Monday 3/11/2025

problems
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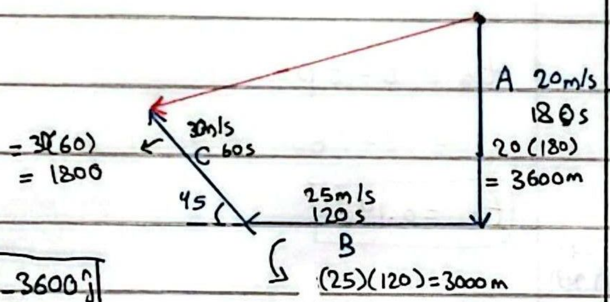
Q1 A motorist drives south at 20 m/s for 3 m, then turns west and travels at 25 m/s for 2 m, and finally travels northwest at 30 m/s for 1 m. for this 6 min trip, Find

$3 \times 60 = 180\,s$; $2 \times 60 = 120\,s$; $60\,s$

الزاوية 45°

a) the total vector displacement.



$\boxed{\vec{A} = -3600\hat{j}}$

$\vec{A} = 0\hat{i} - 3600\hat{j}$

$\vec{B} = -3000\hat{i} + 0\hat{j}$ $\quad \boxed{\vec{B} = -3000\hat{i}}$

$\vec{C} = -1800\cos 45\,\hat{i} + 1800\sin 45\,\hat{j}$

$\boxed{\vec{C} = -1272.8\hat{i} + 1272.8\hat{j}}$

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

$= (0 + (-3000) + (-1272.8))\hat{i} + (-3600 + 1272.8)\hat{j}$

$\boxed{\vec{R} = -4272.8\hat{i} - 2327.2\hat{j}} \rightarrow \Delta\vec{r}$

(b) the average speed.

$S = \dfrac{\text{total distance}}{\text{total time}} = \dfrac{3600 + 3000 + 1800}{180 + 120 + 60}$

$S = 23.3\ m/s$

(c) the average velocity.

$\Delta t = 180 + 120 + 60$ $\quad \boxed{\Delta t = 360}$

$\vec{v}_{avg} = \dfrac{\Delta\vec{r}}{\Delta t} = \dfrac{\Delta x}{\Delta t}\hat{i} + \dfrac{\Delta y}{\Delta t}\hat{j}$

$= -\dfrac{4272.8}{360}\hat{i} + -\dfrac{2327.2}{360}\hat{j}$

$\vec{v}_{avg} = -11.87\hat{i} - 6.46$

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Q3 problems

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

$x(t) = t + 1$ / $y(t) = 0.125t^2 + 1$

(a) Calculate the average velocity during the $t = 2s$ to $t = 4s$.

$\vec{v}_{avg}$ from $t = 2 \rightarrow t = 4$

$\vec{v}_{avg} = v_x\hat{i} + v_y\hat{j}$

$\vec{v}_x = \dfrac{x_f - x_i}{t_f - t_i} = \dfrac{5 - 3}{4 - 2} = 1\ m/s$

$\vec{v}_y = \dfrac{y_f - y_i}{t_f - t_i} = \dfrac{3 - 1.5}{4 - 2} = 0.75\ m/s$

$\vec{v}_{avg} = 1\hat{i} + 0.75\hat{j}$

* احل كل جزء لحال أحسن *

at any time أو لما يطلبن velocity عند زمن محدد
نستخدم المشتقة $\vec{v} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j}$

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

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j}$$

$$\boxed{\vec{v} = 1\hat{i} + 0.25t\hat{j}} \leftarrow t=2$$

$$\vec{v} = \hat{i} + 0.5\hat{j}$$

* speed $= |\vec{v}| = \sqrt{(1)^2 + (0.5)^2} = 1.12$ m/s

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Q6 A particle initially located at the origin has an acceleration of $\vec{a} = 3\hat{j}$ m/s and an initial velocity of $\vec{v_i} = 5\hat{i}$ m/s. Find

x_i and $y_i = 0$

$\vec{r_i} = 0\hat{i} + 0\hat{j}$

$a_y = 3$ / $a_x = 0$] we can use معادلات الحركة

$v_{ix} = 5$, $v_{iy} = 0$

يعطيك ال $\hat{i}$ لحالها فمعناه انو $\hat{j}$ صفر.

$\vec{r_f}$

(a) the vector position of the particle at any time.

$$\Delta x = v_{ix}t + \frac{1}{2}\cancel{a_x}^{(0)}t^2$$

$$x_f - \overset{(0)}{x_i} = 5t$$

$$\boxed{x_f = 5t}$$

$$\Delta y = \cancel{v_{iy}t}^{(0)} + \frac{1}{2}a_y t^2$$

$$y_f - \overset{(0)}{y_i} = \frac{1}{2}(3)t^2$$

$$\boxed{y_f = 1.5t^2}$$

$$\vec{r_f} = x_f\hat{i} + y_f\hat{j}$$

$$\boxed{\vec{r_f} = 5t\hat{i} + 1.5t^2\hat{j}}$$

(b) the velocity of the particle at any time.

يقصد اطلعها بطريقتين

(1) $\vec{v} = \frac{d\vec{r}}{dt} = 5\hat{i} + 3t\hat{j}$] عن طريق المشتقة

(2) $\vec{v_f} = \vec{v_i} + at$

$v_{fx} = v_{ix} + \cancel{a_x t}^{(0)}$
$\boxed{v_{fx} = 5}$

$v_{fy} = \cancel{v_{iy}}^{(0)} + a_y t$
$\boxed{v_{fy} = 3t}$

] عن طريق معادلات الحركة

$$\vec{v_f}(t) = 5\hat{i} + 3t\hat{j}$$

(c) the coordinates of the particle at $t=2s$.

الإحداثيات (x_f, y_f)

$x_f = 5(2) = 10$ m   (10, 6)

$y_f = 1.5(2)^2 = 6$ m

d) the speed of the particle at $t=2s$.

$|\vec{v}| = ??$

$\vec{v_f} = 5\hat{i} + 3t\hat{j} \leftarrow t=2$

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

$$|\vec{v}| = \sqrt{5^2 + 6^2} = \sqrt{61} = 7.81 \text{ m/s}$$

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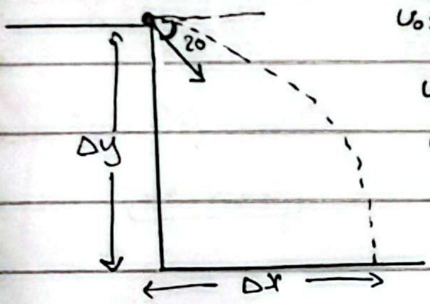
Q20 A ball is tossed تم إلقاؤه from an upper-story طابق علوي window of a building. The ball is given an initial velocity of $\underline{8\ m/s}$ v_o at an angle of 20° below the horizontal. It strikes the ground $\underline{3\ s}$ t later.

$v_{ox} = v_o \cos 20 = 8\cos 20$

$v_{ox} = 7.5$

$v_{oy} = -v_o \sin 20 = 8\sin 20$

$v_{oy} = -2.7$



$\Delta x = ??$

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

$\Delta x = v_{ox}t + \cancel{\frac{1}{2} a_x t^2}$ (0)

$\Delta x = 7.5(3) = 22.5\ m$

b) Find the height Δy from which the ball was thrown.

$\Delta y = v_{oy}t - \frac{1}{2}a_y t^2$

$= -2.7(3) - \frac{1}{2}(9.8)(3)^2$

$\boxed{\Delta y = -52.2}$

c) How long $t = ??$ does it take the ball to reach a point $\underline{10\ m}$ Δy below the level of launching?

$\Delta y = v_{oy}t - \frac{1}{2}a_y t^2 \Rightarrow 10 = -2.7t - \underbrace{\frac{1}{2}(9.8)}_{-4.9}t^2$

$4.9t^2 + 2.7t - 10 = 0$ → على الآلة الحاسبة نكبس setup, رقم 5 ثم 3

$\boxed{t_1 = 1.18}$ ← الجواب

$\boxed{t_2 = -1.73}$ ✗ خطأ لأنه سالب

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Q36 A tire إطار $\underline{0.5\ m}$ قطره r in radius rotates يدور at at a constant rate معدل of 200 rev/min. Find the speed and acceleration of a small stone lodged عالق in the tread سطح الإطار الخارجي of the tire [on its outer edge].

* ملاحظة

200 rev/min → الزمن في المقام لازم نقلب لحتى نحصل على الزمن

$T = \frac{1}{200}$ min/rev $*60$ ← لتحويلها من دقيقة لثانية

$\boxed{T = 0.3\ s/rev}$

1) $v = \frac{2\pi r}{T} = \frac{2\pi(0.5)}{0.3} = 10.5\ m/s$

2) $a_c = \frac{v^2}{r} = \frac{(10.5)^2}{0.5} = 220.5\ m/s^2$

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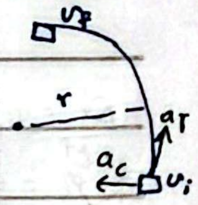
Q41 $v_i = 90\ km/h$ $v_f = 50\ km/h$ $\Delta t = 15 s$

$r = 150 m$



$v_f = v_i + at$

$a = \frac{v_f - v_i}{t} \Rightarrow a_T = \frac{13.9 - 25}{15}$

$\boxed{a_T = -0.74\ m/s}$

$a_c = \frac{v^2}{r}$, $v = 50\ km/h = 13.9\ m/s$

$a_c = \frac{(13.9)^2}{150} = 1.28\ m/s^2$

$1\ km = 10^3\ m$

$1\ h = 3600\ s$

$v_i = 90\left(\frac{10^3}{3600}\right) = 25\ m/s$

$v_f = 13.9\ m/s$

clok wise — مع عقارب الساعة
Counterclok wise — عكس عقارب الساعة

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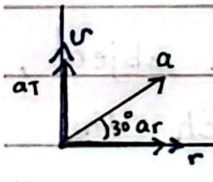
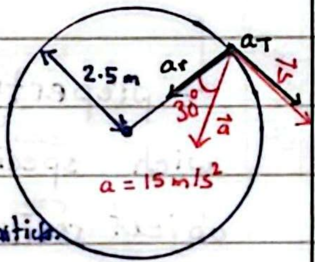
Q40 Figure P4.40 represents the total acceleration of a particle moving clokwise (مع عقارب الساعة) in a circle of radius (r) 2.50 m at a certain instant (لحظة معينة) of time. For that instant, Find



* دائماً الأقرب للزاوية الأصغر يوزن $\cos\theta$



a) the radial acceleration of the particle.

$a_r = a\cos\theta$

$a_r = 15\cos 30 = 13\ m/s^2$

$a_T = a\sin\theta$

$a_T = 15\sin 30 = 7.5\ m/s^2$

b) the speed of the particle.

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

$v = \sqrt{a_c r}$

$v = \sqrt{13(2.5)}$

$\boxed{v = 5.7\ m/s}$

c) its tangential acceleration (a_T).

$\boxed{a_T = 7.5\ m/s^2}$ * طلعناه بالفرع الأول

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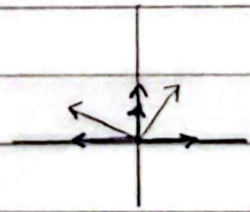
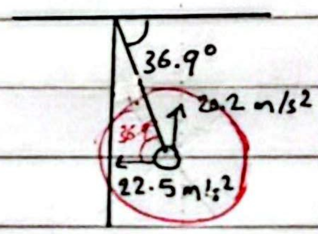
Q42 A ball swings counterclokwise (عكس عقارب الساعة) in a vertical circle (دائرة رأسية) at the end of a rope (حبل) 1.5 m (r) long. When the ball is 36.9° past the lowest point on its way up, its total acceleration is $(-22.5\hat{i} + 20.2\hat{j})\ m/s^2$. For that instant.

a) sketch a vector diagram showing the components of its acceleration.





b) determine the magnitude of its radial acceleration.

$a_r = a\cos\theta$ * *

$= 22.5\cos 36.9°$

$\boxed{a_r = 17.9}\ m/s^2$

c) determine the speed and velocity of ball. $a_c = \frac{v^2}{r} \Rightarrow v = \sqrt{a_c r}$

$v = \sqrt{(17.9)(1.5)} \Rightarrow v =$

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Chapter 5 The Laws of Motion

* Newton's Law's * :

1 Newton's ~~E~~ 1st law:-

الجسم يبقى ساكناً مالم تؤثر فيه قوى خارجية تغير من حالته.

The object ~~Cannot~~ Cannot Change in its state.

2

*اذا اثرت قوة على جسم فإنها تكسبه تسارعاً يتناسب طردياً مع مقدار القوة وعكسياً مع كتلته

$a \propto F$

$F \propto a$

$F = \text{const } a$

$\boxed{F = ma}$

3 Action and Reaction

* لكل فعل رد فعل مساوٍ له في المقدار ومعاكس له في الاتجاه.

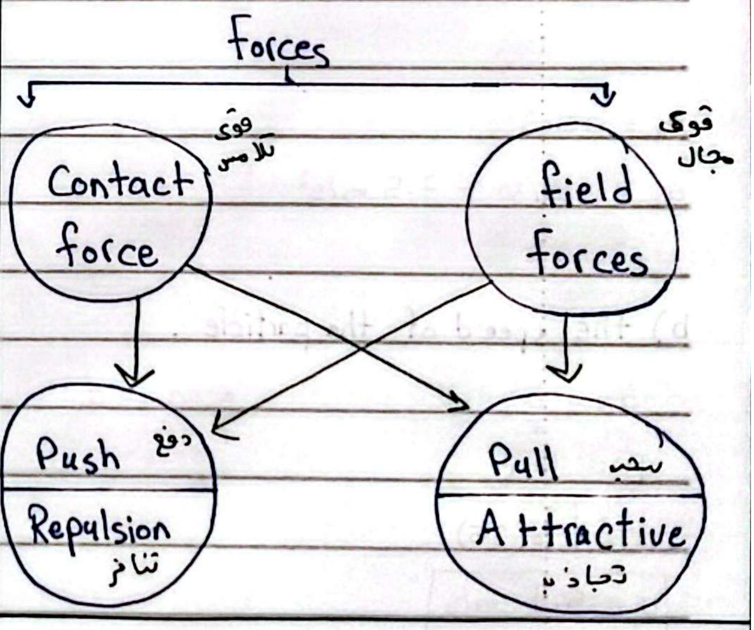
* الجسم وردة الفعل ما بكونوا على جسم واحد بكونوا على جسمين منفصلين.

$\boxed{\Sigma \vec{F} = m\vec{a}}$

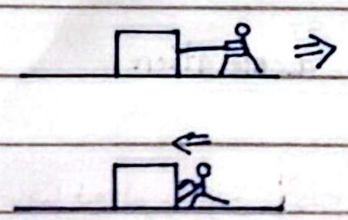
(Σ: سيجما — المحصلة)

m = mass ⇒ kg

↳ property (خاصية) for the object, wich specify (تحدد) how much the object resist (تقاوم) the change in motion.

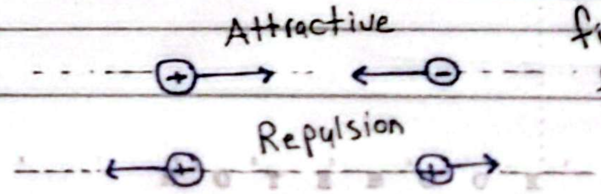


contact force



pull

push



field forces

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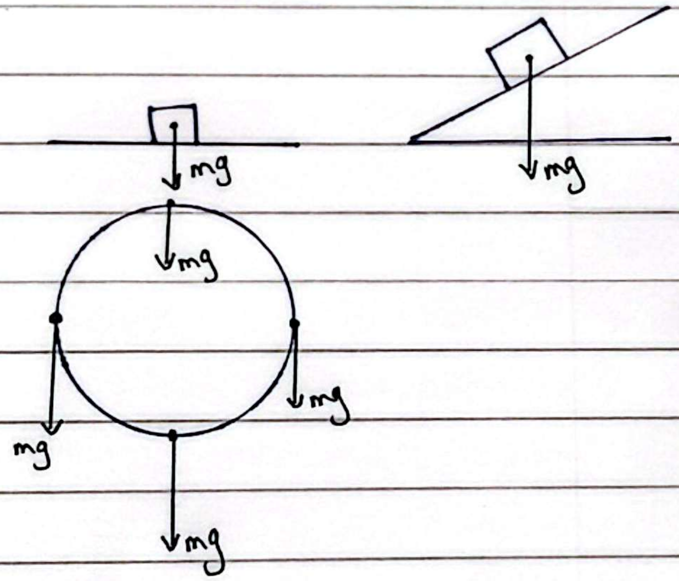
مخطط الجسم الحر

* Free Body Diagram *

← رسم يوضح جميع القوى المؤثرة على جسم واحد فقط ، معزولا عن الأجسام الأخرى ، بهدف تحليل حركته أو اتزانه .

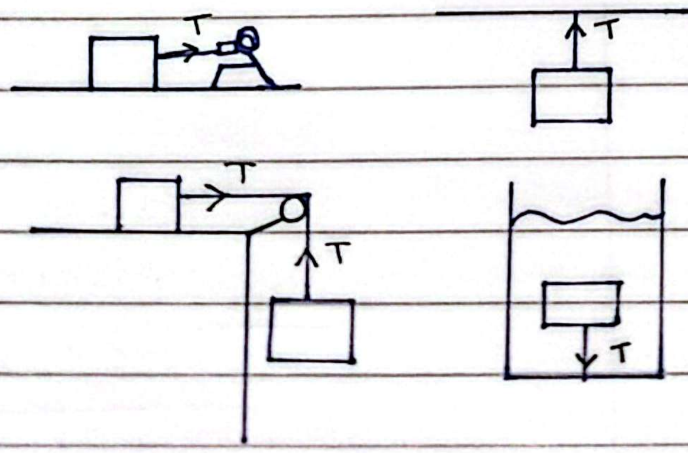
[1] weight (w)



قوة الشد

* دائما باتجاه الخيط *

[2] Tension (T)



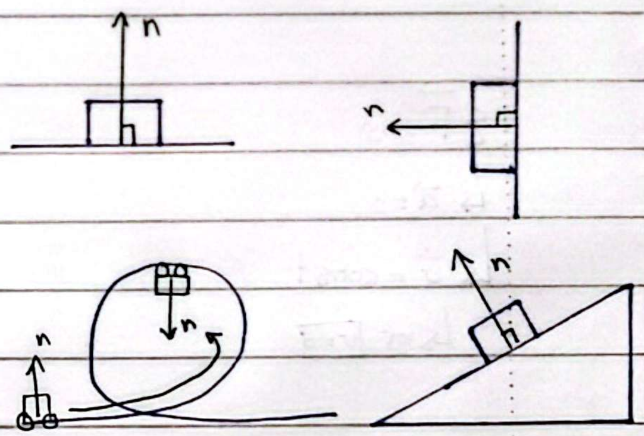
* ما تحدث إلا إذا كان فيه تلامس مع السطح

القوة العمودية

[3] Normal force (n)

السطح

Exist only when touch the surface



قوة الاحتكاك

[4] Frictional Force (f)

* دائما عكس حركة الجسم

Frictional Force

ساكن

static frictional force

حركي

kinetic frictional force

$f_s \ll \mu_s n$

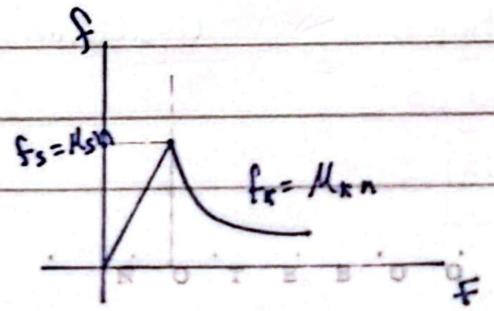
$f_k = \mu_k n$

معامل

μ_k = coeffient of kinetic frictions.

معامل الاحتكاك الحركي

μ_s = coeffient of static frictions.



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نموذج تحليل

* Analysis Model for Newton's 2nd law

الاتزان

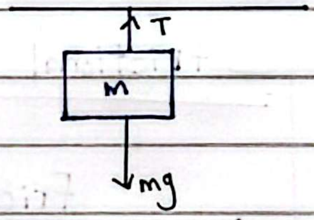
* object in Equilibrium *

$$\sum \vec{F} = 0$$

$\hookrightarrow \vec{a} = 0$

$\hookrightarrow \vec{v} = \text{const}$

$\hookrightarrow$ or $\boxed{v=0}$



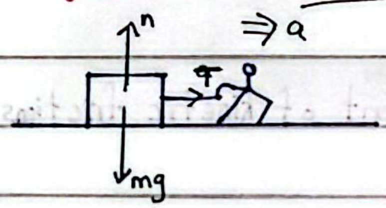
$$\sum \vec{F} = 0$$

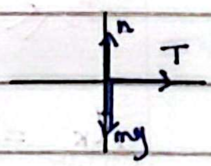
$$\sum F_y = 0$$

$$T - mg = 0 \Rightarrow \boxed{T = mg}$$

قوى محصلة

* object in a net force.





$$\sum F_y = 0 \qquad \text{(Equilibrium)}$$

$$n - mg = 0$$

$$\boxed{n = mg}$$

$$\sum F_x = ma$$

$$\boxed{T = ma}$$

$$\boxed{a = \frac{T}{m}}$$