تقدم لجنة ElCoM الاكاديمية

دفتر لمادة:

فيزياء عامة (1)

من شرح:

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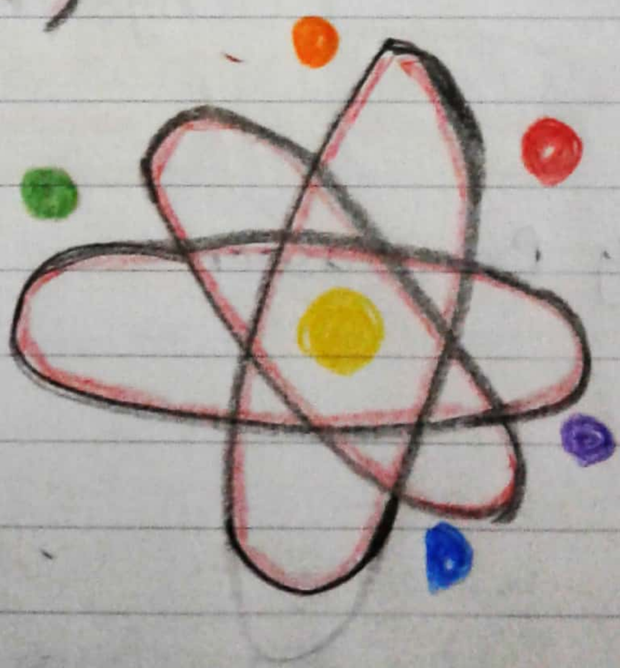
جزيل الشكر للطالبة:

سالي بني ياسين

First

Physics 1



#Sally Bani yaseen

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ch 1 :- Dimensional Analysis :-

* International units system :-

1. mass M Kg
2. distance L m
3. Time T secound.

Ex. (1) avarage speed $= \frac{\text{Distance}}{\text{time}}$

$$S = \frac{D}{t} \rightarrow [S] = \frac{[D]}{[t]}$$
$$= \frac{m}{s} = m/s$$
$$= ms^{-1} \quad (LT^{-1})$$

(2) acceleration $= \frac{\text{speed}}{\text{time}}$

$$a = \frac{S}{t} \rightarrow [a] = \frac{[s]}{[t]}$$

$$[a] = \frac{\frac{m}{s}}{s} = \frac{m}{s^2}$$

$$= m/s^2 = ms^{-2} \quad (LT^{-2})$$

(3) Force = mass * acceleration

$$F = ma$$
$$[F] = [m][a]$$
$$= Kg\ ms^{-2}$$
$$= \text{Newton} \quad (N)$$

$N = kg\ ms^{-2}$
$= MLT^{-2}$

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(4) work = Force * dis

$w = Fd$

$[w] = [F][d] \rightarrow [w] = N \cdot m =$ Joule $\underline{\underline{J}}$

$J = Nm$

$= kg\, m s^{-2} \cdot m$

$J = kg\, m^2 \cdot s^{-2}$

Ex. Let $F = \frac{G m_1 m_2}{r^2}$

$F \equiv$ force

$m =$ mass

$r =$ distance

Find $[G]$

$G = \frac{F r^2}{m_1 m_2}$

$[G] = \frac{[F][r^2]}{[m_1][m_2]}$

$= \frac{N \cdot m^2}{Kg^2} = N \cdot m^2 \cdot Kg^{-2}$

$= kg\, m\, s^{-2}\, m^2\, Kg^{-2}$

$= m^3\, Kg^{-1}\, s^{-2}$

Ex. Let $A = e^{\alpha t}$

find $[\alpha]$

Sine $e^{\alpha t}$ is unit less $[\alpha t]$ unit less

S $[\alpha] = s^{-1}$

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*For any equation to be correct

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

* لتكون المعادلة صحيحة يجب ان تكون وحدات القياس متكافئة

Ex. Check be equation if correct or not :-

$$v = at^2$$

سرعة $v \equiv$ Speed

$a \equiv$ acceleration

$t \equiv$ time

وحدتها تكافئ وحدتها

$$[v] \equiv [a][t^2]$$

$$\frac{m}{s} \equiv \frac{m}{\cancel{s^2}} * \cancel{s^2}$$

$$\frac{m}{s} \overset{??}{\not\equiv} m$$

not correct

Ex.

$$x = v_i \overset{\text{time}}{t} + \frac{1}{2} \overset{\text{acceleration}}{a} t^2$$

حد جبري

$$m \equiv \frac{m}{\cancel{s}} \cdot \cancel{s} + \frac{m}{\cancel{s^2}} \cdot \cancel{s^2}$$

* يجب ان تكون وحدات القياس متكافئة

$m \equiv m$ ✓ correct

Ex. Consider the equation :-

$$S = \frac{1}{2} a^k t^h$$

Find the values of k & h that fit the equation

where $S \equiv$ distanse

$a \equiv$ acceleration

$t \equiv$ time

$$[s] = [a^k] \cdot [t^h]$$

$$m = \left(\frac{m}{s^2}\right)^k \cdot s^h$$

$$m = \frac{m^k}{s^{2k}} \cdot s^h$$

$$m = m^k \cdot s^{-2k} \cdot s^h$$

$$m^1 = m^k \cdot s^{h-2k}$$

$\boxed{k = 1}$ تعبيرها (1) اس (0) 10 $\rightarrow h - 2k = 0 \Rightarrow \boxed{h = 2}$

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smi;)e...

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Let $a = v^k r^h$

$a \equiv$ aceleration
$v \equiv$ speed
$r \equiv$ radius

→ Find k, h

$[a] \equiv [v^k] \cdot [r^h]$

$\frac{m}{s^2} \equiv (m s^{-1})^k \cdot (m)^h$

$m s^{-2} \equiv m^k \cdot s^{-1k} \cdot m^h$

$m s^{-2} \equiv \boxed{m^{k+h}} \cdot \boxed{s^{-1k}}$

$\frac{-2}{-1} = \frac{-1k}{-1}$

$\boxed{k = 2}$

$h + k = 1$

$h + 2 = 1$
$\quad -2 \quad -2$

$\boxed{h = -1}$

$a = \frac{v^2}{r}$ تسارع مركزي

H.w Let $T = 2\pi L^h g^k$

$T \equiv$ time
$L \equiv$ Length
$g \equiv$ acceleration

$[T] \equiv [L^h][g^k]$

$s \equiv m^h \cdot \left(\frac{m}{s^2}\right)^k$

$\boxed{s} \equiv m^h \cdot m^k \cdot \boxed{s^{-2k}}$

$\frac{1}{-2} = \frac{-2k}{-2}$

$\boxed{k = -\frac{1}{2}}$

$h + k = 0$

$h - \frac{1}{2} = 0$
$\quad + \frac{1}{2} \quad + \frac{1}{2}$

$\boxed{h = \frac{1}{2}}$

#

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No.

Ex. Let $v = C_1 t + C_2 t^2 + C_3 t^4$

Find the dimensions of C_1, C_2, C_3.

$$[v] \equiv [C_1 t] \equiv [C_2 t^2] \equiv [C_3 t^4]$$

$$\frac{1}{s} \times \frac{m}{s} \equiv [C_1] s \times \frac{1}{s} \rightarrow \boxed{[C_1] = \frac{m}{s^2} = ms^{-2}}$$

acceleration

Also $\frac{1}{s^2} \times \frac{m}{s} \equiv [C_2] s^2 \times \frac{1}{s^2} \rightarrow \boxed{[C_2] = ms^{-3}}$

Also $\frac{1}{s^4} \times \frac{m}{s} \equiv [C_3] s^4 \times \frac{1}{s^4} \rightarrow \boxed{[C_3] = ms^{-5}}$

H.w

[9] which of the following equations are dimensionally correct?

(a) $v_f = v_i + ax$

(b) $y = (2m) \cos(kx)$ where $k = 2m^{-1}$

[11] Kinetic energy K has dimensions $kg \cdot m^2/s^2$

It can be written in terms of the momentum p and mass m as

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

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$\boxed{13}$ The position of a particle moving under uniform acceleration is some function of time and the acceleration. Suppose we write this position as $x = k a^m t^n$, where k is a dimensionless constant. Show by dimensional analysis that this expression is satisfied if $m = 1$ and $n = 2$. Can this analysis give the value of k

$\boxed{14}$ (a) Assume the equation $x = At^3 + Bt$ describes the motion of a particular object, with x having the dimension of length and t dimension of time. Determine the dimensions of the constants A & B

$x = At^3 + Bt$

$[x] \equiv [A][t]^3 + [B][t]$

$m \equiv [A][s]^3 + [B]\, s$

$m \equiv \frac{m}{s^3} \cdot s^3 + \frac{m}{s}\, s$

[A] dimension of

[B] dimension of speed

(b) Determine the dimensions of the derivative

$dx/dt = 3At^2 + B$

$[dx]/[dt] \equiv [A][t^2] + [B]$

$\equiv \frac{m}{s^3} s^2 + \frac{m}{s}$

$[dx][dt] \equiv \frac{m}{s}$

dimension of speed

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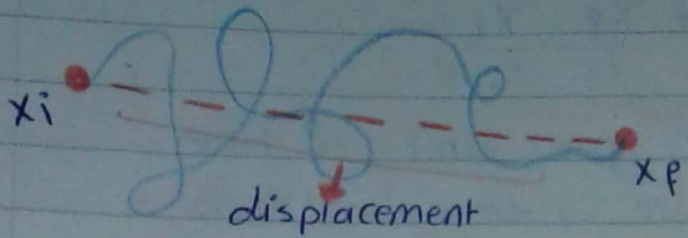
Ch:-2 Motion in One dimension

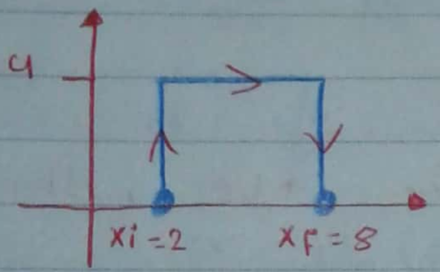
* Displacement Δx الإزاحة



* الازاحة تعبر عن اقصر مسافة بين نقطتين البداية والنهاية

$\Delta x \equiv$ change in position and it is the shortest distance between two points

$$\boxed{\Delta x = x_f - x_i}$$



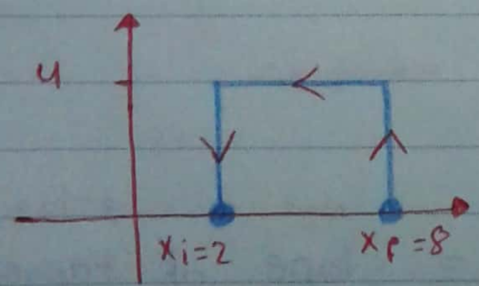
إلى اليمين الحركة

To positive

$\Delta x = x_f - x_i$ لأنه الحركة الى اليمين

$= 8 - 2 = (+) 6\ m$

المسافة كاملة Distance $= 4 + 6 + 4 = 14\ m$



إلى الشمال الحركة

To negative

لأنه الحركة الى اليسار عكس الاتجاه

$\Delta x = 2 - 8 = (-) 6\ m$

Distance $= 4 + 6 + 4 = 14\ m$

الازاحة * Displacement has direction & magnitude it could be +ve, -ve or Zero

المسافة * Distance has only magnitude and it is always +ve.

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* Avarage Velocity السرعة المتجهة

$$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

$v \equiv$ displacment per unit of time

- v could be +ve , -ve or zero and it has magnitude & direction

* Avarage speed $\underline{S}$ السرعة القياسية

$$S \equiv \frac{\text{total distance}}{\text{total time}}$$

$$S = \frac{D}{t}$$ & +ve , direction

* Instantaneous Velocity السرعة اللحظية

نها
$0 \leftarrow ; D$

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$ تعريف المشتقة

ميل مماس

$$v_{ins} = \frac{dx}{dt}$$ $\equiv$ slope of tangent

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* avarage acceleration التسارع

• change in Velocity per unit of time

تغير السرعة بالنسبة للزمن

$$\boxed{a = \frac{\Delta v}{\Delta t}} \rightarrow \frac{v_f - v_i}{\Delta t} \qquad +ve$$

• $v_f > v_i \rightarrow a > 0$ acceleration زيادة

• $v_f = v_i \rightarrow a = 0$ constnt velocity

• $v_f < v_i \rightarrow a < 0$ decelerastion نقصان

* Instantaneous acceleration

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$$a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t}$$

$$a = \frac{dv}{dt} \quad ; \quad v = \frac{dx}{dt}$$

$$a = \frac{d}{dt}\left(\frac{dx}{dt}\right) \rightarrow \boxed{a = \frac{d^2x}{dt^2}}$$ مشتقة ثانية

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* equation of motion :- معادلات الحركة

شروط معادلات الحركة

[1] Constant accelearation * التسارع التغير فيه منتظم خلال فترة زمنية

[2] We have constant mass * تغيرفي الكتلة

$$a = \frac{v_f - v_i}{t_f - t_i}$$

t_i → Zero في البداية تكون

$$a = \frac{v_f - v_i}{t_f} \Rightarrow v_f - v_i = at$$

علاقة خطية طردية

$$\boxed{1} \quad v_f = v_i + at$$

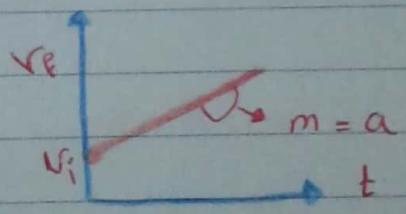
Constant سرعة لحظة البداية

acceleration constant

معادلة الخط المستقيم $y = mx + b$

slope y-inter step

$$v_f = at + v_i$$



*Since we have constant acceleration

10, 20, 30, 40, 50, 60 → 70/2 = 35 → 35

1, 2, 3, 4, 5 → 6/2 = 3 → 3

$$\bar{v} = \frac{v_f + v_i}{2} \; ; \text{ but } \bar{v} = \frac{\Delta x}{\Delta t}$$

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$$\frac{\Delta x}{\Delta t} = \frac{1}{2}(v_i + v_f)$$

$\boxed{2}$

$$\Delta x = \frac{1}{2}(v_i + v_f)\, t$$

But $v_f = v_i + at$ تعويض

$$\Delta x = \frac{1}{2}(v_i + v_i + at)\, t$$

$\boxed{3}$

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

* Now using e.1

$t = \frac{v_f - v_i}{a}$ So $\Delta x = v_i \left(\frac{v_f - v_i}{a}\right) + \frac{1}{2} a \left(\frac{v_f - v_i}{a}\right)^2$

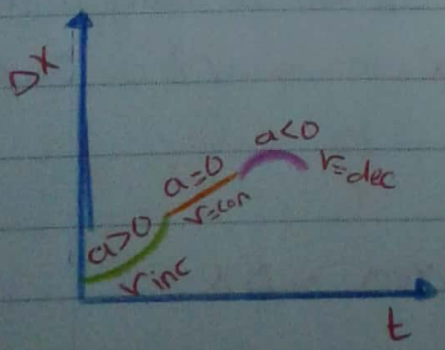
$\boxed{4}$

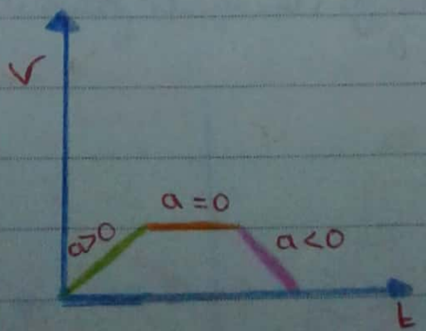
$$v_f^2 = v_i^2 + 2a\Delta x$$

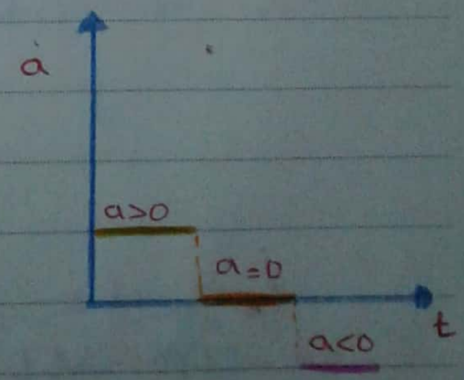
* Now $\Delta x = v_i t + \frac{1}{2} a t^2$

constant constant

$$Ax^2 + Bx + C = 0$$ معادلة تربيعية







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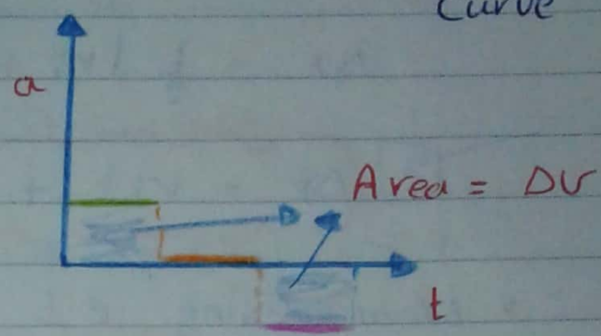
$$a = \frac{dv}{dt}$$

$$\int_{v_i}^{v_f} dv = \int_0^t a\,dt$$

$$\Delta v = \underbrace{\int_0^t a\,dt}_{\text{area}} \longrightarrow \Delta v \equiv \text{Area under } \underline{a} \,\&\, \underline{t} \text{ curve}$$



↳ $\Delta v = a\,\Delta t$

$$v_f - v_i = a(t_f - t_i)$$

$$\boxed{v_f = v_i + at}$$

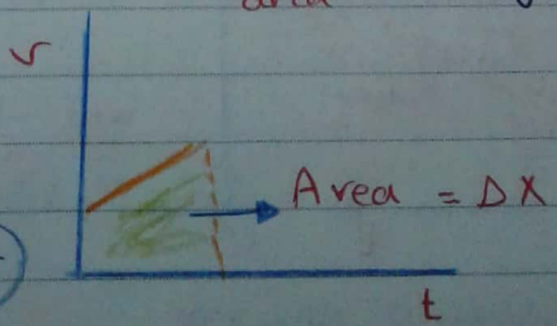
But $v_i = \frac{dx}{dt}$

$$\frac{dx}{dt} = v_i + at$$

$$\int_{x_i}^{x_f} dx = \int_0^t (v_i + at)\,dt$$

$$\Delta x = \int_0^t (v_i + at)\,dt \longrightarrow \Delta x \equiv \text{Area under } v \,\&\, t \text{ curve}$$

→ area



↳ $\boxed{\Delta x = v_i t + \frac{1}{2}at^2}$

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* Free Falling :- سقوط حر (تسارع الجاذبية)

- Motion due to gravity حركة في مجال الجاذبية الأرضية

$a \equiv g = 9.8\ ms^{-2} \approx 10\ ms^{-2}$ down

$$\left.\begin{aligned} v_f &= v_i \mp gt \\ \Delta y &= \tfrac{1}{2}(v_i+v_f)t \\ \Delta y &= v_i t \mp \tfrac{1}{2}gt^2 \\ v_f^2 &= v_i^2 \mp 2g\,\Delta y \end{aligned}\right\} \quad \begin{aligned} g &= 10 \text{ down} \\ &= -10 \end{aligned}$$

12-2-2018

* Velocity → Magnitude → speed
→ dirction

$v = \underset{\text{اتجاه اليسار, أو للأسفل}}{-}\underset{\text{speed}}{5}\ ms^{-1}$

Q3) 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 $\xrightarrow{5\,ms^{-1}}$ B, B $\xrightarrow{3\,ms^{-1}}$ A

constant speed
سرعة ثابتة
تسارع صفر

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

$$\text{Average speed} = \frac{\text{total } d}{\text{total } t}$$

$$S = \frac{d}{t} = \frac{X + X}{t + t}$$

نفس المسافة
الوقت مختلف

$$= \frac{2X}{t_1 + t_2}$$

$A \to B \Rightarrow X = 5t_1 \to t_1 = \frac{X}{5}$

$B \to A \to X = 3t_2 \to t_2 = \frac{X}{3}$

$$S = \frac{2X}{\frac{X}{5} + \frac{X}{3}} \to = (\quad)\ ms^{-1}$$

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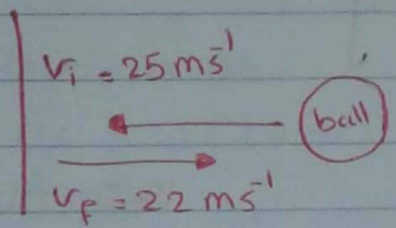
(b) What is her average velocity over the entire trip?

Average velocity $= 0$ لأن السرعة ثابتة

Q14) A 50.0-g Super Ball traveling at $25\ m s^{-1}$ bounces off a brick wall and rebounds at $22\ m s^{-1}$. A high-speed camera records this event. If the ball is in contact with the wall for 3.5 ms, what is the magnitude of the average acceleration of the ball during this time interval?



الزمن $t = 3.5\ ms$

موجب

$$a = \frac{V_f - V_i}{\Delta t}$$ سالب

$$= \frac{22 - {}^{-}25}{3.5 \times 10^{-3}}$$

$$= \frac{22 + 25}{3.5 \times 10^{-3}}$$

$$a = 13.4 \times 10^{3}\ m s^{-2}$$

Q21) 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?

بدها الموقع اللحظي تعويض الزمن اللحظي

$X = 2 + 3t - t^2 \rightarrow t = 3s$

$X = 2 + 3 \times 3 - 3^2$

$X = 3m$

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b) its velocity ?

مشتقة الأولى للمعادلة المعطاة

$$\text{Velocity} = \frac{dx}{dt} = 3 - 2t$$

$$= 3 - 2 * 3$$

$$= -3 \ m s^{-1}$$

اتجاه

speed = 3 m

c) its acceleration ?

مشتقة الثانية للـ velocity

$$a = \frac{dv}{dt} = -2 \ m s^{-2}$$

Q29) An object moving with uniform acceleration has velocity of $12 \ cm s^{-1}$ in the positive x direction when its x coordinate is 3 cm. If its x coordinate 2 s later is −5 cm what is its acceleration ?

$v = 12 \ cm s^{-1}$, $x_i = 3 cm$, $t = 2 s$, $x_f = -5 cm$

$\Delta x = -8 \ cm$

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

$$-8 = 12 * 2 + \frac{1}{2} a \, 4$$

$$-8 = 24 + 2a \quad \Rightarrow \quad \frac{2a}{2} = \frac{-32}{2}$$

$$-24 \quad -24$$

اتجاه

$$a = -16 \ cm \cdot s^{-2}$$

* Find v_f

$$v_f = v_i + at$$

$$v_f = 12 + -16 * 2$$

$$v_f = -20 \ cm s^{-1}$$

التسارع في الاتجاه المعاكس عشان هيك زادت عندي السرعة

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Q38) A particle moves along the x axis. Its position is given by the equation $X = 2 + 3t - 4t^2$ with x in meters and t in secounds. Determine

a) its position when it ~~returns to the~~ changes direction

b) " velocity " " returns to the position it had at $t = 0$

$X = 2 + 3t - 4t^2$

Position when change direction $\underline{\underline{V = 0}}$

$V = \frac{dX}{dt} \rightarrow V = 3 - 8t$

$0 = 3 - 8t$

$3 = 8t \rightarrow t = \frac{3}{8}$ Sec.

$X = 2 + 3 \times \frac{3}{8} - 4\left(\frac{9}{64}\right) = (\quad)$ m

---

Q51) A ball is thrown (رمي) directly downward (لأسفل) with an initial speed of $8\ ms^{-1}$ from a height of 30 m. After what time interval does it strike (اصطدم) the ground?

$y_i = 30$

$v_i = 8\ ms^{-1}$

30 m

$y_f = 0$

$\Delta y = y_f - y_i$

$= -30$ m

$v_i = -8\ ms^{-1}$

$g = -10$

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

$-30 = -8t - \frac{1}{2} 10 t^2$

$5t^2 + 8t - 30 = 0$

$\Rightarrow$

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smile for life

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No.

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عالمميز $\quad \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} \rightarrow$ or

معامل t $\quad$ معامل t^2

$$t = \frac{-8 \pm \sqrt{64 + 4 * 5 * 30}}{2 * 5}$$

$$t = \frac{-8 \pm 25.7}{10}$$

نهمل لانه الزمن مابصير سالب

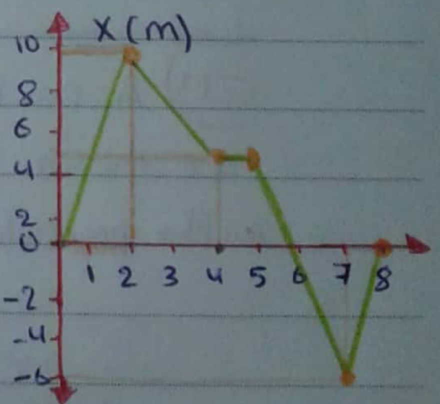
$$t = \frac{-8 + 25.7}{10} \rightarrow t = 1.77 \text{ sec.}$$

* Find its speed when stiking the ground

$$v_f = v_i + gt$$
$$= -8 - 10 * 1.77$$
$$= -25.7 \ ms^{-1}$$
$$\text{speed} = 25.7 \ ms^{-1}$$

H.W

Q1) The position versus time for a certain particle moving along the x axis is shown. Find the average velocity in the time intervals



(a) 0 to 2s

$$v = \frac{\Delta X}{\Delta t} \rightarrow \frac{X_f - X_i}{t_f - t_i}$$

$$= \frac{10 - 0}{2 - 0} \rightarrow v = \frac{10}{2} = 5 \ ms^{-1}$$

(b) 0 to 4s

$$v = \frac{\Delta X}{\Delta t} = \frac{5.5}{4 - 0} = 1.37 \ ms^{-1}$$

(c) 2s to 4s

$$v = \frac{5.5 - 10}{4 - 2} = \frac{-4.5}{2} = -2.25 \ ms^{-1}$$

(d) 4s to 7s

$$v = \frac{-6 - 5.5}{7 - 4} = \frac{-11.5}{3} = -3.8 \ ms^{-1}$$

(e) 0 to 8s $\quad v = 0$

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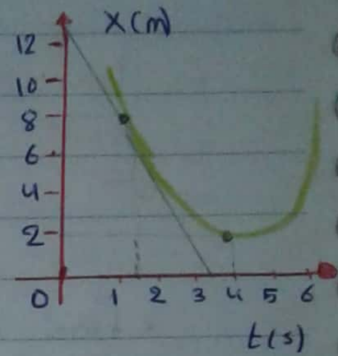
Q7) A position-time graph for a particle moving along the x axis.

(a) Find the average velocity in the time interval $t = 1.50$ to $t = 4s$



$$v = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

$$= \frac{2-8}{4-1.5} = \frac{-6}{2.5} = -2.4 \ m s^{-1}$$

(b) Determine the instantaneous velocity at $t = 2s$ by measuring the slope of the tangent line shown in the graph

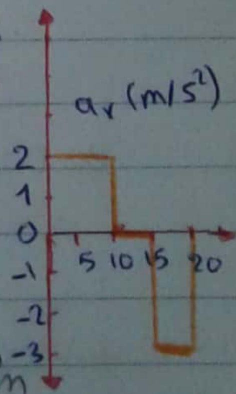
$$v = \frac{x}{t} = \frac{6}{2} = 4 m s^{-1}$$

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

$t = 3s$ to $t = 5s$

Q19) A particle starts from rest and acceleration as shown. Determine

(a) the particle's speed at $t = 10.0s$ and at $t = 20.s$



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

$$v = \Delta a * \Delta t$$

$$v = (-3-0) * (20-10)$$

$$v = -3 * 10 = -30 m s^{-1}$$ speed = 30 m

(b) the distance traveled in the first 20 s

$$S = \frac{D}{t}$$

$$30 = \frac{D}{20}$$ $D = 600$ m.

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Q20) An object moves along the x axis according to the equation $x = 3t^2 - 2t + 3$ where x is in meters and t is in seconds. Determine.

(a) The average velocity between $t = 2s$ to $t = 3s$

$v = \frac{\Delta x}{\Delta t}$ $x_f = 3*9 - 2*3 + 3 = 24m$

$x_i = 3*4 - 2*2 + 3 = 11m$

$v = \frac{24-11}{3-2} = 13 \ m.s^{-1}$

(b) the instantaneous speed at $t = 2s$ and $t = 3s$

$v = \frac{dx}{dt} \rightarrow v = 6t - 2$

at $\boxed{t = 2s} \rightarrow v = 6*2 - 2 = 10 \ m.s^{-1} \rightarrow$ speed $= 10 \ m.s^{-1}$

at $\boxed{t = 3s} \rightarrow v = 6*3 - 2 = 16 \ m.s^{-1} \rightarrow$ speed $= 16 \ m.s^{-1}$

(c) The average acceleration between $t = 2s$ and $t = 3s$

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

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d) the instantaneous acceleration at $t = 2s$ and $t = 3s$

$a = \frac{dv}{dt} \rightarrow a = 6 \ m.s^{-2}$

e) At what time is the object at rest?

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No.

Q28) A truck covers 40 m in 8.50 s while smoothly slowing down to a final speed of 2.8 ms^{-1}

(a) Find its original speed $X = 40 m$, $t = 8.5 s$, $V_f = 2.8 ms^{-1}$

$\Delta X = \frac{1}{2}(V_i + V_f)t \Rightarrow 40 = \frac{1}{2}(V_i + 2.8)\, 8.5$ 4.25

$9.41 = V_i + 2.8)$

$V_i = 6.61 \; ms^{-1}$

(b) Find its acceleration

$V_f = V_i + at$

$2.8 = 6.61 + a * 8.5$

$6.61 - \quad 6.61 \quad -$

$\frac{a * 8.5}{8.5} = \frac{-3.81}{8.5}$ $\quad a = 0.44 \; m.s^{-2}$

Q35) The driver of a car slams on the brakes when he sees a tree blocking the road. The car slows uniformly with an acceleration of $-5.6 \; m.s^{-2}$ for 4.2 s making straight skid marks 62.4 m long, all the way to the tree. with what speed does the car then strike the tree?

$X = 62.4 m$, $a = -5.6 \; m.s^{-2}$, $t = 4.2 s$

$\Delta X = V_i t + \frac{1}{2}at^2 \Rightarrow 62.4 = V_i * 4.2 + \frac{1}{2} * -5.6 * (4.2)^2$

$62.4 = V_i * 4.2 + 49.3$

$\frac{13.1}{4.2} = \frac{V_i * 4.2}{4.2}$ $\quad V_i = 3.1 \; ms^{-1}$

$V_f = V_i + at$

$= 3.1 + -5.6 * 4.2$

$V_f = -10.5 \; ms^{-1}$

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Q48) A baseball is hit so that it travels straight upward after being struck by the bat. A fan observes that it takes 3 s for the ball to reach its maximum height Find

(a) the ball's initial velocity

(b) the height it reaches

Q49) It possible to shoot an arrow at a speed as high as $100\ m.s^{-1}$

(a) If friction can be ignored, how high would an arrow launched at this speed rise if shot straight up?

(b) How long would the arrow be in the air

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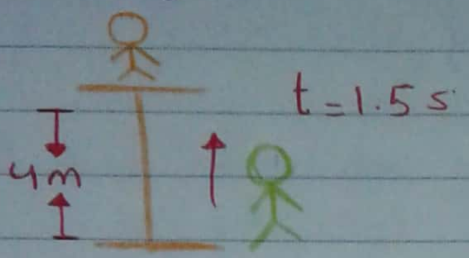
Q 53 A student throws a set of keys vertically upward to her sorority sister, who is in a window 4 m above. The second student catches the keys 1.5 s later



a) with what initial velocity were the keys thrown?

$\Delta y = +4 m$

$t = 1.5 s$

$g = -10 m s^{-2}$

$v_i = ??$

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

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

$v_i \simeq 10 m s^{-1}$

b) what was the velocity of the keys just before they were caught? $v_f = ??$

$v_f = v_i + g t$

$v_f = 10 - 10 * 1.5$

$v_f = -5 m s^{-1}$

بعدما وصل اقصى ارتفاع

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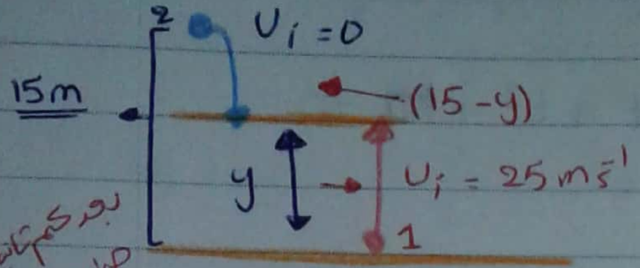
Q52 A ball is thrown upward from the ground an initial speed of $25\,ms^{-1}$ at the same instant, another ball is dropped from building 15 m high. After how long will the balls be at the same height above the ground



بعد كم ثانية صاروا في المستوى وشو الي راح نطلع بجو ~~عندو~~ بيحتاجو نفس الزمن

ball 2

$\Delta y = -(15-y)$ $\quad g = -10\,ms^{-2}$

$V_i = 0$

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

$15 - y = 0t - 5t^2$

ball 1

$\Delta y = y$

$V_i = 25\,ms^{-1}$

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

$y = 25t - 5t^2$

$15 - (25t - 5t^2) = -5t^2$

$15 - 25t = 0$

$25t = 15$

$t = 0.6\,s \Rightarrow y = 25t - 5t^2$

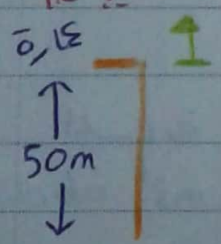
$= 25 * 0.6 - 5(0.6)^2$

$= 15 - 5 * 0.35$

$= 15 - 1.8$

$= 13.2\,ms^{-1}$

ie :-



من سطحها قذف جسم للاعلى بسرعة

$V_i = 20\,ms^{-1}$

رجع كم الوقت الذي استغرقه $t = ?$

$\Delta y = -50 \quad V_i = +20 \quad t = ??$

$g = -10\,ms^{-2}$

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

$-50 = 20t - 5t^2$

$5t^2 - 20t - 50 = 0$

$t^2 - 4t - 10 = 0$

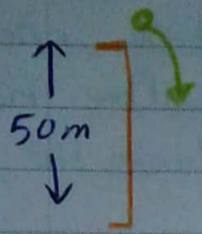
$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ على المميز

$\frac{-4 \pm \sqrt{16 - 4 * -10}}{2} \rightarrow t = 1.75\,s$

* Sally Bani Yaree

smile

i.e



قذف للأسفل

$V_i = 20m$

$t = ??$

الأختلاف $V_i = -20$

$50 = -20t - 5t^2$

$\frac{-20t}{-5} - \frac{5t^2}{-5} + \frac{50}{-5} = 0$

$4t + t^2 + \cancel{10} = 0$

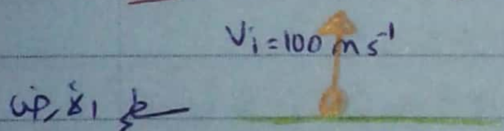
$t^2 + 4t + 10 = 0$ عمل المميز

$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$t = \frac{-4 \mp \sqrt{16 - 4 * 1 * 10}}{2}$

t

i-e



$t = ??$ الزمن اللازم للعودة

* الزمن صعود نفسه زمن النزول

* راح ورجع للأرض الازاحة = 0

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

$0 = 100t + 5t^2$

$0 = t(100 - 5t)$

$t = 20$ sec.

اقصى ارتفاع total المسافة المقطوعة

* at what time the object is at 200 ms^{-1} above ground

$200 = 100t - 5t^2$

$5t^2 - 100t + 200 = 0$

$t^2 - 20t + 40 = 0$

$t = \frac{20 \mp \sqrt{400 - 4 * 1 * 40}}{2}$

$t = \frac{20 \pm \sqrt{240}}{2}$ → $t = 2.25$ sec

or $t = 17.7$ sec

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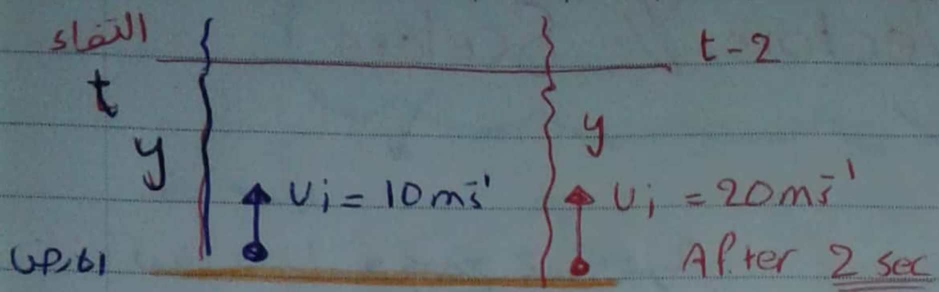
No.

i.e

25



* الازاحة متساوية

بس زمنا مختلف

$$y = 20(t-2) - 5(t-2)^2 \qquad y = 10t - 5t^2$$

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Ch 3:- Vectors & Scelars

متجهات — قياسي

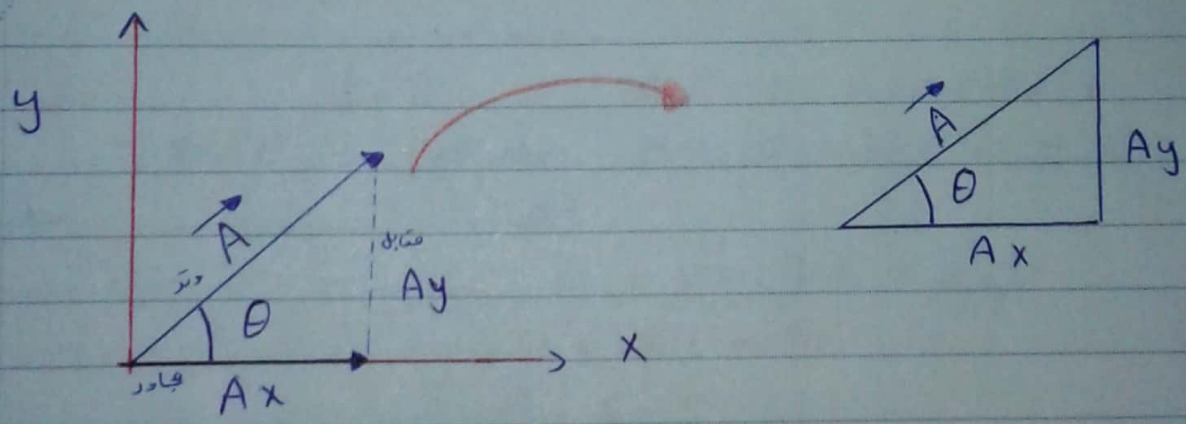
بدها مقدار واتجاه — بدها مقدار، وتجمع جمعاً جبرياً

* Vectors :- quantities that charactarized by magnitude & direction

* Scelars :- quantities that charactarized by magnitude <u>only</u>

19-2-2018

* Component method *



المجاور / وتر $\cos\theta = \frac{A_x}{A} \Rightarrow A_x = A\cos\theta$

المقابل / وتر $\sin\theta = \frac{A_y}{A} \Rightarrow A_y = A\sin\theta$

المقابل / مجاور $\tan\theta = \frac{A_y}{A_x} \Rightarrow \theta = \tan^{-1}\frac{A_y}{A_x}$

فيثاغورس $|\vec{A}| = \sqrt{A_x^2 + A_y^2}$

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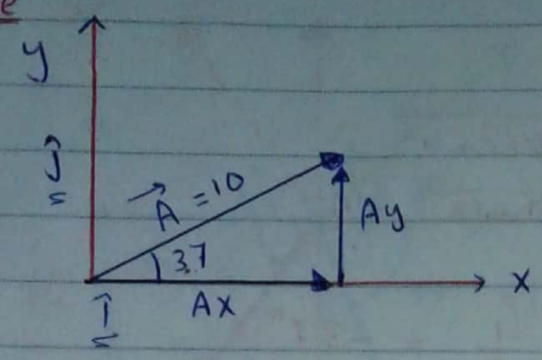
i.e



$Ax = |\vec{A}| \cos\theta = 10 \cos 37 = 6$

$Ay = |\vec{A}| \sin\theta = 10 \sin 37 = 8$

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

unit vector x-axis   unit vector y-axis

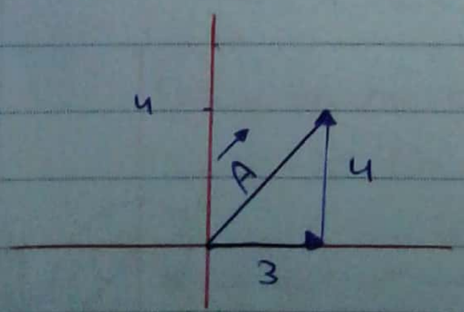
i.e Consider the vector $\vec{A} = 3\hat{i} + 4\hat{j}$
Find the magnitud & direction of $\vec{A}$

* Magnitud $\equiv |\vec{A}| = \sqrt{Ax^2 + Ay^2}$

  $|\vec{A}| = \sqrt{3^2 + 4^2} = \underline{5}$

* direction $\equiv \theta = \tan^{-1} \frac{Ay}{Ax}$

  $\theta = \tan^{-1} \frac{4}{3} = 37^\circ$



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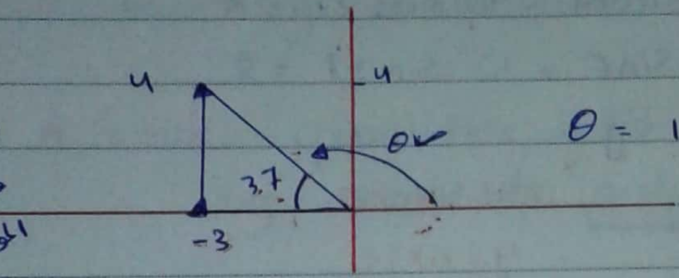
i.e $A = -3\hat{i} + 4\hat{j}$

magnitud $\equiv |\vec{A}| = \sqrt{(-3)^2 + 4^2}$
$= \sqrt{9+16} = 5$

direction $\equiv \theta = \tan^{-1} \frac{4}{-3} = -37^\circ$

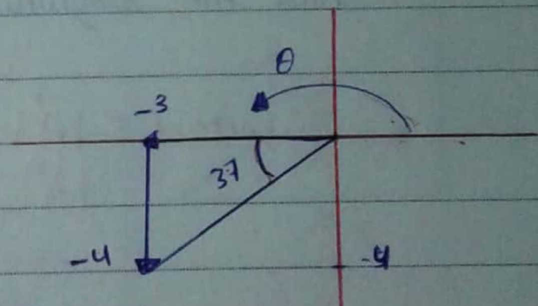
نقيس الزاوية من محور السينات الموجب عكس عقارب الساعة



$\theta = 180 - 37 = 143^\circ$

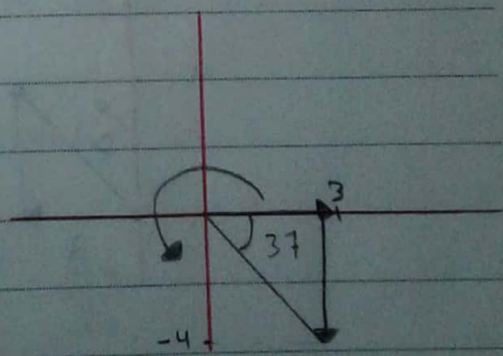
---

i.e $\vec{A} = -3\hat{i} - 4\hat{j}$
$|\vec{A}| = 5$
$\theta = \tan^{-1} \frac{-4}{-3} = 37^\circ$



$\theta = 180 + 37$

H.W $\vec{A} = 3\hat{i} - 4\hat{j}$
$|\vec{A}| = 5$
$\theta = \tan^{-1} \frac{-4}{3} = -37^\circ$



$\theta = 360 - 37$

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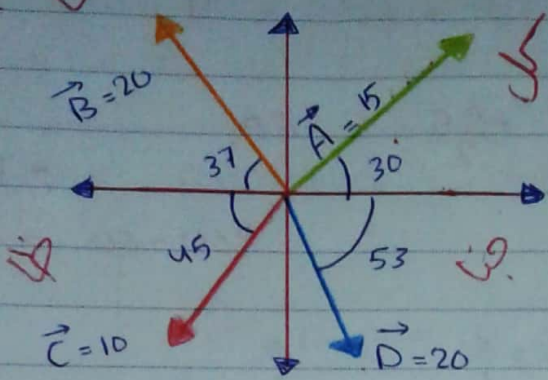
No. 29

Ex



الحالة العامة

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Find the resultant vector

$\vec{A} \rightarrow$ $A_x = |\vec{A}| \cos\theta = 15 \cos 30 = 13$

$A_y = |\vec{A}| \sin\theta = 15 \sin 30 = 7.5$

$$\underbrace{\vec{A} = 13\hat{i} + 7.5\hat{j}}$$

$\vec{B} \rightarrow$ $B_x = -20 \cos 37 = -16$

$B_y = 20 \sin 37 = 12$

$$\underbrace{\vec{B} = -16\hat{i} + 12\hat{j}}$$

$\vec{C} \rightarrow$ $C_x = -10 \cos 45 = -7$

$C_y = -10 \sin 45 = -7$

$$\underbrace{\vec{C} = -7\hat{i} - 7\hat{j}}$$

$\vec{D}$ $D_x = 20 \cos 53 = 12$

$D_y = -20 \sin 53 = -16$

$$\underbrace{\vec{D} = 12\hat{i} - 16\hat{j}}$$

Now

$\vec{R} = \vec{A} + \vec{B} + \vec{C} + \vec{D}$

$\vec{R} = (13 + {}^{-}16 + {}^{-}7 + 12)\hat{i} + (7.5 + 12 + {}^{-}7 + {}^{-}16)\hat{j}$

$\vec{R} = 2\hat{i} - 3.5\hat{j}$

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No.

30

magnitud $|\vec{R}| = \sqrt{2^2 + 3.5^2} = \underline{4}$

direction $\theta = \tan^{-1} \frac{-3.5}{2} = -60$

ربع رابع

$360 - 60 = 300^\circ$

Ex Let $\vec{A} = 2\hat{i} - 3\hat{j}$

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

Find $|\vec{A}|$, $|\vec{B}|$, $|\vec{A} + \vec{B}|$

Find $\vec{R} = 3\vec{A} - 2\vec{B}$

$|\vec{A}| = \sqrt{4+9} = \sqrt{13} = 3.6$

$|\vec{B}| = \sqrt{36+46} = 10$

$\vec{A} + \vec{B} = -4\hat{i} + 5\hat{j}$

$(2 - +6)\hat{i} + (-3+8)\hat{j}$

$-4\hat{i} + 5\hat{j}$

$|\vec{A} + \vec{B}| = \sqrt{16 + 25} = 6.4$

$|\vec{A} + \vec{B}| \neq |\vec{A}| + |\vec{B}|$

$\vec{R} = 3\vec{A} - 2\vec{B}$

$3\vec{A} = 6\hat{i} - 9\hat{j}$

$2\vec{B} = -12\hat{i} + 16\hat{j}$

$3\vec{A} - 2\vec{B} = (6 - 12)\hat{i} + (-9 - 16)\hat{j}$

$\vec{R} = 18\hat{i} - 25\hat{j}$

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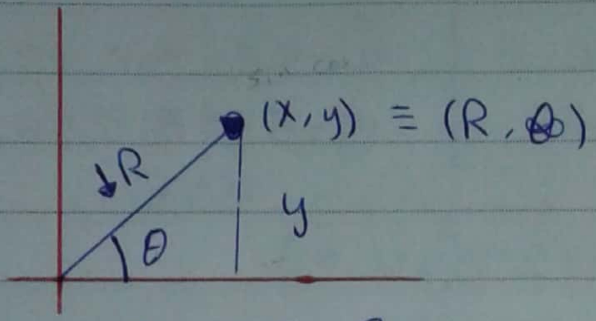
in general $\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z \hat{k}$

ثلاثي الأبعاد

* Polar coordinates :- المحاور القطبية



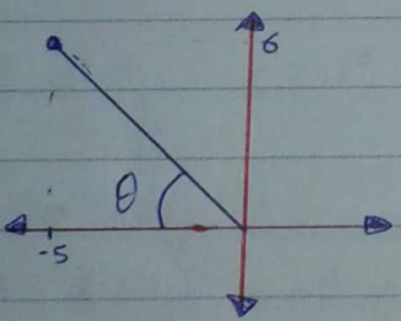
$x = r \cos\theta$

$y = r \sin\theta$

$\theta = \tan^{-1} \frac{y}{x}$

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

(−5, 6) convert to (r, θ)



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

$r = \sqrt{25 + 36} \approx 7$

$\theta = \tan^{-1} \frac{6}{-5} = -50$

$\theta = 180 - 50$

$\theta = 130$

$(-5, 6) \equiv (7, 130^\circ)$

smile

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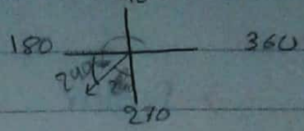
No.

H.w

32

Q1 The polar coordinates of a point are $r = 5.50\ m$ and $\theta = 240^\circ$. what are the Cartesian coordinates of this point?



$\theta - 180$

$240 - 180$

$X = r\cos\theta$	$y = r\sin\theta$
$X = 5.50\cos$ [illegible]	$y = 5.50 \sin 60$
$X = 5.50 * 0.5$	$y = 5.50 * 0.86$
$X = 2.75$	$y = 4.73$

$(5.50, 240^\circ) \equiv (2.75, 4.73)$

Q2 The rectangular coordinates of a point are given by $(\overset{x}{2}, y)$ and its polar coordinates $(r, \overset{\theta}{30^\circ})$.

Determine :-

a, b) the value of $\underline{\underline{y}}$ and $\underline{\underline{r}}$

$X = r\cos\theta$

$2 = r\cos 30^\circ$

$\frac{2}{0.86} = \frac{r * 0.86}{0.86}$

$\boxed{r = 2.3}$

$y = r\sin\theta$

$y = 2.3 \sin 30$

$y = 2.3 * 0.5$

$\boxed{y = 1.15}$

** Sally Bani Yaseen

smile

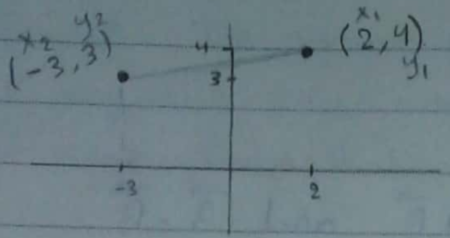
19-2-2018

No.

H.w

Q3 Two points in the xy plane have Cartesian coordinates $(2, 4)$ m and $(-3, 3)$ m. Determine

a) the distance between these points



112.5

$$\text{Distans} = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}$$
$$= \sqrt{(-3-2)^2 + (3-4)^2}$$
$$= \sqrt{25+1} = \sqrt{26} = 5.09 \text{ m}$$

b) their polar coordinates

$(2,4)$ $r = \sqrt{x^2+y^2}$

$r = \sqrt{4+16} = \sqrt{20} = 4.4$

$\theta = \tan^{-1}\frac{4}{2} = 63.4°$

$(4.4, 63.4°)$

$(-3,3)$ $r = \sqrt{9+9} = \sqrt{16}$

$r = 4.2$

$\theta = \tan^{-1}\frac{-3}{3} = -45°$

$\theta = 180 - 45$

$(4.2, 135°)$

Q10 A force $\vec{F_1}$ of magnitude 6 units acts on an object at the origin in a direction $\theta = 30°$ above the positive x axis, A second force $\vec{F_2}$ of magnitude 5 units acts on the object in the direction of the positive y axis.
Find graphically the magnitude and direction of the resultant Force $\vec{F_1} + \vec{F_2}$

$x = r\cos\theta$

$6 = r\cos 30$

$6 = r \times 0.8$

$r = 7.5$

$y = r\sin 30$

$y = 7.5 \times 0.5$

$y = 3.75$

$\vec{F_1} = 6\hat{i} + 3.75\hat{j}$

$\vec{F_2} = 0\hat{i} + 5\hat{j}$

$\vec{R} = \vec{F_1} + \vec{F_2}$

$\boxed{\vec{R} = 6\hat{i} + 8.75\hat{j}}$

$|\vec{R}| = \sqrt{36 + 76.5}$
$= 10.6$

$\theta = \tan^{-1}\frac{8.75}{6} = 55.5°$

smi)e

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Q23 Consider the two vectores $\vec{A} = 3\hat{i} - 2\hat{j}$ and $\vec{B} = -\hat{i} - 4\hat{j}$ Calculate

a) $\vec{A} + \vec{B}$

b) $\vec{A} - \vec{B}$

c) $|\vec{A} + \vec{B}|$

d) $|\vec{A} - \vec{B}|$

e) the directions of $\vec{A} + \vec{B}$ and $\vec{A} - \vec{B}$

a) $\Rightarrow$ $\vec{A} + \vec{B} = 2\hat{i} - 6\hat{j}$

$\theta = \tan^{-1} \frac{-6}{2} = -71.6°$ $\quad \theta = 180 - 71.6°$

$\theta = 108.4°$

b) $\Rightarrow$ $\vec{A} - \vec{B} = 4\hat{i} + 2\hat{j}$

$\theta = \tan^{-1} \frac{2}{4} = 26.5$

c) $\vec{A} + \vec{B} = 2\hat{i} - 6\hat{j}$

$|\vec{A} + \vec{B}| = \sqrt{4 + 36} = \sqrt{40} = 6.32$

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

$|\vec{A} - \vec{B}| = \sqrt{16 + 4} = \sqrt{20} = 4.47$

e) $\vec{A} + \vec{B}$ $\quad \theta = 108.4°$

$\vec{A} - \vec{B}$ $\quad \theta = 26.5°$

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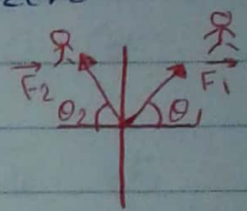
Q29 The helicopter view in Fig shows two people pulling on a stubborn mule. The person on right pulls with a force $\vec{F_1}$ of magnitude 120 N and direction of $\theta_1 = 60°$. The persone on the left pulls with a force $\vec{F_2}$ of magnitude 80 N and direction of $\theta_2 = 75°$ Find

a) the single force that is equivalent to the two forces sho

b) the force that third person would have to exert on the mule to make resultant force equal to zero



Q31 Consider the three displacement vectors $\vec{A} = (3\hat{i} - 3\hat{j})$ m $\vec{B} = (\hat{i} - 4\hat{j})$m and $\vec{C} = (-2\hat{i} + 5\hat{j})$m Use the component method to determine.

a) the magnitude and direction of $\vec{D} = \vec{A} + \vec{B} + \vec{C}$

b) " " " " " $\vec{E} = -\vec{A} - \vec{B} + \vec{C}$

a) $\vec{D} = \vec{A} + \vec{B} + \vec{C} \Rightarrow \vec{D} = 2\hat{i} - 2\hat{j}$

magnitude $|\vec{D}| = \sqrt{4+4} = \sqrt{8} = 2.8$

Direction $\theta = \tan^{-1} \frac{-2}{2} = -45$ $\quad 180 - 45$

$\theta = 135°$

b) $\vec{E} = -\vec{A} - \vec{B} + \vec{C} \Rightarrow \vec{E} = -6\hat{i} + 12\hat{j}$

Magnitude $|\vec{E}| = \sqrt{36 + 144} = \sqrt{180} = 13.4$

Direction $\theta = \tan^{-1} \frac{12}{-6} = -63.4$

$\theta = 180 - 63.4 \quad \theta = 116.6°$

smile
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Q36 Given the displacement vectors $\vec{A} = (3\hat{i} - 4\hat{j} + 4\hat{k})m$ and $\vec{B} = (2\hat{i} + 3\hat{j} - 7\hat{k})m$ find the magnitudes of following vectors and express each in terms of its rectangular components

a) $\vec{C} = \vec{A} + \vec{B}$

b) $\vec{D} = 2\vec{A} - \vec{B}$

a) $\vec{C} = \vec{A} + \vec{B} \Rightarrow \vec{C} = 5\hat{i} - 1\hat{j} - 3\hat{k}$

$|\vec{C}| = \sqrt{5^2 + (-1)^2 + (-3^2)} = \sqrt{32} = 5.9$

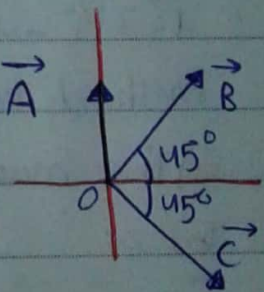
b) $\vec{D} = 2\vec{A} - \vec{B} \Rightarrow \vec{D} = 2\hat{i} - 14\hat{j} + 22\hat{k}$

$|\vec{D}| = \sqrt{2^2 + (-14)^2 + 22^2} = 684$

Q38 Three displacement vectors of a croquet ball where $|\vec{A}| = 20$ units, $|\vec{B}| = 40$ units and $|\vec{C}| = 30$ units

Find a) the resultant in unit vectore notation

b) the magnitude and direction of the resultant displacement



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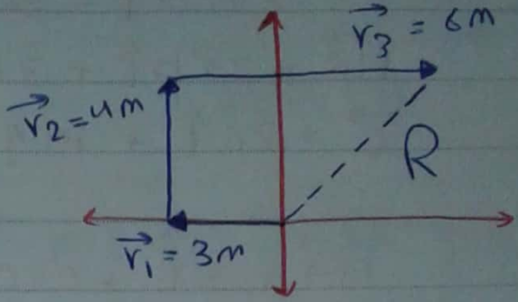
Q20 A girl delivering newspapers covers her route by traveling 3 blocks west غرب, 4 blocks north شمال and then 6 blocks east شرق

a) What is her resultant displacement

$\vec{R} = \vec{r_1} + \vec{r_2} + \vec{r_3}$



$\vec{r_1} = -3\hat{i} + 0\hat{j}$
$\vec{r_2} = 0\hat{i} + 4\hat{j}$
$\vec{r_3} = 6\hat{i} + 0\hat{j}$

$\vec{R} = 3\hat{i} + 4\hat{j}$ magnitude $|\vec{R}| = \sqrt{9+16} = 5$

direction $\theta = \tan^{-1}\frac{4}{3} = 25.3$

b) What is the total dictance she travels?

Distans $= 4 + 3 + 6 = \underline{13\ m}$

Q32 vector $\vec{A}$ has x and y components of -8.70 cm and 15.0 cm respectively vector $\vec{B}$ has x and y components of 13,2 cm and -6.6 cm respectiakly If $\vec{A} - \vec{B} + 3\vec{C} = 0$ what are the components of $\vec{C}$?

$\vec{A} = -8.7\hat{i} + 15\hat{j}$, $\vec{B} = 13.2\hat{i} - 6.6\hat{j}$

$\vec{A} - \vec{B} + 3\vec{C} = 0$

$3\vec{C} = \vec{B} - \vec{A} \rightarrow \vec{C} = \frac{1}{3}(\vec{B} - \vec{A}) = \frac{1}{3}\left[(21.9)\hat{i} + (21.6)\hat{j}\right]$

$\vec{C} = 7.3\hat{i} + 7.2\hat{j}$

H.w $\vec{A} - \vec{B} + 3\vec{C} = 4\hat{i} + 6\hat{j}$

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Q37 $\vec{A} = 6\hat{i} - 8\hat{j}$ if $a\vec{A} + b\vec{B} + \vec{C} = 0$

$\vec{B} = -8\hat{i} + 3\hat{j}$ where a, b constants

$\vec{C} = 26\hat{i} + 19\hat{j}$ Find a, b

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

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

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

$a\vec{A} + b\vec{B} + \vec{C} = 0$

$(6a - 8b + 26)\hat{i} + (-8a + 3b + 19)\hat{j} = 0$

$6a - 8b + 26 = 0$

$-8a + 3b + 19 = 0$

$\frac{3b}{3} = \frac{1}{3}(8a - 19)$

$b = \frac{1}{3}(8a - 19)$

$6a - 8b + 26 = 0$

$6a - 8 * \frac{1}{3}(8a - 19) + 26 = 0$

$6a - 2.6(8a - 19) + 26 = 0$

$6a - (20.8a - 49.4) + 26 = 0$

$6a - 20.8a + 49.4 + 26 = 0$

$-14.8a + 75.4 = 0$

$\frac{-14.8a}{-14.8} = \frac{-75.4}{-14.8}$

$\boxed{a = 5.09}$

$6 * 5.09 - 8b + 26 = 0$

$30.54 - 8b + 26 = 0$

$\frac{-8b}{-8} = \frac{-56.54}{-8}$

$b = 7.06$

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H.w $a\vec{A} + b\vec{B} + \vec{C} = 6\hat{i} + 10\hat{j}$

$a(6\hat{i}-8\hat{j}) + b(-8\hat{i}+3\hat{j}) + (26\hat{i}+19\hat{j}) = (6\hat{i}+10\hat{j})$

$a(6\hat{i}-8\hat{j}) + b(-8\hat{i}+3\hat{j}) + (20\hat{i}-9\hat{j}) = 0$

$(6a-8b-20)\hat{i} + (-8a+3b-9)\hat{j} = 0$

$6a-8b-20=0$

$-8a+3b-9=0$

$\frac{3b}{3} = \frac{8a+9}{3}$

$b = \frac{1}{3}(8a+9)$

$6a-8b-20=0$

$6a - 8 * \frac{1}{3}(8a+9) - 20 = 0 \Rightarrow 6a - 2.6(8a+9) - 20 = 0$

$6a - 20.8a + 23.4 - 20 = 0$

$-14.8a + 3.4 = 0$

$-14.8a = -3.4$

$\boxed{a = .22}$

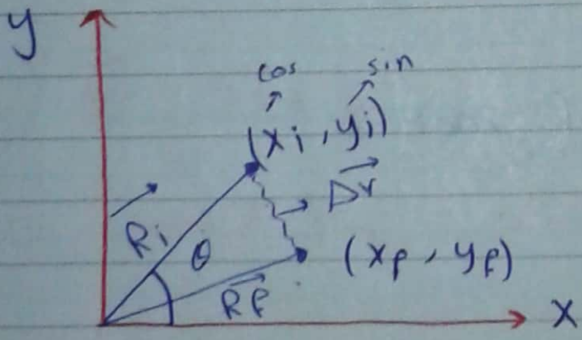
$6a - 8b - 20 = 0$

$6*0.22 - 8b - 20 = 0$

$8b - 18.68 = 0$

$\boxed{b = 2.33}$

Ch:-4 Motion in 2-D



Position Vector

$\vec{r} = x\hat{i} + y\hat{j}$

Displasment $\Delta\vec{r}$

$\Delta\vec{r} = \vec{r}_f - r_i$

$= (x_f\hat{i} + y_f\hat{j}) - (x_i\hat{i} + y_i\hat{j})$

$= \underbrace{(x_f - x_i)}_{\Delta x}\hat{i} + \underbrace{(y_f - y_i)}_{\Delta y}\hat{j}$

Displasment Vector

$\Delta\vec{r} = \Delta x\hat{i} + \Delta y\hat{j}$

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- Velocity vector $\vec{V}$

$$\vec{V} = \frac{\Delta \vec{r}}{\Delta t} = \frac{\Delta x \hat{i} + \Delta y \hat{j}}{\Delta t}$$

مشتقة

$$\boxed{\vec{V} = V_x \hat{i} + V_y \hat{j}} \quad \text{or} \quad \vec{V} = \frac{d\vec{r}}{dt}$$

- acceleration vector

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

$$\boxed{\vec{a} = a_x \hat{i} + a_y \hat{j}}$$

* So equations of motion

1. $\vec{v}_f = \vec{v}_i + \vec{a} t$

2. $\Delta \vec{r} = \frac{1}{2} (\vec{v}_i + \vec{v}_f) t$

3. $\Delta \vec{r} = \vec{v}_i t + \frac{1}{2} \vec{a} t^2$

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Q6 A particle initially located at the origin has an acceleration $\vec{a} = 3\hat{j}\ m/s^2$ and an initial velocity of $\vec{v}_i = 5\hat{i}\ ms^{-1}$ Find $\vec{v}_f$, speed

$$\vec{a} = 0\hat{i} + 3\hat{j}\ ,\ \vec{v}_i = 5\hat{i} + 0\hat{j}\ ,\ \vec{r}_i = 0\hat{i} + 0\hat{j}$$

at $t = 2$ $\quad \Delta\vec{r} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$

$$\vec{r}_f - \cancel{\vec{r}_i} = (5\hat{i} + 0\hat{j}) * 2 + \frac{1}{2}(0\hat{i} + 3\hat{j}) * 4$$

$$r_f = 10\hat{i} + 6\hat{j}$$

$$\vec{v}_f = \vec{v}_i + \vec{a}t$$

$$\vec{v}_f = (5\hat{i} + 0\hat{j}) + (0\hat{i} + 3\hat{j}) * 2$$

$$\vec{v}_f = 5\hat{i} + 6\hat{j}$$

speed $|\vec{v}_f| = \sqrt{25 + 36}$

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Q9 A fish swimming in a horizontal plane has velocity $\vec{V_i} = 4\hat{i} + 1\hat{j}\ ms^{-1}$ at a point in the ocean where the position relative to a certain rock is $\vec{r_i} = 10\hat{i} - 4\hat{j}\ m$. After the fish swims with constant acceleration for 20 s its velocity is $\vec{V_f} = (20\hat{i} - 5\hat{j})\ ms^{-1}$

a) What are the components of the acceleration of the fish & the $\vec{r_f}$

$\vec{V_i} = 4\hat{i} + 1\hat{j}$, $\vec{V_f} = 20\hat{i} - 5\hat{j}$

$\vec{r_i} = 10\hat{i} - 4\hat{j}$, $t = 20s$

$$\vec{V_f} = \vec{V_i} + \vec{a}t$$

$$(20\hat{i} - 5\hat{j}) = (4\hat{i} + 1\hat{j}) + \vec{a} * 20$$

$$\frac{16\hat{i} - 6\hat{j}}{20} = \frac{20\vec{a}}{20}$$

$$\vec{a} = \underbrace{0.8\hat{i}}_{x} - \underbrace{0.3\hat{j}}_{y}$$

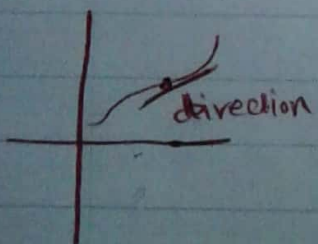
$$\Delta\vec{r} = \frac{1}{2}(\vec{V_i} + \vec{V_f})\ t$$

$$\vec{r_f} - (10\hat{i} - 4\hat{j}) = \frac{1}{2}(4\hat{i} - 1\hat{j} + 20\hat{i} - 5\hat{j}) * 20$$

$$\vec{r_f} - (10\hat{i} - 4\hat{j}) = 240\hat{i} - 40\hat{j}$$

$$\vec{r_f} = 250\hat{i} - 44\hat{j}$$

b) What is the direction of motion at direction of the velocity $\vec{V_f}$ $t = 25$ sec



$$\vec{V_f} = \vec{V_i} + at$$

$$\vec{V_f} = (4\hat{i} + 1\hat{j}) + (0.8\hat{i} - 0.3\hat{j}) * 25$$

$$\vec{V_f} = (4\hat{i} + 1\hat{j}) + (20\hat{i} - 7.5\hat{j})$$

$$\vec{V_f} = (24\hat{i} - 6.5\hat{j})$$

$$|V_f| = \sqrt{576 + 43.56} = 24.8$$

$$\theta = \tan^{-1}\frac{-6.5}{24} = -15$$

$$360 - 15 = 345$$

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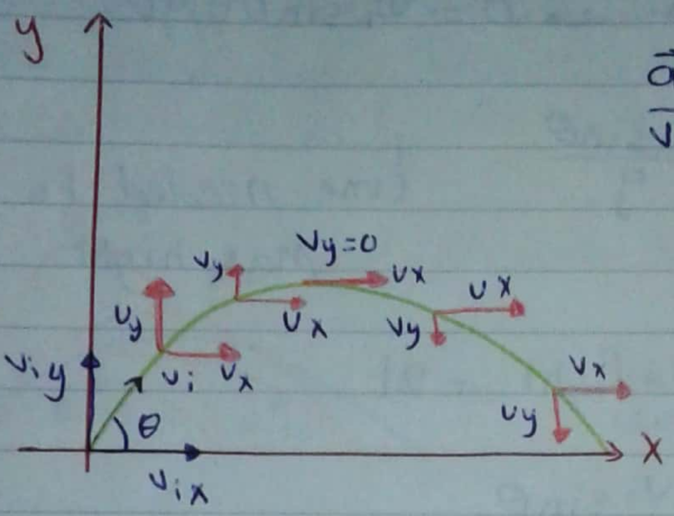
* Projectial motion :- حركة المقذوفات

$$\vec{a} = 0\hat{i} - \overset{g}{10}\hat{j}$$

$$\vec{v_i} = \underbrace{v_i\cos\theta}_{v_{ix}}\hat{i} + \underbrace{v_i\sin\theta}_{v_{iy}}\hat{j}$$



X-axis

صفر

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

$$v_{xf} = v_{yi} \Rightarrow \boxed{v_{xf} = v_i\cos\theta}$$

No change on v_x the v_x $a_x = 0$

صفر

$$\Delta x = v_{ix} t + \cancel{\frac{1}{2} a_x t^2}$$

$$\boxed{\Delta x = v_i \cos\theta \, t}$$

y-axis

$$v_{yf} = v_{yi} + a_y t^2$$

$$\boxed{v_{yf} = v_i \sin\theta - g t^2}$$

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

$$\boxed{\Delta y = v_i \sin\theta t - \frac{1}{2} g t^2}$$

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* Now of Max hight ymax (h)

$v_{yf} = 0 \longrightarrow 0 = v_i \sin\theta - gt$

$t = \frac{v_i \sin\theta}{g}$ time needed to reach Max hight

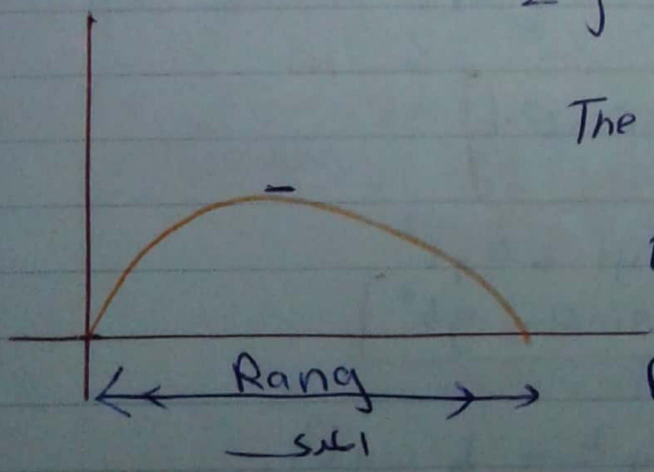
↳ time of fight = 2t

$t = 2\frac{v_i \sin\theta}{g}$

↳ Max hight (h)

$y_{max} = v_i \sin\theta \frac{v_i \sin\theta}{g} - \frac{1}{2} g \frac{v_i^2 \sin^2\theta}{g^2}$

$h = \frac{v_i^2 \sin^2\theta}{2g}$



The Range $\underline{R}$ بدو زمن الطيران كامل

$t = 2\frac{v_i \sin\theta}{g}$, $\Delta x = v_i \cos\theta \, t$

$R = \frac{v_i \cos\theta \, 2 v_i \sin\theta}{g}$

$R = \frac{v_i^2 \sin 2\theta}{g}$

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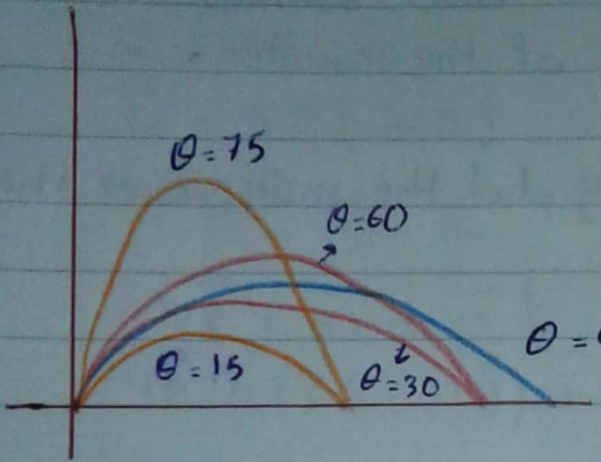
$R_{max} \rightarrow \sin 2\theta = 1$

$2\theta = 90 \rightarrow \theta = 45° \longrightarrow$ له اعلى مدى



اكبر- اعلى مدى

Now $\Delta X = V_i \cos\theta\, t$

$$t = \frac{\Delta X}{V_i \cos\theta}$$

$$\Delta y = V_i \sin\theta\, t - \frac{1}{2} g t^2$$

$$\Delta y = V_i \sin\theta \frac{\Delta X}{V_i \cos\theta} - \frac{1}{2} g \frac{\Delta X^2}{V_i^2 \cos^2\theta}$$

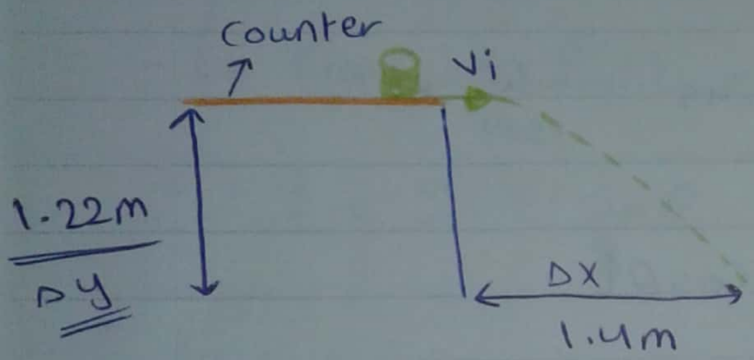
$$y = X \tan\theta - \frac{g}{2 V_i^2 \cos^2\theta} X^2$$

معادلة المسار

#Sally Bani Yaseen

Q13 In a local bar, a customer slides an empty beer mug down the counter for a refill. The height of the counter is 1.22m. The mug slides off the counter and strikes the floor 1.4 m from the base of the counter.

a) With what velocity did the mug leave the counter?



$a_x = 0 \qquad a_y = -g$

$V_{ix} = V_i \qquad V_{iy} = 0$

صفر

$V_i = ?$

$$\Delta X = V_{ix}\,t + \cancel{\frac{1}{2}a_x t^2}$$

$$1.4 = V_i\,t$$

$$\text{but } \Delta y = \cancel{V_{iy}t}^{\,0} + \frac{1}{2}a_y t^2$$

$$-1.22 = -\frac{1}{\cancel{2}}\,\cancel{10}^{\,5}\,t^2$$

$$-1.22 = -5\,t^2$$

$$t = 0.5 \text{ sec}$$

So $\quad 1.4 = V_i * 0.5$

$$V_i = 2.8\ m\,s^{-1}$$

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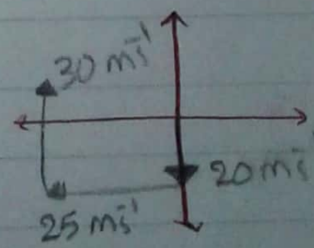
b) What was the direction of the mug's velocity just before it hit the floor?

$\vec{v_f} = ??$
$\vec{a} = 0\hat{i} - 10\hat{j}$
$\vec{v_i} = 2.8\hat{i} + 0\hat{j}$
$t = 0.5$ sec

$$\vec{v_f} = \vec{v_i} + \vec{a}t$$
$$\vec{v_f} = (2.8\hat{i} + 0\hat{j}) + (0\hat{i} - 10\hat{j}) * 0.5$$
$$\vec{v_f} = \underbrace{2.8}_{x}\hat{i} - \underbrace{5}_{y}\hat{j}$$
$$|\vec{v_f}| = \sqrt{7.84 + 25} = \sqrt{32.84} = 5.7$$
$$\theta = \tan^{-1}\frac{-5}{2.8} = -60.7$$

H.W Q1 A motorist drives south at $20\ ms^{-1}$ for 3 min then turns west and travels at $25\ ms^{-1}$ for 2min and finally travels northwest at $30\ ms^{-1}$ for 1min For this 6min trip find.

a) the total vector displacement



Displacement vector

$\vec{\Delta r} = \Delta x\hat{i} + \Delta y\hat{j}$

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b) The avarage speed

c) The average velocity

Q3 Suppose the position vector for a particle is given as a function of time by $\vec{r}(t) = x(t)\hat{i} + y(t)\hat{j}$ with $x(t) = at + b$ and $y(t) = ct^2 + d$ where $a = 1\,m\,s^{-1}$, $b = 1m$, $c = 0.125\,m\,s^{-2}$ and $d = 1m$

a) Calculate the average velocity during the time interval from $t = 2s$ to $t = 4s$

$\vec{V} = \frac{d\vec{r}}{dt}$ $\vec{V} = V_x \hat{i} + V_y \hat{j}$

$\vec{V} = (at + b\,\hat{i}) + (ct^2 + d)\,\hat{j}$

$\vec{V} = (1 * 2 + 1)\hat{i} + (0.125 * 16 + 1)\hat{j}$

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b) Determine the velocity and the speed at $t = 2s$

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Q7 The vector position of a particle varies in time according to the expression $\vec{r} = 3\hat{i} - 6t^2\hat{j}$ where $\vec{r}$ is in meters and t in second.

a) Find an expression for the velocity of the particle as a function of time

b) Determine the acceleration of the particle as a function of time

c) Calculate the particle's position and velocity at $t = 1$ sec.

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Q10 A snowmobile is orignally at the point with position vector 29 m at 95° counterclockwise from the x-axis, moving with velocity 4.5 $m s^{-1}$ at 40° It moves with constant acceleration 1.9 $m s^{-2}$ at 200° After 5 s have elapsed Find

a) its Velocity

b) its position vector

Q12 An astronaut on a strange planet finds that she can jump a maximum horizontal distance of 15 m if her initial speed is 3 $m s^{-1}$ What is the free fall acceleration on the planet ?

$V_i = 3 m s^{-1}$, $R = 15 m$

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No.

Q15 A projectile is fired in such a way that its horizontal range is equal to three times its maximum height. what is the angle of projection ?

Q33 The athlete rotates a 4.0 kg discus along a circular path of radius 1.06 m The maximum speed of the discus is 20 $m.s^{-1}$ Determine the magnitude of the maximum radial acceleration of the discus

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smile

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Q38 An athlete swings a ball, connected to the end of a chain in a horizontal circle. The athlete is able to rotate the ball at the rate of 8 rev. s^{-1} when the length to 0.9 m he is able to rotate the ball only 6 rev/s^{-1}

a) Which rate of rotation gives the greater speed for ball ?

b) What is the centripetal acceleration of the ball at 8 rev. s^{-1} ?

c) What is the centripetal acceleration at 6 rev. s^{-1} ?

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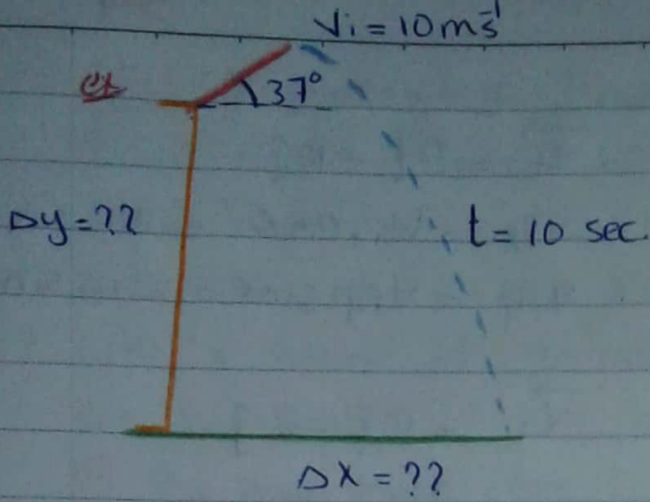

$\vec{a} = 0\hat{i} - 10\hat{j}$

$\vec{V}_{ix} = V_i \cos\theta = 10 \cos 37 = 8$

$V_{iy} = V_i \sin\theta = 10 \sin 37 = 6$

$\vec{V}_i = \underbrace{8\hat{i}}_{V_{ix}} + \underbrace{6\hat{j}}_{V_{iy}}$

$$\Delta y = V_{iy}\, t + \frac{1}{2} a_y t^2$$

$$\Delta y = 6 * 10 + \frac{1}{2}(-10) * 100$$

$$\Delta y = 60 - 500 \Rightarrow \Delta y = -440$$

$$\Delta x = V_{ix}\, t + \cancel{\frac{1}{2} a_x t^2}$$

$\Delta x = 8 * 10 = 80\,m$ $\qquad \vec{\Delta r} = 80\hat{i} - 440\hat{j}$

<u>or</u> $\vec{\Delta r} = \vec{V}_i t + \frac{1}{2}\vec{a}\, t^2$

$$\vec{\Delta r} = (8\hat{i} + 6\hat{j}) * 10 + \frac{1}{2}(0\hat{i} - 10\hat{j}) * 100$$

$$\vec{\Delta r} = \underbrace{80\hat{i}}_{\Delta x} - \underbrace{440\hat{j}}_{\Delta y}$$

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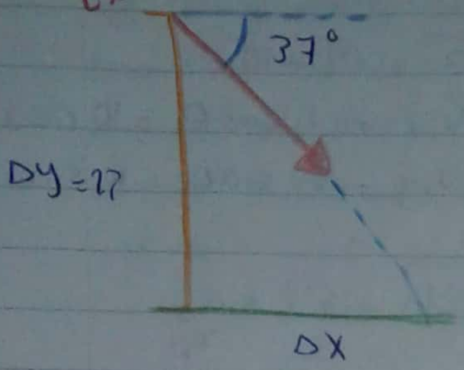
Ex



$\vec{a} = 0\hat{i} - 10\hat{j}$

$v_{ix} = V_i \cos\theta = +10 \cos 37 = 8$

$v_{iy} = V_{iy} \sin\theta = -10 \sin = -6$

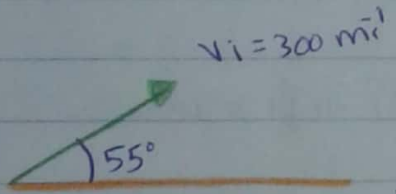
$\vec{V}_i = 8\hat{i} - 6\hat{j}$

$\Delta y = -6 * 10 - 5 * 100 = -560\ m$

$\Delta X = 8 * 10 = 80 m$

$\vec{\Delta r} = 80\hat{i} - 560\hat{j}$

Q16 To start an avalanche on mountain slope an artillery shell is fired with an initial velocity of $300\ m.s^{-1}$ at $55°$ above the horizontal. It explodes on the mountainside 42 s after firing. What are the x & y coordinates of the shell where it explodes relative to its firing point



انفجرت بعد
$t = \underline{42\ sec}$

$\vec{a} = 0\hat{i} - 10\hat{j}$

$\vec{V}_i = 300 \cos 55\,\hat{i} + 300 \sin 55\,\hat{j}$

$\vec{V}_i = 172\hat{i} + 246\hat{j}$

$\vec{\Delta r} = \vec{V}_i t + \frac{1}{2} a t^2$

$\vec{\Delta r} = (172\hat{i} + 246\hat{j}) * 42 + \frac{1}{2}(0\hat{i} - 10\hat{j}) * (42)^2$

$\vec{\Delta r} =$

بدي احسب زمن اقصى ارتفاع مشان اعرف وين انفجرت

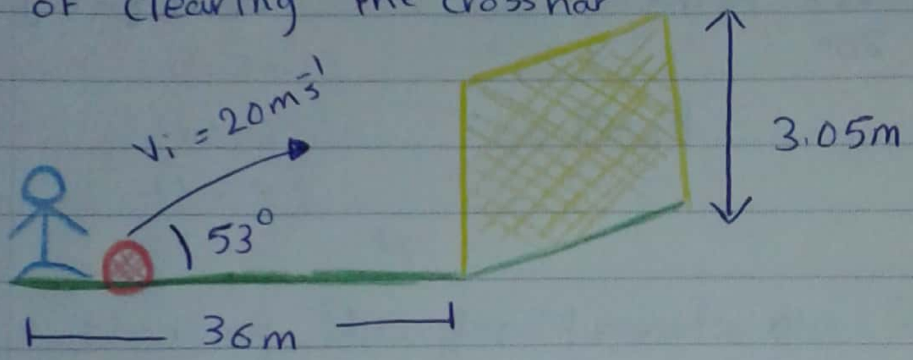
$\vec{V}_f = \vec{V}_i + at \Rightarrow \vec{V}_f = (172\hat{i} + 246\hat{j}) + (0\hat{i} - 10\hat{j}) * 42$

$\vec{V}_f = (\underset{\Delta X}{172\hat{i}} \underset{\Delta y}{- 174\hat{j}})$

سالبه انفجرت وهي نازلة

Q23 A placekicker must kick a football from a point 36 m (about 40 yards) from the goal. Half the crowd hopes the ball will clear the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a speed of 20 ms^{-1} at an angle of 53.0° to the horizontal.

a) By how much does the ball clear or fall short of clearing the crossbar



نحسب Δy اذا كانت 3m بتحقق الهدف

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

$$\Delta y = 20 \sin 53 * t - 5 t^2$$

الزمن مش معطى
بس معطى Δx

$$\Delta y = 16 * 3 - 5 * 9$$

$$\Delta y = 48 - 45$$

$$\Delta y = 3 \text{ m}$$

$$\Delta x = v_{ix} t + \cancel{\frac{1}{2} a_x t^2}$$

$$\Delta x = v_{ix} t$$

$$36 = 20 \cos 53 * t$$

$$\frac{36}{12} = \frac{\cancel{12}\, t}{\cancel{12}}$$

$$t = 3 \text{ sec}$$

* Sally Bani Yaseen

smile

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H.W

Q20 A ball is tossed from an upper-story window of a building. The ball is given an initial velocity of $8\,ms^{-1}$ at an angle of 20° belw the horizontal. It strikes the ground 3 s later

a) How far horizontally from the base of the building does the ball strike the ground

$V_i = 8\,ms^{-1}$, 20° $\qquad \vec{a} = 0\hat{i} - 10\hat{j}$

$t = 3\,s$

ΔX ??

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

$$\Delta X = 8\cos 20 * 3$$

$$\Delta X = 22.5\,m$$

b) Find the height from which the ball was thrown

Δy = ??

$$\Delta y = V_{iy} * t + \frac{1}{2} a_y t^2$$

$$= 8\sin 20 * 3 - 5 * 9$$

$$= 8.2 - 45$$

$$\Delta y = -36.8\ m$$

c) How long does it take the ball to reach a point 10.0m below the leved of launching?

$\frac{-b \pm \sqrt{b^2+4ac}}{2a}$

$\Delta y = V_{iy} * t + \frac{1}{2} a_y t^2$

$\frac{2.7 \pm \sqrt{7.29 + 4*5*10}}{2*5}$

$-10 = 8\sin 20 * t - 5t^2$

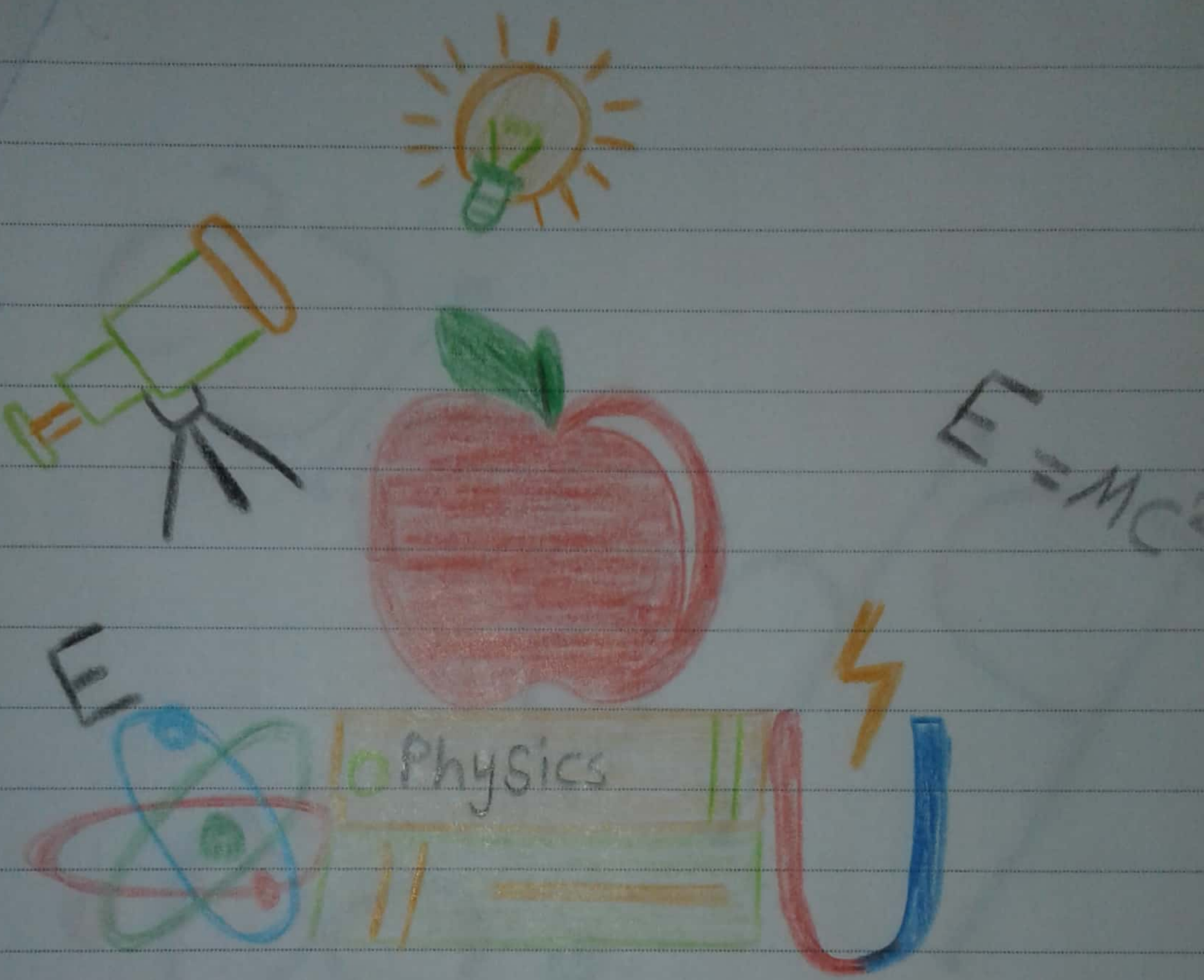
$-10 = 2.7 * t - 5t^2$

$\frac{5t^2}{5} - \frac{2.7t}{5} - \frac{10}{5} = 0$

$t^2 - 0.54t - 2$

2.7 ± 14

$t = 1.6$



* Sally Baniyaseen

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* Circular motion :-

الحركة الدائرية

$\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$ > ممكن تتغير مقداراً واتجاه $= \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$

Call $\vec{v}$ is a vector

↳ changing $\vec{v}$ → change the magnitud (speed)
→ changing the direction

مثلاً $v = 2\,m\,s^{-1}$

$v_i = 2\hat{i}$ تغير في الاتجاه

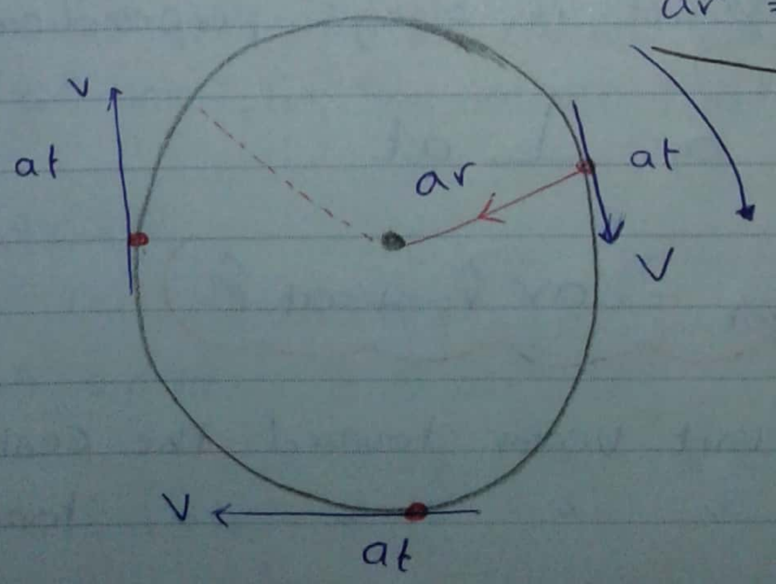
$v_f = 2\hat{j}$

↳ changing the speed greats the linear acceleration (tangential acceleration)

$$a_t = \frac{\Delta |\vec{v}|}{\Delta t}$$

↳ while changing the direction greats the centratiple acceleration (radial acceleration)

$$a_r = \frac{v^2}{r}$$ → radial



حركة الجسم

اتجاه السرعة

اتجاه مماس

$a_t = \frac{\Delta |\vec{v}|}{\Delta t} = \frac{d\vec{v}}{dt}$

is always toward the tangent at $a_r = \frac{v^2}{r}$

is alway toward the center

منتظم • Uniform circular motion

$a_t = 0 \rightarrow$ No change is speed only chang in direction

• Non uniform circular motion

Change is speed & Change in direction

ar & at

متعامدتان

ar & at is always perpendicular

$a_r \perp a_t$

$$\vec{a}_{tot} = a_r \hat{r} + a_t \hat{\theta}$$

$\hat{r} \equiv$ Unit vector toward the center

$\hat{\theta} \equiv$ " " " " tangent

$\hat{r} \perp \hat{\theta}$

$$|\vec{a}_{tot}| = \sqrt{a_{\hat{r}}^2 + a_t^2}$$

smile

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Q36 A tire 0.5 m in radius rotates at a constant rate of 200 rev/min. Find the speed & acceleration of a small stone lodged in the tread of the tire

$r = 0.5m$, $v = 200$ rev/min   تعبير عن دورة

دورة

* منطلع محيط العجل لحول الدورة

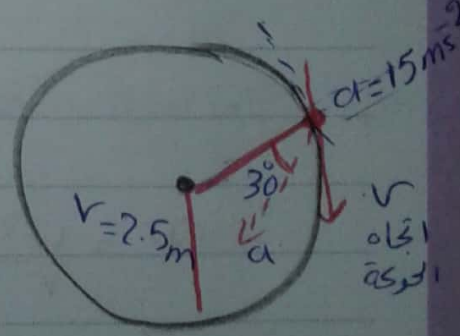
$$v = \frac{n\, 2\pi r}{t}$$

$$= \frac{200 * 2\pi \frac{1}{2}}{1 * 60}$$

$$v = 10.5\ m s^{-1}$$

$$a_r = \frac{v^2}{r} = \frac{(10.5)^2}{0.5} = 214\ m s^{-2}$$

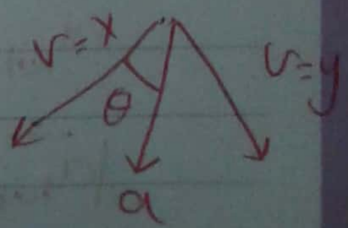
Q40 The total acceleration of a particle moving clockwise in a circle of radius 2.5 m at a certain instant of time, for that instant find



$$a_r = a \cos\theta$$

$$= 15 \cos 30 = 13\ m s^{-2}$$

$$a_t = 15 \sin 30 = 7.5\ m s^{-2}$$



$$\vec{a}_{tot} = 13\,\hat{r} + 7.5\,\hat{\theta}$$

$$a_r = \frac{v^2}{r} \Rightarrow v = \sqrt{13 * 2.5}$$

$$13 = \frac{v^2}{2.5} \qquad \sqrt{v^2} = \sqrt{13 * 2.5}$$

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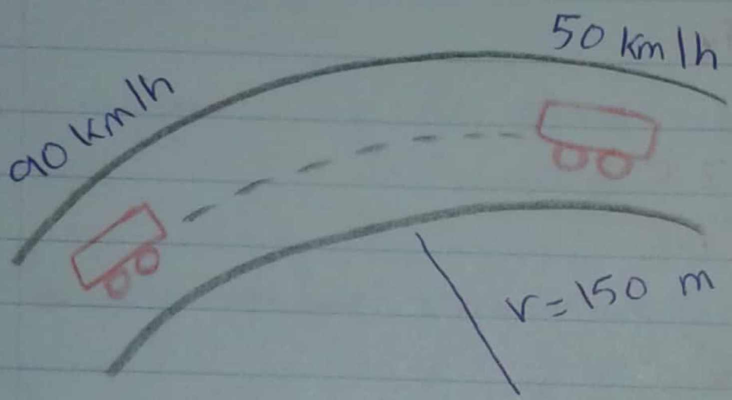
Q41 A train slows down as it rounds a sharp horizontal turn, going from 90. Km/h to 50 km/h in the 15 s it takes to round the bend. The radius of the curve is 150m Compute the acceleration at the moment the train speeed reaches 50 km/h Assume the train continues to slow down at this time at the same rate



t تسارع خطي
r ״ مركزي

لما السرعة تكون 50
total
t = 15 sec.

$$a_t = \frac{|\vec{v}_f| - |\vec{v}_i|}{t}$$

$$v_f = 50 \frac{km}{h}$$

$$= \frac{50 * 1000 m}{3600 sec}$$

$$\boxed{v_f = 14}$$

$$= \frac{14 - 25}{15}$$

$$= -0.73 \ m s^{-2}$$

$$v_i = \frac{90 * 1000}{3600}$$

$$\boxed{v_i = 25}$$

$$a_r = \frac{v^2}{r} = \frac{(14)^2}{150} = 1.3 \ m s^{-2}$$

$$\vec{a}_{tot} = 1.3 \hat{r} - 0.73 \hat{\theta}$$

$$|\vec{a}_{tot}| = \sqrt{(1.3)^2 + (0.73)^2}$$

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Ch:5 Newton's laws :-

1st law :-

Object at rest or moving with constant velocity stay as it's unless an - external force acts on

uniforme

↳ Constant velocity
↓
constant
in magnitud ≡ speed
and direction

↳ if $\vec{a} = 0 \longleftrightarrow \sum \vec{F}_{ext} = 0$

if $\sum \vec{F}_{ext} = 0$ then the object either at rest for moving with constant velocity.

Now

$$\sum \vec{F}_{ext} = 0 \rightarrow \begin{cases} \sum F_x = 0 \\ \sum F_y = 0 \\ \sum F_z = 0 \end{cases}$$

إما ساكن أو بسرعة ثابتة

2nd law :-

if $\sum \vec{F}_{ext} \neq 0$??

then their is an acceleration

$$\sum \vec{F}_{ext} \propto \vec{a}$$

$$\sum \vec{F}_{ext} = \text{Const} \; \vec{a}$$

↓ ثابتة

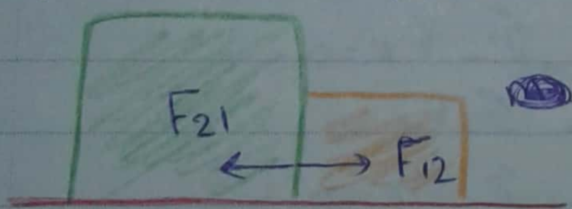
$$\sum \vec{F}_{ext} = \text{mass} * \vec{a}$$

$$\sum \vec{F}_{ext} = m\vec{a}$$ معادلة متجهة

$\sum F_x = m a_x$ / $\sum F_y = m a_y$ / $\sum F_z = m a_z$

3ed law :-

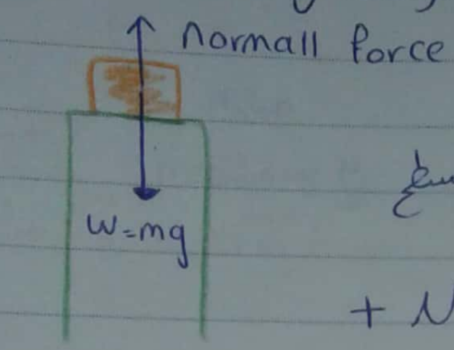
For every action there is a reaction equal in magnitude & opposite in direction



$$\vec{F}_{12} = - \vec{F}_{21}$$

$$\vec{F}_{12} + \vec{F}_{21} = 0 \qquad \sum \vec{F} = 0 \Rightarrow a = 0$$

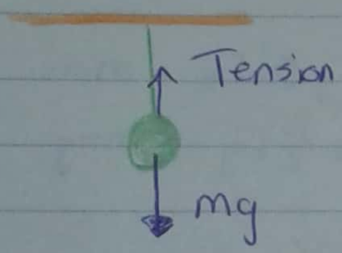
* Free body digram :-



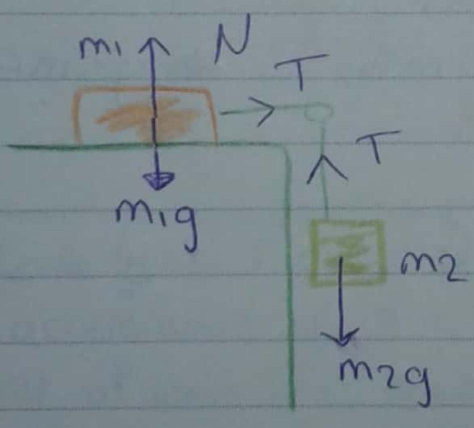
عامودي على السطح

$$+N - mg = 0$$

$$N = mg$$



$$T - mg = 0$$



For m_1

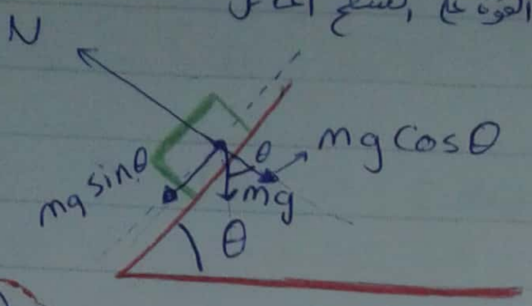
$\Sigma F_x = m_1 a_x \longrightarrow T = m_1 a_x$

$\Sigma F_y = m_1 a_y \longrightarrow N - m_1 g = 0$

For m_2

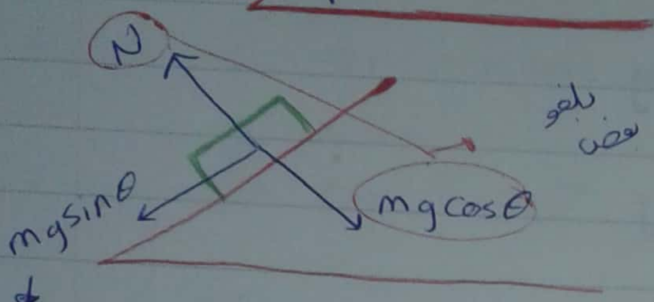
$\Sigma F_y = m_2 a_y \longrightarrow T - m_2 g = -m_2 a$

* تحليل القوة على السطح المائل



الزاوية

عصورة ح $\underline{y}$



بخلي
الجسم يسحل

$$\sum \vec{F} = m\vec{a} \begin{cases} \sum F_x = ma_x \\ \sum F_y = ma_y \end{cases}$$

$$\sum F_x = ma_x$$

$$\cancel{m}g\sin\theta = \cancel{m}a_x \Rightarrow g\sin\theta = a_x$$

$$\sum F_y = ma_y$$

$$N - mg\cos\theta = 0$$ ما في حركة في $\underline{y}$

$$N = mg\cos\theta$$

Q12 Besides the gravitational force, a 2.8 kg object is subjected to one other constant force. The object starts from rest and in 1.2 $\underline{s}$ experiences a displacement of $(4.2\hat{i} - 3.3\hat{j})$ m, where the direction of $\hat{j}$ is the upward vertical direction. Determine the other force

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$m = 2.8\,kg$, $\vec{V_i} = 0$, $\vec{Dr} = 4.2\hat{i} - 3.3\hat{j}$

$t = 1.2\,sec.$

$\sum\vec{F} = m\vec{a}$

$\vec{F_1} + \vec{F_2} = m\vec{a}$ ⟶ $Dr = V_i t + \frac{1}{2}at^2$

$\vec{F_1} = w = mg = -28\hat{j}$

$4.2\hat{i} - 3.3\hat{j} = \frac{1}{2}\vec{a} * 1.44$

$\vec{a} = 5.8\hat{i} - 4.6\hat{j}$

$-28\hat{j} + \vec{F_2} = 2.8 * (5.5\hat{i} - 4.6\hat{j})$

$\cancel{-28}\hat{j} + \vec{F_2} = (15.4\hat{i} - 12.88\hat{j})$

$+\cancel{28}\hat{j}$ $\qquad +28\hat{j}$

$\vec{F_2} = 15.4\hat{i} + 15.12\hat{j}$

Q18 A force $\vec{F}$ applied to an object of mass m_1 produces an acceleration of $3\,ms^{-2}$. The same force applied to a second object of mass m_2 produces an acceleration of $1\,ms^{-2}$

$F \longrightarrow m_1 \longrightarrow a_1 = 3\,ms^{-2}$ / $F \longrightarrow m_2 \longrightarrow a_2 = 1\,ms^{-2}$

$\boxed{1}$ what is the value of the ratio $\frac{m_1}{m_2}$?

$F = m_1 a_1 \Rightarrow F = 3m_1$

$F = m_2 a_2 \Rightarrow F = 1m_2$

$\frac{3m_1}{m_2} = \frac{1\cancel{m_2}}{\cancel{m_2}}$

$1 = \frac{3m_1}{m_2} \Rightarrow \frac{m_1}{m_2} = \frac{1}{3}$

$\boxed{2}$ If m_1 and m_2 are combind into an object find the acceleration under the action of the force $\vec{F}$ $M \rightarrow m_1 + m_2$ / $F \rightarrow M \rightarrow a = ?$

$F = Ma$

$F = (m_1 + m_2)a$ ⟶ $F = (\frac{F}{3} + F)a$

$F = \frac{4F}{3}a$

but $F = 3m_1$, $m_1 = \frac{F}{3}$

$F = m_2$, $m_2 = F$

$a = \frac{4}{3}\,ms^{-2}$

smile

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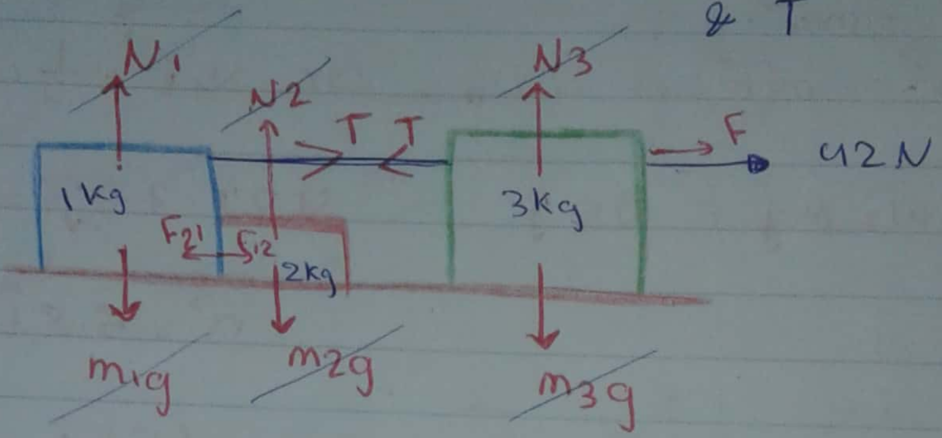
19-3-2018

Q29 Assume the three blocks portrayed move on a frictionless surface and a 42 N force acts as shown on the 3 kg block. Determine the acceleration & T



Take m_3

$\sum \vec{F} = m_3 a$

$F - T = m_3 a$

$\boxed{42 - T = 3a}$

Take m_1

$\sum \vec{F} = m_1 a$

$T - F_{21} = m_1 a$

$\boxed{T - F_{21} = a}$

Take m_2

$\sum \vec{F} = m_2 a$

$\boxed{F_{12} = 2a}$

OR

نعتبرهم كلهم جسم واحد
لأنه تسارعهم نفسه

$\sum F = M a$

$42 = (\overset{m}{1} + \overset{m}{2} + \overset{m}{3})\, a$

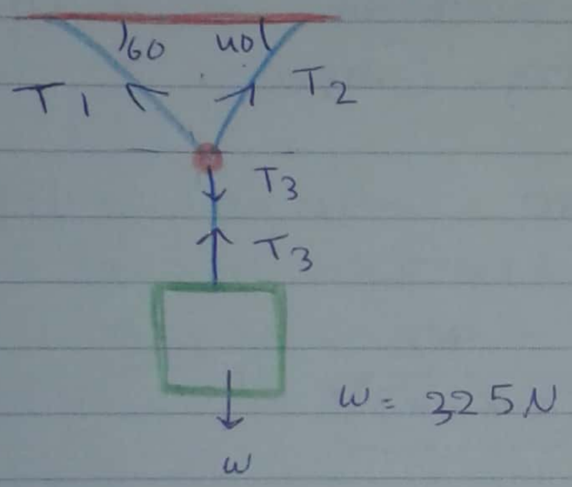
$\boxed{a = 7\ m s^{-2}}$

$42 - T = 3a$

$\cancel{42} - T = 3 * 7$

$\boxed{T = 63}$

Q33 A bag of cement weighing 325 N hangs in equilibrium from three wires as suggested in fig. Two of the wires make angles $\theta_1 = 60°$, $\theta_2 = 40°$ with the horizontal. Assuming the system is in equilibrium find the tensions T_1, T_2, T_3 in the wires



Equilibrum متزن

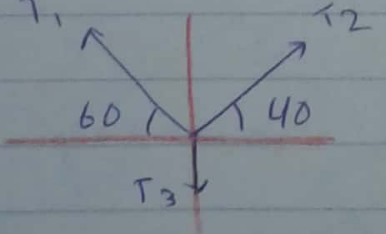
$\Sigma F = 0$

$\Sigma \vec{F}_x = 0$, $\Sigma \vec{F}_y = 0$

$T_3 - w = 0$

$T_3 = w$

$T_3 = 325\ N$



X (axis)

$\Sigma F_x = 0$

$T_2 \cos 40 - T_1 \cancel{\sin}\overset{\cos}{} 60 = 0$

$T_2 * 0{,}76 - T_1 * 0.8 = 0$

$0{,}78\, T_2 = T_1 * 0.8$

$T_2 = T_1 * 1.05$

y (axis)

$T_2 \sin 40 + T_1 \sin 60 - T_3 = 0$

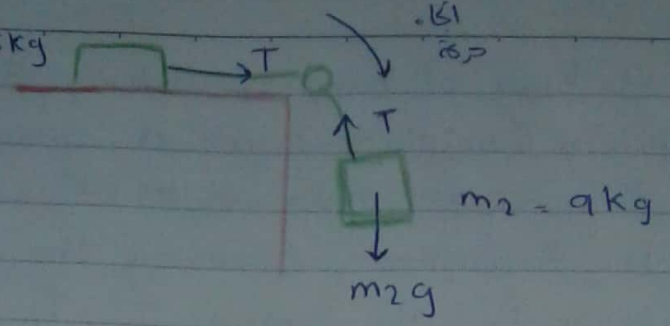
$(T_1 * 1.05) * 0.6 + T_1 * 0.5 - 325 = 0$

⋮

H.w 3,5,15,19,22,32,36,37,49,55,84 19-3-2018

No. 68

Q40



$m_1 \Rightarrow T = 5a$

كونه حركه للتحت

$m_2 \Rightarrow T - m_2 g = (-) m_2 a$

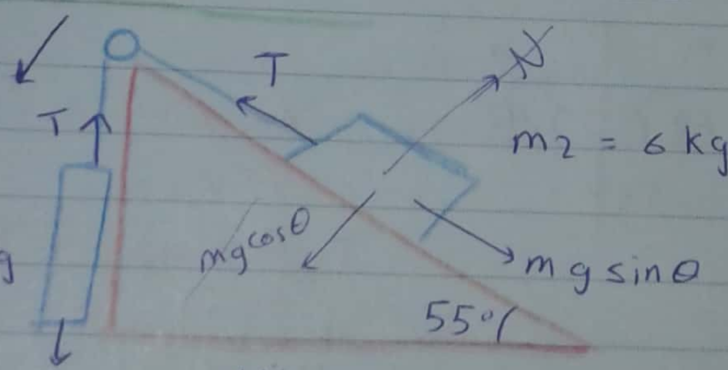
$5a - 90 = -9a$

$14a = 90$

$\boxed{a = 6.4 \ m s^{-2}}$

$T = 6.4 * 5 = \boxed{32 \ N}$

Q42



الجسم ينزل للتحت

*انا فرضنا اتجاه الحركة

$m_1 \Rightarrow T - m_1 g = (-) m_1 a$

$\boxed{T - 20 = -2a}$ رح نستعملها بالأسفل

$m_2 \Rightarrow m_2 g \sin\theta - T = (-) m_2 a$

$6 * 10 \sin 55 - T = -6a$

$49 - T = -6a$

$+ \quad -20 + T = -2a$

$29 = -8a$

اتجاه الحركة عكس الي فرضته $\leftarrow a = (-)3.6 \ m s^{-2}$

$T - 20 = -2 * 3.6 \longrightarrow T = 27.2 \ N$

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smile

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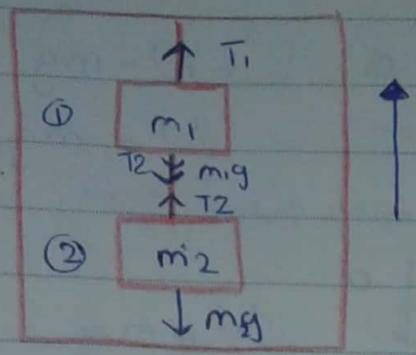
Q43

$m = 3.5\,kg$



$a = 1.6\,m\,s^{-2}$

الحركة

$\sum \vec{F} = ma$

$\boxed{1}$ $T_1 - T_2 - mg = ma$

$T_1 - T_2 - 35 = 3.5 * 1.6$

$T_1 - 40.6 - 35 = 5.6$

$T_1 - 75.6 = 5.6$

$\boxed{2}$ $T_2 - mg = ma$

$T_2 - 35 = 3.5 * 1.6$

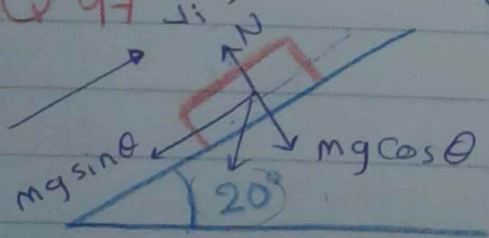
$T_2 - \cancel{35} = 5.6$
$+\cancel{35} \quad +35$

$T_2 = 40.6$

$T_1 = 81.2$

Q47

$V_i = 5\,m\,s^{-1}$ $\quad V_f = 0$



بدو ΔX

$\sum F = ma$

$-\cancel{m}g\sin\theta = \cancel{m}\,a$

$a = -3.4\,m\,s^{-2}$

$V_f^2 = V_i^2 + 2a\,\Delta X$ $\quad \to 0$

$0 = 25 - 2 * 3.4\,\Delta X$

$\Delta X = 3.7\,m$

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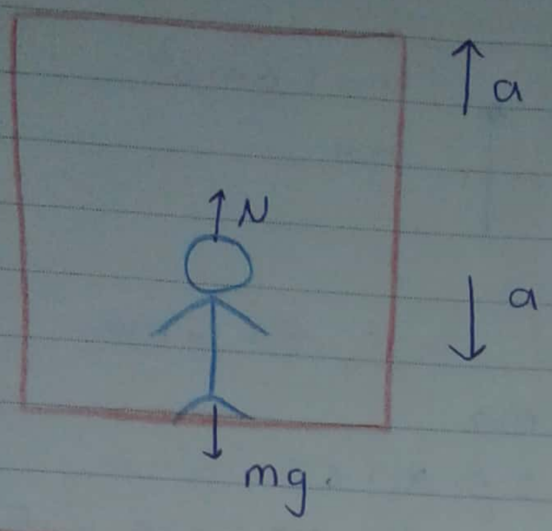


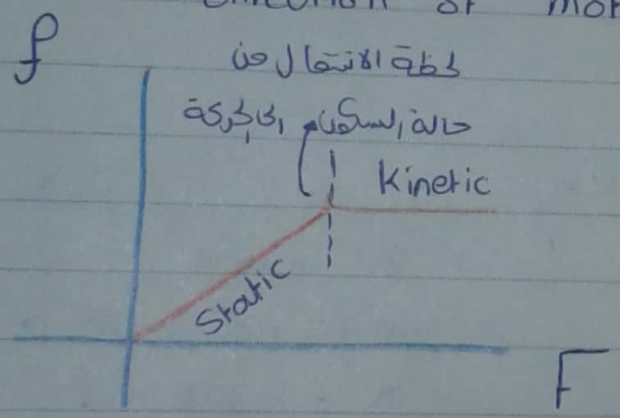
$$N - mg = ma$$
$$N = mg + ma \quad \text{زيادة}$$

$$N - mg = -ma$$
$$N = mg - ma \quad \text{نقصان}$$

* Friction Force f :- قوة الاحتكاك

دائماً تكون عكس اتجاه الحركة

it is a resistive force always opposite to the direction of motion



1. Static Friction f_s

$f_s \propto N$ وجد تجريبياً

$f_s = \mu_s N$ $\quad \mu_s$ cofficient of static friction

2. kinatic friction f_k

$f_k \propto N \rightarrow f_k = \mu_k N$ $\quad$ cofficient of kinatic friction

smile

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In general

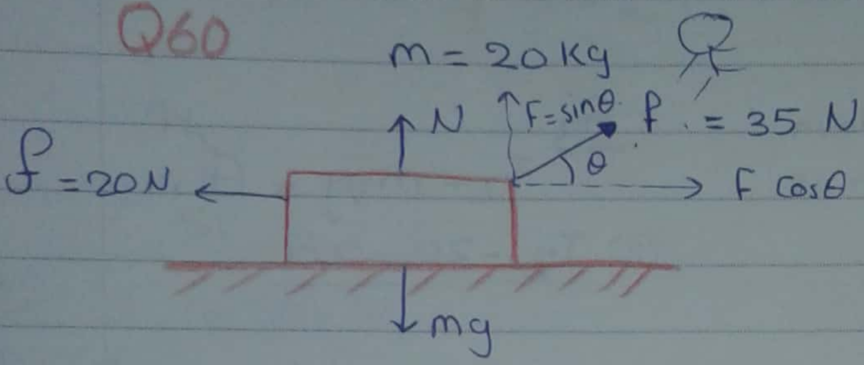
$$f = \mu N$$

معامل الاحتكاك

$1 > \mu$ ويحتمد على طبيعة الاسطح ويقاس تجريبياً قيمته

Q60

$m = 20\,kg$



$\theta = ??$

$N = ??$

constant speed $a = 0$

y-axis

$N + F\sin\theta - mg = 0$

$N = mg - F\sin\theta$

$N = 171\ N$

$\Sigma F = ma$ x-axis

$F\cos\theta - f = 0$

$35\cos\theta - 20 = 0$

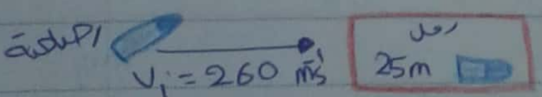
$35\cos\theta = 20$

$\cos\theta = 0.57$

$\theta = 55°$

Q53

$m = 12\,g$



$v_f = 0$

بدون قوة الاحتكاك

$\Sigma F = m(a) \rightarrow v_f^2 = v_i^2 + 2a\Delta x$

$0 = 67600 + 50\,a$

$\frac{-50\,a}{-50} = \frac{67600}{-50}$

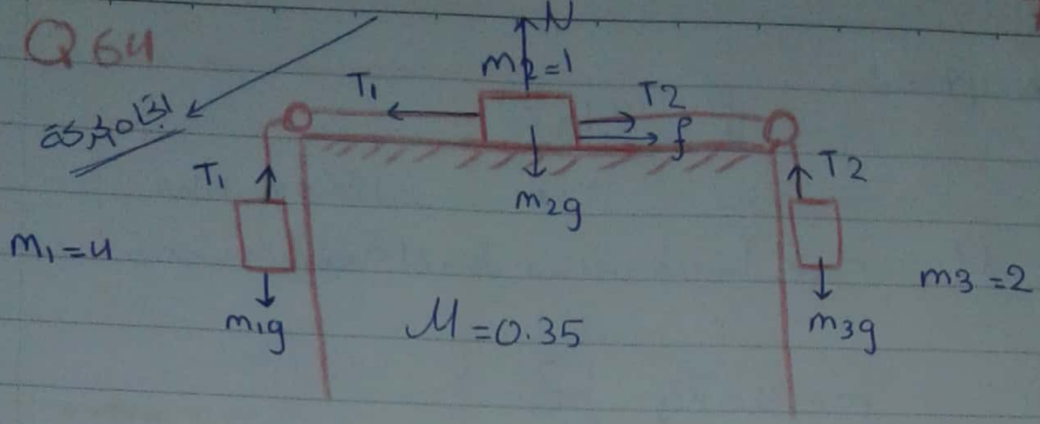
$a = -1352\ m\,s^{-2}$

$f = ma$

$f = 12 * 1.352$

$f = 16.224\ N$

Q64



m_1 (down)

$$T_1 - m_1g = \ominus m_1 a$$

① $T_1 - 40 = -4a$

m_3 (up)

$$T_2 - m_3g = \oplus m_3 a$$

② $T_2 - 20 = 2a$

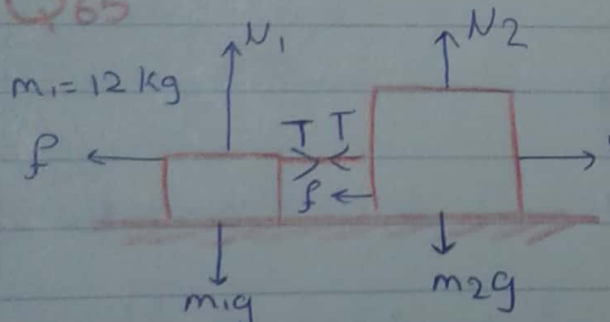
m_2

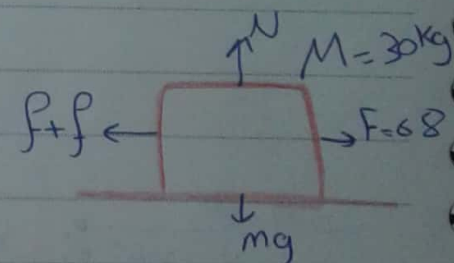
$$T_2 - T_1 + \mu m_2 g = -m_2 a$$

③ $T_2 - T_1 + 3.5 = -a$

⋮

Q65





$T = ??$ $\quad a = ??$

$\mu = 0.1$

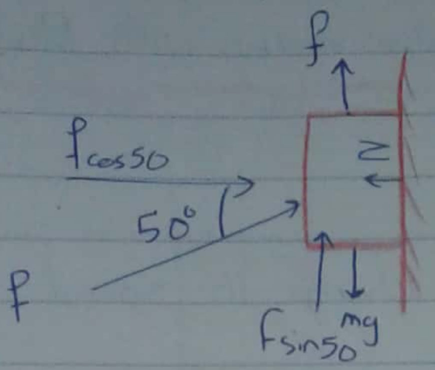
نعتبرهم جسم 1

$$\Sigma F = ma$$
$$F - f = Ma$$
$$F - \mu N = Ma$$
$$F - \mu Mg = Ma$$
$$68 - 0.1 * 300 = 30a$$
$$a = 1.2\ m s^{-2}$$

m_1 $\quad \Sigma F = m_1 a$

$$T - f = m_1 a$$
$$T - 0.1 * 12 * 10 = 12 * 1.2$$
$$T - 0.1 * 120 = 14.4$$
$$T = 26.4\ N$$

Q66

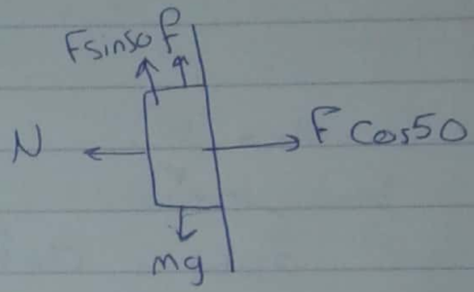


$m = 3\,Kg$

$\mu = 0.25$

الحركة

الاحتكاك



$\Sigma F = 0$

x axis: $F \cos 50 = N$

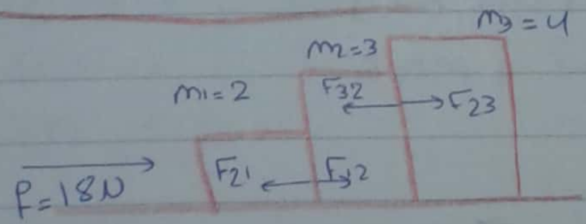
y axis: $F \sin 50 + f = mg$

$F \sin 50 + \mu N = mg$

$F \sin 50 + \mu F \cos 50 = mg$

$F \sin 50 + 0.25 * F \cos 50 = 3 * 10$

Q83



عديم الاحتكاك

$F = ma$

$18 = (2+3+4)\, a$

$\boxed{a = 2\, m\, s^{-2}}$

$m_1 \rightarrow F - F_{21} = ma$

$18 - F_{21} = 4$

$\boxed{F_{21} = 14N}$

$\boxed{F_{12} = 14N}$

m2

$F_{12} - F_{32} = m_2 a$

$14 - F_{32} = 3 * 2$

$\boxed{F_{32} = 8N}$

$\boxed{F_{23} = 8N}$

smile

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No.

26-3-2018

74

Ch :- 6 :- Circular motion with Newtin laws

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

$a_t = \frac{\Delta |\vec{v}|}{\Delta t}$ Change in speed

$a_r = \frac{v^2}{r}$ Change in direction

$\vec{a}_{total} = a_r \hat{r} + a_t \hat{\theta}$

$a_t \perp a_r \longrightarrow |\vec{a}_{total}| = \sqrt{a\hat{r} + a\hat{t}}$

Since $\sum \vec{F} = m\vec{a}$

$\vec{F}_{total} = m(a_r \hat{r} + a_t \hat{\theta})$

$= \underbrace{m a_r}_{\text{قوة الطرد المركزي}} \hat{r} + m a_t \hat{\theta}$

$\vec{F}_{total} = F_r \hat{r} + F_t \hat{\theta}$

where $F_r = m a_r = m\frac{v^2}{r}$ radial force

$F_t = m a_t = m\frac{d|\vec{v}|}{dt}$ tangental force

$F_r \perp F_t$

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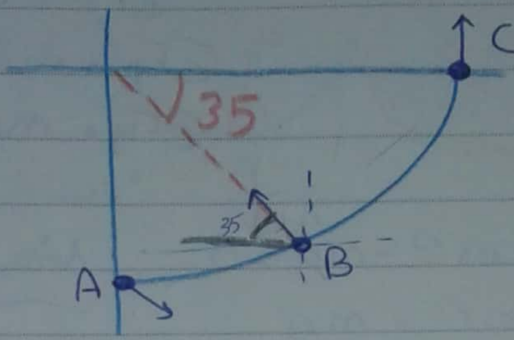
- Uniform circular motion $a_t = 0 \rightarrow F_t = 0$
- Non uniform $a_t \neq 0 \rightarrow a_r \neq 0$

Q6



$ABC = 235m$ ربع محيط دائرة — مسافة   Constant speed

$t = 36s$ زمن

$v = \frac{س}{ز}$

$a_r = \frac{v^2}{r}$

$v = \frac{ABC}{t} = \frac{235}{36} = \boxed{6.5 \ ms^{-1}}$

and $\overset{\frown}{ABC} = \frac{1}{4} \, 2\pi r$

$235 = \frac{1}{2} \pi r$

$r = 150$

$a_r = \frac{(6.5)^2}{1.5}$

$a_r = 0.28 \ ms^{-2}$

$a_r = -0.23\hat{i} + 0.16\hat{j}$ رح تأتي

x y

Avarage acceleration

$a = \frac{\vec{v_f} - \vec{v_i}}{\Delta t}$

$\vec{a} = \frac{6.5\hat{j} - 6.5\hat{i}}{36}$

$v_f = 6.5\hat{j}$

$v_i = 6.5\hat{i}$

$\vec{a} = -0.18\hat{i} + 0.18\hat{j}$

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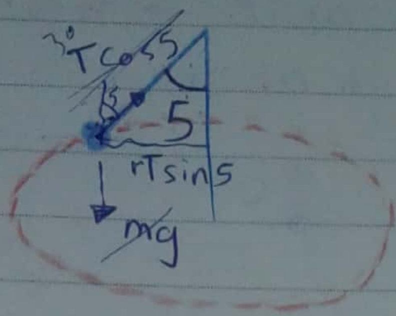
Q8

$L = 30m$

$m = 80kg$



$\sum \vec{F} = m\vec{a}$

$\sum F_x = m a_x$

$\sum F_y = m a_y$

y - axis $\Rightarrow$ $T\cos\theta - mg = 0$ No motion

$T\cos\theta = mg$

$T\cos 5 = 80 \times 10$

$\underline{T = 803\ N}$

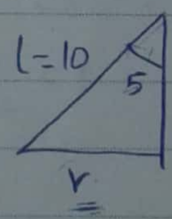
x - axis $\Rightarrow$ $T\sin 5 = ??$ رايحة باتجاه المركز

$T\sin 5 = m a_r$

$\frac{803\sin 5}{8} = \frac{8 a_r}{8}$

$a_r = 7.7\ ms^{-2}$

Velocity $\Rightarrow$ $a_r = \frac{v^2}{r}$



$7.7 = \frac{v^2}{0.87}$

$\sin 5 = \frac{r}{10}$

$v^2 = \_\_\_\_\ ms^{-1}$

$r = 0.87m$

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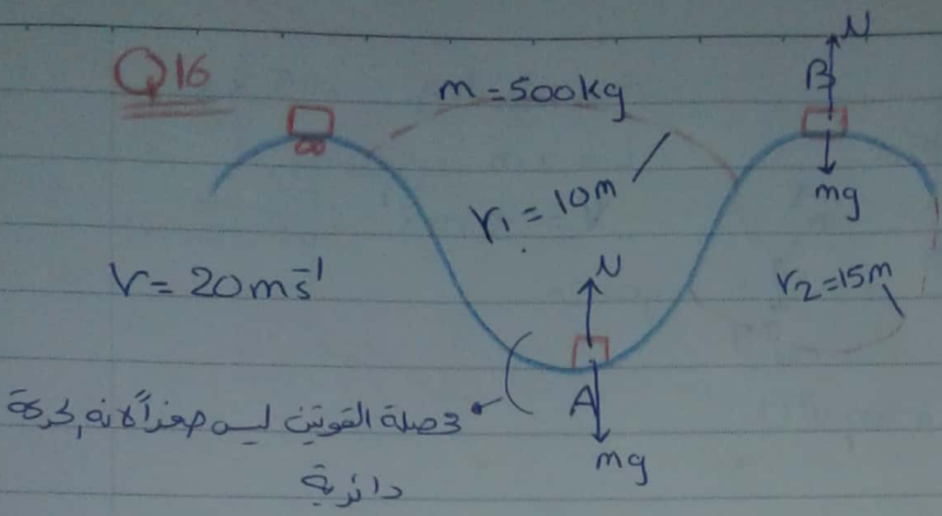
Q16



(A) $N = ??$

$$\sum F = + m a_r$$

$$N - mg = \frac{mv^2}{r}$$

$$N = mg + \frac{mv^2}{r} \Rightarrow N = 5000 + \frac{500 * 400}{10}$$

$$N = 25000 N$$

$$N = 25 kN$$

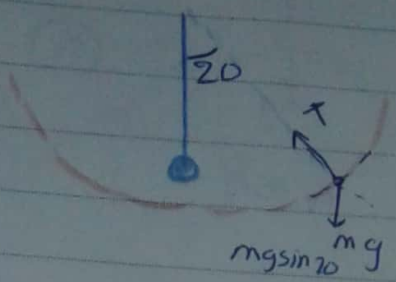
(B) $\sum F = m a_r$

$$N - mg = -\frac{mv^2}{r} \qquad \underline{\underline{N = 0}}$$

$$+\cancel{m}g = -\frac{\cancel{m}v^2}{r}$$

$$v = \sqrt{rg} \Rightarrow v = \sqrt{150} = 12.24 \ m s^{-1}$$

Q18 78



$m = \frac{1}{2}\,kg = 0.5\,kg$

$L = 2m$

$V = 8\,ms^{-1}$

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$T - mg\cos\theta = \frac{mv^2}{r}$

$T = \frac{mv^2}{r} + mg\cos 20 \qquad T = 20.1\,N$

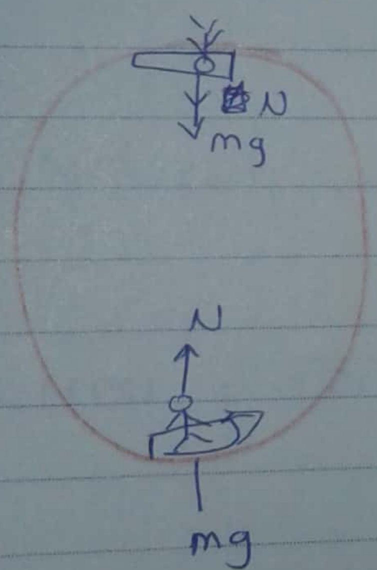
$-\cancel{m}g\sin 20 = \cancel{m}\,a_t$

$a_t = -3.4\,ms^{-2}$

$\vec{a}_{tot} = \frac{v^2}{r}\,\hat{r} - 3.4\,\hat{\theta}$

$\vec{a}_{tot} = 32\,\hat{r} - 3.4\,\hat{\theta}$

loop to loop

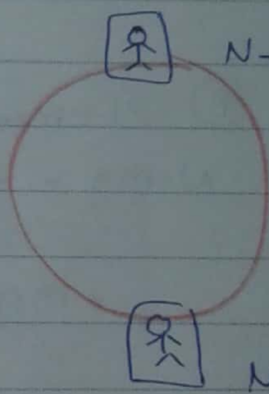


$-N + mg = +\frac{mv^2}{r}$

$N = \frac{mv^2}{r} - mg$

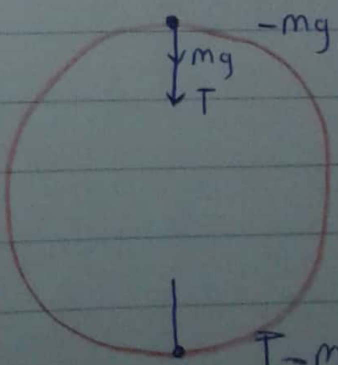
$N - mg = +\frac{mv^2}{r}$

$N = mg + \frac{mv^2}{r}$



$N - mg = -\frac{mv^2}{r}$

$N - mg = \frac{mv^2}{r}$



$-mg - T = \frac{mv^2}{r}$

$T - mg = \frac{mv^2}{r}$

smile

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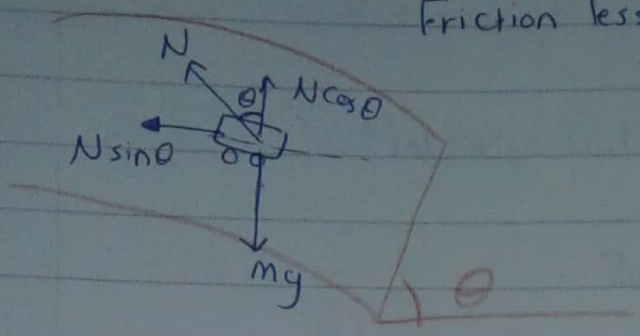
Friction less



$N\cos\theta - mg = 0$

$N = \frac{mg}{\cos\theta}$

$N\sin\theta = \frac{mv^2}{r}$

$mg\tan\theta = \frac{mv^2}{r}$

$v = \sqrt{rg\tan\theta}$

$r = 10$

$\theta = 20 \rightarrow v = 85\ ms^{-1}$

28-3-2018

Ch: 7 Work & Energy

Vectors producte

1- Cross producte

Vector * vector = vector

2- dot (scalar) producte

Vector * vector = Scalar

Dot product

let $\vec{A}$ & $\vec{B}$ to be two vectors

$$\vec{A}.\vec{B} = |\vec{A}||\vec{B}| \cos\theta$$

θ in angle between $\vec{A}$ & $\vec{B}$

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

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

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

$$= A_x B_x \underbrace{\hat{i}\cdot\hat{i}}_{1} + \cancel{A_x B_y \underbrace{\hat{i}\cdot\hat{j}}_{0}} + \cancel{A_x B_z \underbrace{\hat{i}\cdot\hat{k}}_{0}}$$

$$A_y B_y \underbrace{\hat{j}\cdot\hat{j}}_{1} + \cancel{A_y B_x \underbrace{\hat{j}\cdot\hat{i}}_{0}} + \cancel{A_y B_z \underbrace{\hat{j}\cdot\hat{k}}_{0}}$$

$$\cancel{A_z B_x \underbrace{\hat{k}\cdot\hat{i}}_{0}} + \cancel{A_z B_y \underbrace{\hat{k}\cdot\hat{j}}_{0}} + A_z B_z \underbrace{\hat{k}\cdot\hat{k}}_{1}$$

Now $\hat{i}\cdot\hat{i} = |\hat{i}||\hat{i}| \cos\theta$

$$= 1 * 1 * \cos\theta$$

$$= \boxed{1}$$

$$\hat{i}\cdot\hat{j} = |\hat{i}||\hat{i}| \cos\theta$$

$$= 1 * 1 * \cos 90$$

$$= \boxed{0}$$

$$\hat{i}\cdot\hat{k} = |\hat{i}||\hat{k}| \cos\theta$$

$$= 1 * 1 * \cos 90$$

$$= \boxed{0}$$

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Hw 7 → 13 28-3-2018

No. 81

$$\vec{A}\cdot\vec{B} = A_x B_x + A_y B_y + A_z B_z$$

$$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}| \cos\theta$$

$$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{|\vec{A}||\vec{B}|}$$

Ex

let $\vec{A} = 3\hat{i} + 4\hat{j}$

$\vec{B} = -5\hat{i} - 7\hat{j}$

Find $\vec{A}\cdot\vec{B}$ and the angle between $\vec{A}$ & $\vec{B}$

$$\vec{A}\cdot\vec{B} = A_x B_x + A_y B_y$$

$$= (3 * -5) + (4 * -7)$$

$$= -15 - 28 = \boxed{-43}$$

$$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{|\vec{A}||\vec{B}|} \Rightarrow \cos\theta = \frac{-43}{\sqrt{9+16}\sqrt{25+49}} = \frac{-43}{43}$$

$$\boxed{\theta = 180^\circ}$$

Ex let $\vec{A} = 5\hat{i} - 8\hat{j} + 7\hat{k}$

Find the angle between $\vec{A}$ &

ⓐ the x-axis

$$\hat{i}\cdot\vec{A} = |\hat{i}||\vec{A}| \cos\theta_x$$

$$\hat{i}\cdot\vec{A} = \hat{i}(5\hat{i} - 8\hat{j} + 7\hat{k})$$

$$= 5 + 0 + 0 \quad \boxed{5}$$

$$\hat{i}\cdot\vec{A} = |\hat{i}||\vec{A}| \cos\theta_x$$

$$5 = 1 * \sqrt{25+64+49} \cos\theta_x$$

$$\theta_x = 64.8^\circ$$

$\vec{A}$

(b) the y-axis

$\hat{j}\cdot\vec{A} = \hat{j}(5\hat{i} - 8\hat{j} + 7\hat{k})$

$= 0 - 8 + 0$

$= -8$

$\hat{j}\cdot\vec{A} = |\hat{j}||\vec{A}| \cos\theta_y$

$-8 = 1 * 11.75 \cos\theta_y$

$\theta_y = 133^\circ$

(c) the z-axis

$\hat{k}\cdot\vec{A} = \hat{k}(5\hat{i} - 8\hat{j} + 7\hat{k})$

$= \boxed{7}$

$7 = 1 * 11.75 \cos\theta_k$

$\theta_k =$

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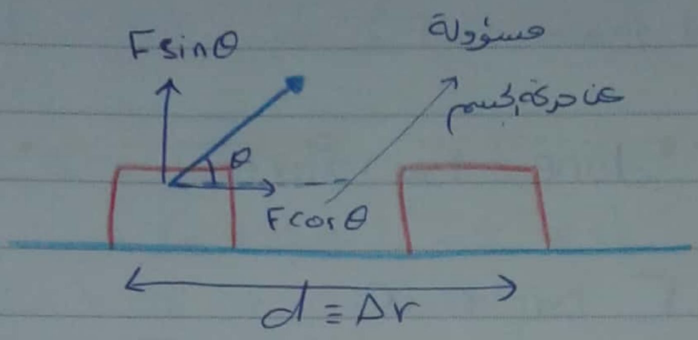
* Work done by const. force

Const. force = const. in magn. & direction



Define

work ≡ Force that Cuased the motion * displacment

$$W = F\cos\theta \, \Delta r$$

$$W = F \, \Delta r \, \cos\theta$$

$$\boxed{W = \vec{F} \cdot \vec{\Delta r}}$$

الوحدة

$[W] = N.m = J$

Note :-

$W = F \, \Delta r \, \cos\theta$

if $W = 0$ → $\Delta r = 0$ اما ارجع مكانه أو ما تحرك

→ $\cos\theta = 0$, $\theta = 90$

work is Scaler could be +ve , -ve , zero

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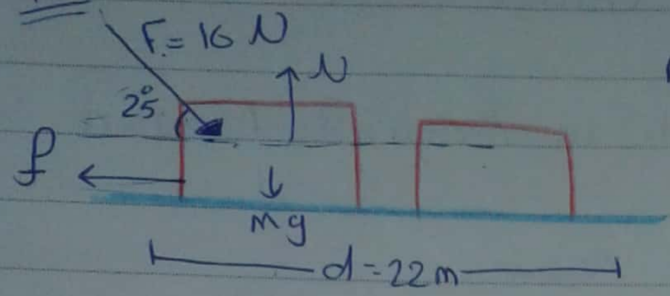
Hw Q 6 2-4-2018

No.

84

Q5



$m = 2.5$ kg

a work done by Force

$W_F = F \, \Delta r \cos\theta$

$= 16(2.2)\cos 25 = 24$ J

b work done by Normal Force

$W_N = N \, \Delta r \cos\theta$

$= N \, \Delta r \cos 90 = 0$

c work done by gravity

$W_{mg} = 0$

d If the friction force = 10 N Find work done by friction

$W_f = f \, \Delta r \cos\theta$

$= 10(2.2)\cos 180 = -22$ J

Q11

$\vec{F} = 6\hat{i} - 2\hat{j}$

$\vec{\Delta r} = 3\hat{i} + \hat{j}$

Find ω & θ

$W = \vec{F} \cdot \vec{\Delta r}$

$= (6 * 3) + (-2 * 1)$

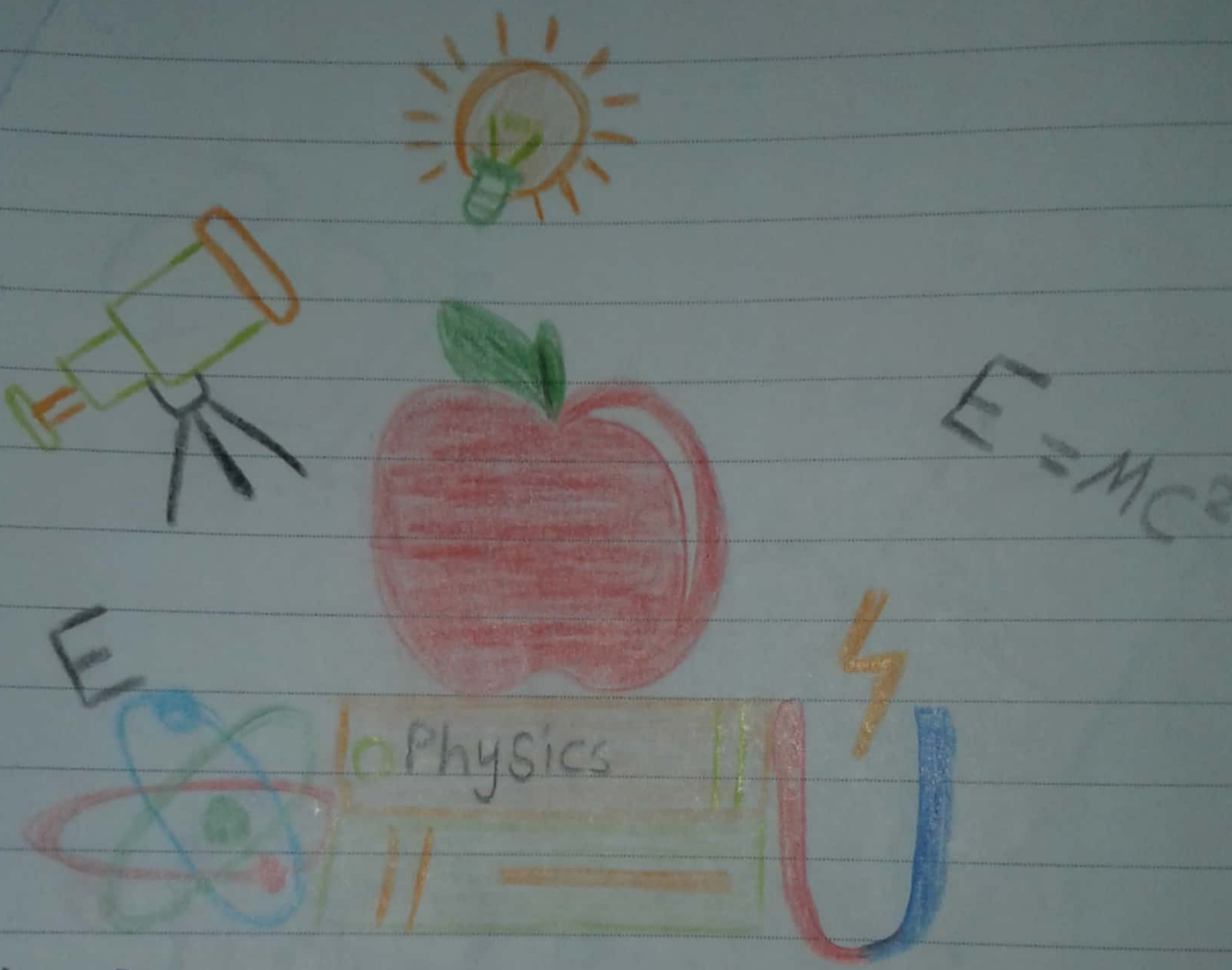
$= 18 + -2 = 16\ J$

$W = F . \Delta r \cos\theta$

$16 = \sqrt{40} \cdot \sqrt{10} \cos\theta$

$\theta = 37°$

^^ Second ال طوص ل



Sally Baniyaseen

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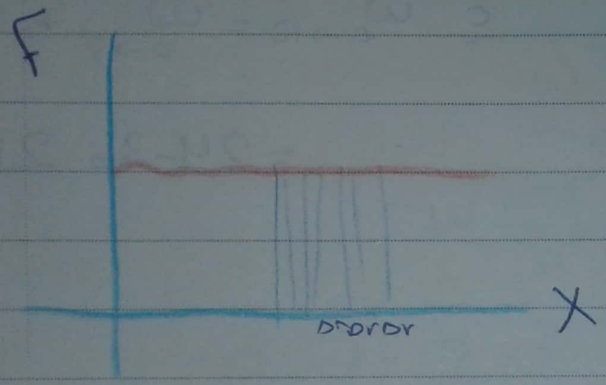
① Final

- Worke done by Vary Force



$\Delta W = F \cdot \Delta r$

$W \approx \sum \Delta W = \sum F \cdot \Delta X$

$$\boxed{W = \sum_{\Delta X \to 0} F \; \Delta X}$$

Integral

$$W = \int_{x_i}^{x_f} \vec{F} \cdot \vec{dx}$$

In general

$$W = \int_{r_i}^{r_f} \vec{F} \cdot \vec{dr}$$

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2 2-4-2018

No.

work = Area under r

F & r Curve

Note if F = Constant

Work = $\vec{F} \cdot \int_{r_i}^{r_f} dr$

$$\boxed{W = \vec{F} \cdot \Delta r}$$

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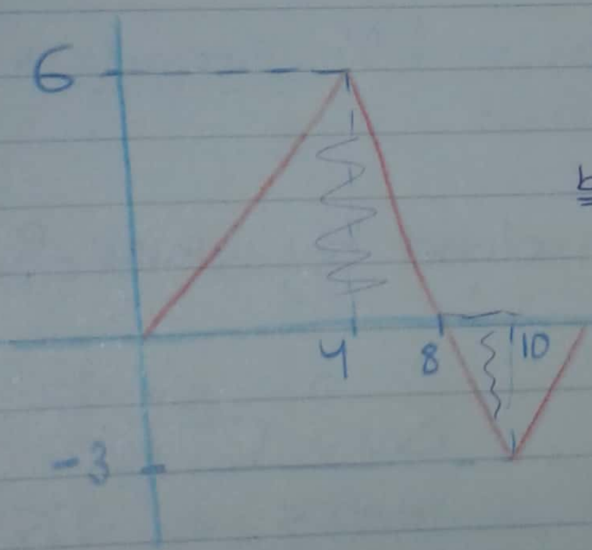
Q14



a $W_{0\to 8} = \frac{1}{2} * 8 * 6 = 24J$

b $W_{8\to 10} = \frac{1}{\cancel{2}} * \cancel{2} * -3 = -3J$

c $W_{0\to 10} = W_{0\to 8} + W_{8\to 10}$

$= 24 - 3 = 21 \ J$

H.W 15

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2-4-2018

No.

Q26 Vary in Force

$F = 8x - 16 \qquad x_i = 0 \quad , x_f = 3$

$$W = \int_{x_i}^{x_f} F \, dx = \int_0^3 (8x - 16) \, dx$$

$$4x^2 - 16x \Big]_0^3 \qquad \boxed{W = -12 \text{ J}}$$

Q29 $\vec{F} = 4x\hat{i} + 3y\hat{j}$ only in x-axis

$x_i = 0 \quad x_f = 5$

Find W

$\vec{F} = F_x \hat{i} + F_y \hat{j}$

$\vec{r} = x\hat{i} + y\hat{j}$

$\vec{dr} = dx\hat{i} + dy\hat{j}$

$W = \int \vec{F} \cdot \vec{dr}$

$= \int (F_x \hat{i} + F_y \hat{j})(dx\hat{i} + dy\hat{j})$

$W = \int F_x dx + F_y dy$

$$W = \int F \cdot dr = \int 4x\hat{i} + 3y\hat{j} \, (dx\hat{i} + dy\hat{j})$$

$$W = \int_0^5 4x \, dx + \cancel{\int 3y \, dy}^{\,0}$$

$$W = 2x^2 \Big]_0^5 = 50 \text{ J}$$

$\vec{r_i} = 0\hat{i} + 0\hat{j}$

$\vec{r_f} = 5\hat{i} + 8\hat{j}$

$$W = \int_0^5 4x \, dx + \int_0^8 3y \, dy$$

$$W = 2x^2 \Big]_0^5 + \frac{3}{2} y^2 \Big]_0^8$$

smile

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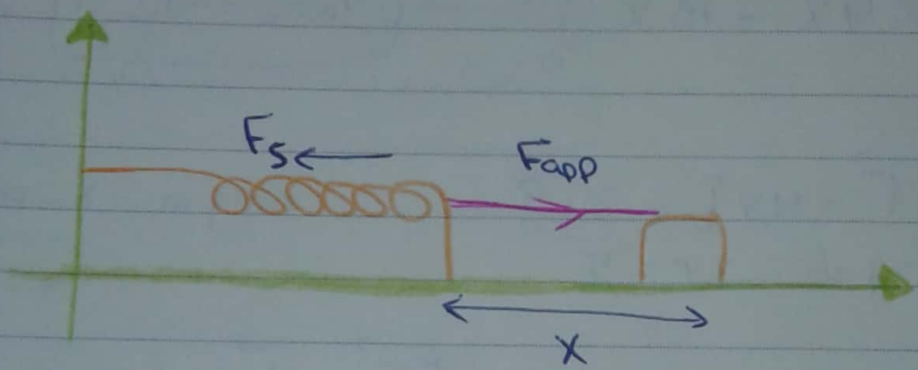
$$w = \int_{r_i}^{r_f} \vec{F} \cdot \vec{dr}$$

as a good example

Spring Force



$F_{app} \propto X$

$F_{app} = KX$

$k \equiv$ Spring Const

$[k] = N/m$

The spring force (F_s) is always opposite to the displacement

$\boxed{F_s = -KX}$ Hook law.

9-4-2018

No.

$$W_{app} = \int_{x_i}^{x_f} f \, dx \qquad kx$$

$$= \int_{x_i}^{x_f} k x \cdot dx \rightsquigarrow \frac{1}{2} k x^2 \Big]_{x_i}^{x_f}$$

$$W_{app} = \frac{1}{2} k x_f^2 - \frac{1}{2} k x_i^2$$

Define :- the elastic potiutioal energy U_s

طاقة الوضع المرونية

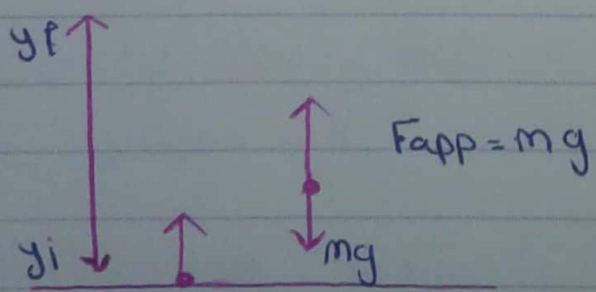
$$f = kx$$

$$\underline{U_s} = \frac{1}{2} k x^2$$

$$\Rightarrow W_{app} = U_{if} - U_{si} \Rightarrow W_{app} = \Delta U_s$$

$$W_s = -\Delta U_s$$

* gravitational potintial energy U :-



$$W_{app} = F_{app} \, \Delta y$$

$$= mg(\hat{j}) \cdot (y_f - y_i)\, \hat{j}$$

$$W_{app} = mg\,y_f - mg\,y_i$$

Define :- $U = mgy$

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9-4-2018

No.

$W_{app} = U_f - U_i$ $W_{app} = \Delta U$ $W_g = -\Delta U$

* if the only change is in the heighe then the work done by the applied force is equal to the change in grow gravity potintial energy

16-4-2018

$$W = \int_{r_i}^{r_f} \vec{F} \cdot \vec{dr}$$

$$U_s = \frac{1}{2} k x^2$$

$$W_{app} = \Delta U$$

$$W_{app} = \Delta U_s$$

$$W_g = -\Delta U$$

$$W_s = -\Delta U_s$$

$$U = mgy$$

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No.

* Work - Kinetic energy theorm

$$W = \int_{r_i}^{r_f} \vec{F} \cdot \vec{dr}$$

$$F = ma = \frac{m\,dv}{dt}$$

Now $a = \frac{dv}{dt} = \frac{dv}{dr}\frac{dr}{dt}$ chain roles

$$\hookrightarrow W = \int m \frac{dv}{\cancel{dr}} \frac{dr}{dt} \to \cancel{dr}$$

$$W = m \int_{v_i}^{v_f} v\,dr \longrightarrow W = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

Define the kinetic energy $\underline{\underline{K}}$

$$K = \frac{1}{2} m v^2$$

$$\hookrightarrow W = K_f - K_i$$

$$W_{app} = \Delta K$$

if the only change is in the Velocity in the speed then the work done by the applied force is equal to the chang in the kinetic energy.

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No.

* Total energy. (mechanical energy)

$$E = K + U$$

$$E = \frac{1}{2}mv^2 + mgy$$

if No external force No total energy change

↳ No energy loss or gaine

$$\boxed{\Delta E = 0}$$

$$E_f = E_i$$

$$K_f + U_f = K_i + U_i$$

$$K_f - K_i = U_i - U_f$$

$$\Delta K = -\Delta U$$

$$\Delta U = -\Delta K$$

→ Conservative system or force

نظام لا يضيع طاقة

i.e Spring gravity.

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Ex

	U	K (طاقة حركية)	E	
m = 10kg	1000	0	1000	
				$\Delta E = 0$
	800	200	1000	
10m				
	300	700	1000	$\Delta E = 0$
سطح الأرض	0	1000	1000	$\Delta E = 0$

- the work done by the applied force

$W_{app} = \Delta E$

↳ there is a change in height and speed

In general work done by applied − work done by friction = ΔE

$$W_{app} - f_k d = \Delta E$$

if $f_k = 0 \rightarrow \Delta E = W_{app}$

if $f_k = 0$, $W_{F_{app}} = 0 \rightarrow \Delta E = 0$ Conservative

if $W_{F_{app}} = 0 \rightarrow \Delta E = -f_k d$

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No.

* Conserivative Force

① $\Delta E = 0$

$\Delta K = -\Delta U$ or $\Delta U = -\Delta K$

② $W = \int_{r_i}^{r_f} \vec{F} \cdot dr$

work done by conseirvative force is independent on the track is depends only on displasminet

③ $W = \oint \vec{F} \cdot \vec{dr} = 0$ مع ملاحظة

the work done by conservative force on a closed track is Zero

$W = \int_{r}^{r} \vec{F} \cdot \vec{dr} = 0$

④ for any conservative force we can define apotential energy function U such that

$W_{cons} = -\Delta U$

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$W_s = -\Delta U_s$

$D_y = -\Delta U_y$

فرضًا

Now $-\Delta U = W_{cons}$ $U_i = 0$

$-U = \int \vec{F}_{cons} \cdot \vec{dr}$

$-du = \vec{F}_{cos} \cdot \vec{dr}$

$$\boxed{\vec{F} = \frac{-du}{dr}}$$

$F_x = \frac{-du}{dx}$ $F_y = \frac{-du}{dy}$ $F_z = \frac{-du}{dz}$

EX

let $U_{(x,y,z)} = 3x^2yz^3 + 5x^2y$

to be apotential energy function for Snoa conservative force Find $\vec{F}$ at $(1,1,1)$

$F_x = \frac{-dU}{dx} = -(6xyz^3 + 10xy)$

ثوابت z, y

$= -16$

smile

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$$F_y = \frac{-du}{dy} = -(3x^2 z^3 + 5x^2)$$
$$= -8$$

$$F_z = \frac{-du}{dz} = -(3x^2 y\, 3z^2 + \cancel{5x}^{\,0})$$
$$= -9$$

$$\vec{F} = -16\,\hat{i} - 8\,\hat{j} - 9\,\hat{k}$$

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* Power القدرة

Work (energy) done per unit of time

$$P = \frac{w}{t}$$

$$[P] = J/s = \text{Watt.}$$

$$P = \frac{w}{t} = \frac{\vec{F} \cdot \vec{r}}{t} = \vec{F} \cdot \vec{v}$$

$$P = \vec{F} \cdot \vec{v}$$

$$P_{\text{average}} = \frac{\Delta W}{\Delta t} \; ; \quad P_{ins} = \frac{dw}{dt}$$

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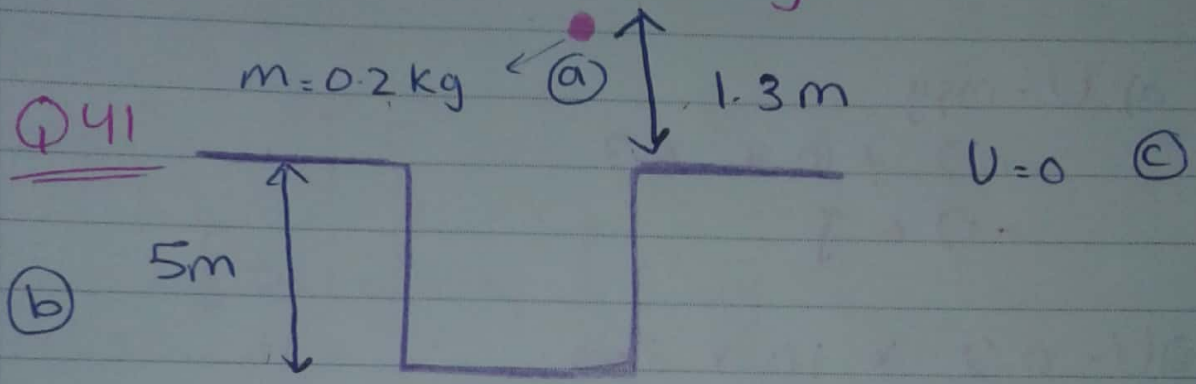
No.

H.w Ch7 [5, 6, 9, 10, 11, 12, 15, 17, 31, 33, 42, 50, 39]

Ch8 [6, 12, 22]

Q41



a) $U = mgy$
$= 0.2 * 10 * (1.3)$
$= 2.6\ J$

b) $U = 0.2 * 10 * (-5)$
$= -10\ J$

c) $\Delta U = U_f - U_i$
$= -10 - 2.6$
$= -12.6\ J$

What the work done by the gravetation word

$W_{gra} = -\Delta U = +12.6\ J$

W_{gr}

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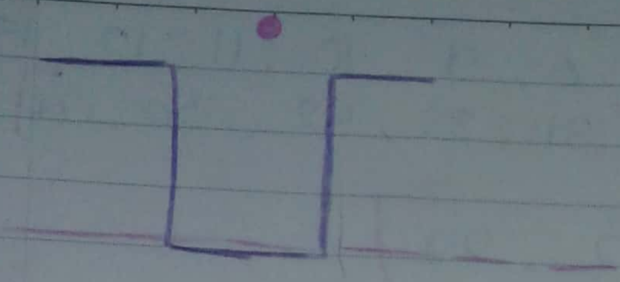


$U = 0$ المرجع

a) $U = mgy$

$= 0.2 \times 10 \times 6.3$

$= 12.6\ J$

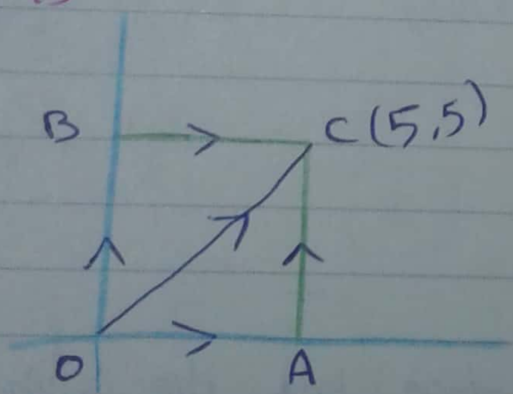
b) $U = 0.2 \times 10 \times \text{Zero}$

$= 0$

c) $\Delta U = U_f - U_i = 0 - 12.6 = -12.6\ J$

$W_{gra} = -\Delta U = +12.6\ J$

Q 45



$\vec{F} = 2y\hat{i} + x^2\hat{j}$

work done in each case

a) $W_{O \to A \to C} = W_{OA} + W_{AC}$

$W_{OA} = \int \vec{F} \cdot \vec{dr}$

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$= \int (2y\hat{i} + x^2\hat{j}) \cdot (dx\hat{i} + dy\hat{j})$

$= \int 2\cancel{y}^{0} dx + \int x^2 \cancel{dy}^{0} = 0$

$y = 0 \rightarrow dy = 0$

$W_{AC} = \int \vec{F} \cdot \vec{d_r}$

$= \int 2y \cancel{dx}^{0} + \int x^2 dy$

$x = 5 \rightarrow dx = 0$

$= \int_0^5 25\, dy = 25(5-0) = 125\, J$

(b) $W_{OBC} = W_{OB} + W_{AC}$

$W_{OB} = \int 2y \cancel{dx}^{0} + \int \cancel{x^2}^{0} dy = 0$

$x = 0 \quad dx = 0$

$W_{AC} = \int 2y\, dx + \int x^2 \cancel{dy}^{0}$

$y = 5 \quad dy = 0$

$= \int_0^5 10\, dx = 10(5-0) = 50\, J$

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No.

ⓒ $W_{oc} = \int 2y\,dx + \int x^2\,dy$

معادلة الخط المستقيم

but $y = mx + b$

$m = \text{slope} = \dfrac{5-0}{5-0} = 1$

$y = x \qquad dy = dx$

$W_{oc} = \int_0^5 2\cancel{y}\,dx + \int_0^5 \cancel{y}^2 \cdot dy$

$= 10(5-0) + 25(5-0) = \quad J$

Q4a

$U = 3x^3y - 7x$

Find $\vec{F}$

$F_x = \dfrac{-dU}{dx} = 9x^2y - 7$

$= 7 - 9x^2y$

$F_y = \dfrac{-dU}{dy} = 3x^3 - 0$

$= -3x^3$

$(7 - 9x^2y)\hat{i} - 3x^3\hat{j}$

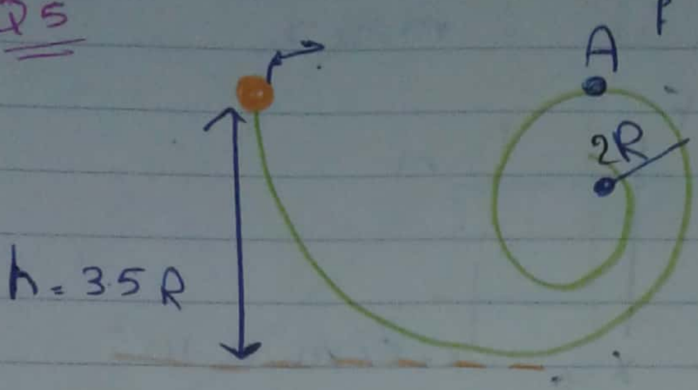
$\underset{x}{} \qquad \underset{y}{}$

Find $\vec{F}$ at (2,3)

No.

Ch 8

Q5



$E_i = E_f$

$U_i + \cancel{k_i}^{0} = U_f + k_f$

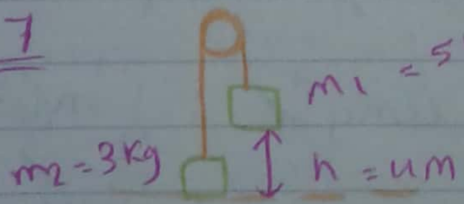
$U_i = U_f + k_f$

$\cancel{m} g y_i = \cancel{m} g y_f + \frac{1}{2} \cancel{m} v^2$

$10 * 3.5R = 10 * 2R + \frac{1}{2} v^2$

$v = \sqrt{30R} \; m s^{-1}$

Q7



سرعة m1 لحظة الاصطدام بالأرض

$E_i = E_f$

$(U_i + \cancel{k_i})_1 + (\cancel{U_i + k_i})_2 \; (\cancel{U_f} + k_f)_1 + ($

$(U_i)_1 = (k_f)_1 + (U_f + k_f)_2$

$m_1 g h = \frac{1}{2} m_1 v_f^2 + m_2 g h + \frac{1}{2} m_2 v_f^2$

$50 * 4 = \frac{1}{2} 5 v_f^2 + 3 * 10 * 4 + \frac{1}{2} 3 v_f^2$

$v_f =$ ______

smile

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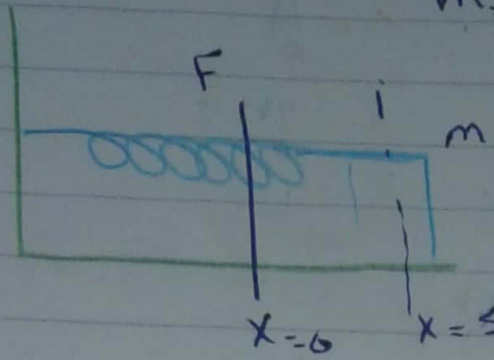
18

No. 18-4-2018

Q15

$k = 5000\ N/m$

$m = 0.2$



$U = mgy$

$U_s = \frac{1}{2} k x^2$

a) smooth

$E_i = E_f$

$\cancel{K_i}^{0} + U_i = K_f + \cancel{U_f}^{0}$

$U_{si} = K_f$

$\cancel{\frac{1}{2}} k x^2 = \cancel{\frac{1}{2}} m v^2$

$v = \sqrt{\frac{k}{m}}$

$v = 0.8\ m s^{-1}$

b) friction

$\mu_k = 0.35$ معامل احتكاك

$w = f d$

$\cancel{W_{app}}^{0} - \underbrace{f_k d}_{w_f} = \underline{\Delta E}$

$-f_k d = \Delta E$

$-\mu N d = E_f - E_i$

$-\mu m g d = K_f - U_{si}$

$-\mu m g \cancel{d}^{x} = \frac{1}{2} m v^2 - \frac{1}{2} k x^2$

نبيايها

$v = \_\_\_\_$

$\uparrow N$

$\downarrow mg$

$w_{app} - f_k d = \Delta E$

$f = \mu N$

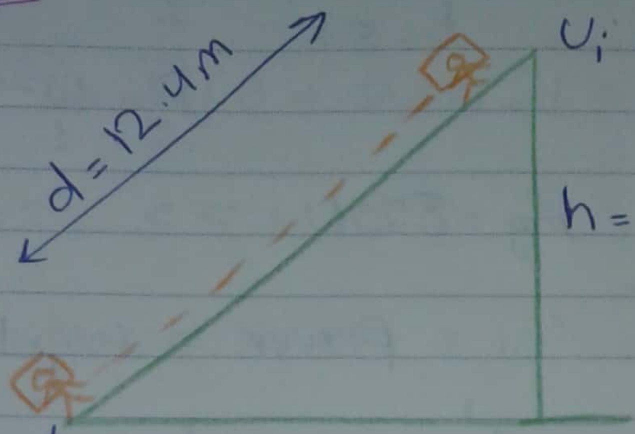
$\Delta E = E_f - E_i$

$K_f - U_i$

Q18

$m = 47\,kg$

$U_i = 1.4\,m\,s^{-1}$



$h = 2.6\,m$

$f_K = 41\,N$

$U_f = 6.2\,m\,s^{-1}$

* work done by the motor

$$W_{app} - \underbrace{f_K\, d}_{W_{f_K}} = \Delta E$$

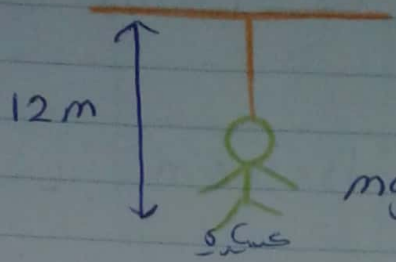
$$W_{app} - 41 * 12.4 = E_f - E_i$$
$$= K_f - (K_i + U_i)$$
$$W_{app} - 508.4 = \frac{1}{2} m v_f^2 - \left(\frac{1}{2} m v_i^2 + mgh\right)$$

$$W_{app} - 508.4 = \frac{1}{2} 47(6.2) - \left(\frac{1}{2} 47(1.4)^2 + 47 * 10 * 2.6\right)$$

$$W_{app} - 508.4 = 145.7 - (46.06 + 1.222)$$
$$W_{app} - 508.4 = 145.7 - 1{,}268.06$$

$$W_{app} = -613.96\ J$$

Q29



$t = 8s$

$mg = 820N$

$P = \frac{W}{t} \rightarrow W = F\,Dr$ 820 * 12

$Power = \frac{work}{t}$

الوزن فقط

$P = \frac{\vec{F}\, d \cos\vec{\theta}}{t} = \frac{mgd}{t}$

$= \frac{820 * 12}{8} = 1230$

OR $W = \Delta U = U_f - \cancel{U_i}^{\,0}$

$= mgy = 820 * 12$

$P = \frac{W}{t} = \frac{820 * 12}{8} = 1230$ Watt

Q30

$m = 0.875\ kg$ $\quad v_i = 0$ $\quad v_f = 0.62\ ms^{-1}$

$t = 21ms$ $\quad$ power?!

$P = \frac{W}{t}$; $W = F\,d$

$m\,a$

قوانين الحركة

قوانين الحركة

ma

but $F = ma$

$v_f = v_i + at$

$0.62 = 0 + a\ 21 * 10^{-3}$

$a = 29.5\ ms^{-2}$

$F = 0.875 * 29.5$

$= 25.8N$

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No.

$$\Delta x = \frac{1}{2}(v_i + v_f)t$$

$$= \frac{1}{2}(0 + 0.62)\ 21 * 10^{-3}$$

$$\Delta x = 6.5 * 10^{-3}\ m$$

$$W = 25.8 * 6.5 * 10^{-3} = 0.168\ J$$

$$P = \frac{0.168}{21 * 10^{-3}} = 8 \text{ watt}$$

OR

$$W = \Delta K = \frac{1}{2}(m(v_f^2 - v_i^2)$$

$\frac{1}{2}\ m\ v^2$

$$= 0.168\ J$$

$$P = \frac{0.1688}{21 * 10^{-3}} = 8 \text{ watt}$$

Ch8 done

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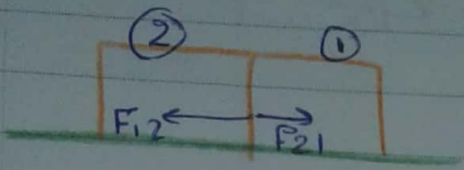
No.

Ch 9:- Momentum at Collisions



$$\vec{F}_{12} = -\vec{F}_{21}$$

$$\vec{F}_{12} + \vec{F}_{21} = 0$$

$$m_2\vec{a}_2 + m_1\vec{a}_1 = 0$$

$$m_2\frac{dv_2}{dt} + m_1\frac{dv_1}{dt} = 0$$

$$\frac{d}{dt}(m_2\vec{v}_2 + m_1\vec{v}_1) = 0$$

Define → the linear momentum $\vec{p}$

$\vec{P} = m\vec{v}$ $\quad \vec{P} \to P_z, P_y, P_x$

$$\hookrightarrow \frac{d}{dt}(\vec{P}_2 + \vec{P}_1) = 0$$

$$\vec{P}_1 + \vec{P}_2 = \text{const}$$

$$\Delta\vec{P}_{total} = 0$$

$$\hookrightarrow \vec{P}_i = \vec{P}_f$$

$$\vec{P}_{total} = \text{const}$$

For an isolated system the total momentum is conserved

↳ $\Delta\vec{p} = 0$

$\sum \vec{p}_i = \sum \vec{p}_f$

Now $\vec{p} = m\vec{v}$

$p^2 = m^2 v^2 \rightarrow \frac{p^2}{2m} = \frac{m^2 v^2}{2m}$

$\frac{p^2}{2m} = \frac{1}{2} m v^2$

↳ $K = \frac{p^2}{2m}$

Now $\vec{p} = m\vec{v}$

$\frac{d\vec{p}}{dt} = \frac{d}{dt} m\vec{v}$

$\vec{F} = \frac{d\vec{p}}{dt}$ So Newton's 2nd

$\sum \vec{F}_{ext} = \frac{d\vec{p}}{dt}$

$\sum \vec{F}_{ext} = \frac{d}{dt}(m\vec{v})$

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No.

we can write

$$\vec{F} = \frac{\Delta \vec{p}}{\Delta t}$$

So $\vec{F} \neq \frac{d\vec{p}}{dt}$

$$\int_{P_i}^{P_f} d\vec{p} = \int_0^t \vec{F}\, dt$$

$$\Delta \vec{p} = \int_0^t \vec{F}\, dt$$

Implluse $\vec{I}$ الدفع

Define the Implluse $\vec{I}$

$$\vec{I} = \Delta \vec{p} = \int_0^t F\, dt$$

$|\vec{I}| \equiv$ Area under the Curve

H.w 2, 4, 8, 13, 19, 20

23, 25, 33, 34

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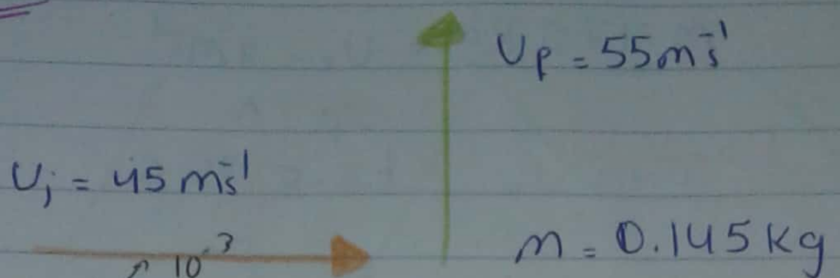
Q5



$t = 2\, ms \rightarrow 10^{-3}$

$\vec{F} = ??$

$$\vec{F} = \frac{\Delta \vec{P}}{\Delta t}$$

$$\Delta \vec{P} = \vec{P}_f - \vec{P}_i$$
$$= m\vec{v}_f - m\vec{v}_i \qquad \text{vectors}$$

$$= 0.145 * 55\, \hat{j} - 0.145 * 45\, \hat{i}$$

$$\Delta \vec{P} = 8\hat{j} - 6.5\hat{i}$$

$$\vec{F} = \frac{8\hat{j} - 6.5\hat{i}}{2 * 10^{-3}}$$

$$\vec{F} = 4000\,\hat{j} - 3250\,\hat{i}$$

$$\vec{F} = -3250\,\hat{i} + 4000\,\hat{j}$$

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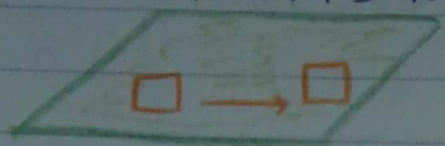
No.

Q3

$m = 17.5$ kg

ice 

$V_i = 3 m s^{-1}$

$V_f = 0$

$t = 8.75$ s

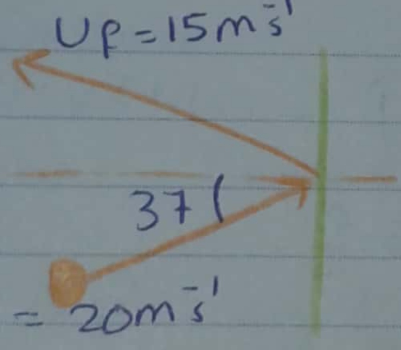
$F = P$

$P = mV$

$$\vec{F} = \frac{\Delta \vec{P}}{\Delta t} = \frac{\vec{P}_f - \vec{P}_i}{\Delta t} = \frac{0 - 3 * 17.5}{8.75}$$

$$\vec{F} = -6 \hat{i} \ N$$

H.W

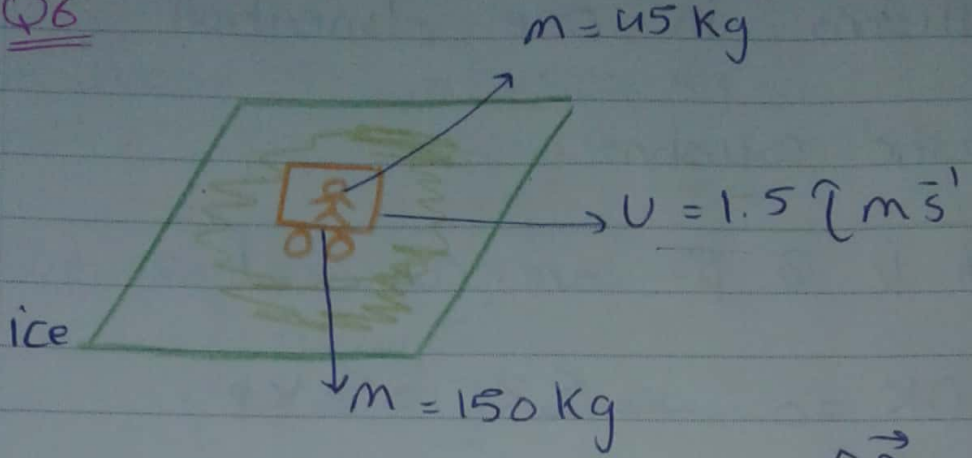


$m = 100 g$

$t = 0.1$ s

$\vec{F} = ??$

Q6



$\Delta \vec{P} = 0$

$\Delta P = 0$

$\vec{P}_i = \vec{P}_f$

$0 = \vec{P}_G + \vec{P}_p$

$= m_G v_G + m_p v_p$

$= 45 * 1.5\hat{i} + 150\, v_p$

$v_p = -0.45\,\hat{i}$

Q 11

$\Delta \vec{P} = 0$

$\vec{P}_i = \vec{P}_f$

$0 = m\vec{v} + 3m\,2\,\hat{i}$

$\vec{v} = -6\,\hat{i}\,m\,s^{-1}$

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No.

التصادمات * Collisions in one dimention

① ellastic Collisions

Both K & $\vec{p}$ are conserved

$$\Delta K = 0 \longrightarrow \sum K_i = \sum K_f$$

$$\Delta P = 0 \longrightarrow \sum \vec{P}_i = \sum \vec{P}_f$$

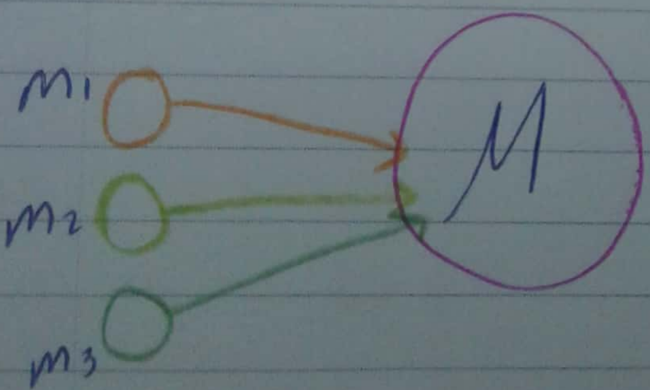
② in ellastic Collisions

K is not conserved $\Delta K \neq 0$
but $\vec{p}$ is conserved

$$\Delta \vec{P} = 0 \longrightarrow \sum \vec{p}_i = \sum \vec{p}_f$$

So $\vec{P}$ is always conserved

Completly in ellastic



عديم المرونة
تماماً

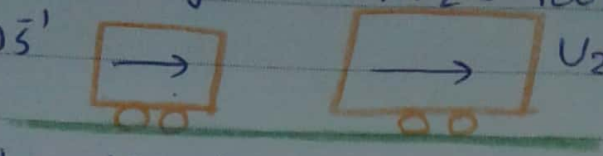
29 25-4-2018

No.

Q 22

$m_1 = 1200\,Kg$ $m_2 = 9000\,Kg$

$u_{1i} = 25\,m s^{-1}$ $u_{21} = 20\,m s^{-1}$



$u_{1f} = 18\,m s^{-1}$

كم سرعة

الشاحنة بعد التصادم

$\Sigma p_i = \Sigma p_f$

$$\Sigma \vec{P_i} = \Sigma \vec{P_f}$$

$$\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_{1f} + \vec{P}_{2f}$$

$$m_1 \vec{U}_{1i} + m_2 \vec{U}_{2i} = m_1 \vec{U}_{1f} + m_2 \vec{U}_{2f}$$ بدي اياها

$$1200 * 25\hat{i} + 9000 * 20\hat{i} = 1200 * 18\hat{i} + 9000 + \vec{V}_{2f}$$

$$\vec{U}_{2f} = 21\,\hat{i}\ m s^{-1}$$

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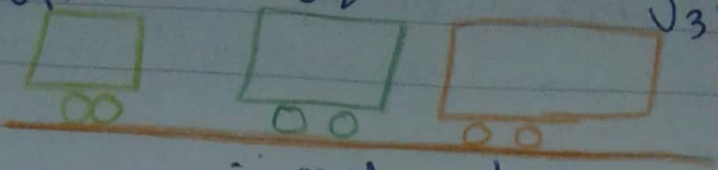
Q34 $m_1 = 4kg$ $v_{1i} = 5ms^{-1}$ $m_2 = 10kg$ $v_{2i} = 3ms^{-1}$ $m_3 = 3kg$ $v_{3i} = 4ms^{-1}$



صاروجسم واحد سرعة الجسم الذي نتج

$$\sum \vec{P}_i = \sum \vec{P}_f$$

$$\vec{P}_{1i} + \vec{P}_{2i} + \vec{P}_{3i} = \vec{P}$$

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} + m_3\vec{v}_{3i} = \underline{M}\,\vec{v}_f$$

$$4 * 5\hat{i} + 10 * 3\hat{i} + 3 * (-4)\hat{i} = 17\,\vec{v}_f$$

$$38\hat{i} = 17\,\vec{v}_f$$

$$\vec{v}_f = 2.2\,\hat{i}\,ms^{-1}$$

لليمين

let $m_3 = 50kg$

$$20\hat{i} + 30\hat{i} - 200\hat{i} = 63\vec{v}_f$$

$$-150\hat{i} = 63\vec{v}_f$$

$$\vec{v}_f = -2.4\hat{i}\,ms^{-1}$$

لليسار

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