is (4 m/s), find (a) the tangential acceleration component (b) the centripetal acceleration component, and (c) the magnitude of the total acceleration?

- Solution: (a) $a_t = \frac{d|v|}{dt} = \boxed{0.6\ m/s^2}$

(b) $a_c = \frac{v^2}{r} = \frac{4*4}{20} = \boxed{0.8\ m/s^2}$

(c) $a_r = -a_c = \boxed{-0.8\ m/s^2}$

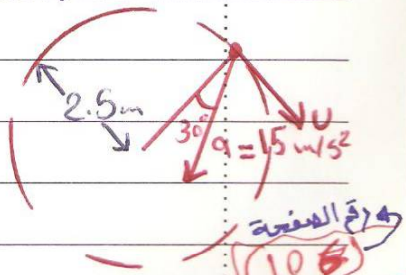
$$a = \sqrt{(a_r)^2 + (a_t)^2} = \sqrt{(0.6)^2 + (-0.8)^2}$$

$$\boxed{a = 1\ m/s^2}$$

* Ex: Figure beside represents the total acceleration of a particle moving clockwise in a circle of radius (2.5 m) at a certain instant of time. At this instant, find: (a) the radial acceleration, (b) the speed of the particle, (c) its tangential acceleration.

- Solution: (a) $a_r = -a_c = \frac{-v^2}{r} = a*\cos\theta$

$a_r = 15 * \cos 30^\circ = \boxed{13\ m/s^2}$



(b) $a_r = \frac{-v^2}{r} \Rightarrow v^2 = -a_r * r$

$\sqrt{v^2} = \sqrt{13 * 2.5}$

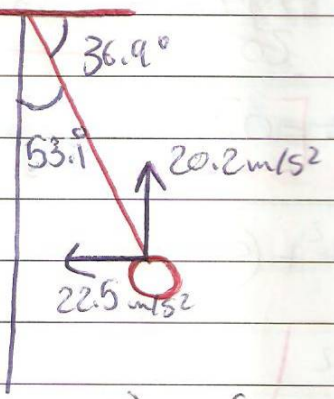
$\boxed{v = 5.7\ m/s}$

(c) $a_t \Rightarrow a = \sqrt{a_r^2 + a_t^2} \Rightarrow a^2 = a_r^2 + a_t^2 \Rightarrow a_t = \sqrt{a^2 - a_r^2} = \sqrt{(15)^2 - (13)^2} = 7.5$

NOTEBOOK

*Ex: A ball swings in a vertical circle at the end of a rope (1.5 m) long. When the ball is 36.9° past the lowest point on its way up, it total acceleration is $(22.5\,\hat{i} + 20.2\,\hat{j})$ m/s². At that instant.
(a) Sketch a vector of its acceleration.
(b) determine the magnitude diagram showing the components of its radial acceleration.
(c) determine the speed and velocity of the ball.

- Solution: (a)



(b) $a_r = (22.5 * \cos 53.1°) + (20.2 * \cos 36.9°)$
$= 29.7\ m/s^2$

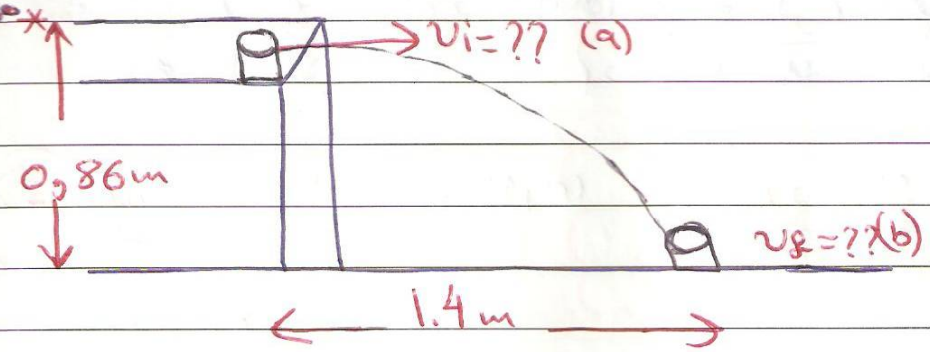
c) $a_r = \frac{v^2}{r}$

$29.7 = \frac{v^2}{1.5} \Rightarrow v = \sqrt{29.7 * 1.5}$

$v = 6.67$ m/s (at 36.9) above the horizontal

(11) Vectors

Ex 8



a) $v_{ix} = v_i$

$v_{iy} = 0$

$\Delta y = y_f - y_0 = v_{iy}t - \frac{1}{2} g \Delta t^2$

$= 0.86 - 0 = 0 * t - \frac{1}{2} * 10 * \Delta t^2$

$= -0.86 = -\frac{1}{2} * 10 * \Delta t^2$

$0.86 = 5 \Delta t^2$

$\Delta t^2 = 0.172\ s^2 \Rightarrow t = .41472827$

$\Delta x = x_f - x_i = v_{ix} t$

$= 1.4 - 0 = v_{ix} * 0.41472827$

$v_{ix} = \frac{1.4}{0.414} = 3.375\ \hat{i}\ m/s$

$\Rightarrow \vec{v_i} = (3.375\hat{i} + 0\hat{j})\ m/s$

(b) x-axis $\rightarrow v_i = v_f = 3.375\ m/s$

y-axis $\rightarrow v_{fy} = v_{iy} - g \Delta t$

$v_{fy} = 0 - 9.8 * 0.41472827$

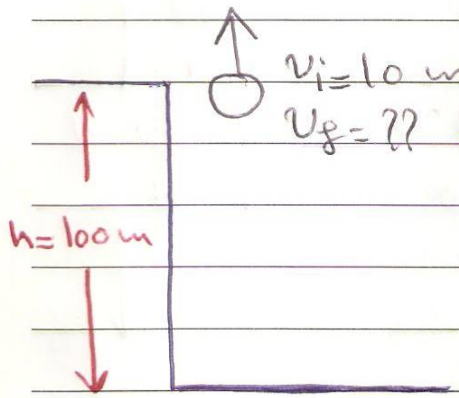
$v_{fy} = -4.0643\ m/s$

$\Rightarrow \vec{v_f} = (3.37\hat{i} - 4.0643\hat{j})\ m/s$

speed = magnitude

Subject Date No.

* Ex 8 * Find the total velocity after (2 S) in the following cases? (في الحالات التالية)



(a) $v_f = ??$

(b) $v_f = ???$ عندما تصل للأرض

ملاحظة: عندما يقذف الجسم للأعلى لا يوجد سرعة في الـ X...

(a) $v_f = v_i - g\Delta t$

$v_f = 10 - 10 * 2$

$\boxed{v_f = -10 \text{ m/s}}$

(b) $(v_{fy})^2 = (v_{iy})^2 - 2g\Delta y$

$(v_{fy})^2 = (10)^2 - (2 * 10 * (-100 - 0))$

$(v_{fy})^2 = 100 - -2000$

$v_{fy} = -\sqrt{2100}$

$\boxed{v_{fy} = \ominus 45.8 \text{ m/s}}$

عند قذف جسم رأسياً لأعلى فإن سرعته عند أقصى ارتفاع = صفر فقط

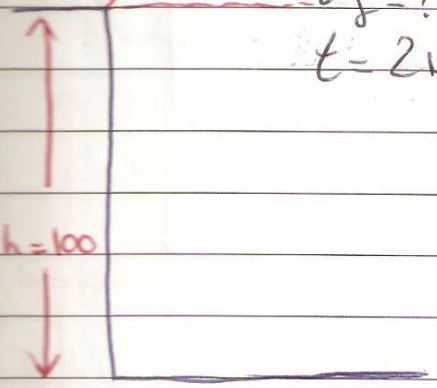
Subject Date No.

$v_i = 10\ m/s$

$\theta = 37°$

$v_f = ??$

$t = 2s$



حالة ثانية

* ملاحظة *
السرعة في أعلى نقطة (Top Point) تساوي السرعة الابتدائية في الـ x

* x-axis ∴ $v_{fx} = v_{ix}$

$v_{ix} = v_i * \cos\theta$

$v_{ix} = 10 * \cos 37°$

$v_{ix} = 8\ m/s$ $\quad v_{fx} = 8\ m/s$

* y-axis ∴ $v_{iy} = v_i * \sin\theta$

$v_{iy} = 10 * \sin 37°$

$v_{iy} = 6\ m/s$

$v_{fy} = v_{iy} - g\Delta t$

$v_{fy} = 6 - 10 * 2$

$v_{fy} = -14\ m/s$

$\Rightarrow v_{fy}^2 = v_{iy}^2 - 2g\Delta y$ * السرعة النهائية عند سطح الأرض:

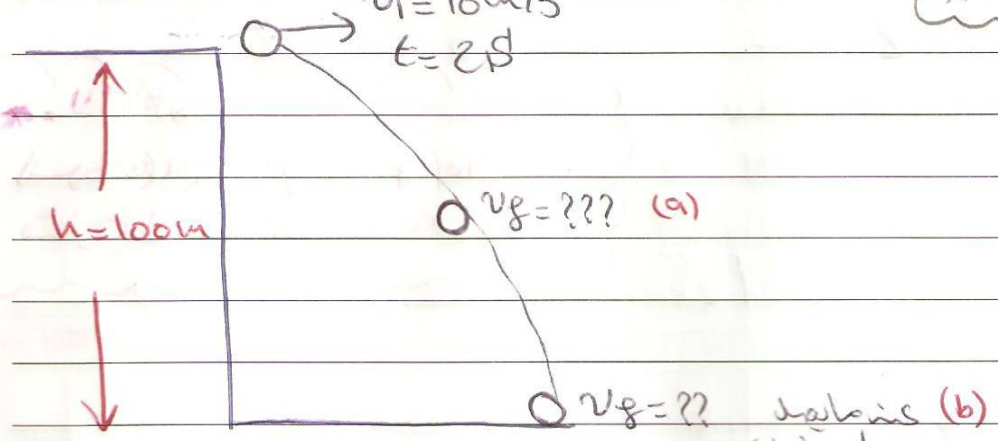
$v_{fy}^2 = (6)^2 - (2 * 10 * (-100 - 0))$

$v_f = -45.1\ m/s$

$\vec{v} = (8\hat{i} - 45.1\hat{j})\ m/s$

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حالة ثالثة



- (a) $\theta_i = 0$

$v_{ix} = v_i = 10 m/s$

$v_{iy} = 0$

$v_{ix} = v_{fx} = 10 m/s$

- $v_{fy} = v_{iy} - g\Delta t$

$v_{fy} = 0 - (10 * 2)$

$v_{fy} = \boxed{-20 m/s}$

$\vec{v} = (10\hat{i} - 20\hat{j}) m/s$

- (b) $v_{fy}^2 = v_{iy}^2 - 2g\Delta y$

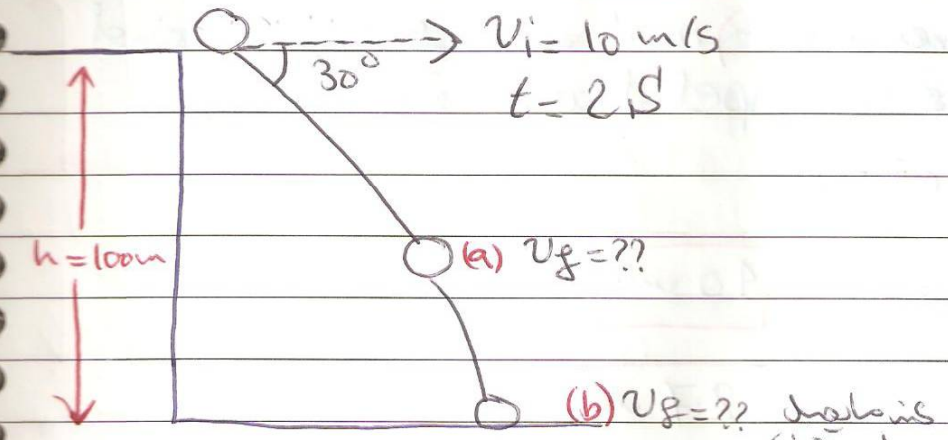
$v_{fy}^2 = 0 - (2 * 10 * (-100 - 0))$

$\sqrt{v_{fy}^2} = \sqrt{2000}$

$\boxed{v_f = -44.7 m/s}$

$\vec{v} = (10\hat{i} - 44.7\hat{j}) m/s$

المسألة الرابعة



(a) $v_{ix} = v_i = v_{fx} = v_i * \cos\theta$

$= 10 * \cos 30°$

$= 8.66$ m/s

$v_{iy} = v_i * \sin\theta = 10 * \sin 30° = 5$ m/s

$v_{fy} = v_{iy} - g\Delta t$

$v_{fy} = 5 - (10 * 2)$

$v_{fy} = -15$ m/s

$\vec{V} = (8.66\hat{i} - 15\hat{j})$ m/s

(b) $(v_{fy})^2 = (v_{iy})^2 - 2g\Delta y$

$= (5)^2 - (2 * 10 * (-100 - 0))$

$= 25 + 2000$

$= -45$ m/s

$\vec{V} = (8.66\hat{i} - 45.0\hat{j})$ m/s

*Ex: a particle travels in a circular path of a circumference (8 m) and makes 0.2 second find the centripetal acceleration?

- Solution: $a_c = \frac{v^2}{r}$

$\Rightarrow v = \frac{2\pi r}{T} = \frac{8}{0.2} = \boxed{40 \text{ m/s}}$

$\Rightarrow r \Rightarrow \frac{2\pi r}{2\pi} = \frac{8}{2\pi} = \boxed{1.27 \text{ m}}$

$a_c = \frac{(40)^2}{1.27} = \boxed{1260 \text{ m/s}^2}$

*Ex: a projectile is fired with an initial speed of 1000 m/s at an angle 37° above the horizontal. if air resistance is neglected what is the horizontal component of the projectiles' velocity after 20 s?

- Solution: $v_{ix} = v_i * \cos\theta$

$= 1000 * \cos 37°$

$= \boxed{800 \text{ m/s}}$ (at all times)

* Ex: A particle initially moving at (4 m/s) along the x-axis, and uniformly accelerated at ($3\ m/s^2$) along the y-axis, find the final speed after (2 s)?

- Solution: $v_{fx} = v_{ix} = 4\ m/s$

$v_{iy} = 0$

$v_{fy} = v_{iy} + a\Delta t$

$v_{fy} = 0 + (3 * 2)$

$v_{fy} = 6\ m/s$

The speed $= \sqrt{(6)^2 + (4)^2} = \boxed{7.2\ m/s}$

* Ex: A ball is thrown with an initial speed 14 m/s at an angle of 37° above the horizontal, what is the magnitude of the acceleration of the ball at the maximum height?

- Solution: $a = g = 9.8\ m/s^2$

* Ex: A particle starts from the origin at t=0 with a velocity of $v = 16\hat{i} - 12\hat{j}$ and moves in xy plane with acceleration $a = 3\hat{i} - 6\hat{j}$, find the speed of the particle after 2 s?

- Solution:

$v_{fx} = v_{ix} + a_x t$

$v_{fx} = 16 + 3 * 2$

$v_{fx} = 22\ m/s$

$v_{fy} = v_{iy} + a_y \Delta t$

$v_{fy} = -12 + -6 * 2$

$v_{fy} = -24\ m/s$

Speed $= \sqrt{(22)^2 + (-24)^2} = \boxed{32.5\ m/s}$

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* Ex: * A ball is thrown vertically upward with an initial speed of (20 m/s). 2 seconds later a stone is thrown vertically (from the same initial height as the ball) with an initial speed (25 m/s). at what height above the release point will the ball and stone pass each other?

⇒ Solution: for the ball ... $x_1 - x_0 = v_{1_0} t_1 + \frac{1}{2} a t_1^2$

for the stone ... $x_2 - x_0 = v_{2_0} t_2 + \frac{1}{2} a t_2^2$

$x_2 - x_0 = v_{2_0}(t_1 - 2) + \frac{1}{2} a (t_1 - 2)^2$

$(x_1 = x_2)$

$\Rightarrow x_0 + v_1 t_1 + \frac{1}{2} a t_1^2 = x_0 + v_2 (t_1 - 2) + \frac{1}{2} a (t_1 - 2)^2$

$\Rightarrow x_0 + v_1 t_1 + \frac{1}{2} a t_1^2 = x_0 + v_2 (t_1 - 2) + \frac{1}{2} a (t_1^2 - 4t_1 + 4)$

$20 t_1 + \frac{1}{2} g t_1^2 = 25(t_1 - 2) + \frac{1}{2} g (t_1^2 - 4t + 4)$

$20 t_1 + \frac{1}{2} g t_1^2 = 25 t_1 - 50 + \frac{1}{2} g t_1^2 - 2g t_1 + 2g$

$20 t_1 = 25 t_1 + 2g - 50 - 2g t_1$

$5 t_1 + 2g - 50 + 20 t_1 = 0$

$5 t_1 - 20 - 50 + 20 t_1 = 0$

$25 t_1 - 70 = 0 \Rightarrow \boxed{t_1 = 2.8\,s}$

$x_1 = x_2 = x_0 + v_1 t_1 + \frac{1}{2} a t_1^2 = 0 + 20(2.8) + \frac{1}{2} \times -10 \times (2.8)^2$

$\boxed{x = 17\,m}$ (15)

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*** The laws of Motion *** (قوانين الحركة)

(5.1) The force

* القوة: هي التي تسبب تغيير في سرعة الجسم المتجهة، وإذا تغيرت السرعة مقدارًا واتجاهًا" تسمى تسارع، وعند تطبيق عدة قوى على الجسم يلزمنا حساب محصلة القوى...

*** إذا كانت المحصلة تساوي صفرًا" يحصل الإتزان (الاتزان Equilibrium) وتسمى القوى لا يوجد لها تأثير على الجسم عندها...

∴ عند السكون أي الاتزان تكون محصلة القوة صفرًا" أي أن ($\sum \vec{F} = 0$)

(5)

(5.2) The Mass

* هي الممانعة التي يبديها الجسم لتغيير سرعته (مقاومة الحركة)...

(5.3) Newton's first laws (قانون نيوتن الأول)

* الجسم الساكن يبقى ساكنًا والجسم المتحرك بسرعة ثابتة يبقى كذلك مالم تؤثر به قوة...

$$\sum \vec{F} = 0 \longrightarrow \sum \vec{F}_x = 0$$

$$\sum \vec{F}_y = 0$$

$$\Rightarrow \vec{v}_f = \vec{v}_i + \vec{a}t \quad , \quad \Delta\vec{x} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$$

$$(\vec{v}_f)^2 = (\vec{v}_i)^2 + 2\vec{a}\Delta\vec{x}$$

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(4_5) Newton's Second Law :
(قانون نيوتن الثاني)

* تتناسب تسارع اي جسم تناسبا طرديا مع القوة المؤثرة عليه وعكسيا مع كتلته...

$$\sum \vec{F} = m\vec{a}$$

حيث أن F : القوة المؤثرة (كمية متجهة) N

m : كتلة (كمية قياسية) Kg

a : تسارع (كمية متجهة) m/s^2

(القوة تسبب التسارع)

(وجب تحليل القوة مركباتها) أكثر X واكثر Y

$$\sum F_x = ma_x \qquad \sum F_y = ma_y \qquad \sum F_z = ma_z$$

*** Ex: A 3Kg object undergoes an acceleration given by $\vec{a} = (2\hat{i} + 5\hat{j})\ m/s^2$. Find the resultant force acting on it and the magnitude of the resultant force?

* Solution: $\sum \vec{F} = m\vec{a}$

$$\sum \vec{F} = 3(2\hat{i} + 5\hat{j})$$

$$\sum \vec{F} = (6\hat{i} + 15\hat{j})\ N$$

magnitude of the resultant force $= \sqrt{(6)^2 + (15)^2}$

$$= \boxed{16.2\ N} \ \#$$

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*** Ex: A toy rocket engine is securely fastened to a large puck, which can glide with negligible friction over a horizontal surface, taken as the x-y plane. The (4 Kg) puck has (a velocity of $3\hat{i}$) m/s at one instant. (8 seconds) later, its (velocity is to be $8\hat{i}+10\hat{j}$) m/s. assuming the rocket engine exerts a constant horizontal force. find the component of the force and its magnitude?

- solution: $v_i = 3\hat{i}$ m/s

$v_f = 8\hat{i}+10\hat{j}$ m/s

$t = 8$ s

$m = 4$ Kg

* $\sum \vec{F} = m\vec{a}$

$\sum \vec{F} = 4(\vec{a_i}\hat{i} + \vec{a_j})$

$\sum \vec{F} = 4(0.625\hat{i} + 1.25\hat{j})$

$\sum \vec{F} = 2.5\hat{i} + 5\hat{j}$

* magnitude $= \sqrt{(2.5)^2+(5)^2}$

$= \boxed{5.59\ N}$ #

* $v_{f_y} = v_{iy} + a_y t$

$10 = 0 + a_y * 8$

$\boxed{a_y = 1.25\ m/s^2}$

* $v_{f_x} = v_{ix} + a_x t$

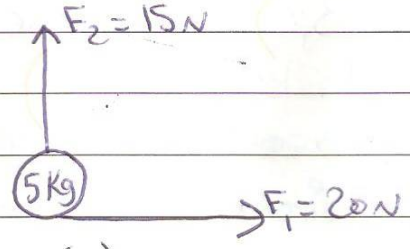
$8 = 3 + a_x * 8$

$\frac{5}{8} = a_x$

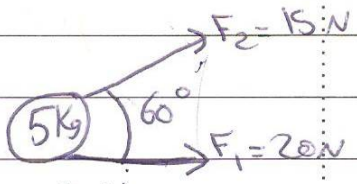
$\boxed{a_x = 0.625\ m/s^2}$

* Ex: There are two forces F_1 and F_2 act on (a 5Kg) object. If $F_1 = 20N$ and $F_2 = 15N$, find the acceleration in pictures (a) and (b) ?

(a)



(b)



- Solution (a) ::

$\sum \vec{F} = m\vec{a}$

$\vec{F_1} + \vec{F_j} = m\vec{a}$

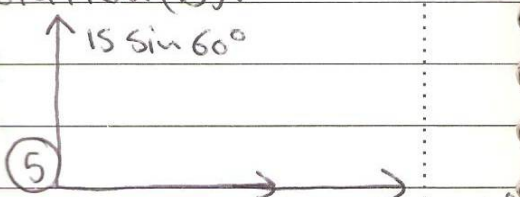
$20\hat{i} + 15\hat{j} = 5\vec{a}$

$\vec{a} = (4\hat{i} + 3\hat{j})\ m/s^2$

$\vec{a} = \sqrt{(4)^2 + (3)^2} = \boxed{5\ m/s^2}$ #

$\tan^{-1}\left(\frac{3}{4}\right) = \boxed{36.9°}$ #

- Solution (b) ::



$\sum \vec{F} = m\vec{a}$

$\vec{F_i} + \vec{F_j} = m\vec{a}$

$(20 + 15\cos 60°)\hat{i} + (15 \sin 60°)\hat{j} = 5\vec{a}$

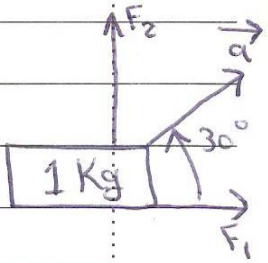
$27.5\hat{i} + 12.99\hat{j} = 5\vec{a}$

$\vec{a} = (5.5\hat{i} + 2.598\hat{j})\ m/s^2$

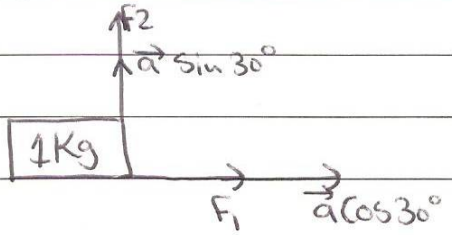
$\vec{a} = \sqrt{(5.5)^2 + (2.5)^2} = \boxed{6.08\ m/s^2}$

$\tan^{-1}\left(\frac{2.5}{5.5}\right) = \boxed{25.3°}$ #

* Ex:- A 1 Kg object is observed to have an acceleration of $10 m/s^2$ in a direction 30° North of east. The force F_2 acting on the object has a magnitude of 5 N and is direction North. Determine the magnitude and direction of the force(1) acting on the object ?



- Solution:-



$$\sum \vec{F} = m\vec{a}$$

$$\vec{F_i}\hat{i} + \vec{F_j}\hat{j} = m(a_i\hat{i} + a_j\hat{j})$$

$$\vec{F_i}\hat{i} + 5\hat{j} = 1(a\cos 30° + a\sin 30°)$$

$$\vec{F_i}\hat{i} + 5\hat{j} = 1(10\cos 30° + 10\sin 30°)$$

$$\vec{F_i}\hat{i} + 5\hat{j} = 8.66\hat{i} + 5\hat{j}$$

$$\vec{F_i}\hat{i} = 8.66\hat{i} + 5\hat{j} - 5\hat{j}$$

$$\vec{F_i}\hat{i} = \boxed{8.66\hat{i}\ N}\ \text{(east)}\ \#$$

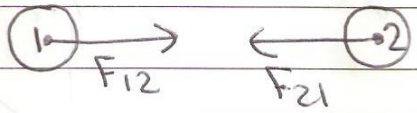
(5.5) The wight:- (الوزن)

* $F_g = mg$ (هذا المقدار الوزن)

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(6.5) Newton's Third laws :
(قانون نيوتن الثالث)

* إذا تفاعل جسمان معاً فإن القوة التي يؤثر بها الجسم (1) على الجسم (2) بقوة (F_{12}) تكون مساوية للقوة (F_{21}) التي يؤثر بها الجسم (2) على الجسم (1) لكن باتجاه معاكس..



$$\vec{F_{21}} = -\vec{F_{12}}$$ وبالتالي :

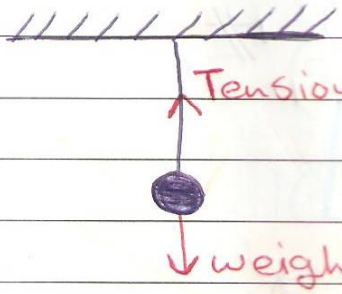
(7.5) Applications :
تطبيقات على قوانين نيوتن...

* (في حالة الإتزان) المتجه يساوي صفر فإن محصلة القوى التي تؤثر على الجسم تساوي صفر وبالتالي :

$$\sum \vec{F_x} = 0$$

$$\sum \vec{F_y} = 0$$

مثال :



* $\sum \vec{F_y} = 0$

$T - w = 0$

$T = w$

$T = mg$

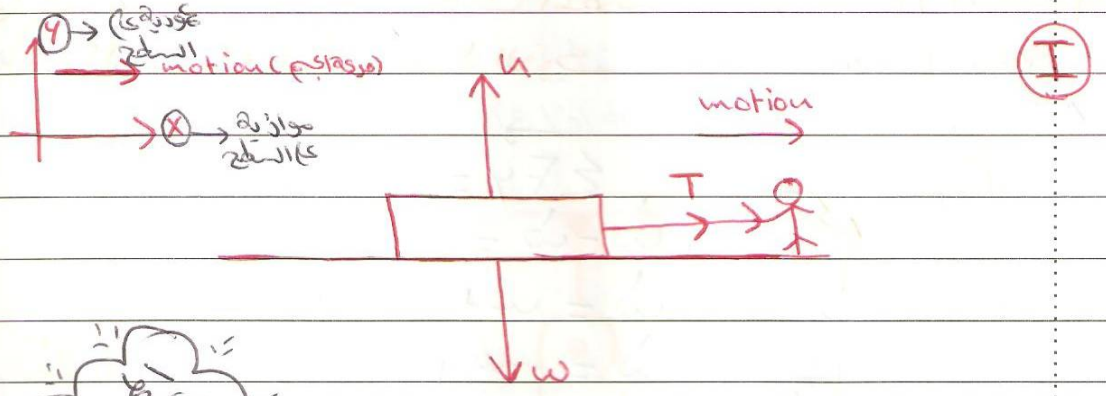
* (في حالة الحركة المستقيمة) تكون محصلة القوى المؤثرة على الجسم تساوي صفر.

مثال: عند وجود شخص يجر صندوقاً على سطح دون الإحتكاك، فهناك قوة أفقية باتجاه اليمين وتمثل القوة بالشد في الحبل وهي التي تسبب تسارع الصندوق، وهناك قوة ثقل الصندوق إلى الأسفل وهي الوزن ورد فعل مقاوم كما في الشكل وهي القوة العمودية (N) وبالتالي:

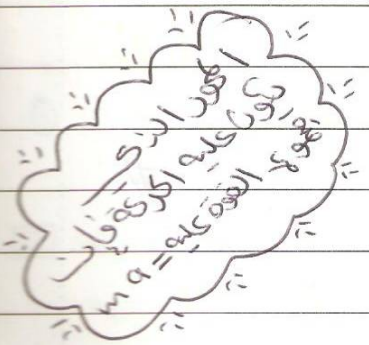
$$\sum \vec{F}_x = m\vec{a}_x$$

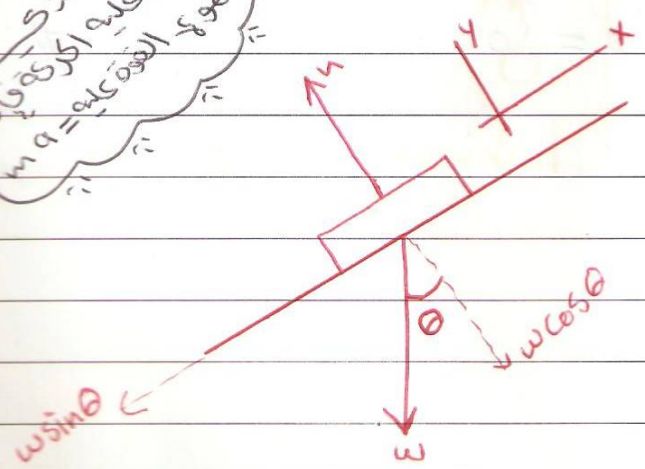
أما على المحور الصادات (y) فلا يوجد هناك حركة فالتسارع صفر فإذاً:

$$\sum \vec{F}_y = 0$$



(I)

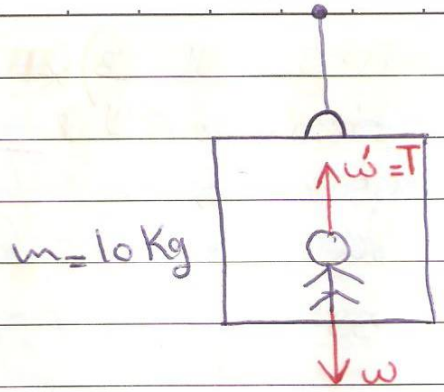




(II)

* الوزن في المصعد :-

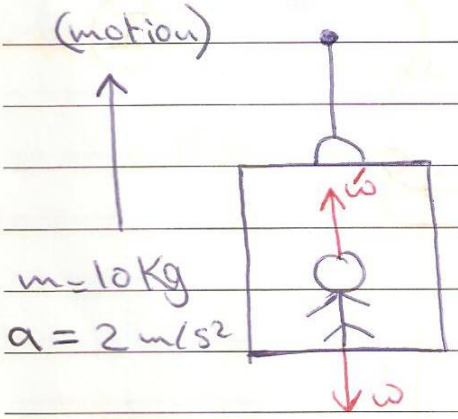
I) في حالة السكون :-



$$\overrightarrow{\Sigma F_y} = 0$$
$$\omega - w = 0$$
$$\omega = w$$
$$\omega = mg$$
$$\omega = 10 * 10$$
$$\boxed{\omega = 100\ N}$$

(الوزن الظاهري) = $\omega = 100\ N$

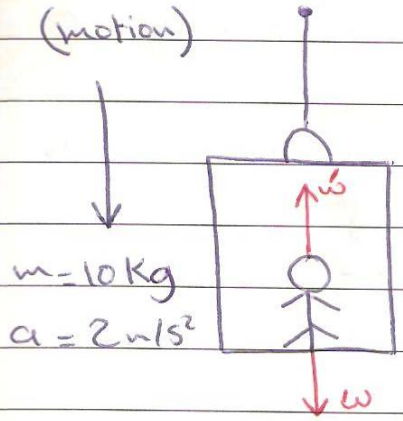
II) عندما يتحرك الجسم في المصعد بتسارع للأعلى (upward motion) بشكل منتظم فيكون تحليل القوى :-



$$\overrightarrow{\Sigma F_y} = ma_y$$
$$\omega - w = ma_y$$
$$\omega = w + ma_y$$
$$\omega = mg + ma_y$$
$$\omega = 10*10 + 10*2$$
$$\omega = 100 + 20 = \boxed{120\ N}\ \#$$

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III) عند صعود وزن جسم في مصعد يتأثر للأسفل بشكل مستقيم يكون تحليل القوى المؤثرة على الجسم كما يلي :-



$\rightarrow$

$\Sigma F_y = ma_y$

$\omega - \omega' = ma_y$

$mg - \omega' = ma_y$

$10 * 10 - \omega' = 10 * 2$

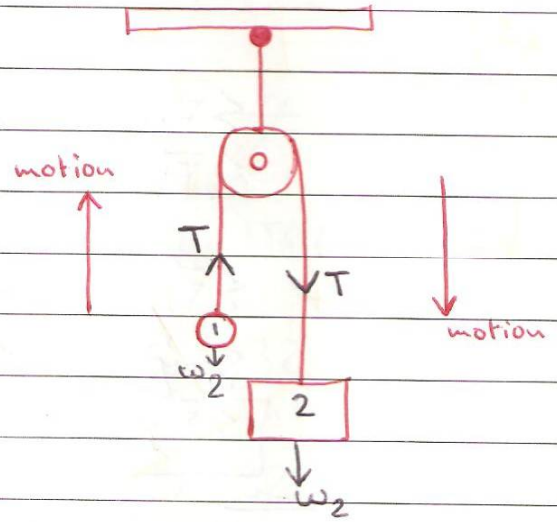
$100 - \omega' = 20$

$\omega' = 100 - 20$

$\boxed{\omega' = 80\ N}$ #

*** في آلة البكرات تكون إشارات القوى موجبة إذا كانت تتبع اتجاه حركة النظام وسالبة إذا كانت عكس اتجاه حركة النظام...

مثلاً :

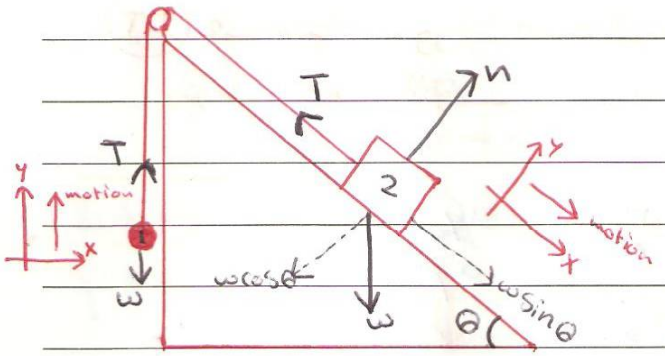


① $T - \omega_1 = m_1 a_y$

$T - m_1 g = m_1 a_y$

② $\omega_2 - T = m_2 a_y$

$m_2 g - T = m_2 a_y$



مثال

① $T - w = m_1 a_y$

$T - m_1 g = m_1 a_y$

② x-axis: $w\sin\theta - T = m_2 a_x$

$m_2 g \sin\theta - T = m_2 a_x$

y-axis: $n - w\cos\theta = 0$

$n - m_2 g \cos\theta = 0$

*** Ex: A 3Kg object is moving in a plane, with x and y coordinates given $X = 5t^2 - 1$ and $Y = 3t^3 + 2$, where x and y are in meters and t is in seconds. Find the magnitude of the net force acting on this object at t = 2S?

- Solution:

$\sum \vec{F}_x = ma_x$

$\sum \vec{F}_x = 3 * \frac{dx^2}{dt^2}$

$\sum \vec{F}_x = 3 * 10$

$\boxed{\sum \vec{F}_x = 30\,N}$

$\sum \vec{F}_y = ma_y$

$\sum \vec{F}_y = 3 * \frac{dy^2}{dt^2}$

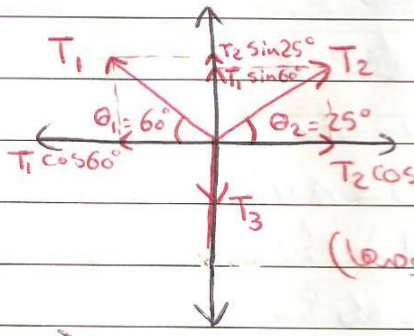
$\sum \vec{F}_y = 3 * 18t$

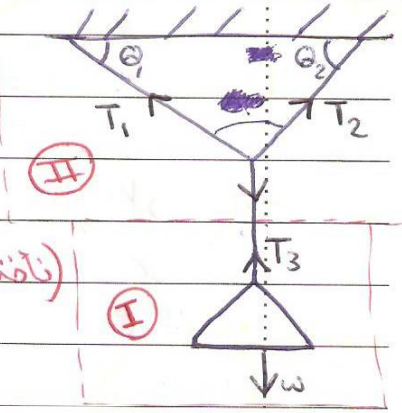
$\sum \vec{F}_y = 3 * 18 * 2$

$\boxed{\sum \vec{F}_y = 108\,N}$

magnitude $= \sqrt{(30)^2 + (108)^2} = \boxed{112\,N}$ #

* Ex: A bag of cement of (weight 325N) hangs from three wires as suggested in figure. Two of the wires make angle $\theta_1 = 60°$ and $\theta_2 = 25°$ with the horizontal. if the system is in equilibrium, find the tensions T_1, T_2 and T_3 in the wires?





- solution: (III) $\sum \vec{F}_x = 0$

$$T_2 \cos 25° - T_1 \cos 60° = 0 \longrightarrow (1)$$

$$\sum \vec{F}_y = 0$$

$$(T_2 \sin 25° + T_1 \sin 60°) = T_3 \longrightarrow (2)$$

(I) $T_3 = w$

$$\boxed{T_3 = 325\ N} \quad \#$$

* (1) $T_2 = \dfrac{T_1 \cos 60°}{\cos 25°}$ ⟹ * (2) $\dfrac{T_1 \cos 60° \sin 25°}{\cos 25°} + T_1 \sin 60° = T_3$

$$\Rightarrow \frac{T_1 \cos 60° \sin 25° + T_1 \sin 60° \cos 25°}{\cos 25°} = 325$$

$$T_1 (\cos 60° \sin 25° + \sin 60° \cos 25°) = 325 \cos 25°$$

$$T_1 (0.996194698) = 294.5500308$$

$$T_1 = 295.6751641 \approx \boxed{T_1 = 296\ N} \quad \#$$

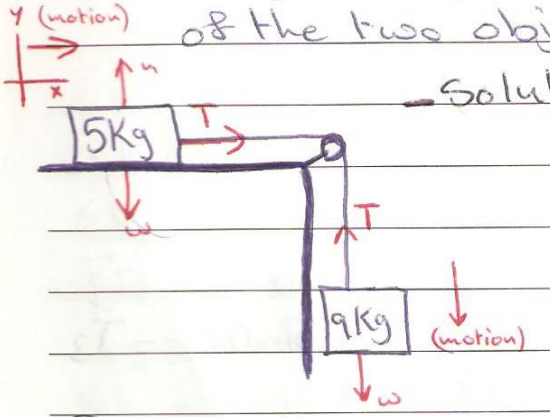
(①و②) $T_2 \cos 25^\circ = T_1 \cos 60^\circ$

$$T_2 = \frac{T_1 \cos 60^\circ}{\cos 25^\circ}$$

$$T_2 = \frac{296 * \cos 60^\circ}{\cos 25^\circ}$$

$$\boxed{T_2 = 163.299932\ N} \#$$

* Ex: (A 5Kg) object placed on a frictionless, horizontal talbe is connected to a string that passes over a pulley and then is fastened to a hanging (9 Kg) object, as in Figure. Draw free-body diagrams of both objects. Find the (acceleration) of the two objects and the (tension) in the string?



- Solution: (I) $*n = w$

$n = mg$

$n = 5 * 10 = \boxed{50\ N}$

$*T = m_1 a$

$T = 5a \rightarrow ①$

(II) $w - T = ma$

$mg - Tg = ma$

$9 * 10 - 9T = 9a$

$90 - 9T = 9a$

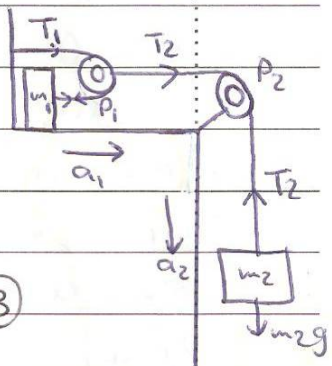
$90 = 14a$

$\boxed{a = 6.4\ m/s^2} \# \Rightarrow T = 5a$ (①و②)

$T = 5 * 6.4 = \boxed{32.2\ N} \#$

22

* **Ex:** An object of mass m_1 on a frictionless horizontal table is connected to an object of mass m_2 through a very light pulley P_1 and a light fixed pulley P_2 as shown in figure. (a) If a_1 and a_2 are the acceleration of m_1 and m_2 respectively, what is the relation between these acceleration? Express? (b) the tensions in the strings and (c) the acceleration a_1 and a_2 in terms of the masses m_1 and m_2 and g?



(a) $a_1 = a_2$

(b) $\sum F = ma$

$T_1 = m_1 a_1 = 2 m_1 a_2 \longrightarrow (1)$

$m_2 g - T_2 = m_2 a_2 \longrightarrow (2)$

$T_2 - 2T_1 = 0 \longrightarrow (3) \longrightarrow T_2 = 2T_1 \longrightarrow (3)$

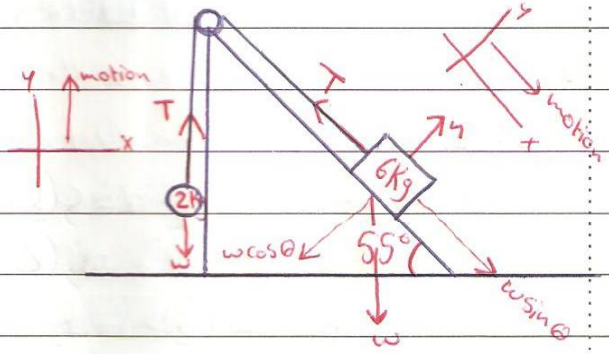
(3 in 2) $m_2 g - 2T_1 = m_2 a_2 \longrightarrow (4)$

add (1) with (2): $\frac{T_1}{m_1}\left(2m_1 + \frac{m_2}{2}\right) = m_2 g$ So $\boxed{T_1 = \frac{m_1 m_2 g}{2m_1 + 0.5 m_2}}$

$\boxed{T_2 = \frac{m_1 m_2 g}{m_1 + 0.25 m_2}}$

(c) $T_1 = m_1 a_1 \Rightarrow \boxed{a_1 = \frac{T_1}{m_1} = \frac{m_2 g}{2m_1 + 0.5 m_2}}$ and $\boxed{a_2 = \frac{1}{2} a_1 = \frac{m_2 g}{4m_1 + m_2}}$

Ex Two objects are connected by a light string that passes over a frictionless pulley, as in Figure. Draw free-body diagrams of both objects. If the incline is frictionless and if ($m_1 = 2Kg$), ($m_2 = 6Kg$), and ($\Theta = 55°$), find (a) the accelerations of the objects. (b) the tension in the string. (c) the speed of each object 2S after being released from rest?



- Solution: (a)

(I) $T - w = m_1 a$

$T - m_1 g = m_1 a$

$T - 2*10 = 2*a$

$T - 20 = 2a$

$T = 2a + 20 \rightarrow (1)$

(II) $w\sin\Theta - T = m_2 a$

$m_2 g \sin 55° - T = m_2 a$

$6*10*\sin 55° - T = m_2 a$

$49 - T = 6a$

$49 - 2a - 20 = 6a$

$49 - 20 = 8a$

$\boxed{a = 3.643640332\ m/s^2}$ #

(b) Solution: $T = 2a + 20$

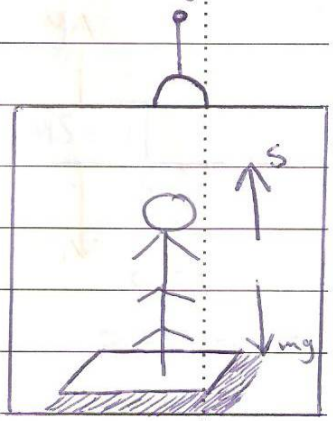
$\boxed{T = 27.28728066\ N}$ #

(c) $v_f = v_i + at$

$v_f = 0 + (3.6*2) = \boxed{7.287280664\ m/s}$ #

* Ex8- (A 72 Kg) man stands on a spring scale in an elevator. (Starting from rest) the elevator ascends, attaining it's maximum (speed of 1.2 m/s in 0.8 S). It traveles with this (constant speed for the next 5 S) (The elevator then undergoes a uniform acceleration in the negative y direction for 1.5 S and comes to rest) what does the spring scale register (a) before the elevator starts to move? (b) During the first 0.8 S? (c) while the elevator is traveling at constant speed? (d) During the time it is slowing down?

* Solution: (a) before the elevator starts to move $a_y = 0$



$$\sum \vec{F} = m a_y$$
$$S - mg = m * 0$$
$$S = mg$$
$$S = 72 \times 9.8$$
$$\boxed{S = 705.6\ N}$$

(b) During the first 0.8 S: $v_f = v_i + at \Rightarrow 1.2 = 0 + 0.8a$

$$\boxed{a = 1.5\ m/s^2}$$

$$\sum \vec{F} = m a_y$$
$$S - mg = m a_y$$
$$S - (72 * 9.8) = (72 * 1.5)$$
$$\boxed{S = 813.4\ N}$$

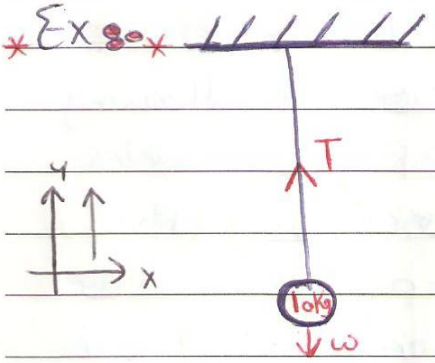
(c) while moving at constant velocity: $a_y = 0 \Rightarrow \boxed{S = 705.6\ N}$

(d) During the time it is slowing down: $v_{fy} = v_{iy} + a_y t$

$$-1.2 = 0 + a_y * 1.5$$
$$\boxed{a_y = -0.8\ m/s^2}$$
$$S - (72 * 9.8) = 72 * -0.8$$
$$\boxed{S = 648\ N}$$

NOTEBOOK

*Ex: Find the weight and tension?



$\sum \vec{F_y} = 0$

$T - \omega = 0$

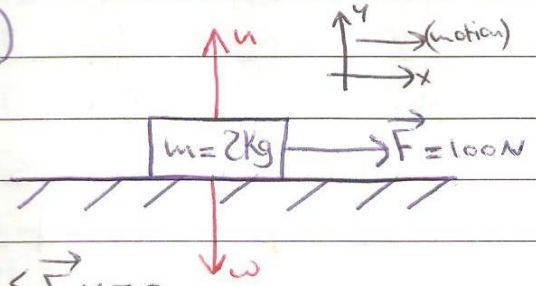
$T = \omega$

$T = mg$

$\boxed{T = 10 * 10 = 100\ N}$ #

*Ex: Find the (ω), normal force, Tension, acceleration, net force ??? in the following cases???

(I)



- Solution:

*$\omega = mg$

$\omega = 2 * 10$

$\boxed{\omega = 20\ N}$ #

*$\sum \vec{F_y} = 0$

$N - \omega = 0$

$N = \omega$

$\boxed{N = 20\ N}$ #

*$\sum \vec{F_y} = ma$

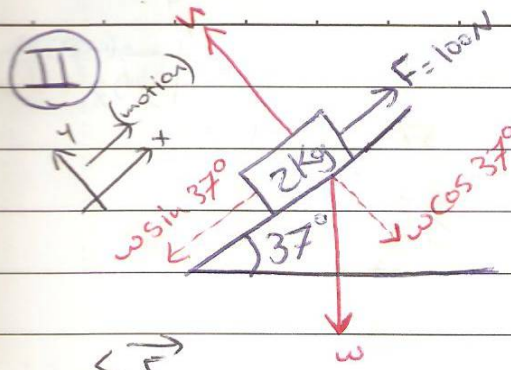
$100 = 2a$

$\boxed{a = 50\ m/s^2}$ #

موجبة اذا كانت باتجاه (motion) والسالبة عكسه اما اذا كان في حالة سكون او بسرعة ثابتة..

*Net force $= 20 - 20 + 100 = \boxed{100\ N}$ #

(II)



- Solution:

* $w = mg$

$w = 2 * 10$

$\boxed{w = 20\ N}$ #

* $\sum \vec{F}_y = 0$

$N - w\cos 37^\circ = 0$

$N = 20\cos 37^\circ$

$\boxed{N = 16\ N}$ #

* $\sum \vec{F}_x = ma$

$100 - w\sin 37^\circ = ma$

$100 - 20\sin 37^\circ = 2 * a$

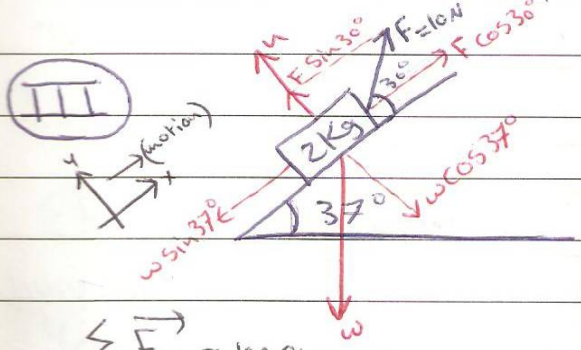
$100 - 12 = 2a$

$\boxed{a = 44\ m/s^2}$ #

* Net force $= 16 - w\cos 37^\circ + 100 - w\sin 37^\circ$

$= 16 - 16 + 100 - 12 = \boxed{88\ N}$ #

(III)



- Solution:

* $w = mg$

$w = 2 * 10 = \boxed{20N}$ #

* $\sum \vec{F}_x = ma$

$10\cos 30^\circ - 20\sin 37^\circ = 2a$

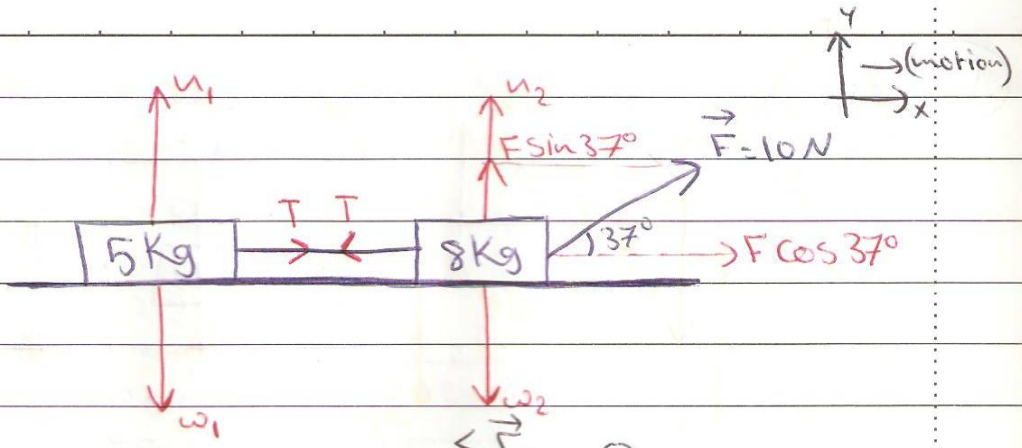
$\boxed{a = -1.688023213\ m/s^2}$ #

عكس الاتجاه الافتراضي (motion)

* Net force $= F\cos 30^\circ - w\sin 37^\circ + \sum \vec{F}_y^{\,\circ}$

$= \boxed{-3.376076425\ N}$ #

III



* $\omega_1 = m_1 g$

$\omega_1 = 5*10 = \boxed{50\,N}$ #

$\omega_2 = m_2 g$

$\omega_2 = 8*10 = \boxed{80\,N}$ #

* $\sum \vec{F}_{y_1} = 0$

$N_1 - \omega_1 = 0$

$N_1 = \omega_1$

$\boxed{N_1 = 50\,N}$ #

* $\sum \vec{F}_{y_2} = 0$

$N_2 + F\sin 37° - \omega_2 = 0$

$\boxed{N_2 = 74\,N}$ #

* $\sum \vec{F}_{x_2} = m_2 a$

$F\cos 37 - T = m_2 a$

$10\cos 37 - T = 8a$

$\boxed{8 - T = 8a}$ → ①

* net force :

$\sum \vec{F} = m_{total}\, a$

$= (5+8)*0.6$

$= \boxed{8\,N}$ #

$\sum \vec{F}_{x_1} = m_1 a$

$\boxed{T = 5a}$ → ②

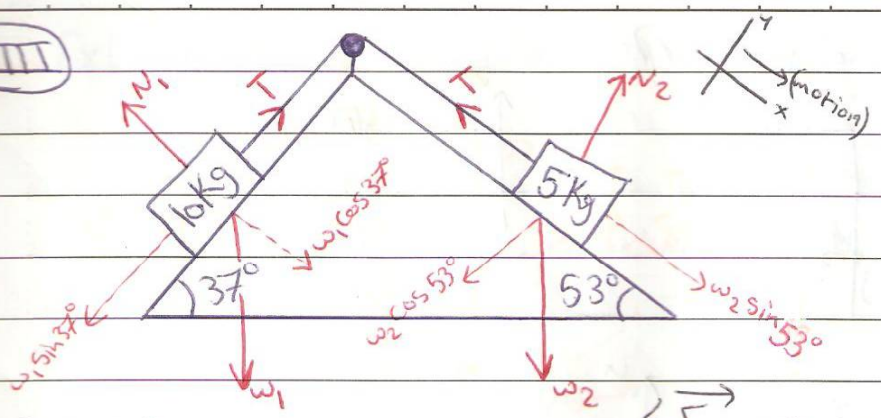
* $T = 5a$

$\boxed{T = 3\,N}$ #

(2 in 1) : $8 - 5a = 8a$

$8 = 13a$

$\boxed{a = 0.6153846153\ m/s^2}$ #



* $w_1 = m_1 g$

* $w_1 = 10 * 10 = \boxed{100N}$ #

* $w_2 = m_2 g$

$w_2 = 5 * 10 = \boxed{50N}$ #

* $\sum \vec{F}_{x_1} = m_1 a$

$T - w_1 \sin 37° = ma$

$T - 60 = 10a$

$T = 10a + 60 \rightarrow (1)$

$\sum \vec{F}_{x_2} = m_2 a$

$w_2 \sin 53° - T = m_2 a$

$40 - T = 5a \rightarrow (2)$

(1 in 2): $40 - 10a - 60 = 5a$

$40 - 60 = 5a + 10a$

$-20 = 15a$

$\boxed{a = -1.3 \ m/s^2}$ #

(motion) السالب يدل على

* $\sum \vec{F}_{y_1} = 0$

$N_1 - w_1 \cos 37° = 0$

$\boxed{N_1 = 80N}$ #

* $\sum \vec{F}_{y_2} = 0$

$N_2 - w_2 \cos 53° = 0$

$\boxed{N_2 = 3N}$ #

* net Force =

$= m_{totale} \ a$

$= (10+5) * 1.3$

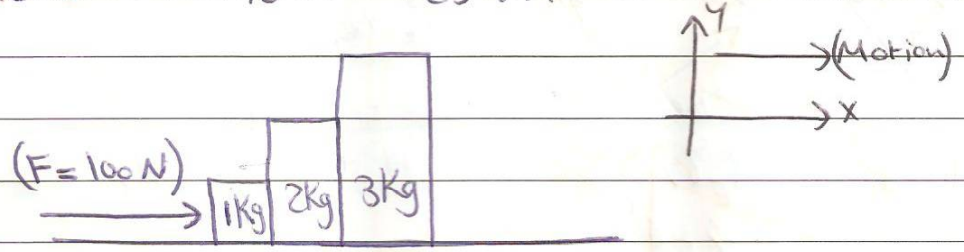
$= \boxed{20N}$ #

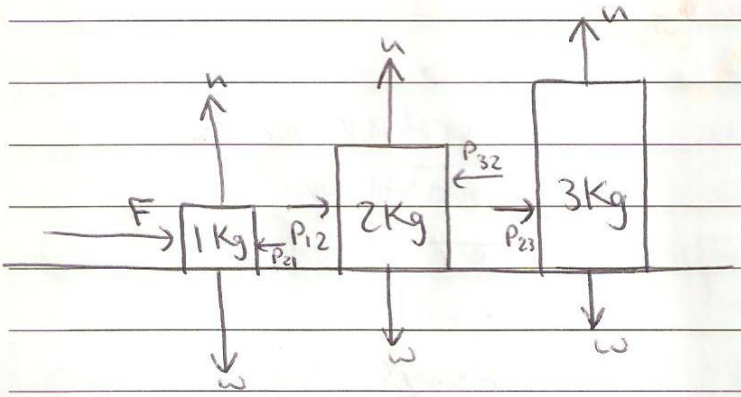
* $T = 10a + 60$

$\boxed{T = 46.6 \ N}$ #

(نتيجة السالب بالسالب)

*Ex: find P_{12} and P_{23} ???





- Solution : $\Sigma F_x = m a$

$$100 = (1+2+3) * a$$

$$\boxed{a = 16.7\ m/s^2}$$ //

(I) $\Sigma \vec{F}_{x_1} = m_1 a$

$$F - P_{21} = 1 * 16.7$$

$$100 - P_{21} = 16.7$$

$$P_{21} = 100 - 16.7 = \boxed{83.3\ N}$$ //

$$\boxed{P_{21} = -P_{12}}$$

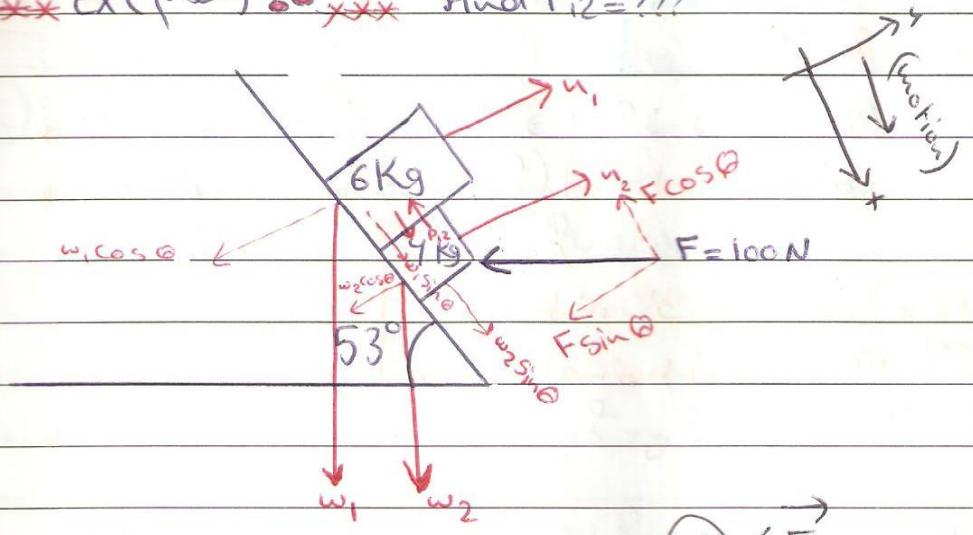
(II) $P_{12} - P_{32} = m_2 a$

$$83.3 - P_{32} = 2 * 16.7$$

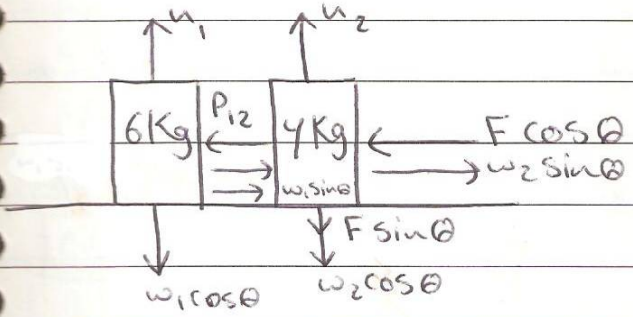
$$\boxed{P_{32} = 49.9\ N}$$ //

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*** Ex (prob) *** Find P_{12} = ???



- Solution:



* (I) $\Sigma \vec{F}_x = m_1 a$

$w_1\sin\theta - P_{12} = m_1 a$

$m_1 g\sin\theta - P_{12} = m_1 a$

$6 * 10\sin 53° - P_{12} = 6a$

$48 - P_{12} = 6a$

$\boxed{P_{12} = 48 - 6a}$ ⟹ (1)

$*P_{12} = 48 - 6*2$

$\boxed{P_{12} = 36}$ #

* (II) $\Sigma \vec{F}_x = m_2 a$

$P_{12} + w_2\sin\theta - F\cos\theta = m_2 a$

$P_{12} + (4 * 10\sin 53°) - (100\cos 53°) = 4a$

$P_{12} + 32 - 60 = 4a$

$P_{12} - 28 = 4a$

$\boxed{P_{12} = 4a + 28}$ ⟹ (2)

$*P_{12} = (4 * 2) + 28$

$\boxed{P_{12} = 36}$ #

*** $P_{12} = -P_{21}$

$48 - 6a = -(4a + 28)$

$48 - 6a = 4a + 28$

$20 = 10a$

$\boxed{a = 2}$ m/s^2 #

(بالعربي)

$P_{12} = 48 - (6 * 2)$

$P_{12} = 48 + 30$

$\boxed{P_{12} = 78\,N}$ #

(8-5) Forces at Friction :: (قوى الإحتكاك)

* قوة الإحتكاك هي قوة مقاومة قوى ، لذا تكون بإتجاه الحركة ..
* قوة الإحتكاك الساكن (Force of Static Friction) (f_s) يتراوح مقدارها بين

$$f_s \leq \eta_s N$$

(η_s معامل الإحتكاك الساكن (coefficient of static friction)) ، (N القوة العمودية (normal force))

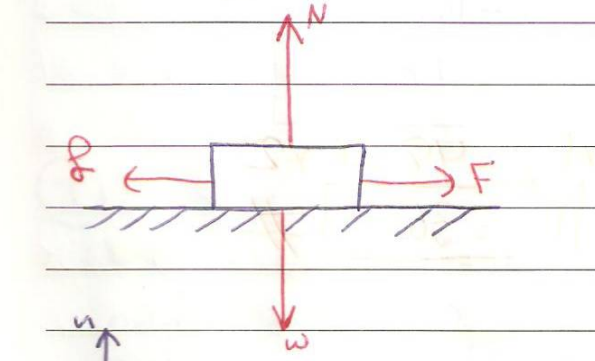
* عندما تكون : $f_s = f_{s_{max}} = \eta_s N$ ... (Impending Motion) على وشك الحركة

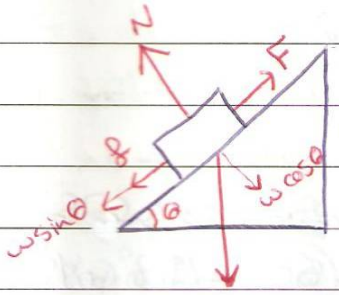
* قوة الإحتكاك الحركي (Force of Kinetic Friction) يعطى بالعلاقة

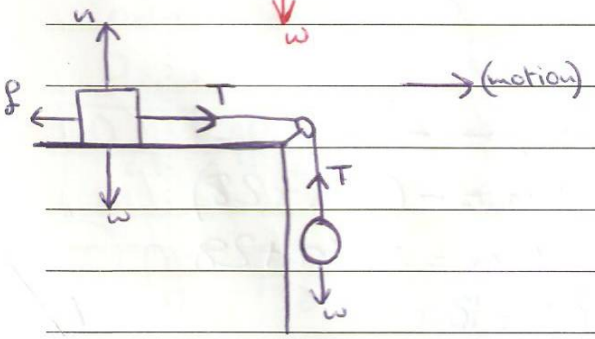
$$f_K = \eta_K N$$

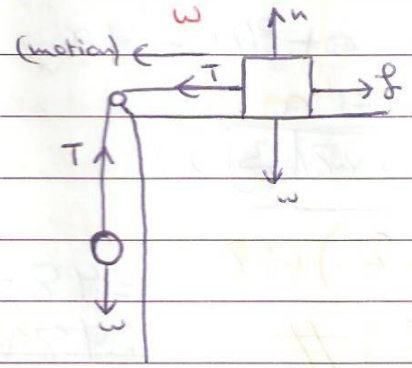
(η_K معامل الإحتكاك الحركي (coefficient of Kinetic friction))

* مثال :



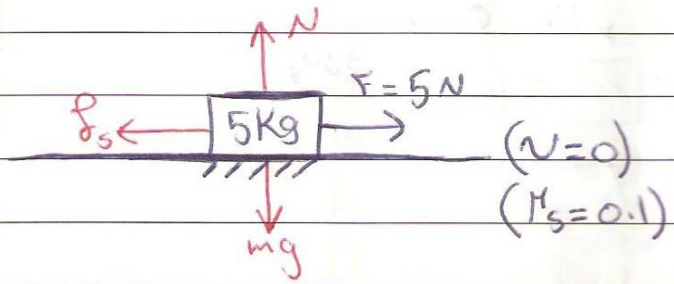






Ex find tension, acceleration and (force of Kinitic friction) or (force of static friction)?

(I)



$(N = 0)$

$(\mu_s = 0.1)$

-Solution: $*\sum \vec{F_x} = 0$

$5 - f_s = 0$

$\boxed{f_s = 5N} \Rightarrow$ or $(f_s = \mu_s * N)$

$f_s = 0.1 * 50$

$\boxed{f_s = 5N}$ #

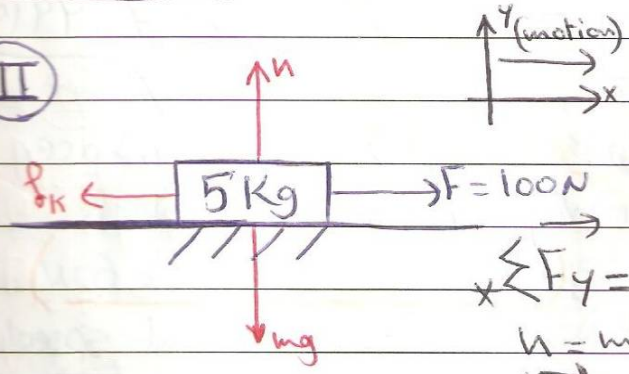
$*\sum \vec{F_y} = 0$

$N - mg = 0$

$N - 5*10 = 0$

$\boxed{N = 50\ N}$ #

(II)



-find μ_K???

$*\sum F_y = 0$

$N = mg \Rightarrow N = 5*10 = \boxed{50\ N}$

$*\sum \vec{F_x} = 0$

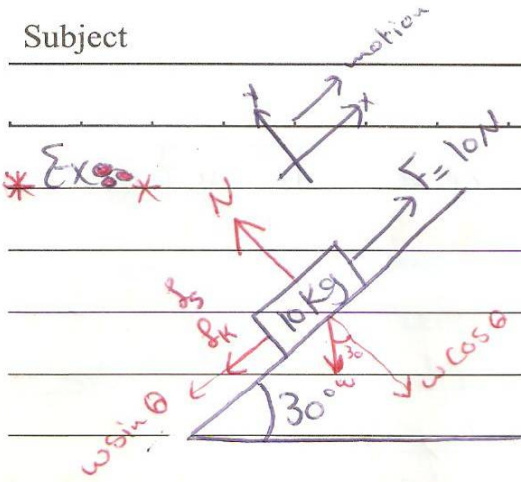
$F - f_K = 0$

$F = f_K$

$\mu_K * N = F$

$\mu_K * 50 = 100 \Rightarrow \boxed{\mu_K = 2}$ #

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* Ex:
* Find acceleration???
* $\mu_s = 0.2$
* $\mu_k = 0.1$

(=30)

Solution: $\sum \vec{F}_y = 0$

$N - w\cos\theta = 0$

$N = w\cos\theta$

$N = mg\cos\theta = 10 * 10\cos 30° = \boxed{86.6\ N}$

$\rightarrow$

$* \sum F_x = ma$

$F - (f_k + w\sin\theta) = ma$

$100 - (n * \mu_k + w\sin\theta) = ma$

$100 - (86.6 * 0.1 + 100\sin 30) = 10 * a$

$100 - 58.66025904 = 10a$

$\boxed{a = 4.133974596\ m/s^2}$ $\neq$

$* \sum F_x = ma$

$F - (f_s + w\sin\theta) = ma$

$100 - (\mu_s + w\sin\theta) = ma$

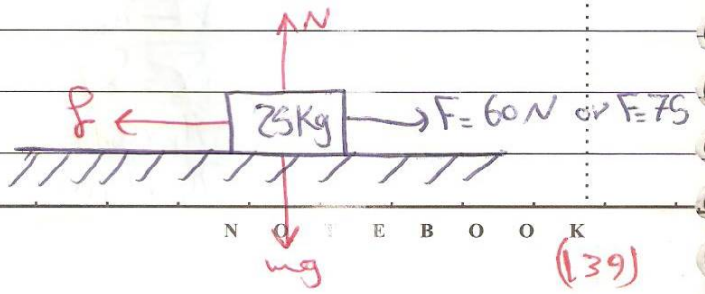
$100 - (86.6 * 0.2 + 100\sin 30) = 10a$

$100 - 67.3 = 10a$

$\boxed{a = 3.267974919}$ $\neq$

(8)

* Ex: A 25Kg block is initially at rest on a horizontal surface. A horizontal force of 75N is required to set the block in motion. After it is in Motion, a horizontal force of 60N is required to keep the block moving with constant speed. Find the coefficients of static and Kinetic friction from this information?



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- Solution: $\sum \vec{F}_y = 0$

$N - mg = 0$

$N = mg$

$N = 25 * 10 = \boxed{250\,N}$ #

$\sum \vec{F}_x = 0$

$F = f \Rightarrow f = \mu * N \Rightarrow \boxed{\mu = \frac{f}{N}}$

$\Rightarrow \mu_s = \frac{75}{250} = \boxed{0.3}$ # $\Rightarrow \mu_K = \frac{60}{250} = \boxed{0.24}$ #

* Ex: A 3Kg block starts from rest at the top of a 30° incline and slides a distance of 2m down the incline in 1.5s. Find (a) the magnitude of the acceleration of the block (b) the coefficient of Kinetic friction between block and plane. (c) the friction force acting on the block (d) the speed of the block after it has slid 2m.

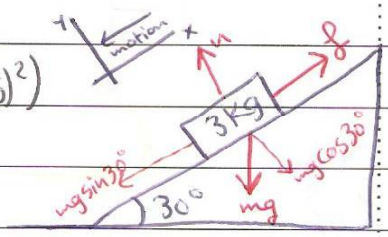
- Solution (a): $x_f - x_i = v_{ix} t + \frac{1}{2} a_x t^2$

$2 - 0 = 0 * 1.5 + \left(\frac{1}{2} a_x (1.5)^2\right)$

$2 = \frac{1}{2} a_x (1.5)^2$

$4 = a_x (1.5)^2$

$\boxed{a_x = 1.78\ m/s^2}$



(b) $\sum \vec{F}_y = 0 \Rightarrow N - mg\cos 30° = 0 \Rightarrow \boxed{N = 26\ N}$

$\sum \vec{F}_x = ma \Rightarrow mg \sin 30° - f = ma \Rightarrow 15 - f = 5.3 \Rightarrow \boxed{f = 9.6}$

$f_K = \mu_K * N$

$\mu_K = \frac{9.6}{26} = \boxed{0.372}$ #

(c) $f_K = \mu_K * N = \boxed{9.672\ N}$ #

(d) $(v_f)^2 = (v_i)^2 + 2a_x(x_f - x_i) \Rightarrow v_f = \sqrt{2 * 1.78 * 2} = \boxed{2.67\ m/s}$ # (140)

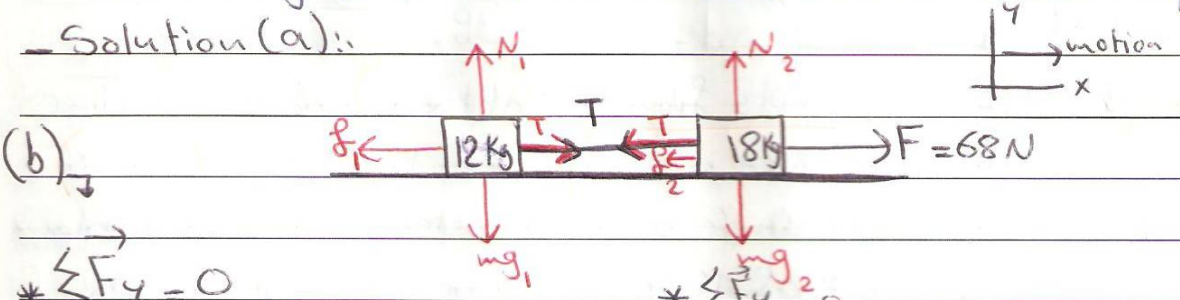
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Additional Problems:

* Ex: Two blocks connected by a rope of negligible mass are being dragged by a horizontal force F. Suppose that ($F = 68\,N$), ($m_1 = 12\,Kg$) ($m_2 = 18\,Kg$), and the (coefficient of kinetic friction between each block and the surface is (0.1)) (a) Draw a free-body diagram for each block. (b) Determine the tension T and the magnitude of the acceleration of the system?

- Solution (a)::



(b)

$* \sum \vec{F}_{y_1} = 0$

$N_1 - m_1 g = 0$

$N_1 = 12 * 10 = \boxed{120\,N}$ #

$* \sum \vec{F}_{x_1} = m_1 a$

$T - f_1 = m_1 a$

$T - (\mu * N_1) = m_1 a$

$T - 0.1 * 120 = 12a$

$T - 12 = 12a$

$\boxed{T = 12a + 12}$ → (1)

$* \sum \vec{F}_{y_2} = 0$

$N_2 - m g_2 = 0$

$N_2 = 18 * 10 = \boxed{180\,N}$ #

$* \sum \vec{F}_{x_2} = m_2 a$

$F - (T + f_2) = m_2 a$

$68 - (T + \mu * N_2) = m_2 a$

$68 - (T + 0.1 * 180) = 18a$

$68 - (T + 18) = 18a$

$68 - T - 18 = 18a$

$50 - T = 18a$

$\boxed{T = 50 - 18a}$ → (2)

$12a + 12 = 50 - 18a$

$12a + 18a = 50 - 12$

$30a = 38$

$\boxed{a = 1.26666667\ m/s^2}$ #

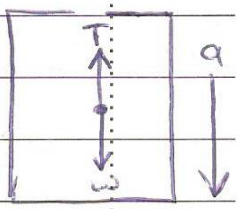
$\Rightarrow T = 12a + 12$

$T = 12 * 1.26 + 12$

$\boxed{T = 27.2\ N}$ #

* Ex: A lamp hangs vertically from a cord in a descending elevator that accelerations at $(2.4\ m/s^2)$. If the tension in the cord is 89 N, what is the mass of the lamp?

- Solution: $w - T = ma$



$mg - T = ma$

$m * 10 - 89 = m * 2.4$

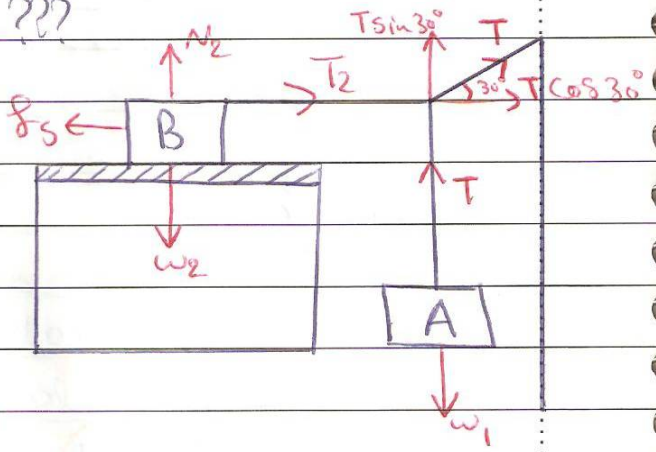
$10m - 89 = 2.4m$

$10m - 2.4m = 89$

$7.6m = 89$

$m = 11.7\ Kg \approx \boxed{12\ Kg}$ #

* Ex: Block B (weights 711 N) the coefficient of static friction between the block and the horizontal surface is 0.25. what is the maximum weight of block A for which the system will be stable (the angle 30°) ???



- Solution:

$\sum \vec{F}_{y_2} = 0$

$N_2 - w_2 = 0$

$N_2 = mg$

$N_2 = 711\,N$

$\sum \vec{F}_{x_2} = 0$

$f_s = T_2$

$\mu * N_2 = T_2$

$0.25 \times 711 = T_2$

$T_2 = 177.75$

$\sum \vec{F}_{y_1} = 0$

$T\sin 30° - w_1 = 0$

$w_1 = T\sin 30°$ → ①

$\sum \vec{F}_x = 0$

$T\cos 30° - T_2 = 0$

$T\cos 30° - 177.75 = 0$

$T = \frac{177.75}{\cos 30°}$

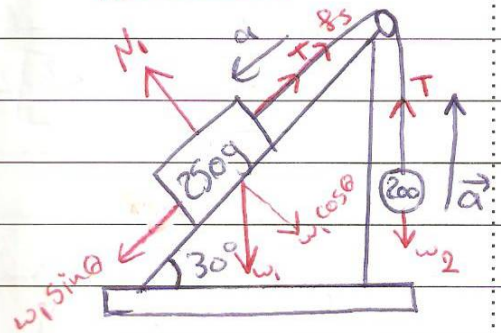
$T = 205.2480207\,N$

$w_1 = 205.2 * \sin 30°$ ① بالتعويض في

$w_1 = 102.6240104\,N$ #

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* Ex:- An object with a mass (M = 250g) is at rest on a plane that makes an angle (30°) above the horizontal (The coefficient of Kinetic friction between M and the plane is $\mu_K = 0.1$). Mass M is attached by a string with another mass (m = 200g), which hangs freely. Calculate (the speed??) of mass m when it has fallen (30 cm)?



- Solution:

* $\sum \vec{F}_{y_1} = 0$

$N_1 - w_1 \cos 30° = 0$

$N_1 = m_1 g \cos 30°$

$N_1 = 0.25 * 10 * \cos 30°$

$N_1 = 2.165063509\ N$

* $\sum \vec{F}_{x_1} = m_1 a$

$w_1 \sin 30° - f_s - T = m_1 a$

$mg \sin 30° - (\mu_s * n) - T = m_1 a$

$1.25 - (0.1 * 2.16) - T = 0.25a$

$1.034 - T = 0.25a$

* $\sum \vec{F}_y = 0$

$T - w_2 = 0$

$T - m_2 g = 0$

$T - 0.2 * 10 = 0$

$T - 2 = 0$

$T = 2$

$1.466506351 - 2 = 0.25a$

$a = -3.864\ m/s^2$

* $V_f^2 = V_i^2 + 2a_x \Delta x$

$V_f^2 = 0 + 2 * 3.8 * 30$

$V_f = 15.22629\ m/s^2$ #

* Ex: A mass is traveling at an initial speed $v_i = 25\ m/s$. It is (brought to rest) in (a distance of 62.5 m) by a (force of 15 N), evaluate the mass?

- Solution: $* v_f^2 = v_i^2 + 2a\Delta x$

$$0 = (25)^2 + (2 * a * 62.5)$$

$$-125a = 625$$

$$\boxed{a = -5\ m/s^2} \ \#$$

$$* \sum \vec{F} = ma$$

$$15 = -5 * m$$

$$\boxed{m = 3\ Kg} \ \#$$

* Ex: A tired worker pushes (a 100 Kg) box on a frictional surface. (The coefficients of Static and Kinetic are 0.6 and 0.4). The worker pushes with force (of 500 N) but the box still at rest. what is the frictional force exerted by the surface?

- Solution: $f_s = \mu_s * N$

$$f_s = 0.6 * mg$$

$$f_s = 0.6 * (100 * 10)$$

$$\boxed{f_s = 600\ N} \ \#$$

* Ex: Two forces $(\vec{F}_1 = 3i^\wedge - 5j^\wedge)$ and $(\vec{F}_2 = 3i^\wedge + j^\wedge)$ act on (2-kg) body. If the body is initially resting at origin, find its coordinates (after 4s)?

- Solution: $\sum \vec{F} = ma$

$$3i^\wedge - 5j^\wedge + 3i^\wedge + j^\wedge = 2 * a$$

$$6i^\wedge - 4j^\wedge = 2 * a$$

$$a = (3i^\wedge - 2j^\wedge)\ m/s^2$$

* $x_f - x_i = v_i t + \frac{1}{2} a_x t^2$

$$x_f - 0 = 0 + \frac{1}{2} * (3i^\wedge - 2j^\wedge)(4)^2$$

$$x_f = 8(3i^\wedge - 2j^\wedge)$$

$$\boxed{x_f = 24i^\wedge - 16j^\wedge} \#$$

* Ex: A mass (m) is traveling at (initial speed $v_i = 25\ m/s$). It is brought to rest in (a distance of (62.5 m)) by (a force of 15N). The mass is:

- Solution:

* $(v_f)^2 = (v_i)^2 + 2a(x_f - x_i)$

$$0 = (25)^2 + 2a(62.5 - 0)$$

$$-125a = 625$$

$$\boxed{a = -5\ m/s^2}$$

* $\sum \vec{F} = ma$

$$15 = 5 * m$$

$$\boxed{m = 3\ kg} \#$$

Subject Date No.

Ex 8: A block traveling on a rough horizontal surface with an initial speed of 40 m/s stops completely after traveling 160 m. find the coefficient friction between the block and the surface?

- Solution: $(v_f)^2 = (v_i)^2 + 2a(x_f - x_i)$

$0 = (40)^2 + 2a(160 - 0)$

$0 = 1600 + 320a$

$-320a = 1600$

$\boxed{a = -5 \text{ m/s}^2}$

$\sum \vec{F} = ma$

$f_K = ma$

$\mu_K * N = ma$

$\mu_K * mg = ma$

$\mu_K = \frac{a}{g} = \frac{5}{10} = \boxed{0.5}$ #

Subject *chapter(6)* Date No.

Uniform Circular Motion (الحركة الدورانية المنتظمة)

(1-6) Newtons Second Law Applied to uniform circular Motion :: (قانون نيوتن الثاني في الحركة الدائرية المنتظمة)

* طريقة حل المسألة في هذا الفصل تشبه الفصل الرابع والخامس:
1. نرسم ٢ مخطط القوى في جميع الحالات ومن ثم نطبق قانون نيوتن الثاني في كل اتجاه (محور x ومحور y) ...

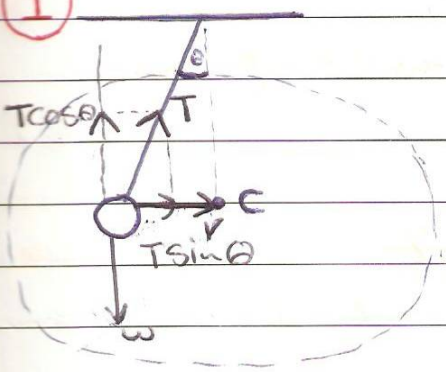
$$\Rightarrow \sum \vec{F} = ma$$

$$*a_c = \frac{v^2}{r} \quad \text{(التسارع المركزي)}$$

$$\sum \vec{F} = m\frac{v^2}{r}$$

(6)

(I)



$\Rightarrow$ X-axis :: (x-axis)

$$\sum \vec{F}_{x} = m\frac{v^2}{r}$$

$$T\sin\theta = m\frac{v^2}{r} \rightarrow (1)$$

$\Rightarrow$ y-axis ::

$$\sum \vec{F}_{y} = 0$$

$$T\cos\theta - \omega = 0$$

$$T\cos\theta = \omega$$

$$T\cos\theta = mg \rightarrow (2)$$

* بقسمة (1) على (2):

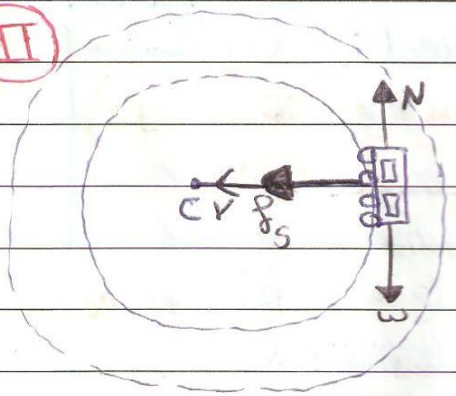
$$\frac{T\sin\theta}{T\cos\theta} = \frac{mv^2}{mgr}$$

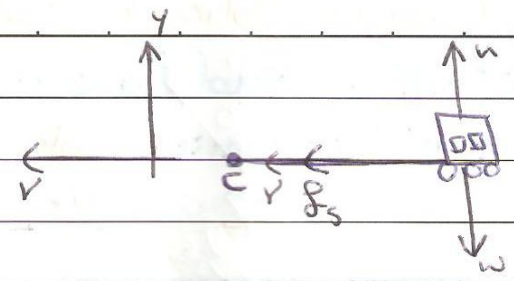
$$g r \tan\theta = v^2$$

$$\boxed{v = \sqrt{rg\tan\theta}} \quad \#$$

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II





$\rightarrow$ y-axis:

$$\sum \vec{F}_y = m a_c$$

$$f_s = m \frac{v^2}{r} \rightarrow (1)$$

$$\mu_s N = m \frac{v^2}{r} \rightarrow (1)$$

$\rightarrow$ y-axis:

$$\sum \vec{F}_y = 0$$

$$N - w = 0$$

$$N = mg \rightarrow (2)$$

بتعويض (2) في (1) لإيجاد (N):

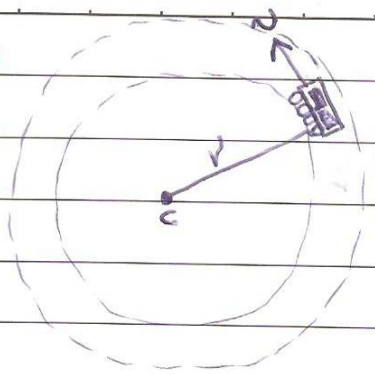
$$\mu_s \cdot mg = m \frac{v^2}{r}$$

$$\mu_s g r = v^2$$

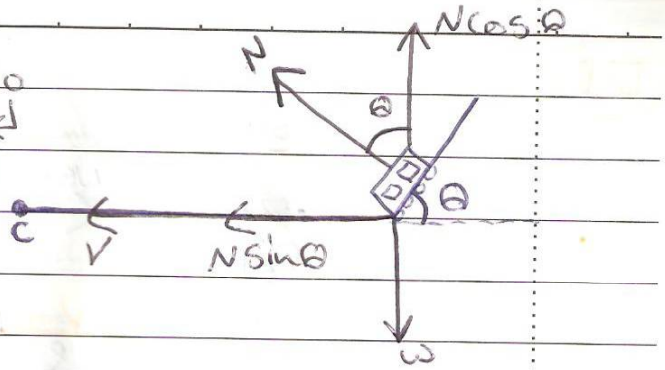
$$\boxed{v = \sqrt{r g \mu_s}} \quad //$$

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(٣٣)



* $\mu_s = 0$ (لا يوجد إمكان)



$\rightarrow$ (P-axis :)

$\sum \vec{F}_p = m \frac{v^2}{r}$

$N \sin\Theta = m \frac{v^2}{r}$ ——→ (1)

$\rightarrow$ (Y-axis :)

$\sum \vec{F}_y = 0$

$N \cos\Theta - w = 0$

$N \cos\Theta = mg$ ——→ (2)

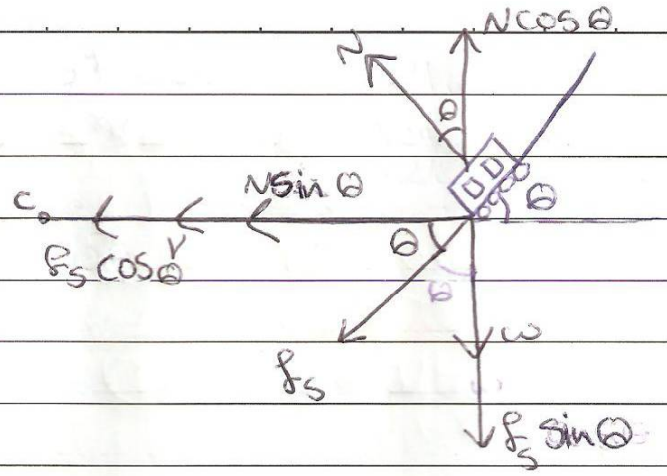
* بقسمة معادلة (1) على (2) :

$\frac{N \sin\Theta}{N \cos\Theta} = \frac{m v^2}{mgr}$

$rg \tan\Theta = v^2$

$v = \sqrt{rg \tan\Theta}$ //

(III)



⇒ (x-axis:)

$$\sum \vec{F}_x = m\frac{v^2}{r}$$

$$f_s \cos\theta + N\sin\theta = m\frac{v^2}{r} \longrightarrow (1)$$

⇒ (y-axis:)

$$\sum \vec{F}_y = 0$$

$$N\cos\theta - \omega - f_s \sin\theta = 0$$

$$N\cos\theta - f_s \sin\theta = \omega$$

$$N\cos\theta - f_s \sin\theta = \omega \longrightarrow (2)$$

∴ (1) ต้องการ x

$$f_s = \frac{mv^2}{\cos\theta r} - \frac{N\sin\theta}{\cos\theta}$$

$$\boxed{f_s = \frac{mv^2}{r\cos\theta} - N\tan\theta}$$ แทนค่าใน (3) ต้องการ (1)

$$N\cos\theta = \left(\frac{mv^2}{r\cos\theta} - N\tan\theta\right)\sin\theta = mg$$

$$N\cos\theta - \frac{mv^2\sin\theta}{r\cos\theta} + N\tan\theta\sin\theta = mg$$

$$N\cos\theta - \frac{mv^2}{r}\tan\theta + N\tan\theta\sin\theta = mg$$

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$$N\cos\theta - mg + N\tan\theta\sin\theta = \frac{mv^2\tan\theta}{r\sin\theta}$$

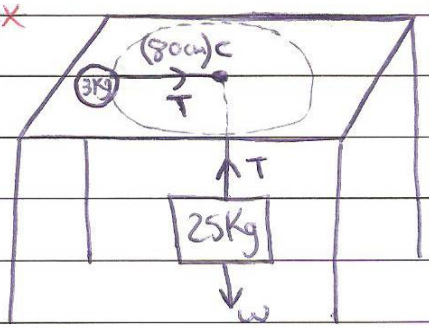
$$\sqrt{\frac{(N\cos\theta - mg + N\tan\theta\sin\theta)r}{m\tan\theta}} = v$$

$$v = \sqrt{\frac{Nr\cos\theta}{m\tan\theta} - \frac{mgr}{m\tan\theta} + \frac{Nr\tan\theta\sin\theta}{m\tan\theta}}$$

$$v = \sqrt{\frac{Nr\cos^2\theta}{m\sin\theta} - \frac{rg\cos\theta}{\sin\theta} + \frac{Nr\sin\theta}{m}}$$

$$v = \sqrt{\frac{Nr\cos^2\theta - rgm\cos\theta + Nr\sin^2\theta}{m\sin\theta}} \quad //$$

Ex



* $f_s = 0$
* $v = ???$ (السرعة الخطية)

$\Rightarrow$ (x-axis):

$$\sum F_x = m\frac{v^2}{r}$$

$$T = m\frac{v^2}{r}$$

$$T = 3\frac{v^2}{80}$$

$$\frac{80T}{3} = v^2 \rightarrow (1)$$

$\Rightarrow$ (y-axis):

$$\sum F_y = 0$$

$$T - w = 0$$

$$T = mg$$

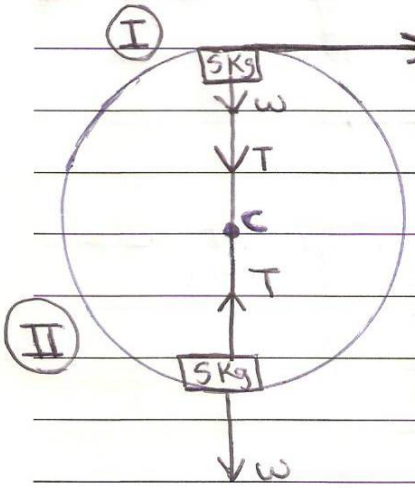
$$T = 25 * 10 = 250\,N$$

$$v^2 = \frac{80 * 250}{3} = 81.64965809\ m/s$$

(15.2)

NOTEBOOK

Ex Find the tension?



Solution:

(I) $\sum \vec{F}_r = m\frac{v^2}{r}$

$T + w = m\frac{v^2}{r}$

$T + mg = m\frac{v^2}{r}$

$T + 5*10 = 5*\frac{(10)^2}{1}$

$T + 50 = 5*100$

$T + 50 = 500$

$T = 500 - 50$

$\boxed{T = 450\ N}$ #

(II) $\sum \vec{F}_r = m\frac{v^2}{r}$

$T - w = m\frac{v^2}{r}$

$T - mg = m\frac{v^2}{r}$

$T - 5*10 = 5*\frac{(10)^2}{1}$

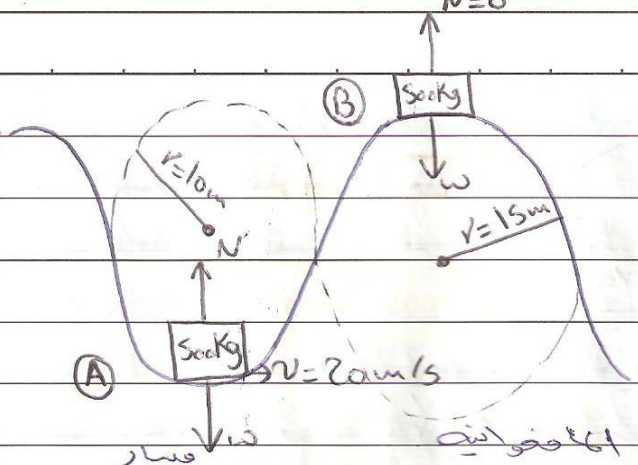
$T - 50 = 500$

$T = 500 + 50$

$\boxed{T = 550\ N}$ #

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Ex



- find force at track on roller coaster = (Normal force)?

Solution at point(A):

$$\Sigma \vec{F} = m\frac{v^2}{r}$$

$$N - w = m\frac{v^2}{r}$$

$$N - mg = m\frac{v^2}{r}$$

$$N - 500\times 10 = \frac{500\times(20)^2}{10}$$

$$N - 5000 = 20000$$

$$N = 20000 + 5000$$

$$\boxed{N = 25000\ N}\ \#$$

- find the maximum speed at (B) point?

(N = 0)

- Solution:

$$\Sigma \vec{F}_r = m\frac{v^2}{r}$$

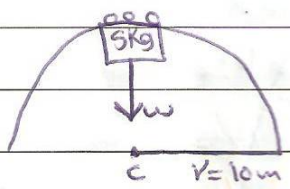
$$w = m\frac{v^2}{r}$$

$$mg = m\frac{v^2}{r}$$

$$10 = \frac{v^2}{15}$$

$$v = \sqrt{150} = \boxed{12.2474487\ m/s}\ \#$$

*Ex:- *



$v_{min} = ???$

↳ (u=0) ما يتحرك

- Solution :: $\sum \vec{F} = m \frac{v^2}{r}$

$w = m \frac{v^2}{r}$

$mg = m \frac{v^2}{r}$

$10 = \frac{v^2}{10}$

$v = \sqrt{100} = \boxed{10\ m/s}$ #

*Ex:- * In the Bohr model of the hydrogen atom, the speed of the electron is approximately ($2.20 * 10^6\ m/s$). find (a) the force acting on the electron as it revolves in a circular orbit of radius ($0.530 \times 10^{-10}\ m$) and (b) the centripetal acceleration of the electron? (mass = $9.11 * 10^{-31}\ kg$)

- Solution (a) :: $\sum F = m \frac{v^2}{r} = \frac{9.11 * 10^{-31} * (2.20 * 10^6)^2}{0.530 * 10^{-10}}$

$\boxed{\sum \vec{F} = 8.3193207555 * 10^{-8}\ N}$ #

solution (b) :: $a_c = \frac{v^2}{r} = \frac{(2.20 * 10^6)^2}{0.530 * 10^{-10}} = \boxed{9.13 * 10^{22}\ m/s^2}$ #

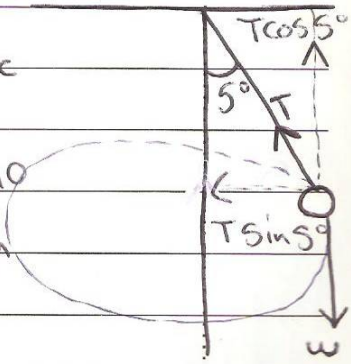
Ex A crate of eggs is located in the middle of the flat bed of a pickup truck as the truck negotiates an unbanked curve in the road. The curve may be regarded as an arc of a circle of radius (35 m). If the coefficient of static friction between crate and truck is 0.600, how fast can the truck be moving without the crate slide?

Solution:: $v = \sqrt{rg\mu_s} \Rightarrow v = \sqrt{35 \times 10 \times 0.6}$

$$v = 14.49137675 \text{ m/s}$$

(بدون تقريب)

Ex Consider a conical pendulum with an (80 Kg) bob on a (10 m) wire making an angle of 5° with the vertical. Determine (a) the horizontal and vertical components of the force exerted by the wire on the pendulum and (b) the radial acceleration of the bob?



*Solution (a):: $(y\text{-axis}:) \Rightarrow T\sin 5° = ma_c$

$(y\text{-axis}:) \Rightarrow T\cos 5° = mg$

$T \times 0.996 = 80 \times 10$

$$T = 803 \text{ N}\ \hat{j}$$

$(x\text{-axis}:) \Rightarrow T\sin 5° = 69.986 \text{ N}\ \hat{i}$

$\therefore T = (69.986\ \hat{i} + 803\ \hat{j})$ N

*Solution (b):: $T\sin 5° = ma_c$

$$\frac{69.986}{80} = a_c \Rightarrow a_c = 0.87482567 \text{ m/s}^2$$

NOTEBOOK

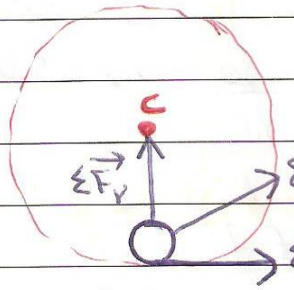
#

Subject Date No.

(2-6) Nonuniform circular Motion:
الحركة الدورانية غير المنتظمة

* في حال أن الجسم يتحرك في مسار دائري بسرعة متغيرة سواء زاد أو نقص فإن الجسم يمتلك مركبتين للتسارع الأولى عامودية للمسار والثانية مماسية للمسار وتكون محصلة التسارع (العجلة) الجسم

$$\vec{a} = \vec{a}_r + \vec{a}_t$$



كل مركبة من مركبات التسارع تنتج عن قوة أي أنها بنفس اتجاه التسارع وستكون هناك قوتين الأولى عامودية على المسار والثانية عودية عليه وبذلك تكون محصلة القوى (العامودية) الجسم

$$\vec{\Sigma F} = \vec{\Sigma F}_r + \vec{\Sigma F}_t$$

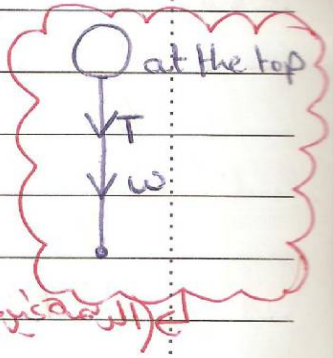
* Ex: * A hawk flies in a horizontal arc of (radius 12 m) at (a constant speed of 4 m/s). a) Find its centripetal acceleration. b) its continues to fly along the same horizontal arc but increases its speed at the rate of ($1.2\ m/s^2$). Find the acceleration (magnitude and direction) under these conditions?

Solution (a): $a_c = \frac{v^2}{r} = \frac{(4)^2}{12} = \frac{16}{12} = \boxed{1.33\ m/s^2}$ #

(b) $a = \sqrt{a_c^2 + a_t^2} = \sqrt{(1.33)^2 + (1.2)^2} = \boxed{1.79\ m/s^2}$ #

direction $\tan^{-1}\left(\frac{1.33}{1.2}\right) = \boxed{48^\circ}$ #

Ex: A (0.400 kg) object is swung in a vertical circular path on a string (0.500 m) long. If its speed is (4 m/s) at the top of the circle, what is the tension in the string there?



- Solution: $\sum \vec{F} = m\frac{v^2}{r}$

$$T + w = m\frac{v^2}{r}$$

$$T + mg = m\frac{v^2}{r}$$

$$T + (0.400 \times 10) = \frac{0.400 \times 4 \times 4}{0.500}$$

$$T + 4 = 12.8$$

$$T = 12.8 - 4$$

$$\boxed{T = 8.8\ N}\ \#$$

(7)

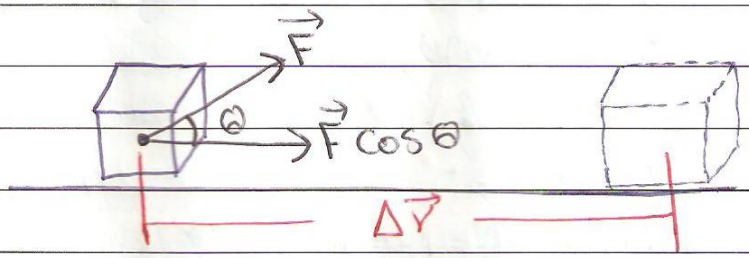
Go to index

Subject *chapter (7)* Date No.

Energy of a system

(2_7) work Done by a constant force :: (الشغل الناتج عن قوة ثابتة)

* الشغل عبارة عن كمية قياسية ناتج عن الضرب النقطي لمتجه القوة و متجه الازاحة

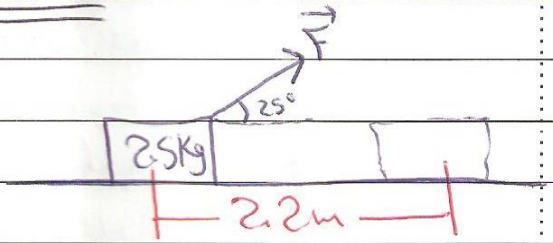


∴ يكون الشغل المبذول لإزاحة الجسم مسافة مقدارها Δr هو

$$W = F \Delta r \cos\theta \longrightarrow (N.m) \longrightarrow (J)$$

(جول) ووحدته بالـ

Ex A block of mass (2.5Kg) is pushed (2.2m) along a frictionless horizontal table by a constant (16 N) force directed 25° below the horizontal. Determine the work done on the block by :



a) The applied force.

↳ $W = F \Delta r \cos\theta$

$W = 16 * 2.2 * \cos 25°$

$\boxed{W = 31.9\ J}$ //

(b) The normal force exerted by table

↳ $W = F \Delta r \cos\theta$

$W = 16 * 2.2 * \cos 90°$

$\boxed{W = 0\ J}$

(c) The gravitational force. (القوة الجاذبية)

↳ $\omega = F D \cos\theta$

$\omega = 16 * 2.2 * \cos 90°$

$\boxed{\omega = 0\ J}$

(d) Determine the total work done on the block?

↳ $\omega_{total} = \omega_1 + \omega_2 + \omega_3$

$= 31.9 + 0 + 0 = \boxed{31.9\ J}$ #

(3_7) Dot product : (الضرب القياسي أو العددي)

$\Rightarrow \boxed{A.B = AB\cos\theta}$

* Ex: vector A has magnitude of 5 units and B has a magnitude of 9 units. The two vectors make an angle of 50° with each other. Find (A.B)?

_solution: $A.B = AB\cos\theta$

$A.B = 9 * 5 * \cos 50°$

$\boxed{A.B = 28.9}$ #

* Ex: The angle between the two vectors $\vec{A} = 3\hat{i} - 2\hat{j} + 5\hat{k}$ and $\vec{B} = 2\hat{i} + 4\hat{j} + 2\hat{k}$ is: _solution: $A.B = AB\cos\theta$

$(3*2)_{\hat{i}} + (-2*4)_{\hat{j}} + (5*2)_{\hat{k}} = \sqrt{(3)^2 + (-2)^2 + (5)^2} * \sqrt{(2)^2 + (4)^2 + (2)^2}\cos\theta$

$8 = \sqrt{38}\ \sqrt{24}\cos\theta$

$\cos^{-1}\left(\frac{8}{\sqrt{38}\sqrt{24}}\right) = \boxed{77.63860463°}$ #

*Ex: (page) A force $F=(6\hat{i}-2\hat{j})$ N acts on a particle that undergoes a displacement $\Delta r=(3\hat{i}+\hat{j})$ m

find:

(a) The work done by the force on the particle.

Solution:

$W=\Delta r * F * \cos\theta = F_x X + F_y Y$

$W=(6*3)+(-2*1)=18-2=\boxed{16\ J}$

(b) The angle between F and Δr?

$W=F\,\Delta r\cos\theta$

$16=\sqrt{(6)^2+(-2)^2} * \sqrt{(3)^2+(1)^2} * \cos\theta$

$16=\sqrt{40}*\sqrt{10}\cos\theta$

$\cos\theta=\frac{16}{\sqrt{40}\sqrt{10}}$

$\boxed{\theta=36.86989765^\circ}$ #

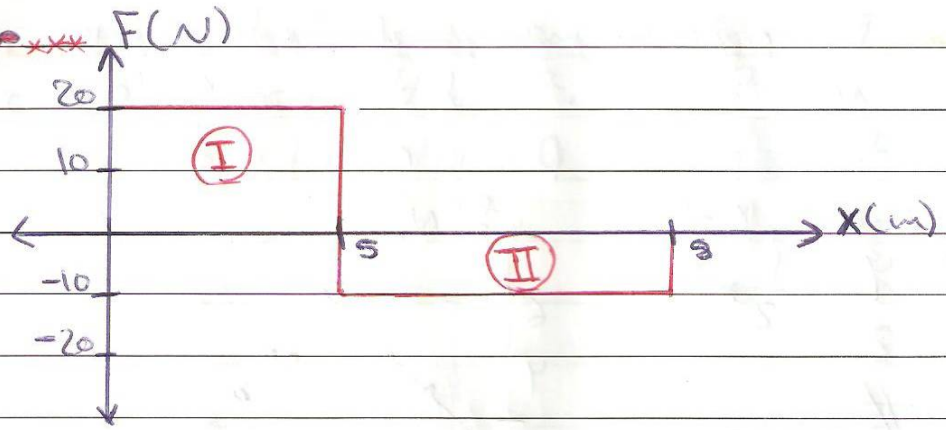
(7.4) Work Done by Varying Force: (الشغل الناتج من قوة متغيرة)

*Work = Area

$$*W=\int_{x_i}^{x_f}(\Sigma F_x)\,dx$$

$$*W=\int_{r_i}^{r_f}F\,dr=\int_{x_i}^{x_f}F\,dx+\int_{y_i}^{y_f}F\,dy+\int_{z_i}^{z_f}F\,dz$$

Ex



→ Find ω_I? ω_I = area = $20*5 = \boxed{100J}$ #

→ Find ω_{II}? ω_{II} = area = $-10*(8-5) = \boxed{-30J}$ #

→ Find total ω? $\omega = \omega_I + \omega_{II} = 100 - 30 = \boxed{70J}$ #

Ex A force $F = (4x_{\hat{i}} + 3y_{\hat{j}})N$, acts on an objects as the object moves in the x direction from the origin to $X = 5m$. Find the work done on the object by the force?

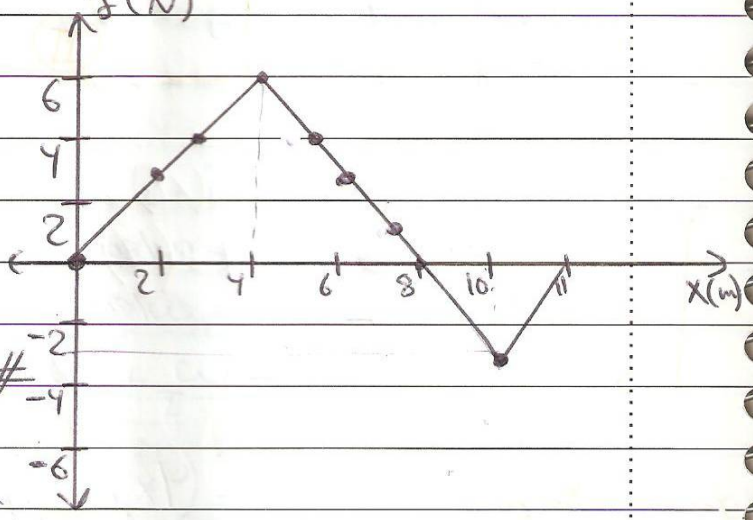
- Solution: $\int_0^5 (4x + 3y)\cdot dx = \int_0^5 4x\cdot dx + 0$

$$= \frac{4x^2}{2} = 2x^2 \Big]_0^5 = 2*5*5$$

$$= \boxed{50J}$$

#

Ex The force acting on a particle varies as in next figure. Find the work done by the force on the particle as it moves!:



(a) From $x=0$ to $x=8$ m

$$w = \frac{1}{2}*6*4 + \frac{1}{2}*6*4$$

$$w = 12 + 12$$

$$\boxed{w = 24\,J} \#$$

(b) From $x=8$ to $x=10$ m

$$w = \frac{1}{2}*2*-3 = \boxed{-3\,J} \#$$

(c) From $x=0$ to $x=10$ m

$$w = \frac{1}{2}*6*4 + \frac{1}{2}*6*4 + \frac{1}{2}*2*-3$$

$$w = 12 + 12 - 3$$

$$\boxed{w = 21\,J} \#$$

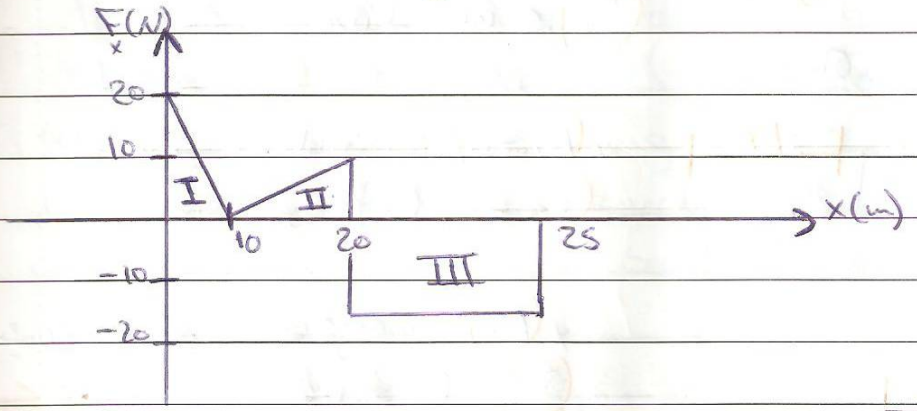
Ex $\vec{F} = (2x\,\hat{i} + 3y^2\,\hat{j})$ From the origin to $(\vec{r} = 2\hat{i} + \hat{j} + 5\hat{k})$ find the work?

Solution: $w = \int_0^2 2x\,dx + \int_0^1 3y^2\,dy + \int_0^5 0\,dz$

$$w = x^2\Big]_0^2 + y^3\Big]_0^1$$

$$w = 4 + 1 = \boxed{5\,J} \#$$

*** Ex *** Find the $work_I$, $work_{II}$ and total work, and $work_{III}$?



- Solution: $work_I = area = \frac{1}{2} \times 10 * 20 = \boxed{100\,J}$

$work_{II} = area = \frac{1}{2} * (20-10) * 10 = \boxed{50\,J}$

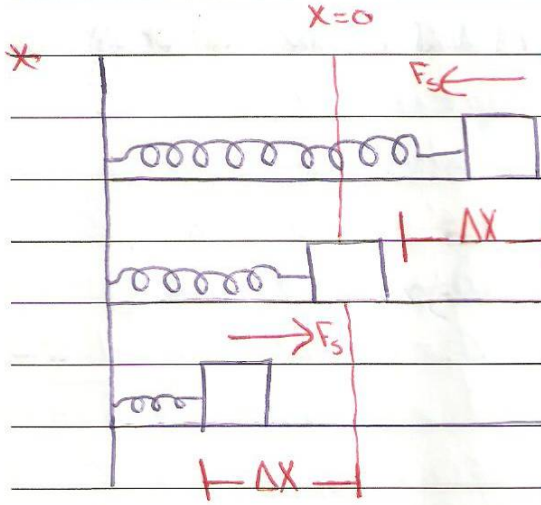
$work_{III} = area = (25-20) * -15 = \boxed{-75\,J}$

total work $= 100 + 50 - 75 = \boxed{75\,J}$ #

(1-4-7) work Done by a spring :

(الشغل المبذول من الزنبرك ..)

* الزنبرك عبارة عن نوع من القوة المرونية وهي قوة معاكسة لأي تغيير في وضع الجسم أي إزاحة (spring force) فعند سحب الزنبرك تكون القوة باتجاه معاكس لسحب أي تتجه لإعادة الزنبرك لحالته وعند ضغط الزنبرك أيضاً تعاكس هذه القوة هذا الوضع وتحاول إعادة الزنبرك إلى حالته الأصلية ..



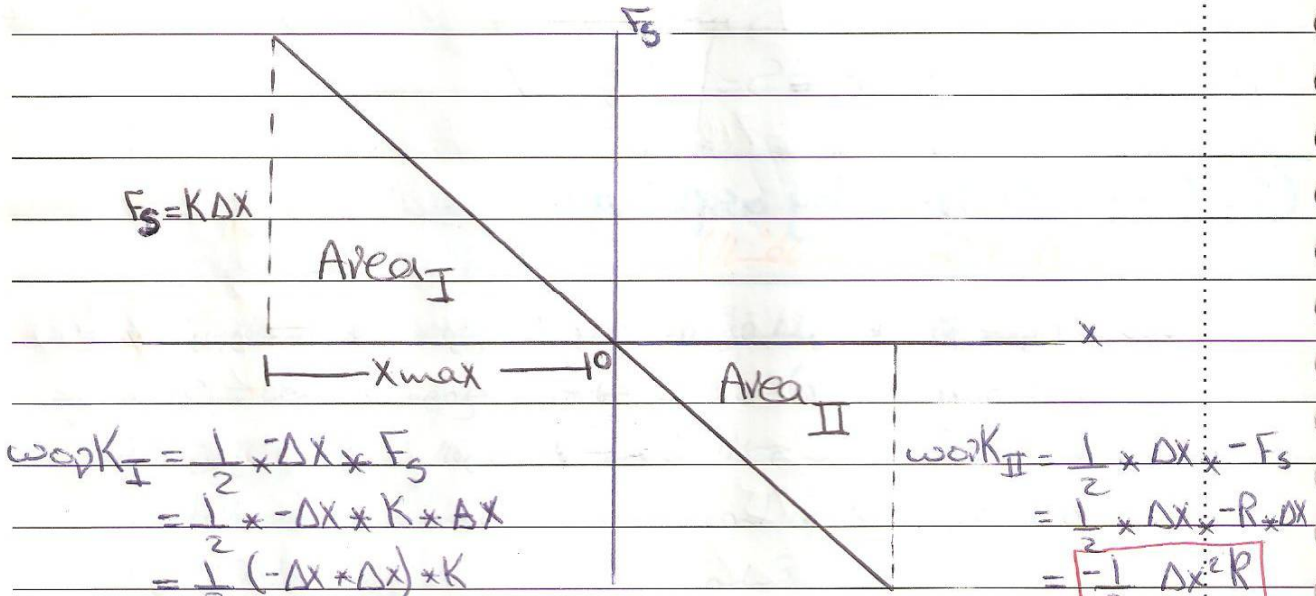
* في حالة الجذب الزنبرك (ΔX) is positive (F_s) is negative
* في حالة الإتزان $(\Delta X = 0)$ طول الزنبرك طبيعي $(F_s = 0)$
* في حالة الضغط الزنبرك (ΔX) is negative (F_s) is positive

← تقوّاز: قوة الزنبرك ← معايرة الزنبرك

$$F_s = -Kx$$

← ثابت الزنبرك
← الإزاحة الأساسية

وحساب الشغل الناتج بواسطة الزنبرك ← (عن طريق التكامل أي المساحة)



$$work_I = \frac{1}{2} * \Delta X * F_s$$
$$= \frac{1}{2} * -\Delta X * K * \Delta X$$
$$= \frac{1}{2}(-\Delta X * \Delta X) * K$$
$$= \boxed{\frac{1}{2}\Delta X^2 K}$$

$$work_{II} = \frac{1}{2} * \Delta X * -F_s$$
$$= \frac{1}{2} * \Delta X * -R * \Delta X$$
$$= \boxed{\frac{-1}{2}\Delta X^2 R}$$

$$\Rightarrow W_{spring} = \frac{1}{2}\Delta X^2_{max} R$$

* Ex: when a (4Kg) object is hung avertically on a certain light spring that obeys Hooke's law, the spring stretches (2.5cm) if the (4Kg) object is removed, (a) How far will the spring stretch if a (1.5Kg) block is hung on it? (b) How much work must an external agent do to stretch the same spring (4 cm) from its unscratched position?

⇒ Solution (a): $\because F_s = K * \Delta X$

$$Mg = K * \Delta X$$

$$(4 * 10) = K * (2.5 * 10^{-2})$$

$$40 = K * 25 * 10^{-3}$$

$$\boxed{K = 1600} \ (N/m)$$

(وحدة ثابت المرونة)

$$* F_s = K * \Delta X$$

$$Mg = K * \Delta X$$

$$(1.5 * 10) = 1600 * \Delta X$$

$$\boxed{\Delta X = 9.375 * 10^{-3} \ m} = 0.9375 \ cm$$

⇒ Solution (b): $\because work = \frac{1}{2} K \Delta X^2$

$$= \frac{1}{2} * 1600 * (4 * 10^{-2})^2$$

$$= 1.28 \ J \ \#$$

Subject Date No.

* Ex: An archer pulls her bowstring back (0.4m) by exerting a force that increases uniformly from zero to 230 N. (a) what is the equivalent spring constant of the bow? (b) How much work does the archer do in pulling the bow?

- Solution: (a) $F_s = K * \Delta X$

$$230 = K * 0.4$$

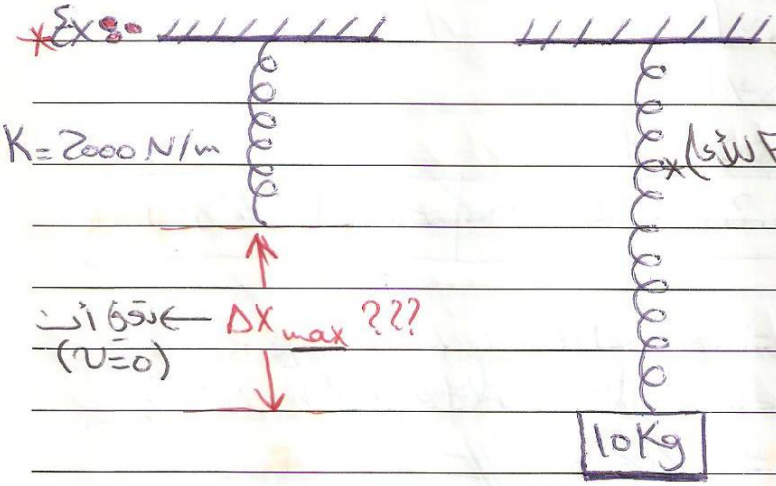
$$K = \frac{230}{0.4} \rightarrow \boxed{K = 575\ N/m}$$

- Solution: (b) $w = \frac{1}{2} K \Delta X^2$

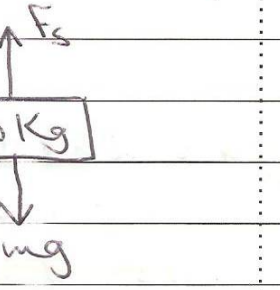
$$= \frac{1}{2} * 575 * (0.4)^2$$

$$= \boxed{46\ J} \#$$

* Ex:



- Solution:



$$\Sigma F_y = 0$$

$$F_s = mg$$

$$K * \Delta X = mg$$

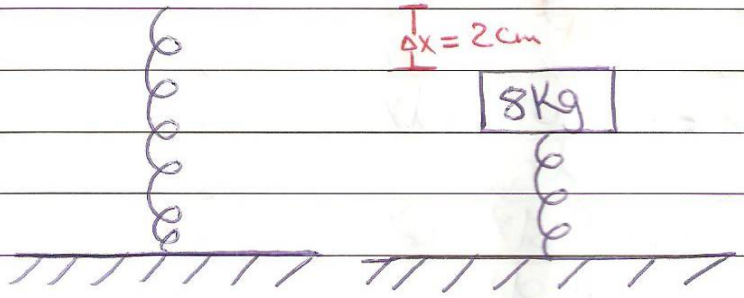
$$2000\ \Delta X = 10 * 10$$

$$\Delta X = \frac{100}{2000} = \boxed{0.05\ m} \#$$

E B O O K

Subject Date No.

Ex Find the spring constant ???



- Solution: * المنحنى كواحد على إذن F_s للأعلى

$F_s = w$

$K * \Delta X = mg$

$K * 2 = 8 * 10$

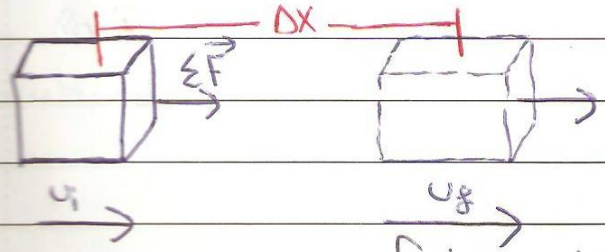
$K = \frac{80}{2} = \boxed{40\ N/cm}$ #



(5-7) Kinetic Energy and The work-Kinetic Energy Theorem:

*** عندما تتغير سرعة جسم ما فإنه يتم شغل (work) ...

ولنفرض أن هناك جسم بكتلة (m) تحرك للأمام بسرعة v_i حتى وصل إلى الموضع النهائي بسرعة v_f قاطعاً مسافة أفقية مقدارها Δx وتكون القوة التي أدت إلى الحركة مساوية لـ ($F = ma$) ويكون الشغل



$$* W = \int_{mg} \Sigma F \cdot dx$$

Subject Date No.

$$W = \int m a \cdot dx$$

$a = \frac{dv}{dt}$

$$= m \int \frac{dv}{dt} \cdot dx$$

$$= m \int \frac{dx}{dt} \cdot dv$$

$$= m \int_{v_i}^{v_f} v \cdot dv$$

$$= \frac{1}{2} m v^2 \Big]_{v_i}^{v_f}$$

$$* W = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$(W = \Delta K = K_f - K_i)$$

$$* K = \frac{1}{2} m v^2$$

إذا بذل شغل على نظام وكانت الزيادة الحاصلة في الوحدة في النظام ... فإن الشغل المبذول يساوي مقدار التغير في الطاقة الحركية للنظام ..

Ex (A 0.300Kg) ball has a speed of (15m/s)
(a) what is its Kinetic energy?
-Solution:: $K = \frac{1}{2} m v^2$

$K = \frac{1}{2} * 0.3 * 15 * 15$

$\boxed{K = 33.75 J}$ #

(b) what IF? If its speed were doubled, what would be its Kinetic energy?
-Solution:: $K = \frac{1}{2} m v^2$

$K = \frac{1}{2} * 0.3 * (30)^2$

$\boxed{K = 135 J}$ #

Ex A 3Kg object has object has a velocity $(6\hat{i} - 2\hat{j})$ m/s.
(a) what is its Kinetic energy at this time?
(b) Find the total work done on the object if its velocity changes to $(8\hat{i} + 4\hat{j})$ m/s?
-Solution(a):: $K = \frac{1}{2} m v^2$

$K = \frac{1}{2} * 3 * (\sqrt{(6)^2 + (-2)^2})^2$

$K = \frac{1}{2} * 3 * (6.324555532)^2$

$\boxed{K = 60 J}$ #

-Solution(b):: $W = \Delta K = K_f - K_i$

$W = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

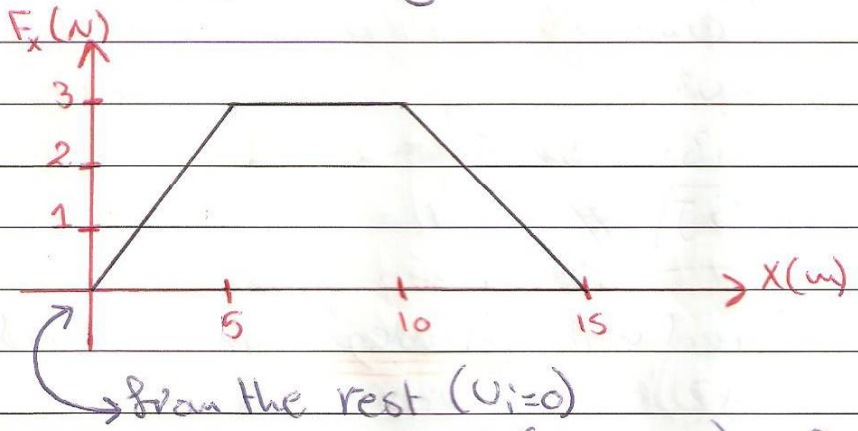
$W = \frac{1}{2} * 3 * ((8)^2 + (4)^2) - 60$

$W = 120 - 60$

$\boxed{W = 60 J}$ #

Subject Date No.

~~Ex~~ $M = 4\,Kg$



from the rest ($v_i = 0$)

- find the velocity at (5, 10, 15) m ?

- Solution (at X = 5m)

$$w = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$\text{area} = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$\frac{1}{2} * 5 * 3 = \frac{1}{2} * 4 * v_f^2 - 0$$

$$7.5 = 2 v_f^2$$

$$\boxed{v_f^2 = 3.75 \text{ m/s} \Rightarrow v_f = 1.9}$$

- Solution (at x = 10m)?

$$w = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$(3 * (10-5)) = \frac{1}{2} * 4 * v_f^2 - \frac{1}{2} * 4 * (1.936491673)^2$$

$$15 = 2 v_f^2 - 7.5$$

$$\boxed{v_f = 3.354101966 \text{ m/s}}$$

- Solution (at x = 15m) ?

$$\frac{1}{2} * 5 * 3 = \frac{1}{2} * 4 * v_f^2 - \frac{1}{2} * 4 * (3.3)^2$$

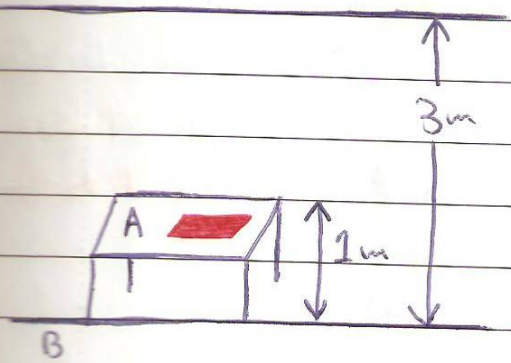
$$7.5 = 2 v_f^2 - 22.5$$

$$\boxed{v_f = 3.872983346 \text{ m/s}} \#\#$$

*** potential Energy and the work - potential Energy ***

$F = -\frac{dU}{dr}$	$U = mgh$ طاقة الوضع	$W = -\Delta U = U_f - U_i = (mgy_f - mgy_i)$

* Ex: * find the potential energy A, B and C ? Mass = 5Kg?



- Solution:

$U_A = mgh_A$
$= 5 * 10 * 0$
$= \boxed{0\ J}$

$U_B = mgh_B$
$= 5 * 10 * 1$
$= \boxed{50\ J}$

$U_C = mgh_C$
$= 5 * 10 * 2$
$= \boxed{100\ J}$

$$\Rightarrow \boxed{\Delta U = -\int F \cdot dr}$$

*** Ex: ① $U = 3x^3 + 5$, find the force at x = 2m?

- Solution:

$$F = -\frac{dU}{dr} = -(9x^2) = -(9 * (2)^2) = \boxed{-36N}\ \#$$

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② If $F = 3x^2 + 4$, from the origin ($U_i = 2J$), find the potential energy at $x = 3m$?

- Solution:

$$\Delta U = -\int F \cdot dr$$

$$U_f - U_i = -\int F \cdot dr$$

$$U_f - 2 = -\int 3x^2 + 4 \cdot dr$$

$$U_f - 2 = -(x^3 + 4x)$$

$$U_f - 2 = -(27 + 12)$$

$$U_f - 2 = -39$$

$$\boxed{U_f = -37\,J}$$ //

③ Find the work?

- Solution: $W = -\Delta U$

$$W = -(U_f - U_i)$$

$$W = -(-37 - 2)$$

$$\boxed{W = 39\,J}$$ //

Subject Date No.

*** Conservatives and noneConservatives forces ***
* القوة المحافظة والقوة غير المحافظة *

- Conservatives forces (القوة المحافظة)
  - * مثل: قوة الجاذبية الأرضية ...
  - الشغل المبذول من قوة محافظة على أي نظام بين أي نقطتين لا يعتمد على المسار المقطوع بين أي نقطتين ...
  - الشغل المبذول من قوة محافظة على أي نظام في مسار مغلق مقداره صفراً ...

$W_g = U_f - U_i$ (الشغل الجاذبية الأرضية) $(y_f = y_i)$

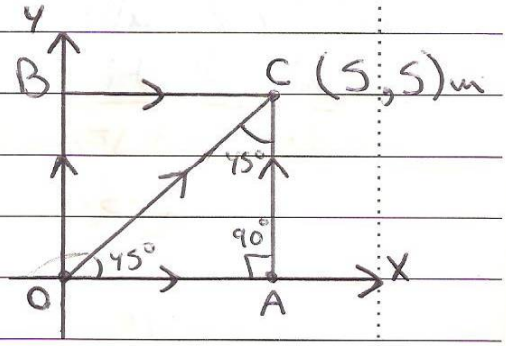
$W_g = mgh_f - mgh_i$ لأن ارتفاع النقطة الأولى والثانية متساوي ...

$\boxed{W_g = 0}$ (مسار مغلق)

- Nonconservatives forces (القوة غير المحافظة)
  - * مثل: قوة الإحتكاك ...

*** Ex 8 ***

A 4 Kg particle moves from the origin to position C, having coordinates X = 5m and y = 5m. one force on the particle is the gravitational force acting in the negative y direction. calculate the work done by the gravitational force in going from O to C along (a) OAC . b) OBC . c) OC . your results should all be identical . why?



90° A 180° B

- Solution (a) : $W = F.\Delta r.\cos\theta(oA) + F.\Delta r.\cos\theta(Ac)$

$W(oAc) = (mg).\Delta r\cos\theta + (mg).\Delta r\cos\theta$

$= (4*9.8)*5\cos 90 + (4*9.8)*5*\cos 180$

$= 0 + (-196)$

$= \boxed{-196\ J}$ #

- Solution (b) : $W = F.\Delta r\cos\theta(oB) + F.\Delta r.\cos\theta(Bc)$

$W = 39.2*5\cos 180 + 39.2*5*\cos 90°$

$= \boxed{-196\ J}$ #

- Solution (c) : $W = F.\Delta r\cos\theta(oc)$

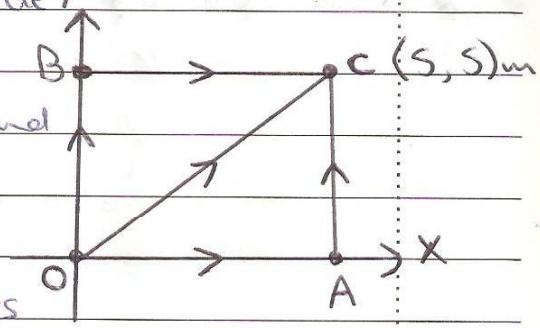
$= 39.2*\sqrt{(5)^2+(5)^2}*\cos 135°$ (180 − 45)

$= \boxed{-196\ J}$ #

* The results should all be the same, since gravitational forces are conservative.

قوة الجاذبية الأرضية قوة محافظة لذلك ـ وأن الشغل المبذول عليها لا يعتمد على المسار ...

Exa A force acting on a particle moving in the xy plane is given by $F=(2y\,\hat{i}+x^2\,\hat{j})$ N, where x and y are in meters. The particle moves from the origin to a final position having coordinates x = 5 m and y = 5 m, as in figure. Calculate the work done by F along (a) OAC (b) OBC (c) OC (d) If conservative or non conservative? Explain?



- Solution (a): $W(OAC) = W(OA) + W(AC)$

$$= F.\Delta r\cos\theta + F.\Delta r\cos\theta$$

$$= \int_0^5 (2y\,\hat{i}+x^2\,\hat{j}).dx + \int_0^5 (2y\,\hat{i}+x^2\,\hat{j}).dy$$

$$= \int_0^5 2y\,\hat{i}.dx + \int_0^5 x^2\,\hat{j}.dy$$

$(y=0)$ $(x=5)$

$$= 0 + ((5*5)*5)$$

(F, r)

$$= \boxed{125\ J}$$

- Solution (b): $W(OBC) = W(OB) + W(BC)$

$$= F.\Delta r\cos\theta + F.\Delta r\cos\theta$$

$$= \int_0^5 (2y\,\hat{i}+x^2\,\hat{j}) + \int_0^5 (2y\,\hat{i}+x^2\,\hat{j})$$

$$= \int_0^5 x^2\,\hat{j}.dy + \int_0^5 2y\,\hat{i}.dx$$

$(x=0)$ $(y=5)$

$$= 0 + ((2*5)*5) = \boxed{50\ J}$$

(F, r)

$y = x$ ←

Solution (C): $W(oc) = \int_0^5 (2x + x^2) \cdot dx$

$= X^2 + \frac{1}{3}x^3 \Big]_0^5$

$= 66.7$ //

*(F) is nonConservative since the work done is path dependent.

← ناظم الجيزاوي لانه الشغل يكون مختلف مسار لمسار آخر ..

***Relationship between Conservative Forces and potential ***

* العلاقة بين القوى المحافظة وطاقة الوضع *

$* W = \int_{x_i}^{x_f} F_x \cdot dx = -\Delta U$

$* \Delta U = U_f - U_i = -\int_{x_i}^{x_f} F_x \cdot dx$

$* F_x = \frac{dU}{dx}$

$* U_s = \frac{1}{2} K x^2$

$* U_g = mgy$

$* F_s = -mg$

Ex: A single conservative force acting on a particle varies as $F = (-Ax + Bx^2)\ i\ N$, where A and B are constant and x is in meters.

(a) Calculate the potential-energy function U(x) associated with this force, taking U = 0 at x = 0?

Solution: $U = -\int_0^x F \cdot dx = -\int_0^x (-Ax + Bx^2) \cdot dx$

$$\boxed{U = -\frac{Ax^2}{2} - \frac{Bx^3}{3}} \quad //$$

(b) Find the change in potential energy and the change in kinetic energy as the particle moves from x = 2m to x = 3m.

Solution: $U = -\int_2^3 (-Ax + Bx^2) \cdot dx$

$$\boxed{U = \frac{5}{2}A - \frac{19}{3}B} \quad //$$

$$\Delta K = -U$$

$$\boxed{\Delta K = \frac{5}{2}A + \frac{19}{3}B} \quad //$$

~~xxx~~ Ex:- ~~xxx~~ A potential-energy function for a two-dimensional force is of the form $U = 3x^3y - 7x$. Find the force that acts at the point (x, y)???

-Solution: $F_x = \frac{-dU}{dx} = \frac{d(3x^3y - 7x)}{dx}$

$F_x = -(9x^2y - 7)$

$F_x = (7 - 9x^2y)\ N$

$F_y = \frac{-dU}{dy} = \frac{d(3x^3y - 7x)}{dy}$

$F_y = -3x^3$

$\boxed{\vec{F} = (7 - 9x^2y)\hat{i} + (-3x^3)\hat{j}}$ //

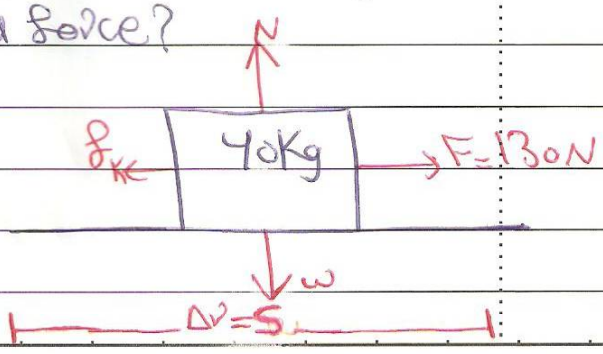
~~xxx~~ Ex:- A (40kg) box initially at rest is pushed (5m) along a rough, horizontal floor with a constant applied horizontal force of 130N. If the coefficient of friction between box and floor is 0.3, find:

(a) The work done by the applied force?

-Solution: $W = \Delta r \cdot F \cdot \cos\theta$

$W = 5 * 130$

$\boxed{W = 650\ J}$



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(b) The increase in internal energy in the box-floor system due to friction?

- Solution: $\Delta E_{int} = f_k * \Delta x$

$$\Delta E_{int} = (\mu_k * n) * \Delta x$$
$$= (0.3 * mg) * 5$$
$$= (0.3 * 40 * 9.8) * 5$$
$$= \boxed{588\ J}$$

(c) The work done by the normal force?

- $W = \Delta F . \Delta r . \cos\theta$
$= (N) . \Delta r . \cos 90°$
$= (mg) . \Delta r . \cos 90°$
$= 392 * 5 * \cos 90°$
$= \boxed{0}$

(d) The work done by the gravitational force?

- $W = F . \Delta r . \cos\theta$
$= (mg) . \Delta r . \cos\theta$
$= 392 * 5 * \cos 90°$
$= \boxed{0\ J}$

(e) The change in Kinetic energy of the box?

- Solution: $\Delta K = K_f - K_i$

$$\Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \quad (v_i = 0)$$
$$\Delta K = \frac{1}{2} * 40 * v_f^2$$

$* \sum F_x = ma$

$F - f_k = ma$

$$\frac{130 - (0.3 * 40 * 9.8)}{40} = \frac{40a}{40} \Rightarrow \boxed{a = 0.31\ m/s^2}$$

NOTEBOOK (180)

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$(v_f)^2 = (v_i)^2 + 2a \times \text{distance}$

$(v_f)^2 = (0)^2 + (2 * 0.31 * 5)$

$v_f = \sqrt{3.1}$

$\boxed{v_f = 1.760681685 \text{ m/s}}$

$\Rightarrow \Delta K = \frac{1}{2} * 40 * (1.760681685)^2 - 0$

$\boxed{\Delta K = 62 \text{ J}}$ //

(f) The final speed of the box?

- Solution: $\Sigma F = ma$

$F - f_k = ma$

$130 - (0.3 * 40 * 9.8) = 40a$

$\boxed{a = 0.31 \text{ m/s}^2}$

$(v_f)^2 = (v_i)^2 + 2a \text{ distance}$

$(v_f)^2 = 0 + 2 * 0.31 * 5$

$v_f = \sqrt{2 * 31 * 5}$

$\boxed{v_f = 1.76 \text{ m/s}}$ //

***Ex:- ***A shopper in a supermarket pushes a car with a force of 35 N directed at an angle of 25° downward from the horizontal. Find the work done by the shopper on the cart as he moves down as aisle (50m) long???

-Solution:: $w = F.\Delta r.\cos\theta$

$w = 35.50.\cos 25°$

$\boxed{w = 1586.038627\ J}$ #

***Ex:- For $\vec{A} = 3i^ + j^ - K^$, $\vec{B} = -i^ + 2j^ + 5K^$, and $\vec{C} = 2j^ - 3K^$, find $C.(A-B)$???

-Solution:: $(A-B) = (3-{-1})i^ + (1-2)j^ + (-1-5)K^$

$(A-B) = 4i^ - j^ - 6K^$

$C.(A-B) = (2j^ - 3K^) * (4i^ - j^ - 6K^)$

$C.(A-B) = (0*4)i^ + (2*-1)j^ + (-3*-6)K^$

$C.(A-B) = 0 + (-2) + (+18)$

$C.(A-B) = \boxed{16}$ #

***Ex:- ***Using the definition of the scalar product, find the angles between:

(a) $A = 3i^ - 2j^$ and $B = 4i^ - 4j^$

(b) $A = -2i^ + 4j^$ and $B = 3i^ - 4j^ + 2K^$

(c) $A = i^ - 2j^ + 2K^$ and $B = 3j^ + 4K^$

- Solution (a): $A.B = AB\cos\theta$

$$(3*4)\hat{j} + (-2*-4)\hat{j} = \sqrt{(3)^2+(2)^2}\sqrt{(4)^2+(4)^2}\cos\theta$$

$$12+8 = (\sqrt{13}\sqrt{32})\cos\theta$$

$$\cos^{-1}\left(\frac{20}{\sqrt{13}\sqrt{32}}\right) = \boxed{11.3^\circ} \#$$

- Solution (b): $A.B = AB\cos\theta$

$$(3*-2)\hat{j} + (-4*4)\hat{j} + (2*0)\hat{k} = \sqrt{(-2)^2+(4)^2}\sqrt{(3)^2+(-4)^2(2)^2} * \cos\theta$$

$$-6 + -16 = \sqrt{20}\sqrt{29}\cos\theta$$

$$\cos^{-1}\left(\frac{-22}{\sqrt{20}\sqrt{29}}\right) = \boxed{156^\circ} \#$$

- Solution (c): $A.B = AB\cos\theta$

$$(1*0)\hat{j} + (-2*3)\hat{j} + (2*4)\hat{k} = \sqrt{(1)^2+(-2)^2+(2)^2}\sqrt{(3)^2+(4)^2}\cos\theta$$

$$-6+8 = \sqrt{9}\sqrt{25}\cos\theta$$

$$\cos^{-1}\left(\frac{2}{15}\right) = \boxed{82.3^\circ} \#$$

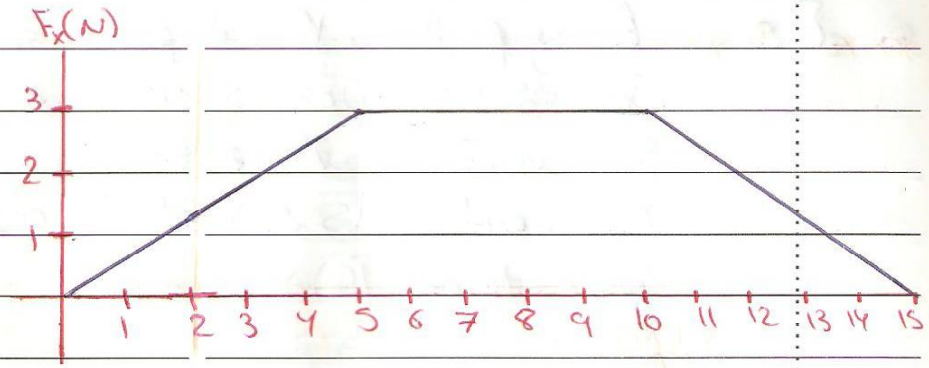
*** Ex: A particle is subject to a force F_x that varies with position as in the below Figure. Find the work done by the force on the particle as it moves:

(a) From $X=0$ to $X=5m$.

(b) From $X=5$ to $X=10m$.

(c) From $X=10m$ to $X=15m$.

(d) What is the total work done by the force over the distance $X=0$ to $X=15m$?



- Solution(a): $\omega = F.\Delta x.\cos\theta$

$\omega =$ area

$\omega = \frac{1}{2} * 5 * 3 = \boxed{7.5J}$ #

- Solution(b): $\omega =$ area

$\omega = (10-5) * 3$

$\omega = 5 * 3 = \boxed{15J}$ #

- Solution(c): $\omega =$ area

$\omega = \frac{1}{2} * 3 * (15-10) = \boxed{7.5J}$ #

- Solution(d): $\omega_{total} = 7.5 + 7.5 + 15 = \boxed{30J}$ #

xxx Ex: If it takes $\boxed{4.J}$ of work to stretch a Hook's-law spring 10 cm from its unstressed length, determine the extra work required to stretch it an additional 10cm?

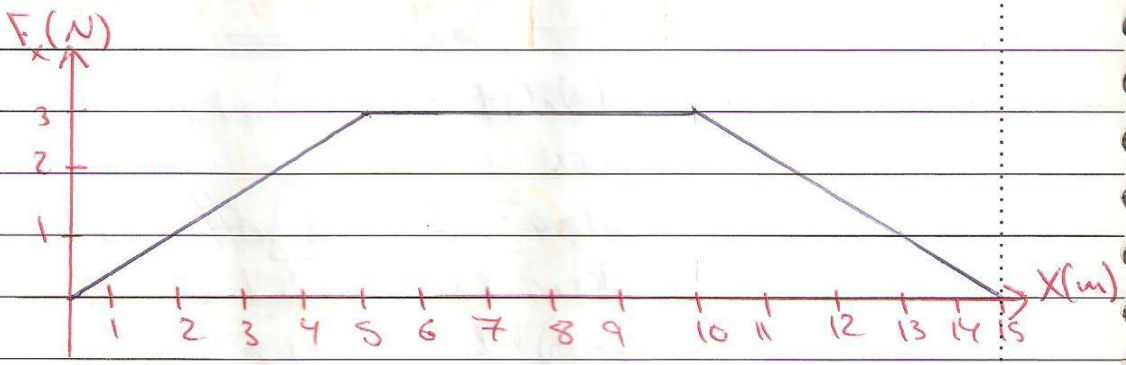
- Solution: $\omega = \frac{1}{2} K(\Delta x)^2$

$4 = \frac{1}{2} K (10 * 10^{-2})^2$

$K = 800\ N/m$ and to stretch the spring to 20 cm requires

$\Delta\omega = \left(\frac{1}{2} * 800 * (20 * 10^{-2})^2\right) - 4 = \boxed{12J}$ #

Ex: A 4Kg particle is subject to a total force that varies with position as shown in the below figure. The particle starts from rest at $x=0$. what is speed at (a) $x=5m$. (b) $x=10m$. (C) $x=15m$.



-Solution (a): $\omega = K_f - K_i$

$$\omega = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

area $= \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$$\frac{1}{2}*5*3 = \frac{1}{2}*4*v_f^2 - 0$$

$$7.5 = 2v_f^2$$

$$v_f = \sqrt{3.75} = \boxed{1.936491673\ m/s}\ \#$$

-Solution (b): $\omega = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$$(10-5)*3 = \frac{1}{2}*4*v_f^2 - \frac{1}{2}*4*(1.936491673)^2$$

$$15 = 2v_f^2 - 7.5$$

$$\boxed{v_f = 3.354101966\ m/s}\ \#$$

- Solution(c): $W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

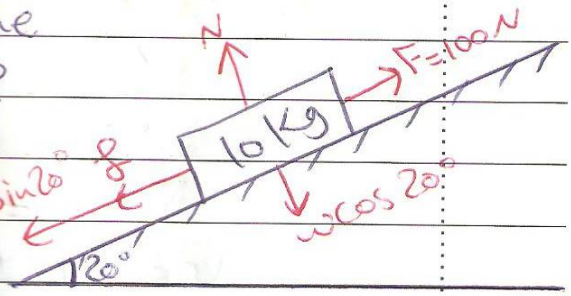
$\frac{1}{2}*(15-10)3 = \frac{1}{2}*4*v_f^2 - \frac{1}{2}*4*11.25$

$7.5 = 2v_f^2 - 22.5$

$\boxed{v_f = 3.872983346\ m/s}$ #

~~***~~ Ex~~***~~ A crate of mass (10kg) is pulled up a rough incline with an initial (speed of 1.5m/s). The pulling force is (100N) parallel to the incline, which makes an (angle of 20°) with the horizontal. The (coefficient of kinetic friction is 0.4) and the crate is (pulled 5m). As in figure

(a) How much work is done by the gravitational force on the crate?



- Solution:

$W = F.\Delta x.\cos\theta$

$W = mg * S * \cos(90+20)^\circ$

$W = 98 * 5 * \cos 110^\circ$

$\boxed{W = -167.5898702\ J}$ #

(b) Determine the increase in internal energy of the crate incline system due to friction?

- Solution: $\Delta E_{int} = f * n$

$\Delta E_{int} = (\mu * n) * \Delta x$

$\Delta E_{int} = (0.3 * mg\cos 20^\circ) * 5$

$= 0.3 * 10 * 9.8 \cos 20^\circ * 5$

$= \boxed{138.1378153\ J}$ #

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(c) How much work is done by the 100N force on the crate?

- Solution: $W = F \cdot \Delta x \cos\theta$

$W = 100 * 5 \cos 20°$

$\boxed{W = 469.8463104\ J}$ #

(d) what is the change in Kinetic energy of the crate?

- Solution: $\Delta K = K_f - K_i$

$\Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$\Delta K = \frac{1}{2} * 10 * v_f^2 - \frac{1}{2} * 10 * (1.5)^2$

$* \sum \vec{F}_x = ma$

$F - f_k - w \sin 20° = ma$

$\frac{100 - (0.4 * (10 * 9.8 * \cos 20°)) - 10 * 9.8 \sin 20°}{10} = \frac{10a}{10}$

$\boxed{a = 2.964607522\ m/s^2}$ #

$(v_f)^2 = (v_i)^2 + 2a\ distance$

$(v_f)^2 = (1.5)^2 + 2 * 2.9 * 5$

$(v_f)^2 = \sqrt{31.8}$

$\boxed{v_f = 5.6\ m/s}$ #

$\Rightarrow \Delta K = \frac{1}{2} * 10 * 31.89607522 - \left(\frac{1}{2} * 10 (1.5)^2\right)$

$\boxed{\Delta K = 148.2303761\ J}$ #

NOTEBOOK

Subject Date No.

Ex: A (15kg) block is dragged over a rough, horizontal surface by a (70N) force acting at 20° above the horizontal. The block is displaced (5m), and the coefficient of Kinetic friction is (0.3). Find the work done on the block by:

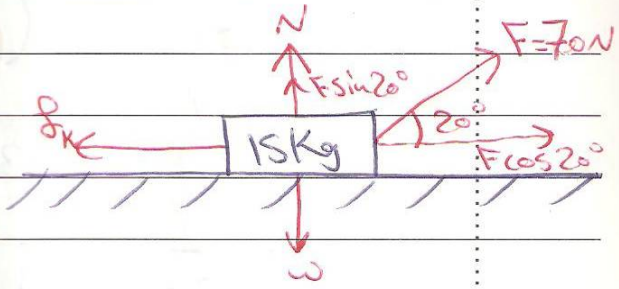
(a) The 70N force?

- Solution:

$W = F.\Delta r \cos\theta$

$W = 70 * 5 * \cos 20°$

$W = 328.924173\ J$ #



(b) The normal force?

- Solution: $W = F.\Delta r.\cos\theta$

$W = 70 * 5 * \cos 90°$

$W = 0\ J$ #

(c) The gravitational force?

- Solution: $W = F.\Delta r.\cos\theta$

$W = 70 * 5 * \cos 90°$

$W = 0\ J$ #

(d) what is the increase in internal energy of the block surface system due to friction?

- Solution: $\Delta E_{int} = f * \Delta x$

$= (\mu * n)\Delta x$

$= (0.3 * 15 * 9.8) * 5$

$= 221\ J$ #

Subject Date No.

Ex8 At time ($t=0$ S) a particle of (2Kg) has a velocity $v_i = (4i^\wedge - 3j^\wedge)$ m/s. At ($t=3$ S) $v_f = (2i^\wedge - 3j^\wedge)$ m/s find the work done???

- Solution: $W = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$$W = \frac{1}{2} m \left(\sqrt{(2)^2 + (3)^2}^{\,2} - \sqrt{(4)^2 + (-3)^2}^{\,2} \right)$$

$$W = \frac{1}{2} m (13 - 25)$$

$$\boxed{W = -12 J} \#$$

Ex8 A 10Kg object undergoes a displacement $\Delta S = (5i^\wedge + 3j^\wedge + 3K^\wedge)$ m, during the displacement constant force $F = -3i^\wedge + j^\wedge + 4K^\wedge$ acts on the object. calculate the work done by the force?

- Solution??? $W = F . \Delta P . \cos\theta$

$$W = (5 * -3) + (3 * 1) + (3 * 4)$$

$$W = -15 + 3 + 12$$

$$W = -15 + 15$$

$$\boxed{W = 0 J} \#$$

xxx Ex xxx A heavy container weighting 6000N is pulled across a surface with coefficient of Kinetic friction is 0.05. If some men pulling the container loosin at (constant) velocity. what is the work done?

- Solution: $\sum F_x = 0$

$F = f$

$F = \mu * N$

$F = \mu * w$

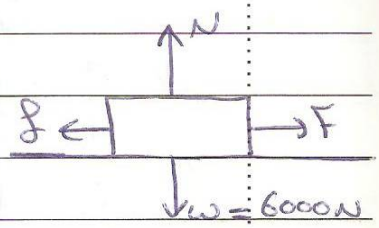
$F = 0.05 * 6000$

$\boxed{F = 300N}$

$* W = F . \Delta . \cos\theta$

$W = 300 * 100$

$\boxed{W = 30000J}$ //



xxx Ex xxx A force acting on an object moving along x-axis is given by $F_x = 14X - 3X^2$, find the work done by this force if the object moves from X = -1m to X = 2m? x8

- Solution: $W = \int_{x_i} F_x . dx$

$W = \int_{-1}^{2} (14X - 3X^2) . dx$

$W = \frac{14}{2} X^2 - X^3 \Big]_{-1}^{2}$

$W = \left(\frac{14}{2} * (2)^2 - (2)^3\right) - \left(\frac{14}{2}(-1)^2 - (-1)^3\right)$

$W = 20 - 8 = \boxed{12J}$ //

Subject Date No.

***Ex:- An object moves in a circle at constant speed the work done by the centripetal force is zero because:

a. The displacement for each revolution is zero.

b. The average force for each evolution is zero.

c. There is no friction.

d. The magnitude of acceleration is zero.

(e.) The centripetal force is perpendicular to the velocity.

***Ex:- which of the following quantities is not expression for energy, where F: force, d: distance, a: acceleration, v: velocity, h: height, m: mass, P: Power, t: time?

(a.) ma

b. mgh

c. Fd

d. Pt

e. $mv^2/2$

xxx Ex:- xxx A 10Kg object undergoes a displacement $\Delta S = 5\hat{i} + 3\hat{j} + 3\hat{k}$. During the displacement, a constant force $F = -3\hat{i} + \hat{j} + 4\hat{k}$ acts on the object. All values are given in SI units. The work done by the force F on the object is:-

(a) $-15J$ (b) $0J$ (c) $15J$ (d) $12J$ (e) $3J$

- Solution:- $W = F \cdot \Delta r \cdot \cos\theta$

$W = (5 * -3)\hat{i} + (3 * 1)\hat{j} + (3 * 4)\hat{k}$

$W = -15 + 3 + 12$

$\boxed{W = 0J}$

xxx Ex:- (A 4Kg) block (starts from rest) and (slides 5m) down a plane inclined at (60°) to the horizontal. The (coefficient of Kinetic friction between the surface and the block is 0.2). The work done by friction on the block is:-

(a) $98J$ (b) $19.6J$ (c) $3.92J$ (d) $3.40J$ (e) $6J$

- Solution:- $W = F \cdot \Delta r \cdot \cos\theta$

$= (\mu * n)\Delta r \cdot \cos\theta$

$= (0.2 * mg)\Delta r \cos\theta$

$= (0.2 * 4 * 9.8) * 5 \cos 60°$

$= \boxed{19.6J}$ #

(8)

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Subject *chapter(8)* Date No.

Conservation of Mechanical energy (حفظ الطاقة الميكانيكية)

*** Mechanical energy (E) = $K + U$
(الطاقة الميكانيكية)

(I) *frictionless (بدون احتكاك)*

* $E_i = E_f$

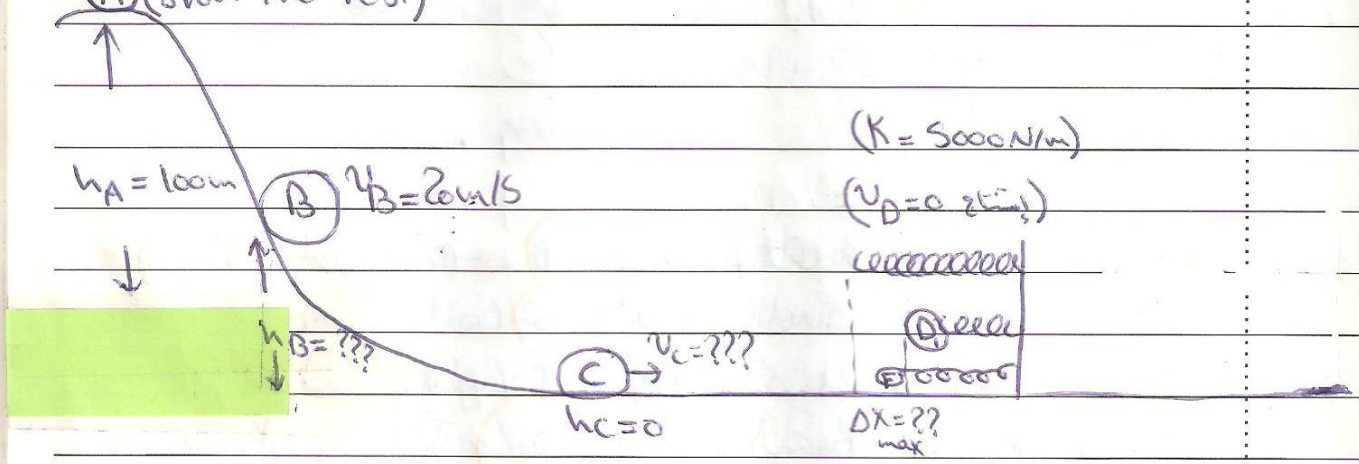
$K_i + U_i = K_f + U_f$

$\Delta K + \Delta U = 0$

$\Delta E = 0$

Ex (Mass = 2Kg)

(A) (from the rest)



-Solution (h_B) (نأخذ مرحلتين نقطتين)

$E_A = E_B$

$K_A + U_A = K_B + U_B$

$\frac{1}{2} m v_A^2 + mgh_A = \frac{1}{2} m v_B^2 + mgh_B$

$\left(\frac{1}{2} * 2 * 0\right) + (2 * 10 * 100) = \left(\frac{1}{2} * 2 * (20)^2\right) + (2 * 10 * h_B)$

$2000 = 400 + 20 h_B$

$\boxed{h_B = 80m}$

Subject Date No.

- Solution (v_c) $E_A = E_C$

$$K_A + U_A = K_C + U_C$$

$$\frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_c^2 + mgh_c$$

$$\left(\frac{1}{2}*2*0\right) + (2*10*100) = \frac{1}{2}*2*v_c^2 + (2*10*0)$$

$$2000 = v_c^2$$

$$v_c = \sqrt{2000}$$

$$\boxed{v_c = 44.721359955 \text{ m/s}} \#$$

- Solution (Δx_{max}) $E_A = E_D$,

$$K_A + U_A = K_D + U_D + U_{spring}$$

$$\frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_D^2 + mgh_D + \left(\frac{1}{2}*K*\Delta x^2\right)$$

$$\left(\frac{1}{2}*2*0\right) + (2*10*100) = \left(\frac{1}{2}*2*0\right) + (2*10*0) + \left(\frac{1}{2}*5000\Delta x^2\right)$$

$$\frac{2000}{2500} = \frac{2500}{2500}\Delta x^2$$

$$\Delta x^2 = 0.8$$

$$\boxed{\Delta x = 0.894427191 \text{ m}} \#$$

- Solution (v_f) $E_D = E_F$

$$K_D + U_D + U_{spring} = K_F + U_F + U_{spring}$$

$$mgh_D + \left(\frac{1}{2}*K\Delta x^2\right) = \frac{1}{2}mv_f^2 + mgh_F + \left(\frac{1}{2}*K*\Delta x^2\right)$$

$$(2*10*0) + \left(\frac{1}{2}*5000*(0.89)^2\right) = \left(\frac{1}{2}*2*v_f^2\right) + (2*10*0) + \left(\frac{1}{2}*5000*50^2\right)$$

$$2000 = v_F^2 + \left(\frac{1}{2}*5000*(50*10^{-4})^2\right)$$

$$2000 = v_F^2 + 625$$

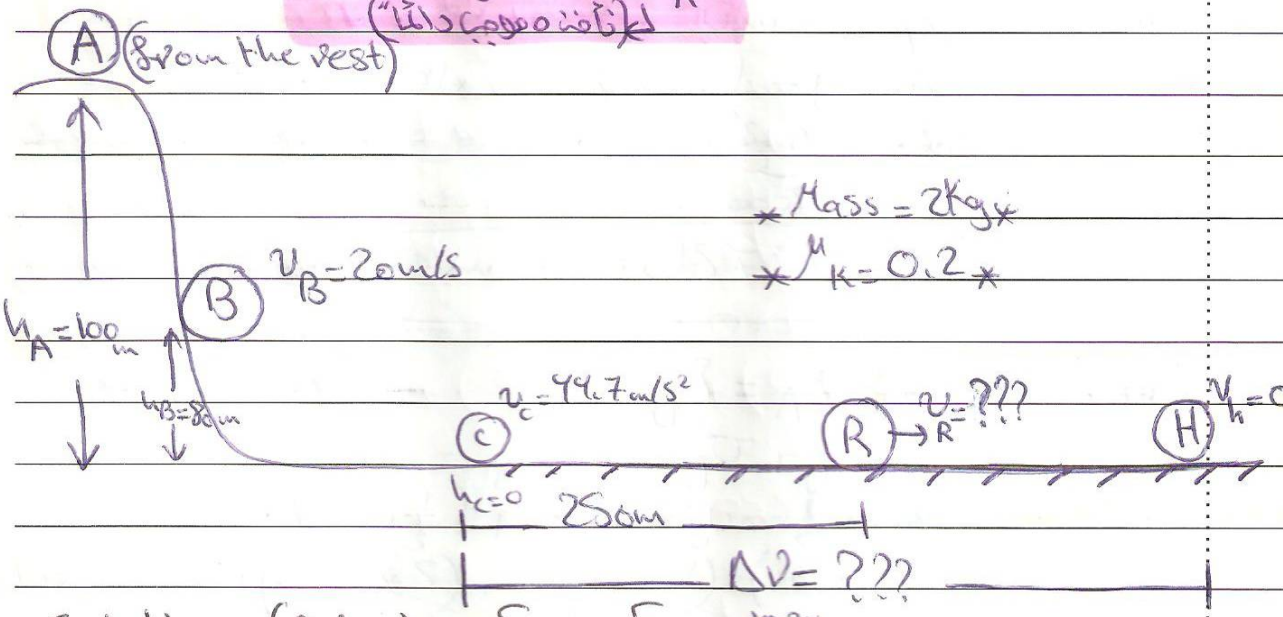
$$\boxed{v_f = 37.08099244 \text{ m/s}} \#$$

Subject Date No.

(II) * friction: * ( )

$$E_i = E_g + \omega_{f_K}$$

("ii) ...



* Mass = 2kg *

* $\mu_K = 0.2$ *

- Solution (ΔV_{max}) $E_A = E_H + \omega_{f_K}^{max}$

$$K_A + U_A = K_H + U_H + \omega_{f_K}$$

$$\frac{1}{2} m v_A^2 + mgh_A = \frac{1}{2} m v_h^2 + mgh_H + (F \cdot \Delta V_{max})$$

$$\left(\frac{1}{2} * 2 * 0\right) + (2 * 10 * 100) = \left(\frac{1}{2} * 2 * 0\right) + (2 * 10 * 0) + (\mu * n \Delta V_{max})$$

$$2000 = (0.2 * mg . \Delta V_{max})$$

$$2000 = 0.2 * 2 * 10 * \Delta V_{max}$$

$$2000 = 4 \Delta V_{max}$$

$$\boxed{\Delta V_{max} = 5000 m} \quad //$$

Subject Date No.

- Solution (v_R) & $E_A = E_R + W_{f_K}$

$$K_A + U_A = K_R + U_R + W_{f_K}$$

$$\frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_R^2 + mgh_R + (F \cdot \Delta r)$$

$$\left(\frac{1}{2} * 2 * 0\right) + (2 * 10 * 100) = \left(\frac{1}{2} * 2 * v_R^2\right) + (2 * 10 * 0) + (\mu_K * n * \Delta r)$$

$$2000 = v_R^2 + (0.2 * mg * 250)$$

$$2000 = v_R^2 + (0.2 * 2 * 10 * 250)$$

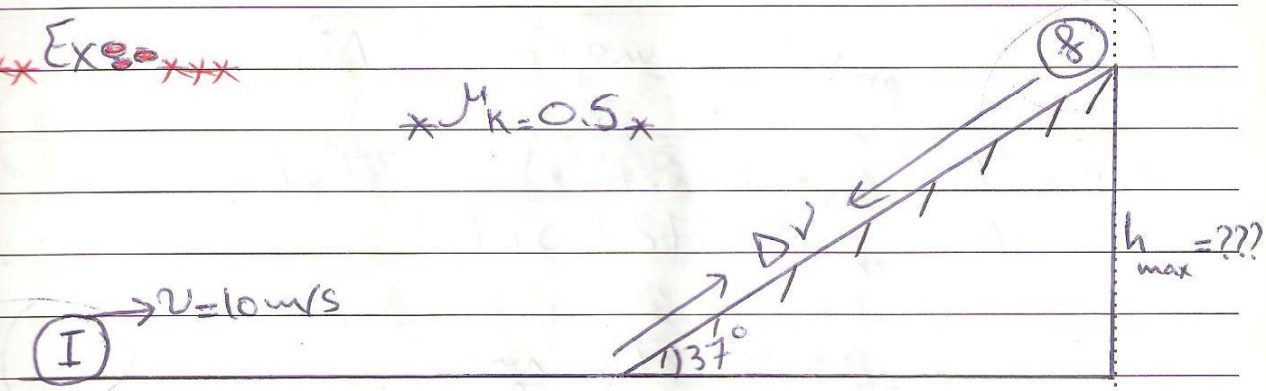
$$2000 = v_R^2 + 1000$$

$$v_R = \sqrt{1000}$$

$$\boxed{v_R = 31.627766\ m/s} \#$$

*** Ex & ***

$*\mu_K = 0.5*$



$*Mass = 4Kg*$

(I) Find(h_{max}) frictionless & Find(h_{max}) &

- Solution: $E_i = E_f$

$$K_i + U_i = K_f + U_f$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$\frac{1}{2} * 4 * (10)^2 + (4 * 10 * 0) = \left(\frac{1}{2} * 4 * 0\right) + (4 * 10 * h_{max})$$

$$200 = 40 h_{max}$$

$$\boxed{h_{max} = 5\ m} \#$$

(II) Friction so find (h_{max}) so

- Solution: $E_I = E_g + \omega_{g_K}$

$K_I + U_I = K_g + U_g + \omega_{g_K}$

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_g^2 + mgh_g + (F \cdot \Delta r)$

$\left(\frac{1}{2} * 4 * (10)^2\right) = \left(\frac{1}{2} * 4 * 0\right) + (4 * 10 * h_{max}) + (\mu_k * n * \Delta r)$

$200 = (40 h_{max}) + (0.5 * \omega \cos 37^\circ * \Delta r)$

$200 = 40 h_{max} + (0.5 * mg \cos 37^\circ * \Delta r)$

$200 = 40 h_{max} + (0.5 * 4 * 10 \cos 37^\circ * \Delta r)$

$200 = 40 h_{max} + 15.9727102 \Delta r$

$* \sin 37^\circ = \frac{h_{max}}{\Delta r}$

$\boxed{h_{max} = \Delta r \sin 37^\circ}$

$200 = 40 \sin 37^\circ * \Delta r + 15.9727102 \Delta r$

$200 = 24.07260093 \Delta r + 15.9727102 \Delta r$

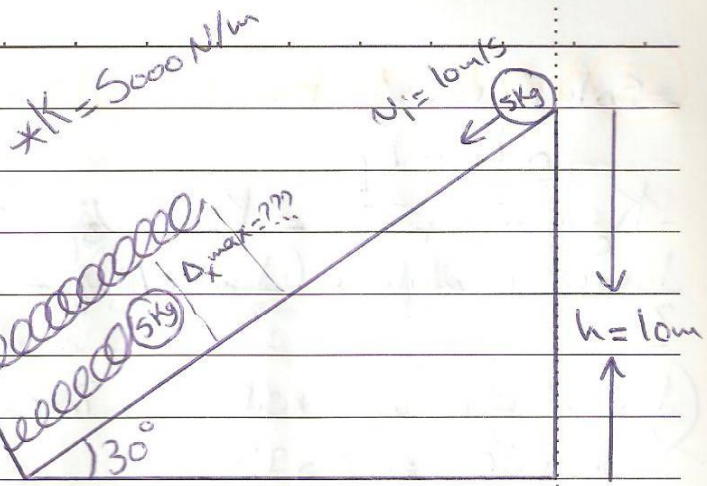
$\boxed{\Delta r = 4.994342517 \text{ m}}$

$* h_{max} = 4.994342517 \sin 37^\circ$

$\boxed{h_{max} = 3.005670358 \text{ m}}$ //

Subject Date No.

H.W.



find Δx max???

-solution: $\Sigma_i = \Sigma_f$

$$K_i + U_i = K_f + U_f + U_{spring}$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f + \left(\frac{1}{2} * K * \Delta x^2_{max}\right)$$

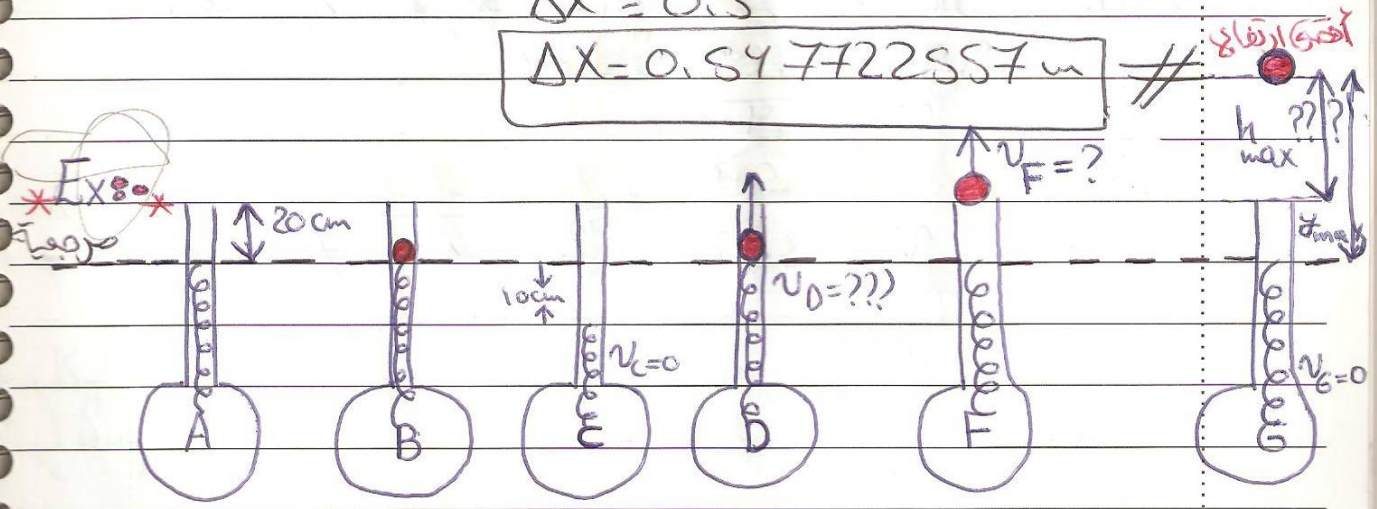
$$\left(\frac{1}{2} * 5 * (10)^2\right) + (5 * 10 * 10) = \left(\frac{1}{2} * 5 * 0\right) + (5 * 10 * 0) + \left(\frac{1}{2} * 5000 \Delta x^2\right)$$

$$250 + 500 = 2500\,\Delta x^2$$

$$750 = 2500\,\Delta x^2$$

$$\Delta x^2 = 0.3$$

$$\Delta x = 0.547722557\ m$$



*Mass = 100g = 0.1Kg

*K = 2000 N/m

Subject Date No.

- Solution: (v_D):

$\Rightarrow E_C = E_D$

$K_C + U_{g_C} + U_{s_C} = K_D + U_{g_D} + U_{s_D}$

$\frac{1}{2}mv_C^2 + mgh_C + \left(\frac{1}{2} * K\Delta x^2\right)_C = \frac{1}{2}mv_D^2 + mgh_D + \left(\frac{1}{2} * K * \Delta x^2\right)_D$

$\left(\frac{1}{2} * 0.1 * 0\right) + (0.1 * 10 * 0.1) + \left(\frac{1}{2} * 2000 * (0.1)^2\right) = \left(\frac{1}{2} * 0.1 v_D^2\right) + (0.1 * 10 * 0) + 0$

$0.1 + 10 = 0.05 v_D^2 + 0$

$\frac{0.1 + 10}{0.05} = v_D^2 \Rightarrow \boxed{v_D = 14.07124728 \text{ m/s}}$ #

- Solution: (v_F):

$\Rightarrow E_D = E_F$

$K_D + U_{g_D} + U_{s_D} = K_F + U_{g_F} + U_{s_F}$

$\frac{1}{2}mv_D^2 + mgh_D + \left(\frac{1}{2} * K * \Delta x^2\right)_D = \frac{1}{2}mv_F^2 + mgh_F + \left(\frac{1}{2} * K * \Delta x^2\right)_F$

$\frac{1}{2} * 0.1 * (14.07)^2 + 0 + 0 = \left(\frac{1}{2} * 0.1 * v_F^2\right) + (0.1 * 10 * 0.2) + 0$

$9.9 = 0.05 v_F^2 + 0.2$

$v_F = \sqrt{\frac{9.9 - 0.2}{0.05}}$

$\boxed{v_F = 13.92838828 \text{ m/s}}$ #

Subject Date No.

- Solution :: (h_{max}) ::

$$\Rightarrow E_D = E_G$$

$$K_D + U_{g_D} + U_{s_D} = K_G + U_{g_G} + U_{s_G}$$

$$\frac{1}{2}mv_D^2 + mgh_D + \left(\frac{1}{2}k\Delta x^2\right)_D = \frac{1}{2}mv_G^2 + mgh_G + \left(\frac{1}{2}k\Delta x^2\right)_G$$

$$\frac{1}{2} * 0.1 * (14.07)^2 = mg\,y_{max}$$

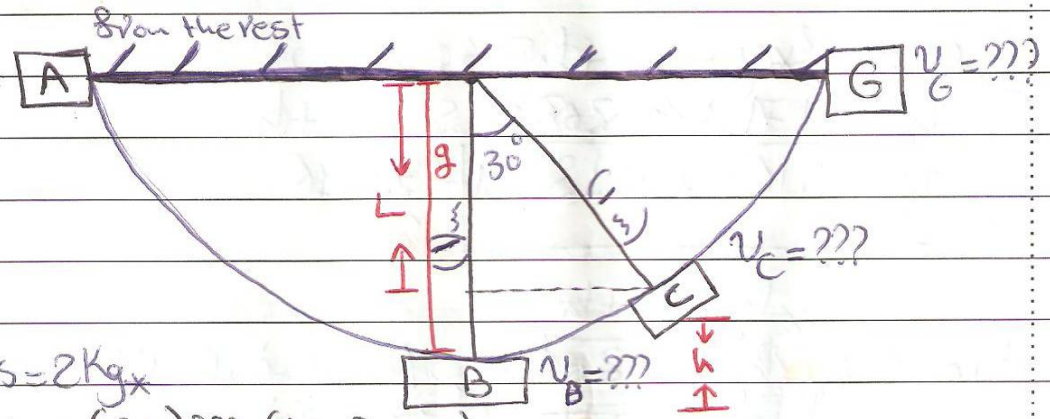
$$9.9 = (0.1 * 10 * y_{max})$$

$$y_{max} = \frac{9.9}{1}$$

$$\boxed{y_{max} = 9.9} \quad \#$$

$$h_{max} = 9.9 - 0.2 = \boxed{9.7\,m} \quad \#$$

* Ex *



* Mass = 2Kg *

- Solution (v_B)??? (A is the highest point)

$$E_A = E_B$$

$$K_A + U_{g_A} = K_B + U_{g_B}$$

$$\frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_B^2 + mgh_B$$

$$\left(\frac{1}{2} * 2 * 0\right) + (2 * 10 * 0) = \left(\frac{1}{2} * 2 * v_B^2\right) + (2 * 10 * 1)$$

$$0 = v_B^2 - 20$$

(move the 20 to the other side)

$$\boxed{v_B = \sqrt{20} = 4.472135955\ m/s} \quad \# \ (2.00)$$

Subject Date No.

- Solution (v_c) ???

$\Rightarrow E_A = E_C$

$K_A + U_A = K_C + U_C$

$0 = \frac{1}{2} m v_c^2 + mgh_c$

$0 = \frac{1}{2} * 2 * v_c^2 + (2 * 10 * (-L))$

$0 = v_c^2 - (20(L))$

(A) كتلة الجرة

$* \cos\theta = \frac{h}{l}$

$\cos 30^\circ = h$

$\boxed{h = 0.866025403 \text{ m}}$ ← (C) الارتفاع عن (A)

$\Rightarrow 0 = v_c^2 - (20 * 0.866025403)$

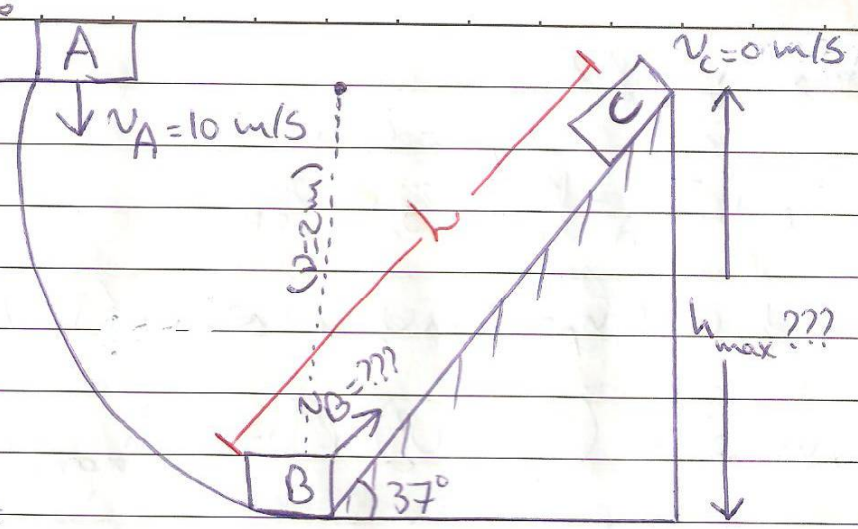
$v_c^2 = 17.32050808$

$\boxed{v_c = 4.161791451 \text{ m/s}}$ //

- Solution (v_6) ??? $\boxed{v_6 = 0}$ ← (عادت = لغة النقطة)

Subject Date No.

Example



* $\mu_K = 0.2$ *

- Solution (v_B) ???

$$E_A = E_B$$

$$K_A + U_{g_A} = K_B + U_{g_B}$$

$$\frac{1}{2} m v_A^2 + mgh_A = \frac{1}{2} m v_B^2 + mgh_B$$

$$\left(\frac{1}{2} * m * (10)^2\right) + 0 = \left(\frac{1}{2} m v_B^2\right) + (m * 10 * 2)$$

$$50 = \frac{1}{2} v_B^2 + 20$$

$$50 = \frac{1}{2} v_B^2 - 20$$

$$70 = \frac{1}{2} v_B^2$$

$$v_B = \sqrt{140} = \boxed{11.83215957 \text{ m/s}} \quad //$$

NOTEBOOK

(202)

- Solution (h_{max}) ???

$$E_A = E_c + W_{f_K}$$

$$K_A + U_{g_A} = K_c + U_{g_c} + W_{f_{K_c}}$$

$$\frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_c^2 + mgh_c + (F_K * L)$$

$$\frac{1}{2}\times m(10)^2 = \left(\frac{1}{2}mv_c^2\right) + (m * 10h_{max}) + (\mu_K mL)$$

$$50 = \frac{1}{2}v_c^2 + 10h_{max} + (0.2(mg\cos 37^\circ)L)$$

$$50 = \frac{1}{2}v_c^2 + 10h_{max} + 1.597271025L$$

$$* \sin 37^\circ = \frac{h_{max}}{L}$$

$$\boxed{h_{max} = L\sin 37^\circ} \Rightarrow (1)$$

$$50 = 10(L\sin 37^\circ) + 1.597271025L$$

$$50 = 6.018150232L + 1.597271025L$$

$$50 = 7.615421252L$$

$$\boxed{L = 6.565624979\ m}$$

بالتعويض في (1) $\Rightarrow$ $h_{max} = 6.565624979 \sin 37^\circ$

$$\boxed{h_{max} = 3.951291749\ m} \#$$

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Subject *Chapter (9)* Date No.

Linear Momentum and collision *الزخم الخطي وحفظ الزخم*

** يعرف الزخم الخطي (Linear Momentum) بـ:
لأي جسم كتلته (m) ويتحرك بسرعة (v) بأنه حاصل ضرب الكتلة بالسرعة، أي أن:

$$*p = mv$$

وهو كمية متجهة ويكون اتجاهها بنفس اتجاه السرعة ووحدة الزخم الخطي هي $Kg.m/s$

** لربط الزخم مع القوة نستخدم قانون نيوتن الثاني حيث:

$$\Sigma F = ma$$

$$dt * \Sigma F = m \frac{dv}{dt} * dt$$

$$\int \Sigma F.dt = \int_{v_i}^{v_f} m.dv$$

$$mv \Big]_{v_i}^{v_f} =$$

$$mv_f - mv_i = P_f - P_i$$

$$\Delta P = \int \Sigma F.dt = I$$

حيث أن الـ (I) هي Impules أي الدفع والزخم...

$$I = F_{avg} * \Delta t$$

(9)

Ex A 3Kg particle has velocity of $(3\hat{i} - 4\hat{j})$ m/s
(a) find its x and y components of momentum.
(b) find the magnitude and direction of its momentum.

- Solution (a): $\vec{P} = mv$

$P = 3(3\hat{i} - 4\hat{j})$

$P = (9\hat{i} - 12\hat{j})$ Kg.m/s

$P_x = 9$ Kg.m/s $\longrightarrow$ $P_y = -12$ Kg.m/s

- Solution (b): $\vec{P} = \sqrt{(9)^2 + (-12)^2}$

$\vec{P} = 15$ Kg.m/s

direction $= \tan^{-1}\left(\frac{-12}{9}\right) = -53.130102^{\circ}$

$\theta = 306.869897^{\circ}$

Ex A 0.1 Kg ball is thrown straight up into the air with an initial speed of 15 m/s. find the momentum of the ball (a) at its maximum height and (b) halfway up to its maximum height?

- Solution (a): height maximum ($v = 0$)

$P = mv = 0$ #

- Solution (b): $K = \frac{1}{2} m v^2$

$K = \frac{1}{2} * 0.1 * (15)^2$

$\boxed{K = 11.25\ J}$

half way up $= 11.25 \div 2 = \boxed{5.625\ J}$

$K = \frac{1}{2} m v^2$

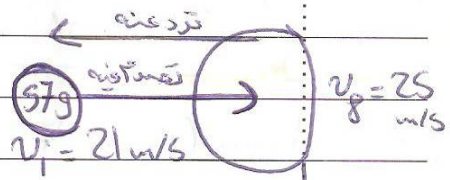
$5.625 = \frac{1}{2} * 0.1 * v^2$

$5.625 = 0.05 v^2$

$\boxed{v = 10.60660172\ m/s}$

$p = mv = 0.1 * 10.60660172 = \boxed{1.060660172\ Kg.m/s}$ #

Ex: find the Impulse ???



- Solution: $I = \Delta P$

$I = P_f - P_i$

$I = mv_f - mv_i$

$I = \ominus(57*10^{-3}*25) - (57*10^{-3}*21)$ $\Delta t = 0.06$

$I = -1.425 - 1.197$

$\boxed{I = \ominus 2.62\ Kg.m/s}$

... "علل"

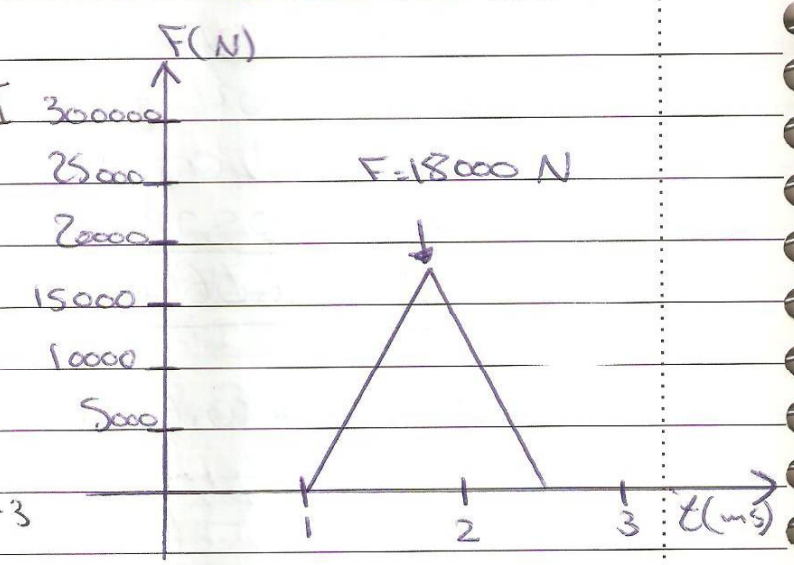
*** find the average force?

- Solution: $I = F_{avg} * \Delta t \Rightarrow F_{avg} = \frac{I}{\Delta t} = \frac{2.62}{0.06}$

$\boxed{F_{avg} = 43.6\ N}$ #

Subject Date No.

***Ex** An estimated force-time curve for a baseball struck by a bat is shown in figure beside from this curve, determine (a) the impulse delivered to the ball, (b) the average force exerted on the ball, (c) the peak force exerted on the ball.



-Solution(a):

$p = \int F.dt = \text{area} = I$

$p = \frac{1}{2}(2.5-1)\,18000$

$p = 13500 \times 10^{-3}$ (تحويل الوحدات)

$p = 13.5$ Kg.m/s //

-Solution(b):

$I = F_{avg} \times \Delta t$

$13.5 = F_{avg} \times (2.5-1) \times 10^{-3}$

$F_{avg} = 9000N$

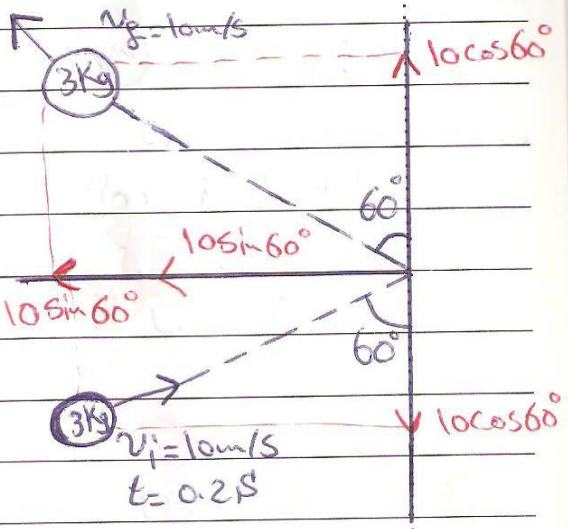
-Solution(c): $F_{max} = 18000N$ ... (From the graph) ...

***Ex** A garden hose is held the hose is originally full of motionless water. what additional force is necessary to hold the nozzle stationary after the water flow is turned on, if the discharge rate is (0.6Kg) with a speed of (25m/s)?

-Solution: $F = \frac{\Delta P}{\Delta t} = \frac{mv_f - mv_i}{\Delta t} = \frac{(0.6 \times 25) - 0}{1} = 15N$ //

Subject Date No.

*** Ex *** A 3Kg steel ball strikes a wall with a speed of 10m/s at an angle of 60° with the surface. It bounces off with the same speed and angle. If the ball is in contact with the wall for 0.2S, what is the average force exerted by the wall on the ball?



- Solution: $P = F_{avg} * \Delta t$

$$F_{avg} = \frac{P}{\Delta t}$$

$$\boxed{F_{avg} = \frac{P}{0.2}} \rightarrow (1)$$

* $P_x = 0 - (mv)$

$P_x = 0 - (m(10\sin 60° + 10\sin 60°))$

$P_x = 0 - (3(10\sin 60° + 10\sin 60°))$

$\boxed{P_x = -51.96152423 \text{ Kg.m/s}}$

* $P_y = mv$

$P_y = m(10\cos 60° - 10\cos 60°) = \boxed{0}$

(1 بتعويض) $\rightarrow F_{avg} = \frac{-51.96152423}{0.2} = \boxed{-259.8076211 \text{ Kg.m/s}}$

//

(تصادم)

Collisions in one dimension (التصادم في بعد واحد)

(I) Elastic collision: هو التصادم الذي تكون فيه الطاقة الحركية والزخم الخطي محفوظين قبل وبعد التصادم... (تصادم مرن)



(Before collision) (After collision)

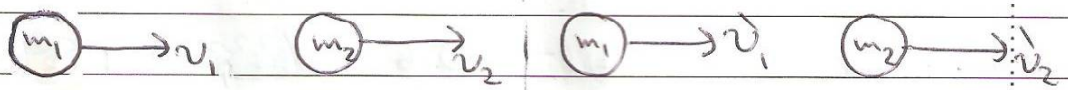
$$* \Sigma K = \Sigma K'$$

$$\frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2 = \frac{1}{2}m_1v_1'^2 + \frac{1}{2}m_2v_2'^2$$

$$* \Sigma P = \Sigma P'$$

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

(II) Inelastic collision: هو التصادم (تصادم غير مرن) الذي تكون فيه الطاقة الحركية غير محفوظة والزخم الخطي محفوظ قبل وبعد التصادم...



$$* \Sigma K \neq \Sigma K'$$

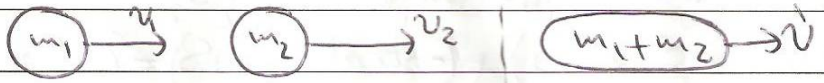
$$* \Sigma P = \Sigma P'$$

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

(III) perfectly inelastic collision :: (التصادم التام غير المرن) ←
إذا التصقت الجسمات المتصادمة معاً أثناء التصادم يسمى بالتصادم التام غير المرن ويحقق قانون الزخم:

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$$

$$* EK \neq EK'$$
$$* EP = EP'$$



Ex high-speed stroboscopic photographs show that the head of a golf club of (mass 200g) is travelling at (55 m/s) just before it strikes (a 46g golf ball at rest on a tee). After the collision, the club head travels (in the same direction) (at 40 m/s). Find the speed of the golf ball just after impact?

- Solution :: $EP = EP'$

$$m v_1 + m_2 v_2 = m v_1' + m_2 v_2'$$

$$(200 * 10^{-3} * 55) + (46 * 10^{-3} * 0) = (200 * 10^{-3} * 40) + (46 * 10^{-3} * v_2')$$

$$11 + 0 = 8 + 0.046 v_2'$$

$$\frac{11 - 8}{0.046} = v_2' \Rightarrow \boxed{v_2' = 65.2173913 \text{ m/s}} \#$$

***Ex** An archer shoots an arrow toward a target that is sliding toward her with a speed of 2.5 m/s on a smooth slippery surface. The 22.5 g arrow is shot with a speed of 35 m/s and passes through the 300 g target, which is stopped by the impact. What is the speed of the arrow after passing through the target?

- Solution: $\Sigma P = \Sigma P'$

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$(22.5 \times 10^{-3} \times 35) + (-300 \times 10^{-3} \times 2.5) = 22.5 \times 10^{-3} v_1' + 0$$

$$0.7875 + 0.75 = 22.5 \times 10^{-3} v_1'$$

(toward)

$$\boxed{v_1' = 1.67 \text{ m/s}} \quad //$$

***Ex** A railroad car of (mass 2.5×10^4 Kg) is moving with a speed of 4 m/s. It collides and couples with three other coupled railroad cars, each of the same mass as the single car and moving in the same direction with an initial speed of 2 m/s. (a) What is the speed of the four cars after the collision? (b) How much mechanical energy is lost in the collision?

- Solution (a): $m_1 v_1 + (m_2 v_2)3 = 4 m v$

$$(2.5 \times 10^4 \times 4) + 3(2.5 \times 10^4 \times 2) = 4 \times 2.5 \times 10^4 \times v$$

$$\frac{4 + 6}{4} = \frac{v \times 4}{4}$$

$$\boxed{v = 2.5 \text{ m/s}} \quad //$$

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- Solution (b): $K_f - K_i = \frac{1}{2} y m v^2 - \left(\frac{1}{2} m v_{1i}^2 + \frac{1}{2} 3 m v_{2i}^2 \right)$

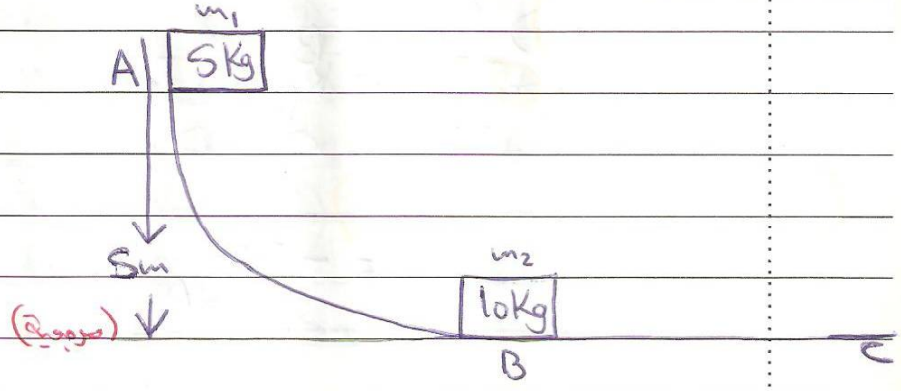
$= \frac{1}{2} * 2.5 * 10^4 * 1 * (25)^2 - \left(\frac{1}{2} * 2.5 * 10^4 * (1)^2 + \frac{1}{2} * 2.5 * 10^4 * (2)^2 * 3 \right)$

$= 312500 - (200000 + 150000)$

$= \boxed{-37500\ J}$ //

*** Ex *** Two Blocks are free to slide along the frictionless wooden track ABC. The block of mass ($m_1 = 5Kg$) is released from A. Noticing the north pole of a strong mangent, repelling the north from its front end is pole of an identical magnet embedded in the back end of the block of mass ($m_2 = 10Kg$) initially at rest. The two blocks never touch. calculate the maximum height to which m_1 rises after the elastic collision???

- Solution:



$E_A = E_B$

$K_A + U_A = K_B + U_B$

$\frac{1}{2} m_A v_A^2 + mgh_A = \frac{1}{2} m v_B^2 + mgh_B$

$\left(\frac{1}{2} * 5 * v_A^2 \right) + (5 * 5 * 10) = (0) + (0)$

$v_A^2 = \frac{2}{5} * 5 * 5 * 10 \Rightarrow v_A = \sqrt{2 * 5 * 10}$

$\boxed{v_A = 10\ m/s}$ (before collision) ← NAOTEBOOK

$\boxed{v_B = 0\ m/s}$

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* $\Sigma P = \Sigma P'$

$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$

$(5 * 9.9) + (10 * 0) = (5 + 10) v$

$v = \frac{5 * 9.9}{15} = 3.3 \text{ m/s}$

(after collision)

* $m_1 g h_{max} = \frac{1}{2} m v'^2$

$5 * 10 * h_{max} = \frac{1}{2} * 5 * (-3.3)^2$

$h_{max} = \frac{(-3.3)^2}{2 * 10}$

$h_{max} = 0.5445 \text{ m}$ //

$\rightarrow E_A = E_B$

$K_A + U_{gA} = K_B + U_{gB}$

$K_A + U_{gA} = 0 + 0$

$K_A = -U_{gA}$

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Ex8

(2Kg) → $v_1 = 10 m/s$ (3Kg) → $v_2 = 5 m/s$

Find the (v_1' and v_2') (Elastic collision) ???

-Solution:

$$* \Sigma K = \Sigma K'$$

$$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v_1' + \frac{1}{2} m_2 v_2'$$

$$\frac{1}{2} * 2(10)^2 + \frac{1}{2} 3(5)^2 = \frac{1}{2}(2) v_1'^2 + \frac{1}{2}(3) v_2'^2$$

$$200 + 75 = 2v_1'^2 + 3v_2'^2$$

$$\boxed{275 = 2v_1'^2 + 3v_2'^2} \rightarrow (1)$$

$$* \Sigma P = \Sigma P'$$

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$(2*10) + (3*5) = (2v_1') + (3v_2')$$

$$35 = 2v_1' + 3v_2'$$

$$3v_2' = 35 - 2v_1'$$

$$\boxed{v_2' = \frac{35 - 2v_1'}{3}} \rightarrow (2)$$

$$275 = 2v_1'^2 + 3\left(\frac{35 - 2v_1'}{3}\right)^2$$

$$275 = 2v_1'^2 + \frac{(35 - 2v_1')^2}{3}$$

$$275 = 2v_1'^2 + \frac{(35^3 - 2v_1')(35 - 2v_1')}{3}$$

$$275 = 2v_1'^2 + \frac{(1225 - 70v_1' - 70v_1' + 4v_1'^2)}{3}$$

$$825 = 6v_1'^2 + 1225 - 70v_1' - 70v_1' + 4v_1'^2$$

$$825 = 10v_1'^2 - 140v_1' + 1225$$

$$\Rightarrow 10v_1'^2 - 140v_1' + 400 = 0$$

$$v_1'^2 - 14v_1' + 40 = 0$$

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$$v_1'^2 - 14v_1' + 40 = 0$$

$$(v_1' - 10)(v_1' - 4) = 0$$

$v_1' = 10\ m/s$ | $v_1' = 4\ m/s$

$$v_2' = \frac{35 - 2*10}{3} \qquad v_2' = \frac{35 - 2*4}{3}$$

$v_2' = 5\ m/s$ | $v_2 = 9\ m/s$

Ex



- Solution:

$$\Sigma P = \Sigma P'$$

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2' = (m_1 + m_2)v'$$

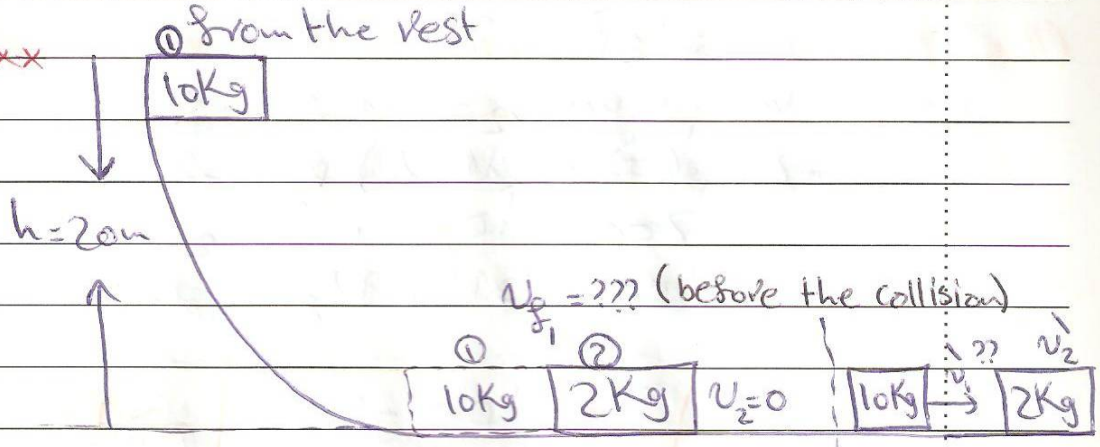
$$(50*10^{-3}*100) + (10*0) = (10 + (50*10^{-3}))v'$$

$$\frac{5}{10.05} = \frac{10.05v'}{10.05}$$

$$v' = 0.497512437\ m/s \quad \#$$

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xxx Ex xxx



- Solution:

~~①~~ $\Sigma E_{①} = \Sigma E_{①g}$

$K_i + U_{g_i} = K_g + U_{g_g}$

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_g^2 + mgh_g$

$\frac{1}{2}10(0) + (10*10*20) = \frac{1}{2}10(v_g^2) + (10*10*0)$

$\frac{2000}{5} = \frac{5}{5}v_g^2$

$\boxed{v_g = 20 m/s}$ #

- Solution:

* $\Sigma K = \Sigma K'$

$\frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2 = \frac{1}{2}mv_1'^2 + \frac{1}{2}mv_2'^2$

$(10*(20)^2) + (2*0) = (10v_1'^2) + (2v_2'^2)$

$4000 = 10v_1'^2 + 2v_2'^2$

$\boxed{2000 = 5v_1'^2 + v_2'^2}$ → ①

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$* \Sigma P = \Sigma P'$

$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

$(10 * 20) + (0) = (10 v_1') + (2 v_2')$

$200 = 10 v_1' + 2 v_2'$

$100 = 5 v_1' + v_2'$

$$\boxed{v_2' = 100 - 5 v_1'} \rightarrow (1)$$

(1) ko solve $\longrightarrow$ $2000 = 5 v_1'^2 + (100 - 5 v_1')^2$

$2000 = 5 v_1'^2 + (100 - 5 v_1')(100 - 5 v_1')$

$2000 = 5 v_1'^2 + 10000 - 500 v_1' - 500 v_1' + 25 v_1'^2$

$2000 = 30 v_1'^2 - 1000 v_1' + 10000$

$\Rightarrow 30 v_1'^2 - 1000 v_1' + 8000 = 0$

$6 v_1'^2 - 200 v_1' + 1600 = 0$

$3 v_1'^2 - 100 v_1' + 800 = 0$

$(3 v_1' - 40)(v_1' - 20) = 0$

$v_1' = \frac{40}{3}$

$$\boxed{v_1' = 13.3}$$

$\rightarrow v_2' = 100 - 5(13.3)$

$v_2 = 100 - 66.5$

$$\boxed{v_2 = 33.3 \text{ m/s}} \neq$$

$$\boxed{v_1' = 20}$$

$\rightarrow v_2' = 100 - (5 * 20)$

$v_2 = 100 - 100$

$$\boxed{v_2 = 0}$$ ULi

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*** Two Dimensional Collisions : *** (التصادم في بعدين)

(بعشر داخل)

*** الزخم سيكون محفوظاً في كل الإتجاهات (x, y, z) وبيع

قانون الزخم في بعدين

$$* m_1 v_{1ix} + m_2 v_{2ix} = m_1 v_{1fx} + m_2 v_{2fx}$$

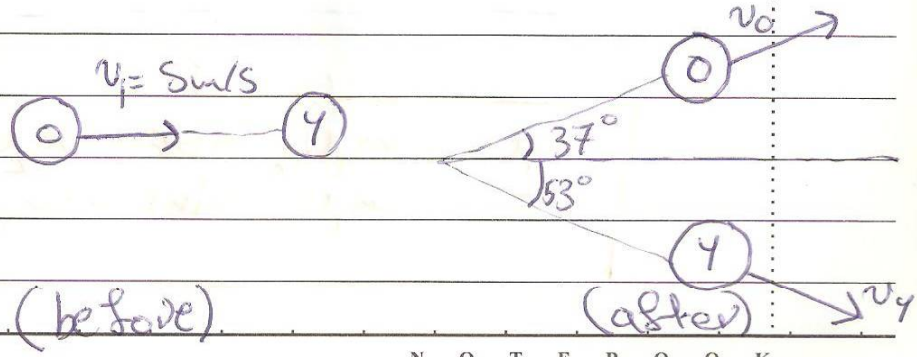
$$* m_1 v_{1iy} + m_2 v_{2iy} = m_1 v_{1fy} + m_2 v_{2fy}$$

* $(v_{2i} = 0)$ اذا كانت تصادم

مرنة وذلك يعني :

$$\frac{1}{2} m_1 v_{1i}^2 = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$$

*** Ex: *** Two shuffleboard disks of equal mass, one orange and the other yellow are involved in elastic, glancing collision. (The yellow disk is initially at rest) and is struck by (the orange disk moving with a speed of 5m/s). After the collision, (the orange disk moves along a direction that makes an angle of 37°) with its initial direction of motion. The velocities of the two disks are perpendicular after the collision. Determine the final speed of each disk?



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- Solution: $* \Sigma P_x = \Sigma P'_x$

$$m U_{oix} + m U_{4ix} = m U_{of_x} + m U_{4f_x}$$

$$\textcircled{1} \leftarrow \quad m \times S = m U_{of_x} \cos 37^\circ + m U_{4f_x} \cos 53^\circ$$

$$S = U_{of_x} \cos 37^\circ + U_{4f_x} \cos 53^\circ$$

$$* \; m U_o \sin 37^\circ - m U_4 \sin 53^\circ = 0$$

$$\textcircled{2} \leftarrow \quad m U_o \sin 37^\circ = m U_4 \sin 53^\circ$$

$$\Rightarrow S = U_4 \sin 53^\circ \cos 37^\circ + U_4 \cos 53^\circ$$

$$S = (U_4 * 0.637818677) + (U_4 * 0.601815023)$$

$$S = 1.239633 7 U_4$$

$$\boxed{U_4 = 4.033749559 \text{ m/s}} \quad \#$$

$$\Rightarrow U_o = \frac{4.033749559 * \sin 53^\circ}{\sin 37^\circ}$$

$$\boxed{U_o = 5.355256835 \text{ m/s}} \quad \#$$

$$m_1 U_{1i} = m_1 U_{1f} \cos\theta + m_2 U_{2f} \cos\theta \quad \therefore$$

$$0 = m_1 U_{1f} \sin\theta - m_2 U_{2f} \sin\theta$$

Ex: An object of (mass 3Kg), moving with an (initially velocity of $5\hat{i}$ m/s). collides with and sticks to an object of (mass 2Kg) with an (initial velocity of $-3\hat{j}$ m/s). find the final velocity of the composite object?

-Solution: $m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f'$

$(3(5\hat{i})) + (2(-3\hat{j})) = (3+2) v_f'$

$15\hat{i} + -6\hat{j} = 5(v_f')$

$$\boxed{v_f' = (3\hat{i} - 1.2\hat{j})\ m/s} \quad \#$$

*The center of Mass (مركز الكتلة)

Group of Particles	*Extended object*
$*X_{cm} = \frac{\Sigma m_i x_i}{\Sigma m_i}$	$*X_{cm} = \frac{1}{M}\int x\,dm$
$*Y_{cm} = \frac{\Sigma m_i y_i}{\Sigma m_i}$	$*Y_{cm} = \frac{1}{M}\int y\,dm$
$*Z_{cm} = \frac{\Sigma m z_i}{\Sigma m_i}$	$*Z_{cm} = \frac{1}{M}\int z\,dm$
$*\vec{r}_{cm} = \frac{\Sigma m \vec{r}_i}{\Sigma m_i}$	$*\vec{r}_{cm} = \frac{1}{M}\int \vec{r}\,dm$
$*\vec{r}_{cm} = \frac{\Sigma m_i x_i + \Sigma m_i y_i + \Sigma m_i z_i \ldots}{\Sigma m_i}$	

Ex8: Four object are situated along the yaxis as follows: a 2Kg object at +3m, a 3kg object is at 2.5m, a 2.5 Kg object is at the origin and a 4Kg object is at -0.5m. where is the center of mass of these objects?

- Solution: $y_{cm} = \frac{\Sigma m_i x_i + \Sigma m_i y_i + \Sigma m_i z_i}{\Sigma m_i}$

$$y_{cm} = \frac{0 + ((2*3)+(3*2.5)+(2.5*0)+(4*-0.5)) + 0}{(2+3+2.5+4)}$$

$$\boxed{y_{cm} = 1\,m} \quad //$$

Ex8: A rod of length (0.3 m) has linear density (mass-per length) given by $\lambda = 50 + 20x$ where x is the distance from one end, measured in meters.

(a) what is the mass of the rod?

(b) How far from the x=0 end is its center of mass?

- Solution(a): $\text{Mass} = \int_0^{0.3} 50 + 20x \, dx$

$$\text{Mass} = 50x + 10x^2 \Big]_0^{0.3}$$

$$\text{Mass} = (50*0.3) + (10*0.3*0.3)$$

$$\text{Mass} = 15 + 0.9$$

$$\boxed{\text{Mass} = 15.9\,g} \quad //$$

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- Solution (b): $\therefore X_{cm} = \frac{1}{M}\int_0^{0.3} \lambda x \, dx$

$$X_{cm} = \frac{1}{15.9} * \int_0^{0.3} x(50 + 20x)\, dx$$

$$X_{cm} = \frac{1}{15.9} * \int_0^{0.3} (50x + 20x^2)\, dx$$

$$X_{cm} = \frac{1}{15.9} * \left(25x^2 + \frac{20}{3}x^3\right)\Big]_0^{0.3}$$

$$X_{cm} = \frac{1}{15.9} * \left(25(0.3)^2 + \frac{20}{3}(0.3)^3\right)$$

$$X_{cm} = \frac{1}{15.9} * (2.25 + 0.6)$$

$$X_{cm} = \frac{2.85}{15.9} = \boxed{0.179245283\ m} \#$$

*** Ex *** A tennis player receives a shot with the ball (0.06 Kg) traveling horizontally at (50 m/s) and returns the shot with the ball traveling horizontally at (40 m/s) in the opposite direction. (a) what is the impulse delivered to the ball by the racquet? (b) what work does the racquet do on the ball?

- Solution (a): $\therefore I = \Delta P = P_f - P_i$

$$I = mv_i - mv_f$$

$$I = (0.06(40 - -50))$$

$$\boxed{I = 5.4\ N.S} \#$$

- solution (b) $\Rightarrow W = K_f - K_i = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$$= \frac{1}{2} * 0.06 (40)^2 - \frac{1}{2} * 0.06 (50)^2$$

$$= \boxed{-27 J} \#$$

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*** Ex8. *** (A 10g) bullet is fired into a stationary block of wood ($m_2 = 5kg$). The relative motion of the bullet stops inside the block. (The speed of the bullet-plus-wood combination immediately after the collision is 0.6 m/s) what was the original speed of the bullet?

- Solution: $\Sigma p = \Sigma p'$

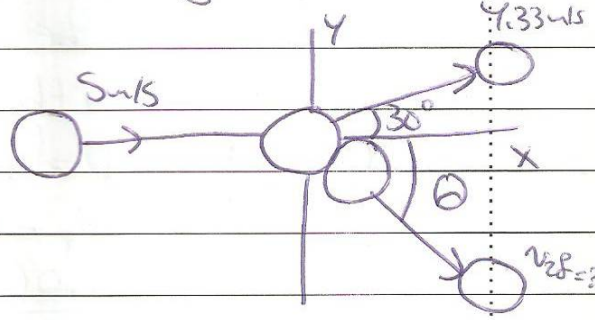
$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$$

$$0.01 v_1 + 0 = (0.01 + 5)\, 0.6$$

$$v_{bullet} = 300.6 \text{ m/s} \quad //$$

*** Ex8. *** A billiard ball moving at (5 m/s) strikes a stationary ball of the same mass. After the collision the first ball moves, at (4.33 m/s) (at an angle of 30°) with the respect to the original line of motion. Assuming an elastic collision (and ignoring friction and rotational motion) find the struck ball's velocity after the collision ???

- Solution:



$$m_1 v_1 \cos\theta + m_2 v_2 \cos\theta = m v$$

$$4.33 \cos 30^\circ + v_2 \cos\theta = 5 \rightarrow (1)$$

$$4.33 \sin 30^\circ = v_2 \sin\theta \rightarrow (2)$$

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$$4.33\cos 30^\circ + \frac{4.33\sin 30^\circ \cos\theta}{\sin\theta} = 5$$

$$3.749889998 + \frac{2.165\cos\theta}{\sin\theta} = 5$$

$$3.749889998 + 2.165\cot\theta = 5$$

$$2.165\cot\theta = 1.250110002$$

$$\cot\theta = 0.577418014$$

$$\frac{1}{\tan\theta} = 0.577418014$$

$$\tan\theta = \frac{1}{0.577418014}$$

$$\boxed{\theta = 60^\circ}$$ ✓

$$\text{ajlee} \rightarrow \textcircled{2}\ \frac{4.33\sin 30^\circ}{\sin 60^\circ} = V_y$$

$$\boxed{V = 2.5\ m/s}$$ ✓

$$\text{ajlee} \rightarrow \textcircled{1}\ 4.33\cos 30^\circ + V_x\cos 60^\circ = 5$$

$$3.749889998 + V_x * 0.5 = 5$$

$$\boxed{V = 2.5\ m/s}$$ ✓ #

Ex: The mass of the earth is $(5.98*10^{24}Kg)$, and the mass of the Moon is $(7.36*10^{22}Kg)$. The distance of separation, measured between their center, is $(3.84*10^{8}m)$. Locate the center of mass of the Earth-Moon system as measured from the center of the earth.

-Solution: $X_{cm} = \frac{(5.98*10^{24}*0)+(7.36*10^{22}*3.84*10^{8})}{(5.98*10^{24}+7.36*10^{22})}$

$X_{cm} = \frac{2.82624*10^{31}}{6.0536*10^{24}}$

$\boxed{X_{cm} = 4668693.009\ m}$ #

Ex: A 0.3Kg ball moving along a straight line velocity of $5i\hat{}\ m/s$. it collides with a wall and rebound with velocity of $-4j\hat{}\ m/s$ if the ball contact with the wall for $5*10^{-3}s$, evaluate the average force exerted on the wall?

-Solution: $I = F_{avg}*\Delta t$

$mv_f - mv_i = F_{avg}*\Delta t$

$(0.3*-4_{j\hat{}}) - (0.3*5_{i\hat{}}) = F_{avg}*5*10^{-3}$

$\frac{-1.2-1.5}{5*10^{-3}} = F_{avg} \Rightarrow \boxed{F_{avg} = -540N}$ #

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*** Ex *** Two bodies A(140g and 80cm/s) and B(60g and 20cm/s) moves toward each other, after a head on perfectly elastic collisions what is the speed of B (in cm/s) ???

- Solution: $\Sigma P = \Sigma P'$

$$m_A v_A + m_B v_B = m_A v_A' + m_B v_B'$$

$$(0.14 * 0.8) + (0.06 * 0.2) = 0.14 v_A' + 0.06 v_B' \longrightarrow (1)$$

$$\Sigma K = \Sigma K'$$

$$\frac{1}{2} m_A v_A^2 + \frac{1}{2} m_B v_B^2 = \frac{1}{2} m_A v_A'^2 + \frac{1}{2} m_B v_B'^2$$

$$0.14 * (0.8)^2 + (0.06 (0.2)^2) = 0.14 v_A'^2 + 0.06 v_B'^2$$

$$0.092 = 0.14 v_A'^2 + 0.06 v_B'^2$$

(بالتبسيط) $0.303315017 = 0.371657536 v_A' + 0.244948974 v_B'$

$$v_B' = \frac{0.303315017 - 0.371657536 v_A'}{0.244948974}$$

$$v_B' = 1.238278373 - 1.527525222 v_A'$$

(1) بالتعويض $\longrightarrow 0.124 = 0.14 v_A' + 0.06 (1.238278373 - 1.5 v_A')$

$$0.124 = 0.14 v_A' + 0.074296702 - 0.091651513 v_A'$$

$$0.124 = 0.048348487 v_A' + 0.074296702$$

$$\boxed{v_A' = 1.028017258 \text{ m/s}} \#$$

$$\boxed{v_B' = -0.332073917 \text{ m/s}} \#$$

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*** Ex *** A 0.3Kg mass moves at 8m/s on a frictionless surface collides with 0.5Kg mass, the two masses struck after the collision and move together with velocity of 2m/s, what is the loss in Kinetic energy due to collision?

Solution: $\Sigma P = \Sigma P'$

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$(0.3 * 8) + (0.5 v_2) = (0.5 + 0.3)2$$

$$2.4 + 0.5 v_2 = 1.6$$

$$\boxed{v_2 = -1.6 m/s^2}$$

$$K_{before} = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

$$= \left(\frac{1}{2}(0.3)(8)^2\right) + \left(\frac{1}{2}(0.5)(-1.6)^2\right)$$

$$= 9.6 + 0.64$$

$$= \boxed{10.24 J}$$

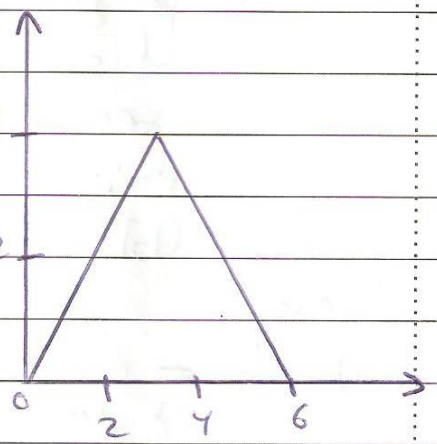
$$K_{after} = \frac{1}{2}(m_1 + m_2) v^2$$

$$= \frac{1}{2}(0.5 + 0.3)(2)^2$$

$$= \boxed{1.6 J}$$

$$\Delta K = 1.6 - 10.24 = \boxed{-8.64 J} \; //$$

Ex: A 4 Kg block initially at rest experiences a force that varies with time as shown in figure. what is the speed of the block when (t = 6 s)?



- Solution:

ΔP = area

$mv_f - mv_i = \frac{1}{2} * 6 * 4$

$m(v_f - v_i) = 12$

$4(v_f - 0) = 12$

$\boxed{v_f = 3 \text{ m/s}}$ //

Ex: The initial path of a rocket is 30° above the horizontal component of the rocket's velocity is 326 m/s. The initial vertical component of the rocket's velocity is:

(a) 188 m/s (b) 330 m/s (c) 380 m/s (d) 280 m/s (e) 250 m/s

- Solution:

$\tan\theta = \frac{v_y}{v_x} \rightarrow v_y = \tan\theta \, v_x$

$v_y = \tan 30° * (326)$

$\boxed{v_y = 188 \text{ m/s}} \Rightarrow$ (a)

*** Ex *** Two bodies A and B move toward each other with speeds of 80 cm/s and -20 cm/s respectively. The mass of A is 140g and that of B is 60g. After a head-on, perfectly elastic collision the speed of B is:

(a) 8.0 cm/s (b) 20 cm/s (c) 92 cm/s (d) 1.2 m/s

- Solution:

$$v_{2f} = \frac{2m_1}{m_1+m_2} v_{1i} + \frac{m_2-m_1}{m_1+m_2} v_{2i}$$

$$v_{2f} = \frac{2*(140)}{(140+60)} * 80 + \frac{(60-140)}{(60+140)} (-20)$$

$$v_{2f} = (112) + (8)$$

$$v_{2f} = 120 * 10^{-2} = \boxed{1.2 \text{ m/s}} \quad //$$

*** Ex *** A bullet with a mass of 20g and a speed of 920 m/s strikes a block of wood mass 4.5Kg from resting on a horizontal surface. The bulet gets embedded in the block. The speed of the block after the collision???

- Solution: $\Sigma P = \Sigma P'$

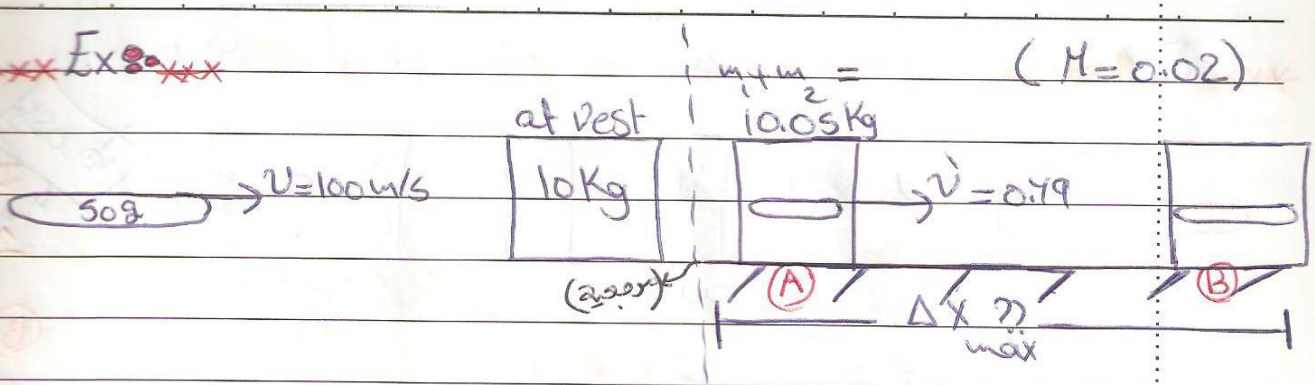
$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v'$$

$$(20 * 10^{-3} * 920) + 0 = (20 * 10^{-3} + 4.5 \ldots) v'$$

$$\boxed{v' = 4.07 \text{ m/s}} \quad //$$

Subject Date No.

*** Ex ***



*** find Δx_{max} ???

Solution: $\Sigma_A = \Sigma_B + \omega_{of\,K}$

$K_A + U_{g_A} = K_B + U_{g_B} + \omega_{of\,K}$

$\frac{1}{2} m v_A^2 + mgh_A = \frac{1}{2} m v_B^2 + mgh_B + (F_K * \Delta x_{max})$

$\left(\frac{1}{2} 10.05 (0.49)^2\right) + (10.05 * 10 * 0) = \frac{1}{2} (10.05)(0)^2 + (10.05 * 10 * 0) +$

$\frac{1}{2} 10.05 (0.49)^2 = M * m * \Delta x_{max}$

$1.206025 = M * mg * \Delta x_{max}$

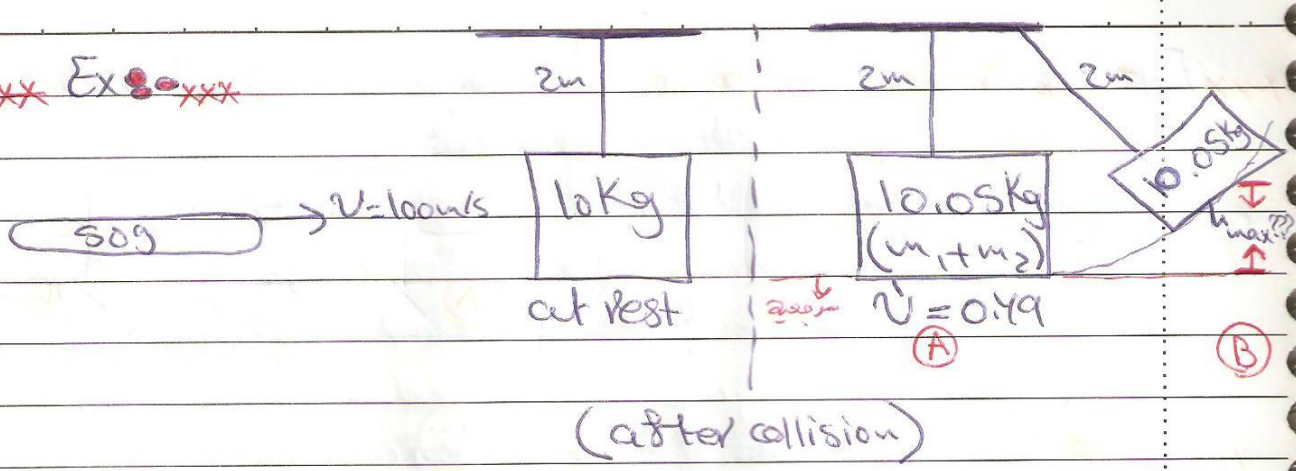
$1.206025 = 0.02 * 10.05 * 10 * \Delta x_{max}$

$1.206025 = 2.01\, \Delta x_{max}$

$\boxed{\Delta x_{max} = 0.60025 \text{ m}}$ //

Subject Date No.

*** Ex ***



*** Find h_{max} ???

⟹ Solution::

$$E_A = E_B$$

$$K_A + U_{g_A} = K_B + U_{g_B}$$

$$\frac{1}{2}(m_1+m_2)v_A^2 = (m_1+m_2)gh_{max}$$

$$\frac{1}{2}(0.49)^2 = 10 * h_{max}$$

$$\boxed{h_{max} = 0.012005\,m}\ \#$$

*** Find v_B Then h_{max} = 1 m ???

⟹ Solution::

$$E_A = E_B$$

$$K_A + U_{g_A} = K_B + U_{g_B}$$

$$\frac{1}{2}(m_1+m_2)v_A^2 = \frac{1}{2}(m_1+m_2)v_B^2 + (m_1+m_2)gh_{max}$$

$$\frac{1}{2}(0.49)^2 = \frac{1}{2}v_B^2 + (10*1) \Rightarrow (0.12005 - 10) = \frac{1}{2}v_B^2$$

$$v_B = \sqrt{19.7} = \boxed{4.4452}\ \#$$

Subject Date No.

*** Power ***

(القدرة)

* القدرة تعرف بأنها معدل انتقال الطاقة في وحدة الزمن ويعبر عنها

$$P = \frac{W}{\Delta t}$$

* وتعرف بـ average power ... أما القدرة اللحظية

$$\text{Instantaneous power} = \frac{dW}{dt}$$

* القدرة اللحظية:

$$P = \frac{dW}{dt} = F \cdot \frac{dx}{dt} = F \cdot v$$

* وتقاس بوحدة (J/S)

*** Ex: The electric motor of a model train accelerates the train from rest to 0.620 m/s in 21.0 ms. The total mass of the train is 875 g. Find the average power delivered to the train during the acceleration???

- Solution: $P = \frac{W}{\Delta t} \Rightarrow W = \Delta K = K_f - K_i$

$$W = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$W = \frac{1}{2} * 875 * (0.620)^2$$

$$W = 168.175 \text{ J}$$

$$W = 168.175 * 10^{-3} \text{ Kg}$$

$$W = 0.168175 \text{ J}$$

$$* P = \frac{168.175 * 10^{-3}}{21 * 10^{-3}}$$

$$\boxed{P = 8.01 \text{ J/S}} \#$$

***Ex** A skier of mass 70 kg is pulled up a slope by a motor driven cable.

(a) How much work is required to pull him a distance of 60 m up a 30° slope (assumed frictionless) at a constant speed of 2 m/s?

- Solution: $W = mgh_f - mgh_i$

$W = 70 * 10 * (60 \sin 30°)$

$W = 2100\,J$

(b) A motor of what power is required to perform this task?

- Solution: $P = \frac{W}{\Delta t}$

$\Rightarrow v = \frac{\Delta x}{\Delta t} \Rightarrow \Delta t = \frac{\Delta x}{v} = \frac{60}{2} = \boxed{30\,s}$

$P = \frac{2100}{30} = \boxed{70}$ #

***Ex** A 700-N Marine in basic training climbs a 6 m vertical rope at a constant speed in 8 s. What is his power output???

- Solution: $P = \frac{W}{\Delta t} = \frac{mgh}{\Delta t} = \frac{(700)(10)}{8} = \boxed{875\,W}$

***Ex** An elevator is used to move 20 people (60 kg each) per min from the first floor to the second floor 5m above. what is the power required?

- Solution:

The total mass moved in elevator is:

$$m = 20 * 60 = 1200\ Kg$$

The force applied on the elevator (tension):

$$F = mg = 1200 * 9.8 = 11760\ N$$

The work done by the elevator:

$$\omega = F_s = 11760 * 5 = 58800\ J$$

$$P = \frac{\omega}{t} = \frac{58800}{60} = \boxed{980\ w}\ \#$$

***Ex** The power developed by a certain engine is a function of time according to $P = 2 + 2t + 3t^2$, where the units are SI. The work done by the engine in the interval from $t = 0$ to $t = 2\ s$ is:

- Solution:

$$P(t) = \frac{\omega}{\Delta t} \Rightarrow \omega = P(t).\Delta t \Rightarrow \omega = \int_0^2 P.\Delta t$$

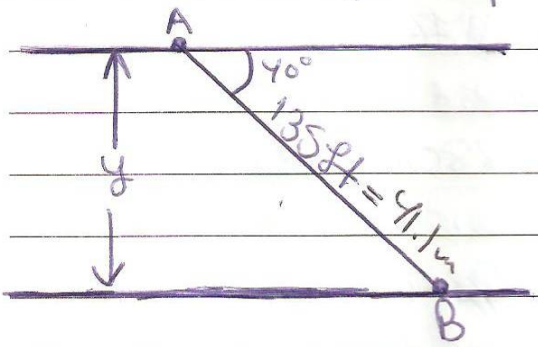
$$\omega = \int_0^2 2 + 2t + 3t^2 .dt = 2t + t^2 + t^3 \Big]_0^2$$

$$\omega = (2*2 + (2)^2 + (2)^3)$$

$$\boxed{\omega = 16\ J}\ \#$$

Subject ***Example*** Date No.

① A 1000 kg Roller coaster train is initially at the top of a rise, at point A. It then moves 135 ft at an angle of 40° below the horizontal, to a lower point B. (a) choose point B to be the zero level for gravitational potential energy. Find the potential energy of the Roller Coaster - Earth system at points A and B and the change in potential energy as the coaster moves



- Solution (a): $U_B = 0$

$$U_A = mgh_A$$

$$U_A = 1000 * 9.8 * (41.1 \sin 40)$$

$$\boxed{U_A = 258901.9934 \text{ J}}$$

The change in potential energy as the car moves from A to B:

$$\Delta U = U_B - U_A = \boxed{-258901.9934 \text{ J}} \#$$

(b) Repeat part (a), setting the zero reference level at point A.

- Solution: $U_A = 0$

$$U_B = mgh_B = 1000(9.8)(-41.1 \sin 40^\circ)$$

$$\boxed{U_B = -258901.9934 \text{ J}} \#$$

② ***A 400-N child is in a swing that is attached to ropes 2m long. Find the gravitational potential energy of the child's lowest position when:

(a) The ropes are horizontal.

(b) The ropes make a 30° angle with the vertical.

(c) The child is at the bottom of the circular arc.

_Solution(a):

$U_g = mgh = (400)(2)$

$U_g = 800J$

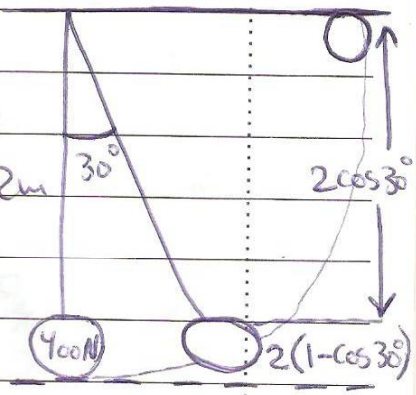
_Solution(b):

$U_g = mgh = (400)(1-\cos 30°)(2)$

$U_g = 107J$

_Solution(c):

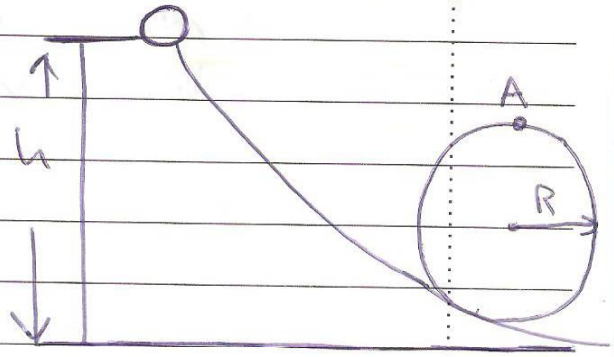
$U_g = 0$



③ ***A bead slides without friction around a loop-the-loop. The bead is released from a height = 3.50R.

(a) what is its speed at point A?

(b) How large is the normal force on it if its mass is 5g?



Subject Date No.

- Solution (A):

$$E_i = E_f$$

$$K_i + U_{g_i} = K_f + U_{g_f}$$

$$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$$

$$0 + (mgh_i) = \frac{1}{2}mv_f^2 + mgh_f$$

$$10 * h_i = \frac{1}{2}v_f^2 + gh_f$$

$$10 * 3.5R = \frac{1}{2}v_f^2 + 10 * (2R)$$

$$30.5R = \frac{1}{2}v_f^2 + 20R$$

$$R(30.5 - 20) = \frac{1}{2}v_f^2$$

$$10.5R = \frac{1}{2}v_f^2$$

$$v_f^2 = 21R$$

$$\boxed{v_f = \sqrt{21R}}$$

- Solution (B):

$$\Sigma F = \frac{mv^2}{r}$$

$$N + mg = \frac{mv^2}{r}$$

$$N + 10m = \frac{m * 21R}{R}$$

$$N + 10m = 21m$$

$$N = 11m$$

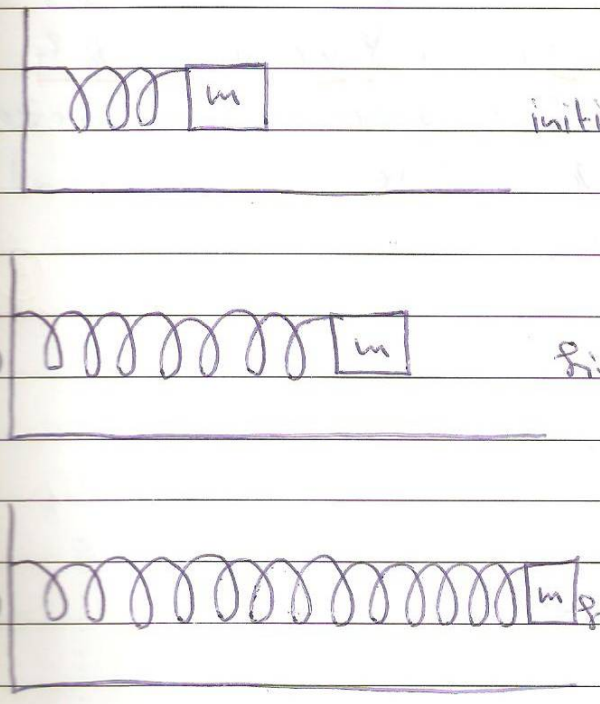
$$N = 11 * 5 * 10^{-3} = \boxed{55 * 10^{-3}\ N}$$ //

(4) A glider of mass 0.150 Kg moves on a horizontal frictionless air track. It is permanently attached to one end of a massless horizontal spring, which has a force constant of 10 N/m both for extension and for compression. The other end of the spring is fixed. The glider is moved to compress the spring by 0.180 m and then released from rest. Calculate the speed of the glider:

(a) At the point where it has moved 0.180 m from its starting point, so that the spring is momentarily exerting no force?

(b) At the point where it has moved 0.250 m from its starting point?

– Solution:



(a) $\Sigma_1 = E_f$

$K_1 + U_{g_1} + U_{s_1} = K_f + U_{g_f} + U_{s_f}$

$\frac{1}{2}mv_1^2 + \left(\frac{1}{2}kx^2\right)_1 = \frac{1}{2}mv_f^2 + \left(\frac{1}{2}kx^2\right)_f$

$\frac{1}{2} \times 10 \times (0.180)^2 = \frac{1}{2}(0.150)v_f^2$

$v_f = \sqrt{\frac{10(0.180)^2}{0.150}}$

$v_f = 1.47 \text{ m/s}$

Subject Date No.

- Solution (b): $E_i = E_f$

$$K_i + U_{g_i} + U_{s_i} = K_f + U_{g_f} + U_{s_f}$$

$$\frac{1}{2}mv_i^2 + \left(\frac{1}{2}\Delta x^2 K\right)_i = \frac{1}{2}mv_f^2 + \left(\frac{1}{2} * K \Delta x^2\right)$$

$$\frac{1}{2} * 10(0.18)^2 = \frac{1}{2}mv_f^2 + \left(\frac{1}{2} * 10(0.25 - 0.18)^2\right)$$

$$0.162 = 0.075v_f^2 + 0.0245$$

$$\boxed{v_f = 1.35400640 \text{ m/s}} \#$$

(5) *** At time t_i, the Kinetic energy of a particle is 30J and the potential energy of the system to which it belongs is 10J. At some later time t_f, the Kinetic energy of the particle is 18J. (a) If only conservative forces act on the particle, what are the potential energy and the total energy at time t_f???

- Solution: $E_i = E_f$

$$K_i + U_{g_i} = K_f + U_{g_f}$$

$$30 + 10 = 18 + U_{g_f}$$

$$40 = 18 + U_{g_f}$$

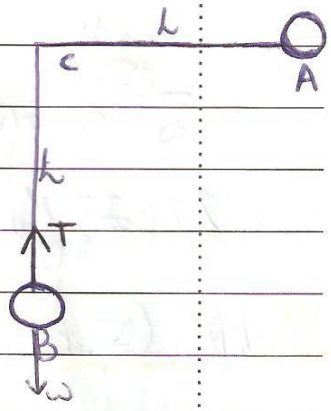
$$U_{g_f} = 40 - 18$$

$$\boxed{U_{g_f} = 22 \text{ J}} \#$$

- total energy $= 18 + 22 = 40$ J (or)

$= 30 + 10 = \boxed{40 \text{ J}} \#$

⑥ A simple pendulum has a bob of mass m. the bob is on light string of length (L). the string is fixed at C. at position A the string is horizontal and the bob is at rest. The bob released from A and stops B. find the tension at point B (when the bob first reaches it)?



- Solution: $T - w = \frac{mv^2}{r}$

$$T - mg = \frac{mv^2}{r}$$

$$T - mg = \frac{mv_B^2}{L} \longrightarrow ①$$

$$* E_A = E_B$$

$$K_A + U_{g_A} = K_B + U_{g_B}$$

$$\frac{1}{2}mv_A^2 + mgh_A = \frac{1}{2}mv_B^2 + mgh_B$$

$$mgL = \frac{1}{2}mv_B^2$$

$$\boxed{2gL = v_B^2}$$

$$① \longrightarrow T - 10m = \frac{m\,2gL}{L}$$

$$T - 10m = 20m$$

$$\boxed{T = 30m}$$ //

Subject Date No.

(7) *** A block of 2kg mass compresses a horizontal spring of one fixed end by 0.3m, when it is released the block moves across a horizontal rough surface of $\mu_k = 0.2$ a distance of 2.25m before coming to rest, find the spring constant?

- Solution:

$U_{spring} = W_{friction}$

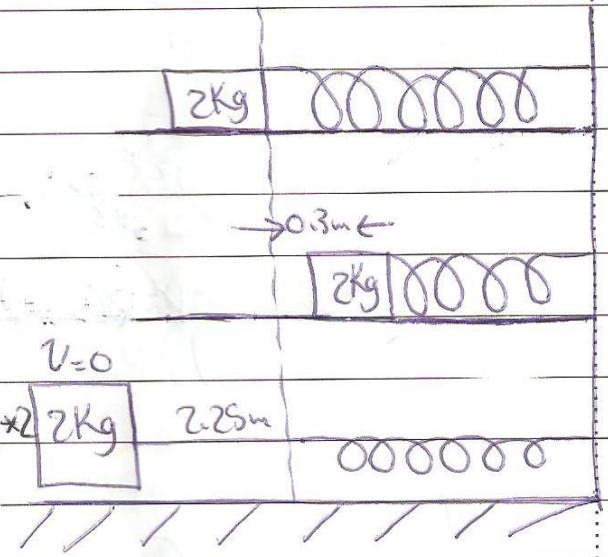
$\frac{1}{2} k \Delta x^2 = \mu_k * N * S$ ...

$\frac{1}{2} K \Delta x^2 = mg \mu_k * S$

$\frac{1}{2} K (0.3)^2 = 2 * 10 * 0.2 * 2.25 * 2$

$\frac{K (0.3)^2}{(0.3)^2} = \frac{18}{(0.3)^2}$

$\Rightarrow \boxed{K = 200 \ N/m}$ #



(8) *** A 0.2kg particle moves along x-axis on a frictionless surface. The particle potential energy is given by $U(x) = 8x^2 + 2x^4$, if the particle has a speed of 5m/s when its at $x = 1m$, what is the particle speed when its at origin?

- Solution: $E_i = E_f$

$K_i + U_i = K_f + U_f$

$\frac{1}{2} m v_i^2 + U(1) = \frac{1}{2} m v_f^2 + U(0)$

$\frac{1}{2} * 0.2 * (5)^2 + 10 = \frac{1}{2} * 0.2 v_f^2 + 0$

(2.41)

$12.5 = 0.1 v_f^2 \Rightarrow \boxed{v_f = 11.18033989}$ #

Subject Date No.

(9) ××× Dave Johnson, the bronze medalist at the 1992 olympic decathlon in Barcleona, leaves the ground at the high jump with vertical velocity component 6 m/s. How far does center of mass move up as he makes the jump?

Solution: $K_i + \cancel{U_{g_i}} = \cancel{K_f} + U_{g_f}$

$$\frac{1}{2}mv_i^2 = mgh_f$$

$$\frac{1}{2} * \cancel{m}(6)^2 = \cancel{m} * 10 * h_f$$

$$18 = 10h_f$$

$$\boxed{h_f = 1.8\,m} \#$$

(10) ××× A light rigied rod is 77 cm long. Its top end is pivoted on a low friction horizontal. The rod hangs straight down at rest with a small massive ball attached to its bottom end. You strike the ball, suddenly giving it a horizontal velocity so that it swings around in a full circle, what minimum speed at the bottom is required to make the ball go over the top of the circle?

$$K_i + \cancel{U_{g_i}} = \cancel{K_f} + U_{g_f}$$

$$\frac{1}{2}mv_i^2 = mgh_f$$

$$\frac{1}{2}\cancel{m}v_i^2 = \cancel{m}g(2L)$$

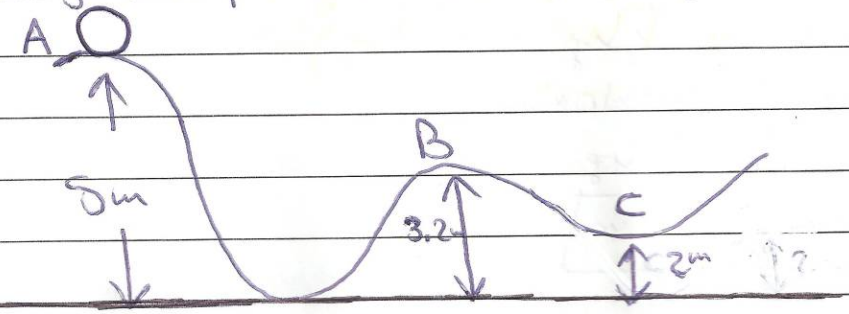
$$\frac{1}{2}v_i^2 = 10 * 2L$$

$$v_i^2 = 2 * 10 * 2 * 77 * 10^{-2}$$

$$\boxed{v_i = 5.5497477\ m/s} \#$$

Subject Date No.

(16) ~~***~~ A particle of mass m=5kg is released from point A and slides on the frictionless track shown in the below figure. Determine (a) the particles speed at point B and C and (B) the net work done by the gravitational force in moving the particle from A to C???



-Solution (A): $*E_A = E_B$

$$K_A + U_{g_A} = K_B + U_{g_B}$$

$$\left(\frac{1}{2}5*0\right) + (5*10*5) = \frac{1}{2}5(v_B^2) + (5*10*3.2)$$

$$250 = 2.5v_B^2 + 160$$

$$\boxed{v_B = 6\,m/s}\ //$$

$$*E_A = E_C$$

$$5*10*5 = \frac{1}{2}5v_C^2 + (5*10*2)$$

$$250 = 2.5v_C^2 + 100$$

$$\frac{150}{2.5} = v_C^2$$

$$\boxed{v_C = 7.745966692\,m/s}\ //$$

Solution(b): $W = \Delta K = K_C - \cancel{K_A}^{\to 0}$

$= \frac{1}{2} m v_C^2$

$= \boxed{15\,J}$ //

* * * *

The end