New
2018

Civilittee

اللجنة الأكاديمية للهندسة المدنية

ملخص

فيزياء 1

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* Physics 101 *

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* Chapter $\boxed{2}$: Motion in one dimention

الحركة في بعد واحد.

Section ①: Position, Velocity & speed:

- الموقع Position: Vector «X»
- الإزاحة displacement: Vector «ΔX». $\boxed{\Delta X = X_f - X_i}$
- المسافة distance: Scalar «d»
- معدل السرعة Average Velocity: Vector «$\bar{V}$» $\boxed{\bar{V} = \frac{\Delta X}{\Delta t}}$
- مقدار السرعة Speed: Scalar $\boxed{\text{speed} = \frac{d}{\Delta t}}$

الوحدات * Units:

- displacement, distance: «m»
- Average Velocity, speed: «m/s»

Section ②: Instantaneous Velocity:

السرعة اللحظية

$$\boxed{V_x = \frac{dX}{dt}}$$

Section ③: acceleration :

التسارع.

- Average acceleration: $\boxed{\frac{\Delta V_x}{\Delta t} = \bar{a}}$ m/s^2

- Instantaneous acceleration:

$$\boxed{a_x = \frac{dV}{dt}} \quad \text{OR} \quad \boxed{a_x = \frac{d^2x}{dt^2}} \quad m/s^2$$

Section ④: Motion with const. acceleration :-

«uniform motion»

ex $a:10$, $a:2$, $a=100$

NOT ! $\cancel{a = 3t}$

*If there is an object moving with constant Velocity «مقداراً واتجاهاً» then: $\boxed{a = 0}$

$\longrightarrow \boxed{V = \frac{\Delta x}{\Delta t}}$ هذه العلاقة تنطبق فقط عندما تكون السرعة ثابتة.

*If the Velocity is changing in magnitude with a const rate :-

مقدار

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* $\boxed{V_2 = V_1 + at}$
* $\boxed{V_2^2 = V_1^2 + 2a\Delta x}$
* $\boxed{\Delta x = V_1 t + \frac{1}{2}at^2}$
* $\boxed{\Delta x = \left(\frac{V_1+V_2}{2}\right)t} = \boxed{\overline{V}t}$

<u>E.X</u> : $V = 3t^2+2t$, Find :-

① Average Velocity. between $t=1$ and $t=3$

② Position at $t=2$

③ Velocity at $t=5$

④ Acceleration at $t=1$

⑤ Average acceleration between $t=1$ and $t=4$

<u>Soln</u>: ① $\overline{V} = \frac{X_2 - X_1}{\Delta t} = \frac{36-2}{2} = 17$ m/s

$X(t) = t^3 + t^2$

② $X(2) = 2^3 + 2^2 = 12$ m

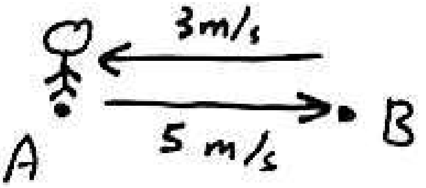
③ $V(5) = 85$ m/s

④ $a(t) = \frac{dv}{dt} = 6t+2$, $a(1) = 8$ m/s²

⑤ $\bar{a} = \frac{V_2 - V_1}{\Delta t} = \frac{56-5}{3} = 17$ m/s²

E.X A Person walks at <u>a constant</u> speed of 5 m/s along a straight line from A to B and then back along the line from B to A at a const speed of 3 m/s, Find the Average speed.

Soln: $\boxed{\text{Speed} = \frac{\text{total distance}}{\text{total time.}}}$



$$V_1 = \frac{X_1}{t_1} \longrightarrow 5 = \frac{X_1}{t_1}$$

$$X_1 = X_2$$

$$V_2 = \frac{X_2}{t_2} \longrightarrow 3 = \frac{X_2}{t_2}$$

$$X = 5t_1 \quad \dots ①$$

$$X = 3t_2 \quad \dots ②$$

$$5t_1 = 3t_2$$

$$\boxed{t_1 = \frac{3}{5}t_2}$$

$$\therefore \text{speed} = \frac{2X}{t_1+t_2} = \frac{2(3t_2)}{\frac{3}{5}t_2+t_2} = \frac{6\cancel{t_2}}{\frac{8}{5}\cancel{t_2}} = 3.75 \text{ m/s}$$

E.X A car moves from rest (السكون), with const acceleration $a = 2\,m/s^2$, 3.s later, Find:

① Final Velocity

② if the initial position $X = 5m$, what the final position.

Solu ① $V_2 = V_1 + at$

$V_2 = 0 + 2 * 3 = 6\ m/s$

② $\Delta X = V_1 t + \frac{1}{2} a t^2$

$X_f - 5 = 0 + \frac{1}{2} * 2 * 9$

مكرر دكتور للتميز

$X_f = 14\ m.$

* motion in 2-D *

E.x If an object started from $\vec{V}_1 = 2\hat{i} - 3\hat{j}$, with $\vec{a} = -2\hat{j}$, 2-sec later, Find :-

① Final Velocity.

② Final speed.

③ displacement.

④ If the initial position is the origin (نقطة الأصل), what is the final position.

Solu: $V_1 = 2\hat{i} - 3\hat{j}$, $a = -2\hat{j}$, $t = 2$

① $\vec{V}_2 = \vec{V}_1 + \vec{a}t \rightarrow V_2 = (2\hat{i} - 3\hat{j}) + (-2\hat{j}) * 2$

$V_2 = (2\hat{i} - 7\hat{j})\ m/s$

② speed $= \sqrt{4 + 49} = \sqrt{53}\ m/s$

③ $\vec{\Delta X} = \vec{V}_1 t + \frac{1}{2} \vec{a} t^2$

$\Delta r = (2\hat{i} - 3\hat{j}) * 2 + \frac{1}{2} * 4 * (-2\hat{j})$

$= (4\hat{i} - 10\hat{j})\ m.$

④ $(4\hat{i} - 10\hat{j})\ m.$

Section ⑤: Free falling motion: الحركة بتأثير الجاذبية الأرضية فقط.

* $a = g = -9.81 \approx -10\ m/s^2$

* **ملاحظة:** تسارع الجاذبية الأرضية يعتمد على بعد الجسم عن مركز الأرض وكلما ارتفعنا للأعلى كل ما قل تسارع الجاذبية الأرضية.

* **ملاحظة:** في هذه المادة سيتم اعتباره ثابتاً ومقداره $(g = -10 m/s^2)$.

$$\Delta x \longrightarrow \Delta y$$

$$a \longrightarrow g$$

$$\boxed{V_2 = V_1 + g t}$$

$$\boxed{V_2^2 = V_1^2 + 2 g \Delta y}$$

$$\boxed{\Delta y = V_1 t + \frac{1}{2} g t^2}$$

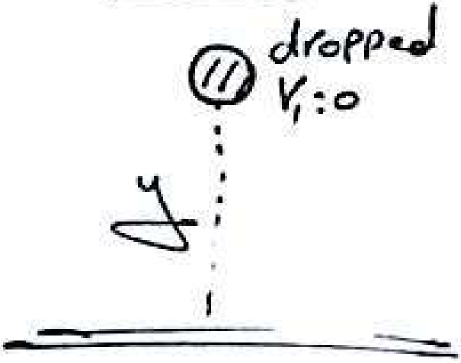
* **NoTe:**

displacement: ↑⊕ ↓⊖

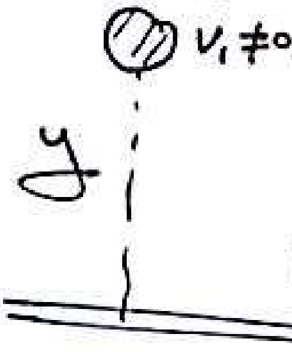
Velocity: ↑⊕ ↓⊖

acceleration: ↑⊖ ↓⊖

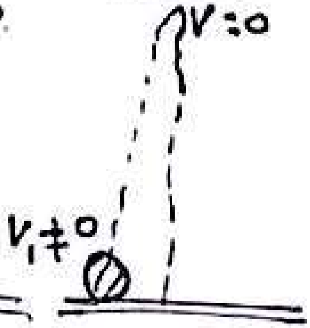
case ①:



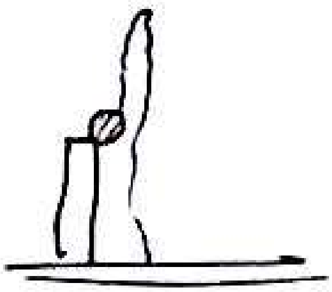
case ②: thrown



case ③:



case ④:



* **ملاحظة**: دائماً معادلات الحركة تطبق بين نقطتين فقط.

E.X an object is dropped (ترك) from rest, from atop of building of 50 m hight. Find:

① Flying time.

② Final speed.

③ hight. after 1 sec.

④ speed at 30 m hight.

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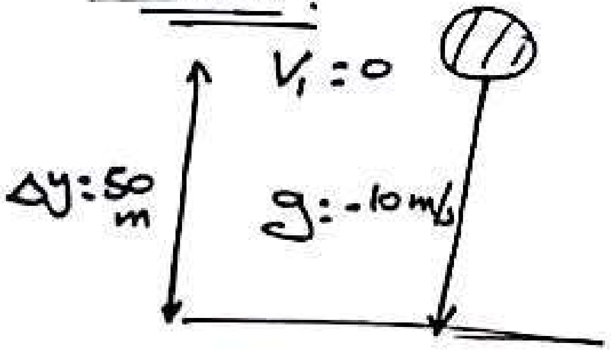
Soln:



① $\Delta y : V_1 t + \frac{1}{2} g t^2$

$-50 = 0 - \frac{1}{2} * 10 * t^2$

$5t^2 = 50 \rightarrow t = \sqrt{10}$ sec.

② $V_2 = V_1 + gt$

$V_2 = 0 - 10 * \sqrt{10} = -10\sqrt{10}$ m/s.

③ $\Delta y = 0 - \frac{1}{2} * 10 * 1 = -5$ m

$y_2 - y_1 = -5 \rightarrow y_2 - 50 = -5 \quad \therefore y_2 = 45$ m

④ $V_2^2 = V_1^2 + 2g\Delta y$

$V_2^2 = 0 - 2 * 10 * -20 \rightarrow V_2 = \sqrt{400} = \pm 20$ m/s

$= -20$ m/s #

. but speed = 20 m/s

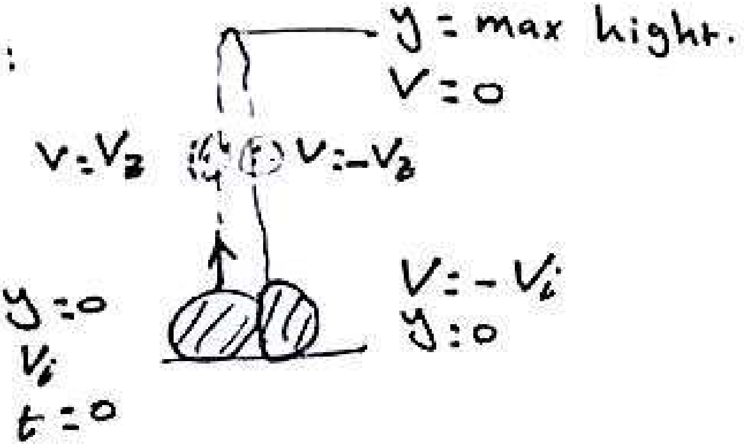
E.x : An object is thrown رمي vertically upword at 45 m/s, the velocity of the object 3-sec Later is:

Solu : $V_1 = 45 m/s$, $t = 3$ sec , $a = -10 m/s^2$

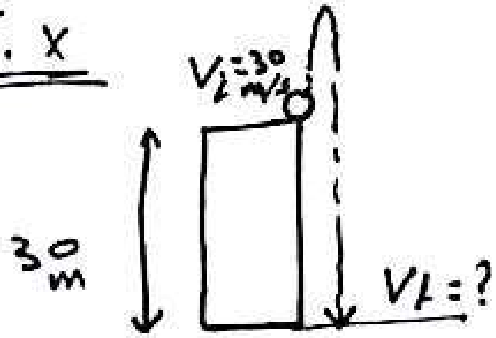
$$V_2 = V_1 + at$$

$$V_2 = 45 - 10 * 3 = 15 m/s$$

* **Notes** :



E.x



and Find the Flying time ??

Solu

$$V_f^2 = V_i^2 + 2a\Delta y$$

$$V_f^2 = (30)^2 + 2*(-10)*(-30)$$

$$V_f^2 = 900 + 600$$

$$V_f = -38.72 m/s$$

$$V_2 = V_1 + at$$

$$-38.72 = 30 - 10t \rightarrow t = 6.87 \text{ sec}$$

E.x: A ball was thrown from hight 30 m ↑ with speed 20 m/s

downward

Solu $V_i = -20$ m/s , $\Delta y = +30$ m , $a = -10$

Point ①: $V_i = -20$ m/s
$\Delta y = -30$ m
$a = -10$ m/s

Point ②: $t = ?$
$V_f = ?$

Find: ① time of Flight.
② Final speed.

Solu ① $\Delta y = V_1 t + \frac{1}{2} a t^2$

$-30 = -20t - \frac{1}{2} * 10 * t^2$

$5t^2 + 20t = +30 \rightarrow t = 1.16$
$t = -5.16$ نهمل

② $V_2 = V_1 + at$

$V_2 = -20 - 10 * 1.16 \rightarrow V_2 = -31.6$ m/s

but speed = 31.6 m/s.

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END

* فيزياء 1 *

بسم الله الرحمن الرحيم

* Chapter $\boxed{3}$: Vectors.

⊛ Vectors and scalar quantity :

الكميات القياسية والكميات المتجهة.

① **Scalar quantity :** هي هذا النوع من الكميات الفيزيائية تحتاج الى قيمة ووحدة فقط ولا يوجد حاجة الى اتجاه.

الكميات القياسية.

$\left(\underset{\text{قيمة}}{\text{Value}} + \underset{\text{وحدة}}{\text{unit}} \right)$

→ No direction : لا يوجد اتجاه

$\overset{\text{مثال}}{\text{e.x}}$: $\overset{\text{الكتلة}}{\text{mass}}$, $\overset{\text{الحجم}}{\text{Volume}}$, $\underbrace{\text{distance, Speed}}$

سيتم ذكرهما لاحقاً بالتفصيل لأهميتهما.

mass ↓ e.x 2 Kg : 2 → Value , Kg → unit

Volume ↓ $3 \ m^3$: 3 → Value , m^3 → unit.

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② **Vector quantity** : في هذا النوع من الكميات الفيزيائية نحتاج الى : قيمة واتجاه ووحدة .

(Value + unit + direction)

e.x : Force (القوة) , displacement , Velocity

$\underbrace{\text{displacement , Velocity}}$ سيتم ذكرهما لاحقاً بالتفصيل لأهميتهما .

Force

$\downarrow$

$$\underset{\underset{\text{Value}}{\swarrow}}{5}\ \underset{\underset{\text{unit}}{\swarrow}}{N}\ \underset{\underset{\text{direction}}{\downarrow}}{\angle 30^\circ}$$

* **NOTE** : ملاحظة يمكن القول بأن المتجه $\vec{A}$ يساوي المتجه $\vec{B}$ اذا توفر شرطين وهما :

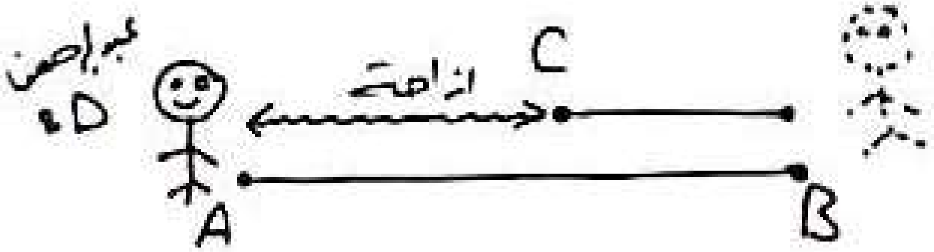
① $|A| = |B|$ قيمة $\vec{A}$ تساوي قيمة $\vec{B}$:

② $\theta_A = \theta_B$: اتجاه $\vec{A}$ بنفس اتجاه $\vec{B}$

* **NOTE** : ملاحظة

Scalar	Vector
distance مسافة	displacement ازاحة
Speed قيمة السرعة.	Velocity سرعة

* **Note :** للتمييز بين الإزاحة والمسافة إليك المثال التالي :



← ذهاب عبدالرحمن من النقطة A إلى النقطة B ثم عودته إلى النقطة C كل هذه المسافة التي مشيها تمثل المسافة .

← ولكن الإزاحة تعتمد على نقطة البداية والنهاية فقط بحيث ان المسافة بين A و C تمثل الإزاحة لعبدالرحمن !! .

⊛ Adding Vectors : جمع المتجهات عن طريق الرسم

* خطوات الحل : ① نرسم المتجه الأول كما هو .

② نضع القلم على رأس الأول ونرسم الثاني كما هو بالسؤال .

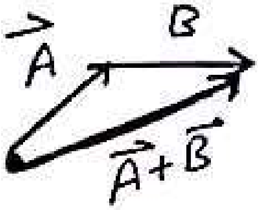
③ المتجه الواصل من بداية الأول حتى رأس الثاني يمثل جمع كل من المتجهين .

E.X : $\vec{A}$  $\vec{B}$  , Find $\vec{A}+\vec{B}$ = ??

الحل

Solution:

*Note: $\vec{A}+\vec{B} = \vec{B}+\vec{A}$



⊛ Subtracting: طرح المتجهات بالرسم.

E.X:

Find $\vec{A}-\vec{B}$ = ??

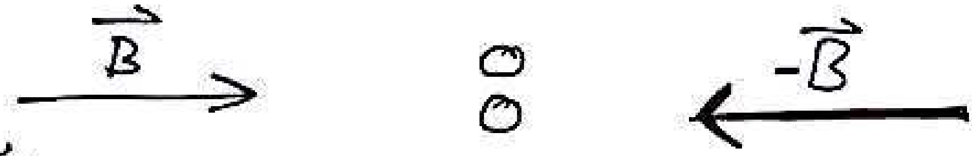
الحل

Solution:

* نحول الطرح الى جمع كالتالي:

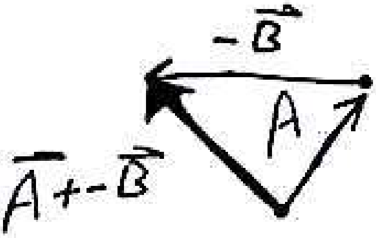
$$\vec{A}-\vec{B} = \vec{A}+(-\vec{B})$$ صح؟؟

أكيد صح :D ، طيب هسا نجد المتجه $(-\vec{B})$ وذلك عن طريق عكس اتجاهه فقط بحيث يصبح:



الآن

Now: $A+(-B) =$ ↲



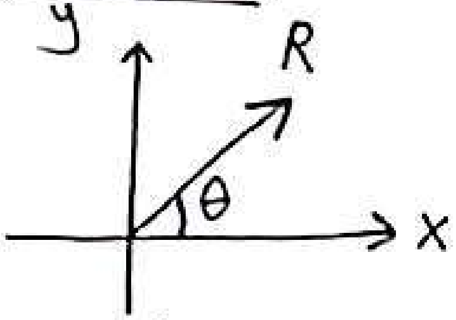
ركّز كثير

⊛ Componants of avectors and unit Vector:

مركّبات المتجهات ومتجه الوحدة .

المركّبات

*** Componants:**



«coordinate system»

نظام الإحداثيات

* أي متجه يميل بزاوية عن محور X فإنه ينتج عنه مركّبتين، مركّبة سينية يعني باتجاه محور السينات والي سميناه هون محور X ومركّبة صادية والي سميناه هون محور y .

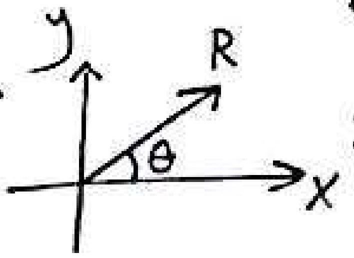
* لإيجاد هذه المركّبات «componants» نتبع القاعدة التالية :

> المركبة القريبة من الزاوية تأخذ «cos»
> والمركبة البعيدة عن الزاوية تأخذ «Sin» ..

← ماذا اقصد بالقريبة والبعيدة ؟؟ ⊙ :

امثلة

e.X :



: مركبة X قريبة لأن الزاوية محصورة بين المتجه ومحور X ومركبة y بعيدة .

إذاً :

$$X = R\cos\theta$$

$$y = R\sin\theta$$

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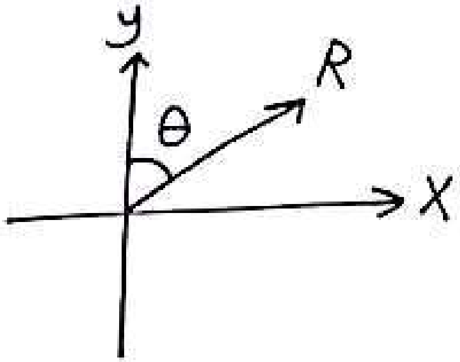
E.X :

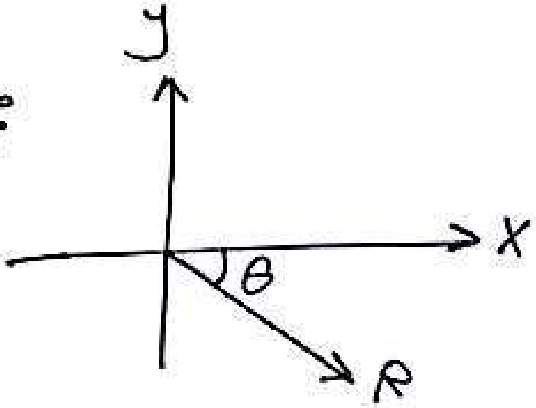


مركبة y قريبة لأنه الزاوية محصورة بين المتجه ومحور y ومركبة X بعيدة.

$X = R\sin\theta$

$y = R\cos\theta.$

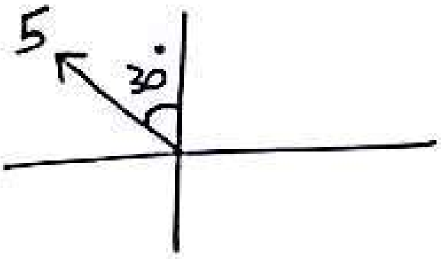
E.X :



$X = R\cos\theta$

$y = -R\sin\theta$ → الإشارة السالبة لأن المركبة ستكون بعكس اتجاه y الموجب.

E.X :



$X = -5\sin(30) = -2.5$

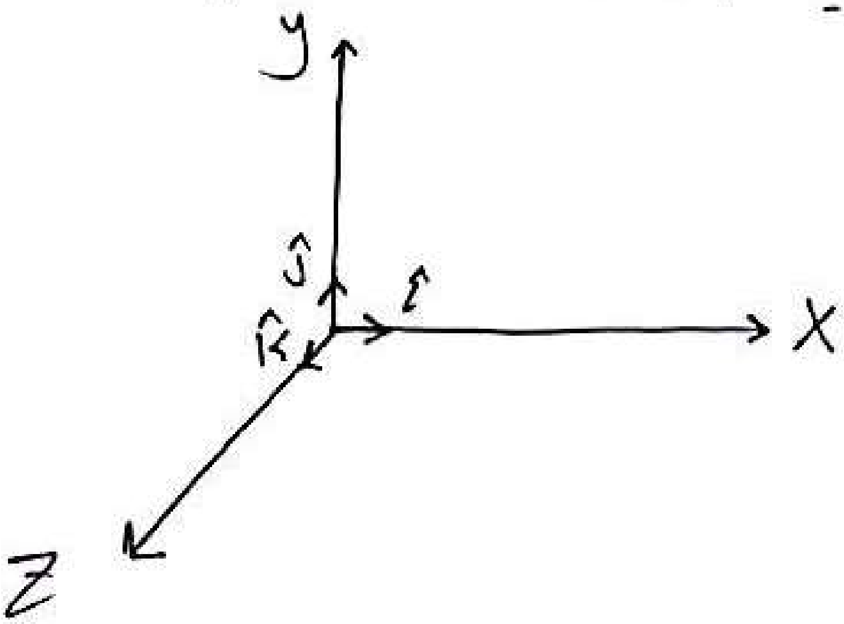
$y = 5\cos(30) = 4.33$

* Unit Vectors :

متجه الوحدة

* **أولاً** : يجب معرفة الهدف من هذا الموضوع :

الهدف الرئيسي هو لمعرفة اتجاهات المتجهات .

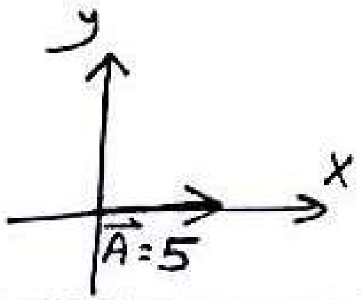


⊛ $\hat{i}$: هو متجه قيمته $\underline{\underline{1}}$ واتجاهه بنفس اتجاه محور $\underline{\underline{X}}$

⊛ $\hat{j}$: هو متجه قيمته $\underline{\underline{1}}$ واتجاهه بنفس اتجاه محور $\underline{y}$

⊛ $\hat{k}$: هو متجه قيمته $\underline{\underline{1}}$ واتجاهه بنفس اتجاه محور $\underline{\underline{Z}}$.

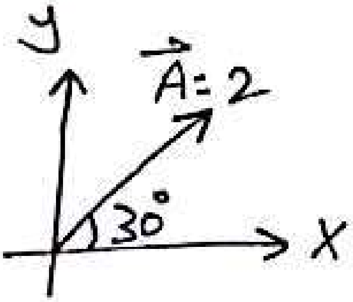
E.X :



: بدلاً من ان اقول ان المتجه $\vec{A}$ قيمته 5 ويتجه بنفس اتجاه $\underline{X}$ اختصر هذا الكلام الى :

$$\boxed{\vec{A} = 5\,\hat{i}}$$

E.X:



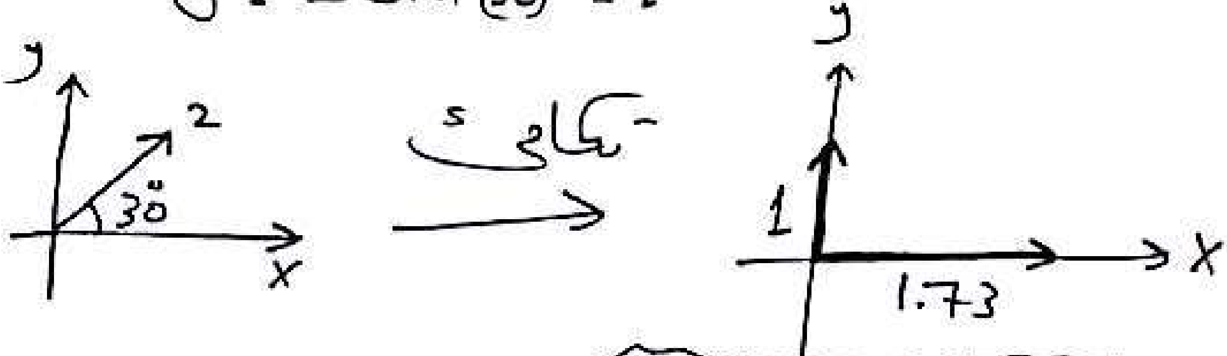
هذا المتجه لا يقع على اي من
المحاور الثلاثه للتعبير عنه بسرعة
لذلك نجد مركباته بال X و y

الحل

Solution:

$$X = 2\cos(30) = 1.73$$
$$y = 2\sin(30) = 1$$

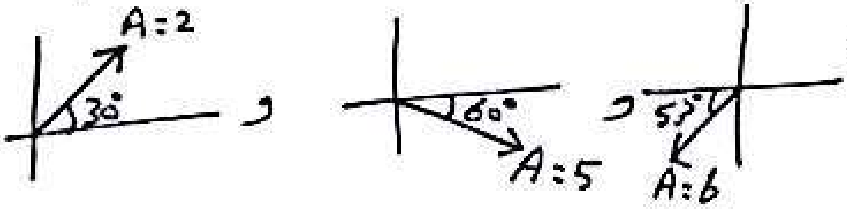
:



$$\vec{A} = 1.73\hat{i} + 1\hat{j}$$ #

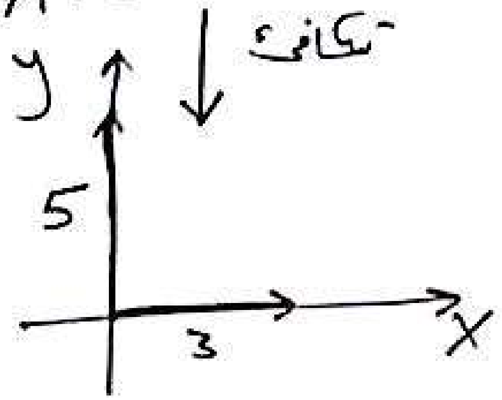
* اذاً يمكن تمثيل او التعبير ن اي متجه بطريقين وهما :

① قيمة واتجاه :



② بدلالة $\hat{k}$ $\hat{j}$ $\hat{i}$:

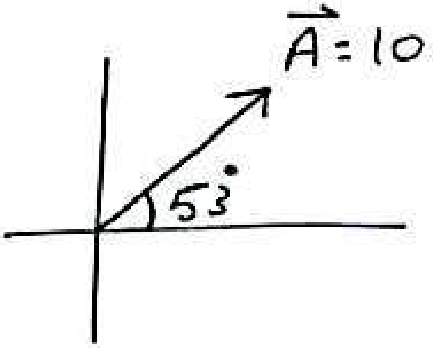
$$\vec{A} = 3\hat{i} + 5\hat{j}$$



ويجب تعلم التحويل بين الشكلين #

$\boxed{1}$ ($\hat{i}$ $\hat{j}$ $\hat{k}$) للتحويل من قيمة واتجاه الى ١

e.x:



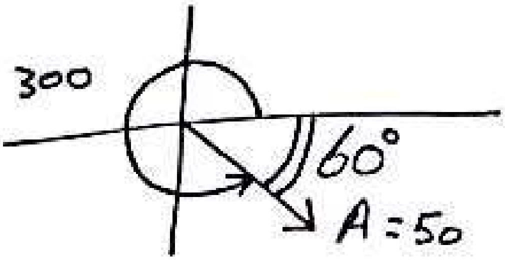
Solution: $X = 10 \cos(53) = 6.01$

$y = 10 \sin(53) = 7.98$

$\therefore \vec{A} = 10 , 53° \xrightarrow{\text{تكافئ}} \vec{A} = 6.01 \hat{i} + 7.98 \hat{j}$

E.X: $\vec{A} = 50 , 300°$

Solution: قيمة المتجه $\vec{A}$ هي 50 واتجاهه بزاوية تميل عن السيني الموجب بزاوية 300° .



$\therefore X = 50 \cos(60) = 25$

$y = -50 \sin(60) = 43.3$

$\therefore \vec{A} = 50 , 300° \xrightarrow{\text{تكافئ}} \vec{A} = 25 \hat{i} + 43.3 \hat{j}$

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2 التحويل $(\hat{i}, \hat{j})$ الى قيمة واتجاه "زاوية".

e.x : $\vec{A} = 3\hat{i} + 5\hat{j}$

Solu: انتبه

* لإيجاد القيمة نطبق القانون :

$$\boxed{R = \sqrt{X^2 + y^2}} \quad \#$$

$$\therefore R = \sqrt{(3)^2 + (5)^2} = 5.83$$

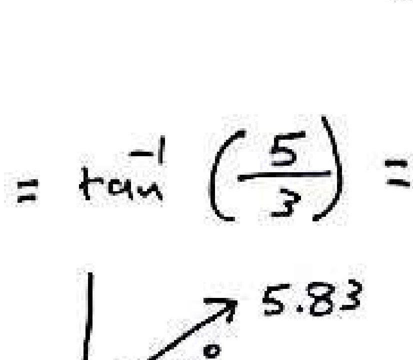
* لإيجاد الإتجاه "الزاوية" نطبق القانون :

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

ولكن نعوّض X و y بقيمة موجبة
ولو كانوا سالبة والزاوية الناتجة تكون
اصغر زاوية يصنعها المتجه مع محور X

$$\therefore \theta = \tan^{-1}\left(\frac{5}{3}\right) = 59^\circ$$

∴



عرفنا ان المتجه بالربع الأول
من قيم X و y .
#

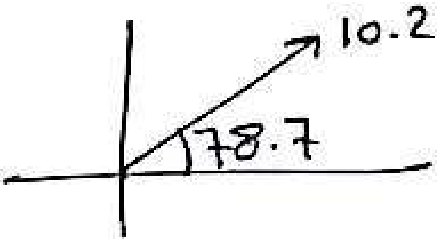
E.x: $\vec{A} = 2\hat{i} + 10\hat{j}$

Solution: الربع الأول

$R = \sqrt{x^2 + y^2} = \sqrt{(2)^2 + (10)^2} \doteq 10.2$ «قيمته»

$\theta = \tan^{-1}\left(\frac{10}{2}\right) = 78.7^\circ$

$\therefore$

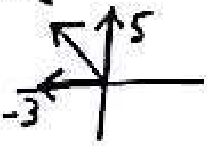


E.x: $\vec{A} = -3\hat{i} + 5\hat{j}$

Solu: $R = \sqrt{(-3)^2 + (5)^2} = 5.83$

$\theta = \tan^{-1}\left(\frac{5}{3}\right) = 59^\circ$

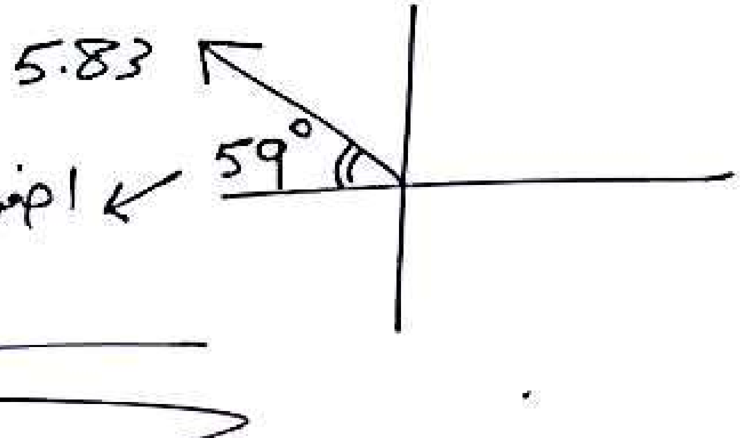
انتبه عوّضناها موجبة



عرفنا ان المتجه بالربع الثاني

* **Note:** من قيم x و y

لذلك:



اصغر زاوية مع محور- X

الآن

*NOW :

جمع ‏ ‏ ‏ ‏ طرح.

① Adding & Subtracting :

e.x : $\vec{A} = 5\hat{i} + \hat{j} + 3K$

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

جد.

Find : ① $\vec{A} + \vec{B}$

② $\vec{A} - \vec{B}$

Solu : ① $\vec{A} + \vec{B} = (5+1)\hat{i} + (1+-6)\hat{j} + (3+0)K$

$= 6\hat{i} - 5\hat{j} + 3K$ #

∴ بجمع المتجهات فإننا نجمع معاملات $\hat{i}$ لوحدها ثم معاملات $\hat{j}$ ثم معاملات $\hat{K}$.

② $\vec{A} - \vec{B} = (5-1)\hat{i} + (1--6)\hat{j} + (3-0)K$

$= 4\hat{i} + 7\hat{j} + 3K$ #

ضرب المتجهات.

② Multiplying :

هنالك طريقتين «نوعين» لضرب المتجهات وهما:

① Scalar Product «dot product» : الضرب النقطي.

② Cross Product : الضرب التقاطعي.

① Scalar product «dot Product»:

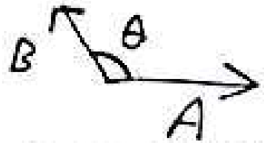
⊛ $\boxed{\vec{A} \cdot \vec{B} = |A|\,|B| \cos\theta}$ حفظ

ملاحظات
*Notes:

① $|A|$ & $|B| \longrightarrow |A| = \sqrt{A_x^2 + A_y^2}$, $|B| = \sqrt{B_x^2 + B_y^2}$

② θ: الزاوية بين $\vec{A}$ و $\vec{B}$ ذيل مع ذيل

مهم جداً



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

يستخدم هذا القانون عندما تكون المتجهات مكتوبة بصيغة $(\hat{i}, \hat{j}, \hat{k})$

∴ في الضرب النقطي يوجد قانونين اساسيين ونستخدم احدهما او كلاهما حسب معطيات السؤال.

*Notes: ① $\vec{A} = A_x \hat{i} + A_y \hat{j} + A_z K$
$\vec{B} = B_x \hat{i} + B_y \hat{j} + B_z K$

لمعرفة ماذا اقصد ب A_z, A_y, A_x
B_z, B_y, B_x

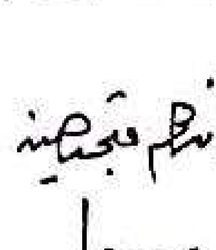
② $\boxed{\hat{i} \cdot \hat{i} = 1}$ طيب كيف؟؟

الجواب: نطبق على القانون الأول:

$\vec{A} = \hat{i} \rightarrow |A| = \sqrt{1^2 + (0)^2}$
$\vec{B} = \hat{i} \rightarrow |B| = \sqrt{1^2 + (0)^2}$

$\vec{A} \cdot \vec{B} = |\vec{A}|\,|\vec{B}| \cos\theta$
$= 1 * 1 * \cos(0) = 1$ ##

الزاوية صفر لأنهم متجانسين
نفس بنهم



والزاوية بنهم صفر.

③ $\boxed{\hat{j} \cdot \hat{j} = 1}$

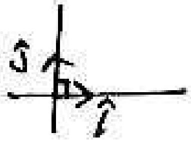
④ $\boxed{\hat{k} \cdot \hat{k} = 1}$

⑤ $\boxed{\hat{i} \cdot \hat{j} = 0}$ ~~~ طيب كيف ؟؟

$\vec{A} = \hat{i} \rightarrow |A| = \sqrt{1^2 + 0^2} = 1$

$\vec{B} = \hat{j} \rightarrow |B| = \sqrt{0^2 + 1^2} = 1$

$\therefore \vec{A} \cdot \vec{B} = 1 * 1 \underset{0}{\cancel{\cos(90)}} = 0$



⑥ $\boxed{\hat{i} \cdot \hat{k} = 0}$

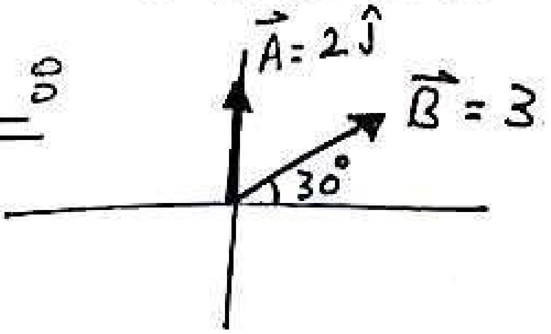
⑦ $\boxed{\hat{j} \cdot \hat{k} = 0}$

* **ملاحظة** : ناتج عملية الضرب النقطي هي كمية قياسية ، هذا يعني ان الجواب يكون رقم .

* **ملاحظة** : عملية الضرب النقطي هي عملية تبديلية .

$$\boxed{\vec{A} \cdot \vec{B} = \vec{B} \cdot \vec{A}}$$

E.X :



Find $\vec{A} \cdot \vec{B} = ??$

الحل

Solution :

يمكن حل هذا السؤال بطريقتين ، إمّا على القانون الأول مباشرة او على القانون الثاني وهنا سأحل على الطريقتين :

Solution ① :

$|A| = \sqrt{0^2 + 2^2} = 2$

$|B| = 3$

$\theta = 60^\circ$ „ انتبه مش °30 ، لازم الزاوية المحصورة «

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

$$= 2 * 3 * \cos 60 = \underset{\downarrow}{3} \quad \#$$

لاحظ الناتج كمية قياسية .

Solution ② :

حتى نتمكن من حل السؤال على القانون الثاني يجب كتابة كل من المتجهين بطريقة $(\hat{i} \;\; \hat{j} \;\; \hat{k})$ ، المتجه $\vec{A}$ جاهز ولكن يجب تحويل المتجه $\vec{B}$.

$$\boxed{\vec{A} = 2\hat{j}}$$

$\vec{B}$: $B_x = 3 * \cos(30) = 2.6$

$B_y = 3 * \sin(30) = 1.5$

$$\therefore \boxed{B = 2.6\,\hat{i} + 1.5\,\hat{j}}$$

Now: $\vec{A} \cdot \vec{B} = (0 * 2.6) + (2 * 1.5) = 3 \quad \#$

معامل $\hat{i}$ في المتجه $\vec{A}$ ضرب
معامل $\hat{i}$ في المتجه B .

معامل $\hat{j}$ في المتجه $\vec{A}$
ضربا معامل $\hat{j}$ فيا المتجه $\vec{B}$

م.

E.X: $\vec{A} = \hat{i} - 2\hat{j}$ **Find** $\vec{A}\cdot\vec{B} = ??$

$\vec{B} = 3\hat{i} + \hat{j} + 5\hat{k}$

Solution: $\vec{A}\cdot\vec{B} = (1 * 3) + (-2 * 1) + (0 * 5) = 1$

احذرك تنسى الإشارة السالبة !!

القانون الثاني نستخدمه عندما يكون المتجه مكتوب بهذه الصيغة

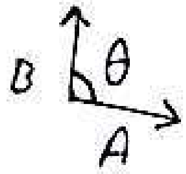
#

② Cross Product:

$$* \boxed{\vec{A} \times \vec{B} = |A|\,|B| \sin\theta}$$

حفظ

θ: الزاوية المحصورة بين $\vec{A}$ و $\vec{B}$
ذيل مع ذيل .



$$* \ \vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

e.x: $\vec{A}: 3\hat{i} + 2\hat{j} + k$

$\downarrow A_x \quad \downarrow A_y \quad \downarrow A_z$

$B: \hat{i} + 2\hat{j} - 3k$

$\downarrow B_x \quad \downarrow B_y \quad \downarrow B_z$

$$= +\left[(A_yB_z) - (B_yA_z)\right]\hat{i} - \left[(A_xB_z) - (A_zB_x)\right]\hat{j} + \left[(A_xB_y) - (A_yB_x)\right]\hat{k}$$

نستخدم هذا القانون عندما تكون المتجهات مكتوبة بصيغة $(\hat{i}, \hat{j}, \hat{k})$

#

*Notes:

① $\boxed{\hat{i} \times \hat{i} = 0}$ كيف؟؟

$\vec{A} = \hat{i} \rightarrow |A| = 1$

$\vec{B} = \hat{i} \rightarrow |B| = 1$

$$\vec{A} \times \vec{B} = |A||B| \sin\theta = 1 * 1 * \underset{0}{\cancel{\sin(0)}} = 0$$

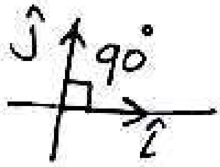
② $\boxed{\hat{j} \times \hat{j} = 0}$

③ $\boxed{\hat{k} \times \hat{k} = 0}$

④ $\boxed{\hat{i} \times \hat{j} = 1}$ كيف؟؟

$\vec{A} = \hat{i} \rightarrow |A| = 1$

$\vec{B} = \hat{j} \rightarrow |B| = 1$



$$\vec{A} \times \vec{B} = |A||B| \sin\theta$$

$$= 1 * 1 * \sin(90) = 1 \quad \#$$

⑤ $\boxed{\hat{i} \times \hat{k} = 1}$

⑥ $\boxed{\hat{j} \times \hat{k} = 1}$

* ملاحظة: ناتج عملية الضرب التقاطعي يكون متجه وعمودي على كل من المتجهين المضروبين.

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سؤال سابقة

E.X: $\vec{A} = 5\hat{i} + 2\hat{j}$ $\vec{B} = 2\hat{i} - 3\hat{j}$

Find $\vec{A} \times \vec{B} = ??$

Solution: بما ان السؤال على صيغة $(\hat{i}, \hat{j}, \hat{k})$ اذاً يكون الحل على القانون الثاني "الطويل".

خطوة ① :

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & K \\ & & \\ & & \end{vmatrix}$$

خطوة ② :

$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & K \\ 5 & 2 & 0 \\ 2 & -3 & 0 \end{vmatrix}$$

وانتبه انه هنا الترتيب مهم $\vec{A} \times \vec{B} \neq \vec{B} \times \vec{A}$ لذلك بأول سطر نضع ارقام المتجه $\vec{A}$ والسطر الثاني المتجه $\vec{B}$.

خطوة ③ :

$$\vec{A} \times \vec{B} = +\left[(2 * 0) - (0 * -3)\right]\hat{i} - \left[(5 * 0) - (0 * 2)\right] + \left[(5 * -3) - (2 * 2)\right]\hat{k}$$

$$\therefore \vec{A} \times \vec{B} = 0\,\hat{i} + 0\,\hat{j} - 19\,\hat{k} \quad \#$$

الآن يوجد فكرتين مهمتين على هذا الموضوع (Product) الضرب

ويجب التفريق بينهم :

فكرة ①: ان طلب زاوية Vector :

سنوات

e.X : $\vec{A} = 12\hat{i} - 16\hat{j}$

$\vec{B} = -24\hat{i} + 10\hat{j}$

What is the direction of the vector

$\vec{C} = 2\vec{A} - \vec{B}$??

Solution:

خطوة ①: $2\vec{A} = (12*2)\hat{i} - (16*2)\hat{j} = 24\hat{i} - 32\hat{j}$

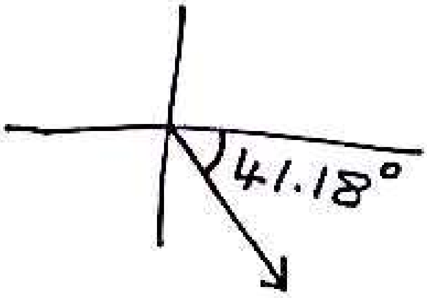
خطوة ②: $\vec{C} = (24 - -24)\hat{i} + (-32 - 10)\hat{j}$

$\therefore \vec{C} = 48\hat{i} - 42\hat{j}$

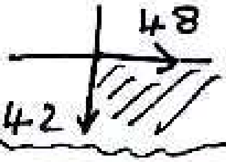
خطوة ③: $\boxed{\theta = \tan^{-1}\left(\frac{y}{x}\right)}$

$\therefore \theta = \tan^{-1}\left(\frac{42}{48}\right) = 41.18°$

↙ التعويض موجب



عرفنا انه ربع رابع من قيم x و y



فكرة ② : ان يطلب زاوية بين متجهين :

سنوات القيم

E.X : $\vec{A} = 5\hat{i} + 6\hat{j} + 7\hat{k}$

$\vec{B} = 3\hat{i} - 8\hat{j} + 2\hat{k}$

Find the angle (زاوية) between (بين) $\vec{A}$ and $\vec{B}$??

Solu :

خطوة ① : $\vec{A}\cdot\vec{B} = (5*3)+(6*-8)+(7*2)$

$= -19$

القانون الثاني في dot product

خطوة ② : $|A| = \sqrt{5^2+6^2+7^2} = 10.48$

نجد الـ magnitude (قيمة) للمتجه الأول.

خطوة ③ : $|B| = \sqrt{3^2+-8^2+2^2} = 8.77$

نجد الـ magnitude للمتجه الثاني

خطوة ④ : $\vec{A}\cdot\vec{B} = |A|\,|B| \cos\theta$

$-19 = 10.48 * 8.77 \cos\theta$

$\cos\theta = -0.2$

نستخدم القانون الأول في dot product

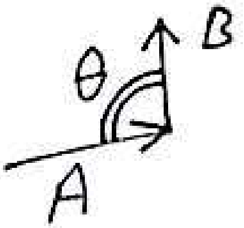
خطوة ⑤ : $\theta = \cos^{-1}(-0.2) = 101.93^\circ$ #

وهو المطلوب

* Cosin law : قانون إلكوساين

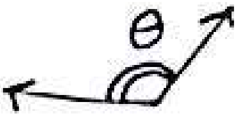
$$\boxed{\vec{A}+\vec{B} = \sqrt{|A|^2+|B|^2-2|A||B|\cos\theta}}$$

θ : رأس مع ذيل



او

OR : $\boxed{\vec{A}+\vec{B}=\sqrt{|A|^2+|B|^2+2|A||B|\cos\theta}}$ θ : ذيل مع ذيل



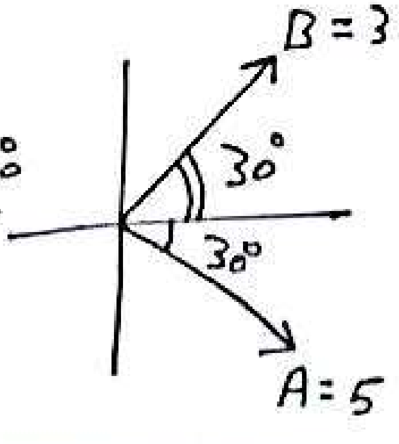
* **Note** : يوجد شرطين لإستخدام القانون :

① ان يكون السؤال فقط متجهين .

② ان تكون الزاوية بينهم معروفة .

* **Note** : في حالة كان السؤال يحتوي على اكثر من متجهين مثل $\vec{A}+\vec{B}+\vec{C}$ فإننا نلجأ الى طريقة تحليل كل منهم الى مركبات السينية والصادية ثم نجد حاصل جمعهم .

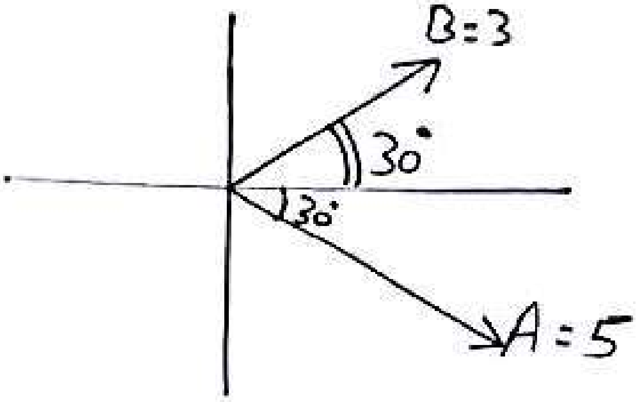
E.x :



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

Solution : يمكن حل السؤال بطريقتين وانتم اختاروا الطريقة الأسهل ::

الحل الأول "الطويل" ::



$A_x = +5\cos(30) = +4.33$

$A_y = -5\sin(30) = -2.5$

$\therefore \vec{A} = +4.33\,\hat{i} - 2.5\,\hat{j}$

$B_x = 3\cos(30) = 2.59$

$B_y = 3\sin(30) = 1.5$

$\therefore \vec{B} = 2.59\,\hat{i} + 1.5\,\hat{j}$

Now : $\vec{A}+\vec{B} = +6.92\,\hat{i} - 1\,\hat{j}$

$$\therefore |A+B| = \sqrt{(+6.92)^2 + (-1)^2} = 6.99$$

الحل الثاني "القصير" : بما ان السؤال يتكون من متجهين والزاوية بينهما معروفة $(30^\circ + 30^\circ)$ و جمع ذيل مع ذيل اذاً يمكن استخدام قانون الـ "cos" الثاني لإيجاد $|\vec{A}+\vec{B}|$.

$$\therefore |\vec{A}+\vec{B}| = \sqrt{|A|^2+|B|^2+2|A||B|\cos\theta}$$

$$= \sqrt{5^2+3^2+(2*5*3*\cos(60))}$$

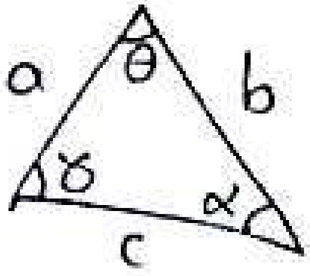
$$= 7 \quad \#$$

اذاً نفس الجواب لذلك عندما يُطلب حاصل ضرب متجهين فقط ومعروف قيمة كل منهما والزاوية بينهما الأسهل استخدام قانون ال "cos" .

*** Sin low :** قانون ال "Sin"

هذا الموضوع ليس مهماً !!

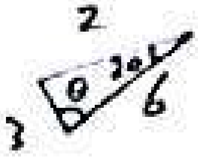
$$\boxed{\frac{c}{\sin\theta} = \frac{a}{\sin\alpha} = \frac{b}{\sin\gamma}} \quad \#$$



a.b.c : أطوال أضلاع

θ,α,γ : رموز للزوايا .

نستخدم هذا القانون اذا كان السؤال عبارة عن مثلث والمطلوب زاوية معينة فيه او طول ضلع معين .

e.x : 

Find $\theta = ??$

Solu : $\frac{3}{\sin(2d)} = \frac{2}{\sin\theta} \rightarrow \sin\theta = 0.228$

$\theta = \sin^{-1}(0.228) = 13.17$

[redacted]

* Chapter $\boxed{4}$: Motion in two dimentions:

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الحركة في بعدين

سوف اقسم هذا الـ "chapter" الى ٣ اقسام اساسية:

① Position, Velocity, Acceleration:

موقع، سرعة، تسارع.

$$\boxed{\text{Position}} \xrightarrow{\text{اشتق}} \boxed{\text{Velocity}} \xrightarrow{\text{اشتق}} \boxed{\text{Acceleration}}$$

اذا يأتي في السؤال: $r(t) = x(t)\,\hat{i} + y(t)\,\hat{j}$ اذا اشتقيناه

Position Vector

مرة واحدة ينتج $V(t) = V_x(t)\,\hat{i} + V_y(t)\,\hat{j}$ اذا اشتقيناه مرة اخرى

Velocity Vector

ينتج $a(t) = a_x(t)\,\hat{i} + a_y(t)\,\hat{j}$.

Acceleration Vector

E.X: Let $r(t) = (3t^2)\hat{i} + (5t^2+t)\hat{j}$, Find:

① Velocity Vector.

② Acceleration Vector.

Solution: ① $V(t) = (6t)\hat{i} + (10t+1)\hat{j}$

$\uparrow$ $(3t^2)$ مشتقة

$\uparrow$ $(5t^2+t)$ مشتقة

② $a(t) = (6)\hat{i} + (10)\hat{j}$

$\uparrow$ $(6t)$ مشتقة

$\uparrow$ $(10t+1)$ مشتقة

* The Instaneous Velocity: "السرعة اللحظية"

$$\boxed{V = \frac{dr}{dt}}$$

اذاً نجد $V(t)$ كما في المثال السابق ثم نعوض قيمة "t" المعطاه بالسؤال وهكذا نكون قد حسبنا السرعة اللحظية عند تلك الثانية.

* The Average Velocity: "معدل السرعة"

$$\boxed{\overline{V} = \frac{\Delta r}{\Delta t}}$$

يكون في السؤال طالب معدل السرعة بين "between" $t_1 : \square$ and $t_2 : \square$

حيث نجد $\boxed{\Delta r = r_2 - r_1}$

r_2: نعوض قيمة t_2 في معادلة $r(t)$

r_1: نعوض قيمة t_1 في معادلة $r(t)$

والناتج نقسمه على $\boxed{\Delta t = t_2 - t_1}$

*Note: $\Delta r \xrightarrow{\text{تكافئ}} \Delta x$
ولكنها 2D
ثنائية الأبعاد.

#

[redacted]

* The instantanous acceleration: «التسارع اللحظي»

$$\boxed{a = \frac{dV}{dt} = \frac{d^2r}{dt^2}}$$

اذا نشتق $r(t)$ فنجد $V(t)$ ثم
نشتق مرة اخرى فنجد $\underline{a(t)}$
#
وهو المطلوب حيث نعوض
قيمة $\underline{t}$ المعطاه بالسؤال
ونجد $\underline{a}$.

* The Average acceleration: «معدل التسارع»

$$\boxed{\bar{a} = \frac{\Delta V}{\Delta t}}$$

يكون في السؤال طالب معدل التسارع
بينه «between» t_1 : ☐ and t_2 = ☐
حيث نشتق $r(t)$ ونجد $V(t)$ ثم نعوض
قيمتي t_1 & t_2 ونجد V_1 & V_2 .

$$\boxed{\bar{a} = \frac{V_2 - V_1}{t_2 - t_1}}$$ #

هذا هو الجزء الأول من # chapter $\boxed{4}$

الصفحة التالية مثال على هذا الجزء البسيط.

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E.X: The Position of a particle moving in the x-y plane (2D-chapter 4) is given by the relation (علاقة)

$r(t) = (2t + 5t^2)\hat{i} + (t - 2t^2)\hat{j}$, **Find:**

① The position at $t = 2$

② The Velocity at $t = 2$

③ The average Velocity between $t = 1$ and $t = 2$

④ The acceleration at $t = 1$

⑤ The average acceleration between $t = 1$ and $t = 3$.

Solu: $* \text{at} \xrightarrow{\text{تعني}} \text{instantanous}$ (لحظي) «عند»

$* \text{between} \xrightarrow{\text{تعني}} \text{Average}$ «بين»

① $r(2) = (24)\hat{i} + (-6)\hat{j}$

نعوض مباشرة في $r(t)$.

② $V(t) = (2 + 10t)\hat{i} + (1 - 4t)\hat{j}$ مشتقة $r(t)$

Now $V(2) = 22\hat{i} + (-7)\hat{j}$

③ $\overline{V} = \frac{\Delta x}{\Delta t}$

$r_1 = r(1) = 7\hat{i} - 1\hat{j}$

$r_2 = r(2) = 24\hat{i} - 6\hat{j}$

$\to \Delta r = r_2 - r_1 = 17\hat{i} - 5\hat{j}$

$\therefore \overline{V} = \frac{17\hat{i} - 5\hat{j}}{2 - 1} = 17\hat{i} - 5\hat{j}$

$\therefore \overline{V} = \sqrt{17^2 + 5^2} = 17.72 \text{ m/s}$

هذه الخطوة إذا طلب السؤال magnitude . $\boxed{4}$

④ $a(1) = ??$

يجب ان نشتق $V(t)$ لنحصل على $a(t)$ ثم نعوض القيمة $\underline{1}$

$a(t) = 10\hat{i} - 4\hat{j}$

$\therefore a(1) = 10\hat{i} - 4\hat{j}$

⑤ $\bar{a} = \dfrac{\Delta V}{\Delta t}$

$$\left.\begin{aligned} V_1 &= V(1) = 12\hat{i} - 3\hat{j} \\ V_2 &= V(3) = 32\hat{i} - 11\hat{j} \end{aligned}\right] \rightarrow \Delta V = V_2 - V_1 = 20\hat{i} - 8\hat{j}$$

$$\therefore \bar{a} = \frac{20\hat{i} - 8\hat{j}}{3-1} = \frac{20}{2}\hat{i} - \frac{8}{2}\hat{j}$$
$$= 10\hat{i} - 4\hat{j}$$

* نهاية الجزء الأول *

امنياتي لكم بالتوفيق

أخوكم « عبدالرحمن موافي »

② Two dimentional motion With constant accele.:

الحركة في بعدين وبتسارع ثابت.

في هذا القسم من الـ "chapter" سوف نستخدم معادلات الحركة كما في chapter② .

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

$$\boxed{V_f^2 = V_i^2 + 2a\Delta r}$$

$$\boxed{\Delta r = V_i t + \frac{1}{2}at^2}$$

Δr : displacement.

"تكون ΔX في one.dimention"

E.X : An object start moving from the origion in the xy-plane with an initial velocity $(V_i = 2\hat{i} - 3\hat{j})$ m/s and with acceleration $(a = -2\hat{i} + 4\hat{j})$ m/s², what is the Position Vector (r) of the object at $t = 1$ second ??

Solution

* From the origin : $r_i = 0$ "نقطة الأصل"

* $V_i = 2\hat{i} - 3\hat{j}$

* $a = -2\hat{i} + 4\hat{j}$

* $t = 1$

* $r_f = ??$

$$\Delta r = V_i t + \frac{1}{2}at^2$$

$$\Delta r = (2\hat{i} - 3\hat{j}) * 1 + \frac{1}{2}(-2\hat{i} + 4\hat{j}) * (1)^2$$

$$\Delta r = (2\hat{i} - 3\hat{j}) + (-\hat{i} + 2\hat{j})$$

$$\boxed{r = \hat{i} - \hat{j}}$$ # وهو المطلوب

E.X: The Position of aparticle moving in the xy-plane with constant acceleration, at $t=0$ second is $(3\hat{i}-4\hat{j})$(m), the particle initial Velocity is $(2\hat{i}+3\hat{j})$. Two second Later, the Particle is at $(5\hat{i}+3\hat{j})$(m), find the magnitude of it's final Velocity??

Solution:

$$\left.\begin{array}{l} r_i = 3\hat{i}-4\hat{j} \\ r_f = 5\hat{i}+3\hat{j} \end{array}\right\} \Delta r = r_f - r_i = 2\hat{i}+7\hat{j}$$

$V_i = 2\hat{i}+3\hat{j}$

$t = 2$ second

$V_f = ??$

$$\Delta r = V_i t + \frac{1}{2} a t^2$$

$$(2\hat{i}+7\hat{j}) = (2\hat{i}+3\hat{j}) \times 2 + \frac{1}{2} a (2)^2$$ نحسب $\underline{\underline{a}}$

$$a = -\hat{i} + 0.5\hat{j}$$

Now: $V_f = V_i + a t$

$$V_f = (2\hat{i}+3\hat{j}) + (-\hat{i}+0.5\hat{j})(2)$$

$$= 4\hat{j}$$

ولكنه السؤال طالب magnitude !!

$$|V_f| = \sqrt{(0)^2+(4)^2} = 4 \text{ m/s}$$

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$\boxed{7}$

*نهاية القسم الثاني #

[redacted]

③ Applications :

تطبيقات على الحركة في بعدين .

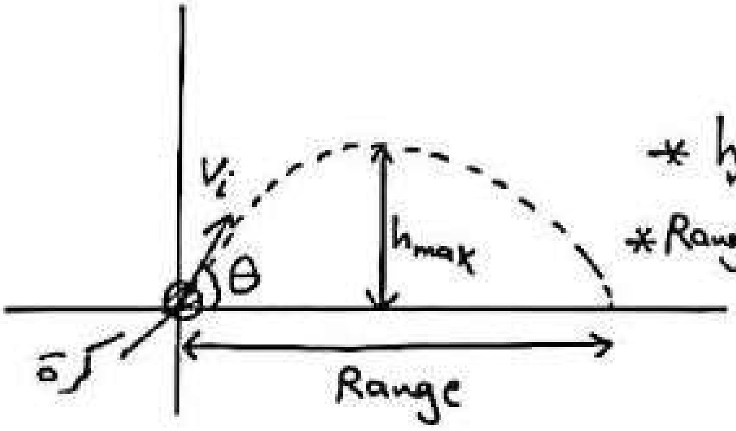
سوف نأخذ تطبيقين على الحركة في بعدين وهي :-

① Projectile motion : حركة المقذوفات .

② Circular motion : الحركة الدائرية .

1 Projectile motion : «المقذوفات»

نصيحة : دائماً عند تحديد السؤال على المقذوفات، اقسم السؤال الى قسمين : ① الحركة في x-axis
② الحركة في y-axis .



* h_{max} : maximum highb

* Range : horizontal distance

[redacted]

* فوائد : انتبه Δ !!

① حركة المقذوفات هي مثال على الحركة في بعدين.

② حركة المقذوفات تقسم الى قسمين: ① الحركة السينية ② الحركة الصادية.

③ الحركة السينية تكون بسرعة ثابتة دائماً ولا يوجد سوى قانون واحد لها وهو:

$$\boxed{V_x = \frac{\Delta X}{\Delta t}}$$

السرعة = $\frac{\text{المسافة}}{\text{الزمن}}$.

حيث $\boxed{V_x = V_i \cos\theta}$ مركبة السرعة الابتدائية السينية. وتكون $\boxed{V_{xi} = V_{xf}}$

④ الحركة الصادية تتأثر بالجاذبية الأرضية وتصبح وكأنها نفس السقوط الحر حيث نطبق قوانين الحركة الثلاث.

$V_f = V_i + at$ ... ①

$V_f^2 = V_i^2 + 2a\Delta y$ ... ②

$\Delta y = V_i t + \frac{1}{2} a t^2$ ... ③

حيث $a = -10 m/s$ تسارع الجاذبية الأرضية.

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⑤ عند تطبيق قوانين الحركة في الحركة السينية، يجب اتباع القواعد التالية :

Ⓐ اذا ارتفع الجسم للأعلى تكون المسافة موجبة $(\Delta y = +ve)$.

Ⓑ اذا انخفض الجسم للأسفل تكون المسافة سالبة $(\Delta y = -ve)$.

Ⓒ اذا ارتفع الجسم للأعلى تكون السرعة موجبة.

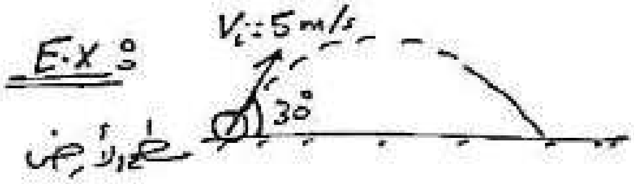
Ⓓ اذا انخفض الجسم للأسفل تكون السرعة سالبة.

Ⓔ التسارع دائماً $(a = g = -10 \, m/s^2)$.

Ⓕ دائماً قوانين الحركة تطبق بين نقطتين فقط.

<u>E.X :</u>

مثال توضيحي



$$V_x = 5\cos(30) = 4.33 \, m/s$$

هذه السرعة استخدمها في قسم الحركة السينية.

$$V_y : 5\sin(30) = 2.5 \, m/s$$

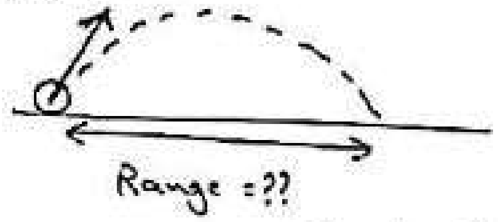
هذه السرعة استخدمها في قسم الحركة الصادية.

«وهيك جاهزين لحل اسئلة»

E.X: What is the horizontal range of aproiectile Initially Launched with avelocity of $V_i = 5\hat{i} + 10\hat{j}$
قذف

Solu:

$V_i = 5\hat{i} + 10\hat{j}$



حاول دائماً ارسم السؤال ::

بما انه طلب Range نبدأ من قسم الحركة السينية ::

$$V_x = \frac{\Delta X}{\Delta t}$$

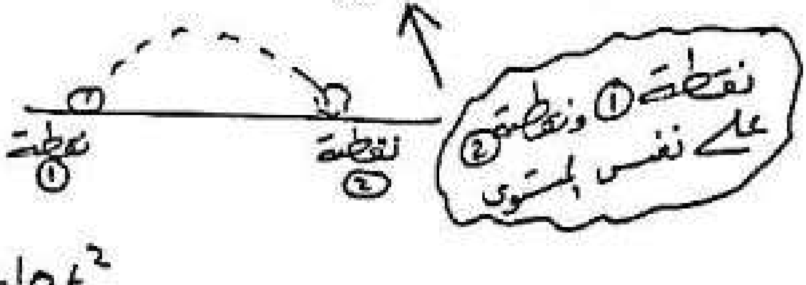
ΔX ← مطلوب بالسؤال

V_x ← 5 m/s « معامل $\hat{i}$ »

Δt ← من وين اجيبه ؟؟

نلجأ لقسم الحركة الصادية لنحصل على Δt لأنه زمن التحليق ثابت للقسمين ::

$V_{yi} = 10$ « معامل $\hat{j}$ » $a = -10 m/s^2$ $\Delta y = 0$



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

$0 = 10t + -5t^2$

$5t^2 - 10t = 0$

$t(5t - 10) = 0$

$t = 0$ $\propto$ « ملغي »

$t = 2$ second #

[redacted]

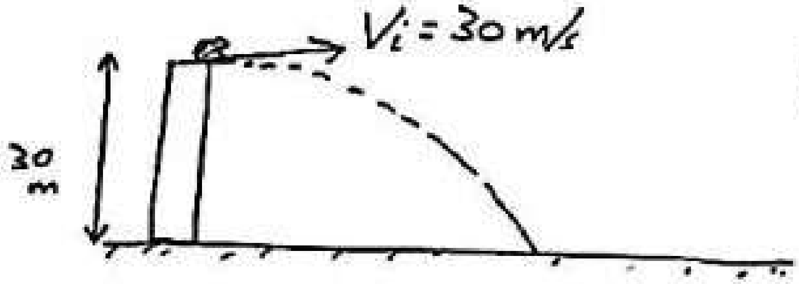
Now : $V_x = \frac{\Delta X}{\Delta t}$

$5 = \frac{\Delta X}{2} \rightarrow \Delta X = \text{Range} = 10 \text{ m}$ #

Re

E.X : A Stone (حجر) is thrown from the top of abuilding (بناية) with an initial Velocity of 30 m/s in the horizontal direction. IF the top of building is 30 m above the ground, What is the speed of the Stone Just befor it strikes (تخبط) the ground ??

Solution :



$V_f = ??$

* معنى كلمة (30m/s in the horizontal) أي أن $\boxed{V_i = V_x}$

و $\boxed{(V_i)_y = 0}$ جميع السرعة الابتدائية كانت في اتجاه الحركة السينية .

* المطلوب هو (V_f) كاملة : $\boxed{V_f = (V_f)_x \hat{i} + (V_f)_y \hat{j}}$ ثم نجد

$$\boxed{|V_f| = \sqrt{V_x^2 + V_y^2}}$$

[redacted]

نبدأ بالحل :-

① الحركة السينية :

؟؟ ↙

$$V_x = \frac{\Delta x}{\Delta t}$$

↗ ؟؟

← لا استفيد اي شيء !!

← تذكر ان السرعة في الإتجاه السيني ثابتة اي ان $\boxed{V_{xi} = V_{xf}}$

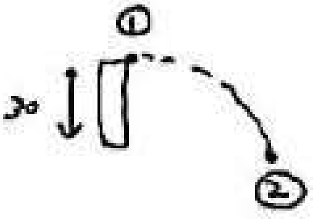
لذلك فإنه الشق الأول من الحل جاهز $\boxed{V_{xf} = 30 \text{ m/s}}$

② الحركة الصادية :-

$V_i = 0$

$a = -10 \text{ m/s}^2$

$\Delta y = -30 \text{m}$



$V_f^2 = V_i^2 + 2a\Delta y$

$V_f^2 = 0 - 2 * 10 * -30$

$V_f^2 = 600 \rightarrow V_f = 24.5 \text{ m/s}$

ولكنه الجسم ينزل للأسفل إذاً السرعة الصادية $V_f = -24.5$

$\therefore \boxed{V_f = 30\hat{i} - 24.5\hat{j}}$

المطلوب speed لذلك نجد $|V_f|$

$|V_f| = \sqrt{30^2 + 24.5^2} = 39 \text{ m/s}$ #

[redacted]

مقذوف

E.X : A projectile is project from the ground With initial Velocity $V_i = 15\hat{i} + 40\hat{j}$ Find the Flying time ??

Solution :

المطلوب هو زمن التحليق !!

$V_i : 15\hat{i} + 40\hat{j}$

$t = ??$

① الحركة الأفقية :

$V_x = \frac{\Delta x}{\Delta t}$ ← ⁇

⁇

طريق مسدود مسدود مسدود !! :D .

② الحركة العامودية :

$(V_i)_y = 40$

$\Delta y = 0$

$a = -10\,m/s^2$

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

$0 = 40t - 5t^2$

$5t^2 - 40t = 0$

$t = 0$ X

$t = 8$ second #

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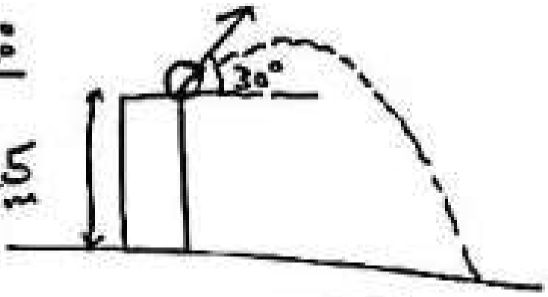
E.X : A Particle is thrown from a hight of (25) m above the ground with an initial Velocity of 20 m/s at an angle 30° above the horizontal, what is the particle speed Just befor it hits the ground??

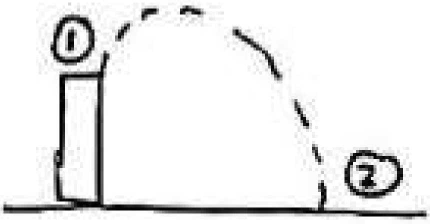
Solu :



① الحركة السينية :. نعرف انه $\boxed{V_{x_i} = V_{x_f}}$

$$V_{x_i} = V_i \cos\theta = 20 * \cos 30 = 17.32 \ m/s$$

② الحركة الصادية :



$$V_i = V_i \sin\theta$$
$$= 20 \sin(30) = 10 \ m/s$$
$$\Delta y = -25$$
$$a = -10 \ m/s^2$$
$$\therefore V_f^2 = V_i^2 + 2a\Delta y$$
$$V_f^2 = (+10)^2 - 2 * 10 * -25$$

لأنه الجسم قذف للأعلا في البداية ثم نزل.

$$(V_f)_y = 24.5 \ m/s$$
$$\therefore V_f = 17.32\hat{i} - 24.5\hat{j}$$
$$|V_f| = 30 \ m/s$$

$\boxed{2}$ Circular motion : الحركة الدائرية

(a) Uniform circular motion : «الحركة الدائرية المنتظمة».

(*) الحركة الدائرية المنتظمة : هي ان الجسم يتحرك بمسار دائري وبسرعة ثابتة .

r : Radius «نصف القطر».

(*) Note : في الحركة الدائرية هنالك نوعين من التسارع :-

① التسارع المماسي (a_t) . «tangential acceleration»

② التسارع المركزي (a_c) or (a_r) . «Radial acceleration»
OR «Centripal acceleration»

(*) في الجزء (a) وهو uniform circular motion ، يكون التسارع المماسي صفر لأن السرعة ثابتة حيث ان التسارع المماسي هو المسؤول عن زيادة او تقليل السرعة والتسارع المركزي هو المسؤول عن تغير اتجاه الحركة باستمرار لتأخذ الشكل الدائري .

(*) اما التسارع المركزي (a_r) فله قيمة ويكون دائماً باتجاه المركز وقيمته :

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

* اذاً:

Unifor circular motion → $V = \text{constant}$ ثابتة , $a_t = 0$

* التسارع الكلي يكون محصلة كل من التسارع المماسي والتسارع المركزي

$$\boxed{a = \sqrt{a_t^2 + a_r^2}}$$

(b) Non-uniform Circular motion:

⊛ الحركة الدائرية غير المنتظمة: أي أن الجسم يتحرك بمسار دائري وبسرعة غير ثابتة.

⊛ بما أن السرعة غير ثابتة، اذاً هنالك قيمة للتسارع المماسي (a_t) لأنه هو المسؤول عن تغير السرعة ويكون اتجاه (a_t) دائماً باتجاه المماس للحركة.

⊛ اذاً خلاصة الموضوع: الحركة الدائرية نوعين، منها منتظم "uniform"، ويكون السرعة ثابتة والتسارع المماسي صفر، والنوع الثاني غير منتظم non-uniform ويكون السرعة غير ثابتة والتسارع المماسي له قيمة ويكون باتجاه المماس للحركة، وفي كلا النوعين من الحركة يكون التسارع المركزي موجود وقيمته $\boxed{a_r = \frac{v^2}{r}}$ واتجاهه باتجاه المركز!!

بس!! سهل كثير :D

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⊛ الآن بقى معرفت بعض المصطلحات لفهم الأسئلة

① **Period Time :** زمن الدورة : وهو الزمن الذي يستغرقه الجسم لإكمال دورة واحدة !!

$$\boxed{T = \frac{2\pi r}{V}}$$

② **Frequency :** التردد : عدد الدورات التي يقطعها الجسم في الثانية الواحدة .

$$\boxed{F = \frac{1}{T}}$$

⊛ **NoTe :** يجب التفريق بين زمن الدورة و التردد من حيث المعنى لأنه احيانا بيكون السؤال بالمعلومات مطلوب منك معرفة ان هذا الرقم يمثل التردد او زمن الدورة .

وبس خلصنا !! احكو يا رب (: .

E.X : An object is moving uniformly on a circle of radius (2m), IF the Particle needs (2 seconds) to complete one revolution, Find it's acceleration ??

Sol : uniformly $\rightarrow V = \overset{\text{ثابتة}}{\text{constant}}$

$+ \boxed{a_t = 0}$

$+$ radius $\rightarrow \boxed{r = 2}$

$+$ 2 sec to complete one revolution $\rightarrow \boxed{T = 2 \text{ sec}}$

يحتاج 2 ثانية ليكمل دورة واحدة

Now: $T = \frac{2\pi r}{V} \rightarrow 2 = \frac{2 * \pi * 2}{V} \rightarrow V = 6.28 \ m/s$

$a = \sqrt{a_t^2 + a_r^2}$ & $a_t = 0$

$a_r = \frac{V^2}{r} = \frac{(6.28)^2}{2} = 19.73 \ m/s^2$

$\therefore a = \sqrt{(0)^2 + (19.73)^2} = 19.73 \ m/s^2$ #

E.X: An object moving at aconstant speed requires (6 second) to go once around acircle With adiameter قطر of (4 m) what is the magnitude of it's acceleration?

Solution: * constant speed → uniform → $V \equiv const$

$a_t = 0$

* Period time $\boxed{T = 6}$

* diameter $d = 4 \rightarrow \boxed{r = \frac{4}{2} = 2m}$

$T = \frac{2\pi r}{V} \rightarrow 6 = \frac{2 * \pi * 2}{V} \rightarrow V = 2.1 \ m/s$

$\therefore a_r = \frac{V^2}{r} = \frac{(2.1)^2}{2} = 2.2 \ m/s^2$

$a = \sqrt{a_t^2 + a_r^2} = \sqrt{(0)^2 + (2.2)^2} = 2.2 \ m/s^2$ #

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E.x: A particle moves at a const speed in a circular Path, with a radius of (2 Cm). IF the particle makes (4 revolutions) each second. What is the magnitude of it's acceleration??

Solution: *const speed → $\boxed{a_t = 0}$, $\boxed{r = 0.02\,m}$

$\boxed{F = 4}$ الجسم يدور ٤ دورات في الثانية الواحدة.

$$\boxed{F = \frac{1}{T} = \frac{V}{2\pi r}} \qquad 4 = \frac{V}{2*\pi*0.02} \rightarrow V = 0.5\,m/s$$

$$a_r = \frac{V^2}{r} = \frac{(0.5)^2}{0.02} = 12.5\,m/s^2$$

$$a = \sqrt{a_t^2 + a_r^2} = \sqrt{(0)^2 + (12.5)^2} = 12.5\,m/s^2$$ #

E.x: A space station of diameter (80 m) is turning about it's axis at a constant speed. IF the acceleration of the outer rim of the station is (2.5 m/s²). What is the period of revolution of the space station??

محطة فضائية

حافة

Solution: $T = \frac{2\pi r}{V}$ ✤ $r = \frac{d}{2} = \frac{80}{2} = 40\,m$

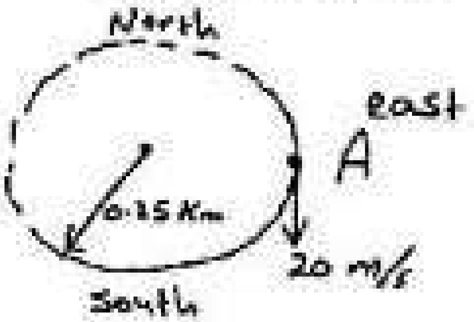
يجب ان نحسب V كيف؟؟!

$a = \sqrt{a_t^2 + a_r^2}$; $a_t = 0$ ∵ const speed.

$\boxed{2.5 = a_r}$ $a_r = \frac{V^2}{r} \rightarrow 2.5 = \frac{V^2}{40} \rightarrow V = 10\,m/s$

Now : $T = \frac{2\pi r}{v} = \frac{2 * \pi * 4.0}{10} = 25.13$

E.X : A car moves around a flat circle of radius ($r = 0.25$ Km) at a constant speed of (20 m/s), when the car is at point A as shown in the figure, what is the car acceleration ?!



Solution: const speed : $\boxed{a_t = 0}$

$a_r = \frac{v^2}{r} = \frac{(20)^2}{0.25 * 10^3} = 1.6 \ m/s^2$

$\uparrow$

"للتحويل من Km لـ m"

في هذا المثال يكون اتجاه a_r نحوَ West لأن اتجاه a_r دائماً

يكون باتجاه المركز .

E.X : The velocity of a car moving on a circular road, of radius (100m), increases with constant rate of ($0.5 \ m/s^2$) what is the magnitude of it's total acceleration when it's speed is 8.4 m/s ??

Sol: هنا السرعة غير ثابتة وتزداد بتسارع (rate) فقط ,[illegible]

$\boxed{a_t = 0.5 \ m/s^2}$

$a_r = \frac{v^2}{r} = \frac{(8.4)^2}{100} = 0.7 \ m/s^2$

$a_{tot} = \sqrt{a_t^2 + a_r^2}$

$= 0.86 \ m/s^2$

سؤال ربط حبل

E.x : A ball is tide to the end of acable of negligible mass, the ball is moving in acircle with radius ($r = 2m$), making 0.7 revelution per second, what is the centripetal accelaration of the ball ??

مهمل

Solution : ($r = 2m$), ($F = 0.7$)

*- ملاحظة: عندما يكون E ثابت هذا يعني أن السرعة ثابتة .

$$\text{Uniform} \longrightarrow a_t = 0$$

$$V = \text{const} \longrightarrow a_t = 0$$

$$F = \text{const} \longrightarrow a_t = 0$$

$\boxed{a_r = \frac{V^2}{r}}$ يجب ان نجد V ولكن كيف؟!! :0

$$F = \frac{1}{T} = \frac{V}{2\pi r} \rightarrow 0.7 = \frac{V}{2\pi * 2} \rightarrow V = 8.79 \, m/s$$

Now $a_r = \frac{(8.79)^2}{2} = 38.6 \, m/s^2$ #

The END

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* Chapter 5 : Newton's law :

القانون الأول

*** First law :** An object at rest remains at rest, and an object in motion remains in motion with a const velocity .

الجسم الساكن يبقى ساكناً والجسم المتحرك في سرعة ثابتة يبقى متحركاً بهذه السرعة ما لم تؤثر عليه بقوة خارجية .

$\Rightarrow V \equiv \text{const} \rightarrow \Sigma F = 0$

$V \equiv \text{not const} \rightarrow \Sigma F \neq 0$

القانون الثاني

*** Second law :** The Net Force (قوة) ΣF on an object and the acceleration of that object are related :

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

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* $\Sigma \vec{F}$: Net Force « total » "N"

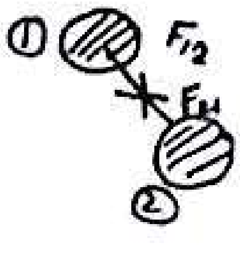
* m : The mass of the object « Kg »

* a : acceleration of the object « m/s^2 »

القانون الثالث

*** Third law :** every action has an equal and opposite (عكس) reaction (رد فعل) .

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



$$\boxed{F_{12} = -F_{21}}$$

* Gravitantional Force and Weight :: "W"

قوة الجاذبية والوزن

$\boxed{W = mg}$ ## unit: N

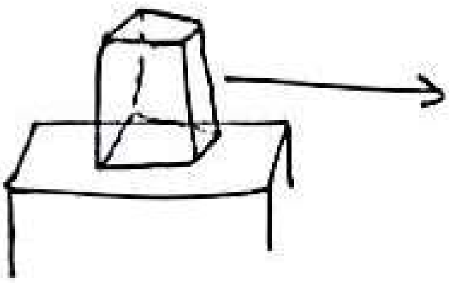
* Normal Force :: "N" القوة العامودية

عمودية سطح

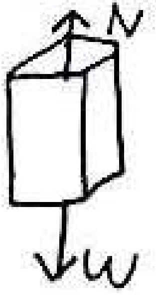
- N is perpendicular "⊥" to the surface.

هي القوة التي تنشأ من تلامس الأجسام مع بعضها .

e.x

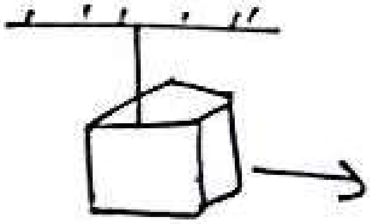


Free body diagram

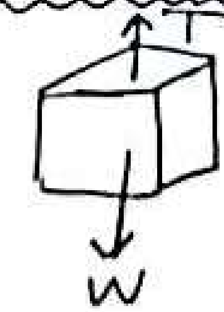


N: Normal Force
W: Weight

e.x

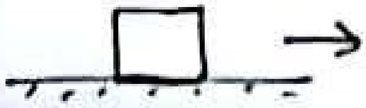


Free body diagram

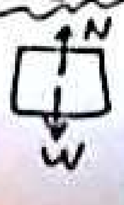


T: Tension . " شد "
W: wight

e.x

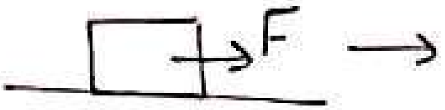


Free body diagram



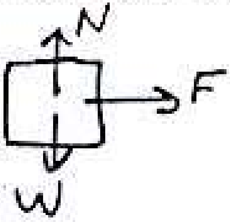
W: Weight.
N: Normal Force

e.x



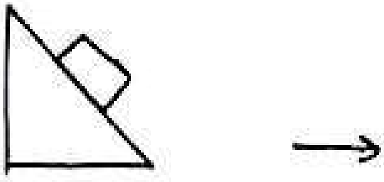
Free body diagram

توضيحي



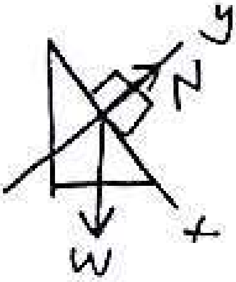
F: external Force
W: Weigt
N: Normal Force

e.x



incline surface

مائل.



W: weight
N: Normal Force

Now: $\boxed{\sum F = m\vec{a}}$

$\boxed{\sum F_x = ma_x}$ $\boxed{\sum F_y = ma_y}$

E.X A $\overrightarrow{\text{Particle}}$ of mass 3-kg is moving with const Velocity of magnitude 10 m/s For 20 second, The magnitude of the resultant Force acting on the Particle: does

Solu $\sum F = ma$

$\sum F = 3*0$

$\boxed{\sum F = 0}$ #

تسارع

E.X: A car of mass 1000 Kg accelerates from rest to 27 m/s in 4 second. What is the net Force of the car??

Solu $\sum F = ma$ **But:** We need a

$V_i = 0$
$t = 4$ sec
$V_f = 27$ m/s

$$V_f = V_i + at$$

$$27 = 0 + 4a \rightarrow a = 6.75\, m/s^2$$

$$\therefore \sum F = 1000 * 6.75 = 6.75 * 10^3 N$$

E.X Three Forces $\vec{F_1} = 2\hat{i} + 3\hat{j}$, $\vec{F_2} = 3\hat{i} + 5\hat{j}$ and $F_3 = \hat{i}$, act on aparticle of mass 2 kg. Find the magnitude of it's acceleration??

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

$$(2\hat{i} + 3\hat{j}) + (3\hat{i} + 5\hat{j}) + (\hat{i}) = 2\vec{a}$$

$$2\vec{a} = 6\hat{i} + 8\hat{j}$$

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

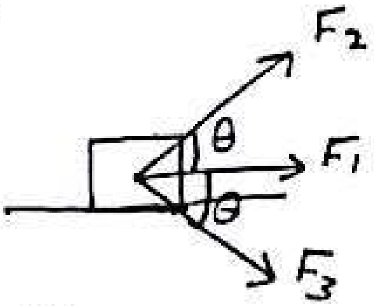
$$|a| = \sqrt{3^2 + 4^2}$$

$$= \sqrt{25}$$

$$= 5\, m/s^2$$

Ex A Particle of mass 2 Kg is subjected to three Forces ($F_1 = F_2 = F_3 = 10$) equal magnitude, as shown, If the particle's acceleration has a magnitude of ($14 m/s^2$) then the angle θ in degrees is 8o

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



$$10 + 10\cos\theta + 10\cos\theta = 2 * 14$$

$$20\cos\theta = 18 \rightarrow \theta = 25.8^\circ \ \#$$

Ex A 1.5 Kg object has a velocity of $(5\hat{j})$ m/s, at $t=0$, It accelerated at const rate For five seconds after which it has a velocity of $(6\hat{i} + 12\hat{j})$ m/s, What is the magnitude of Force, acting on the object during this time interval?

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

$$\left.\begin{array}{l} V_i = (5\hat{j}) m/s \\ t = 5 \text{ sec} \\ V_f = (6\hat{i} + 12\hat{j}) m/s \end{array}\right\} \begin{array}{l} V_f = V_i + at \\ (6\hat{i} + 12\hat{j}) = (5\hat{j}) + 5\vec{a} \end{array}$$

$$\vec{a} = \left(\frac{6}{5}\right)\hat{i} + \frac{7}{5}\hat{j}$$

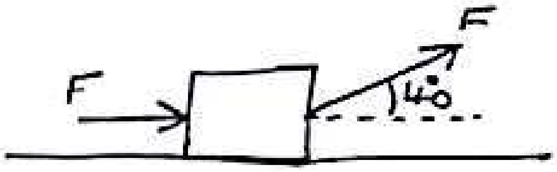
$$|a| = 1.84 \ m/s^2$$

$$\therefore \sum F = ma$$
$$= 1.5 * 1.84$$
$$= 2.76 \ N \ \#$$

« سطح مستوي »

E.X IF $F = 4N$ and $m = 2\ kg$, what is the magnitude of the acceleration for the block shown. The surface is frictionless « smooth » ??

لا يوجد احتكاك



Solu

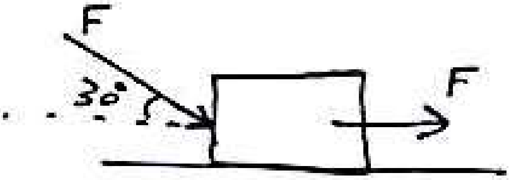
$$\sum F_x = ma_x$$

$$4 + 4\cos(40) = 2a \rightarrow a = 3.5\ m/s^2$$

« سطح مستوٍ »

e.x The horizontal surface shown on which the block slides in africtionless. IF $F = 20\ N$ & $m = 5\ kg$, what is the magnitude of the resulting acceleration of the block?

Solu $\sum F_x = ma_x$



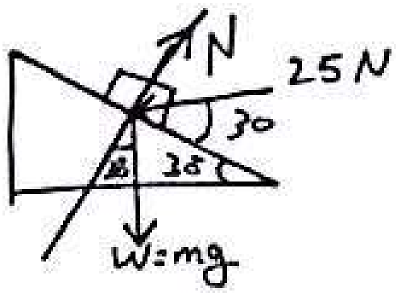
$$20\cos(30) + 20 = 5a_x$$

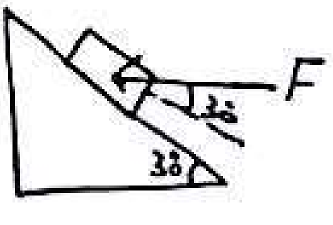
$$a_x = 7.45\ m/s^2$$

« سطح مائل »

E.X A block is pushed up africtionless 30° incline by an applied Force as shown. IF $F = 25N$ & $m = 3\ kg$, What is the magnitude of the resulting acceleration of the block?

Solu





$$\sum F_y = ma_y$$
$$= 0$$

الجسم لا يتحرك للأعلى والأسفل .

$\sum F_x = ma_x$

$25 * \cos(30) - 3*10*\sin(30) = 3 * a_x$

$a_x = 2.2\ m/s^2$ #

*Note: If the question need's: N

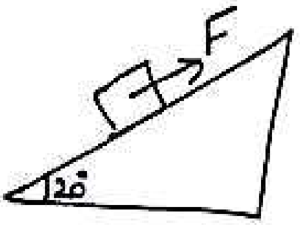
$\sum F_y = 0$

$N - W\cos(30) \overset{-25\sin(30)}{\uparrow} = 0 \longrightarrow N = mg\cos(30) - 25\sin(30)$

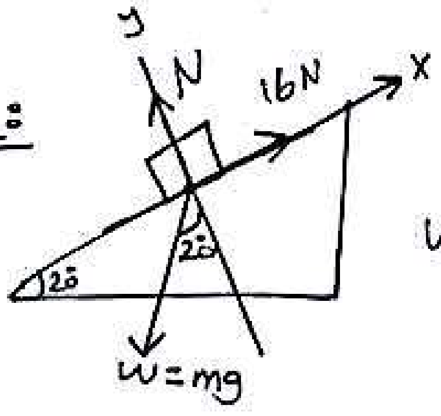
~~$= 3*10*\cos(30) = 25.98N$~~

«مع تال» $= 13.4N$

EX A 3 Kg block slides on africtionless 20° incline plane. AForce of 16 N acting parallel to the incline and up the incline is applied to the block. What is the acceleration of the block ??



Solu:



$W = mg$
$= 3*10 = 30$

$\sum F_y = 0$
«لا نوجدها»

$\sum F_x = ma_x$

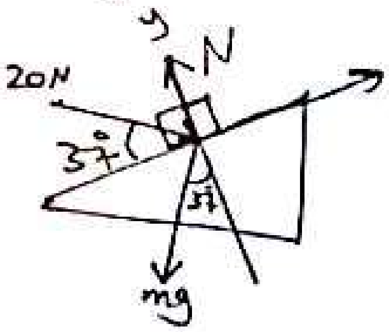
$16 - 30*\sin(20) = 3a_x$

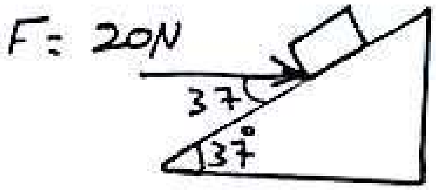
$a_x = 1.9\ m/s^2$
up the incline #

"سطح مائل"

E.x Find the Normal Force on the object,($m = 2kg$) in the figer??

Solu





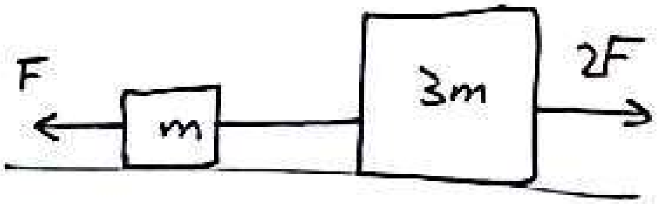
$$\sum F_y = 0$$

$$N - 20 \sin(37) - 2*10*\cos(37) = 0$$

$$N = 28N$$

"جسمين مربوطين بحبل"

E.x The horizontal surface on Wich the objects slide is frictionless. if $F = 4N$, and $m = 1$ kg, what is the magnitud of the Force of the connecting string on the smaller block ??



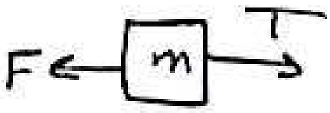
Solu: ⊕ All system:

$$\sum F_x = m a_x$$

$$2*4 - 4 = 4*1*a_x$$

$$\boxed{a_x = 1\ m/s^2}$$

Now:



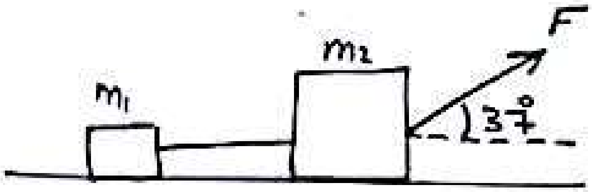
$$\sum F_x = m a_x$$

$$T - 4 = 1*1$$

$$T = 5N \ \#$$

« جسمين مربوطين بحبل »

E.X In the figer shown, $F = 20N$, $m_1 = 1\,kg$, $m_2 = 3\,kg$ and the surfaces are smooth. Find the tention in the rope between m_1 & m_2?

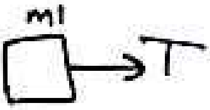


Solu: All system:

$$\Sigma F_x = m a_x$$

$$20 * \cos(37) = (1+3) a_x \qquad \therefore a_x = 4\ m/s^2$$

Now

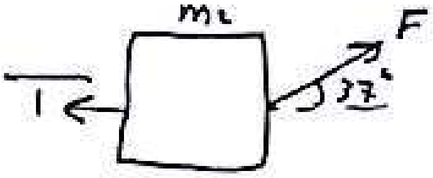


$$\Sigma F_x = m a_x$$

$$T = 1 * 4$$

$$\boxed{T = 4N} \#$$

OR



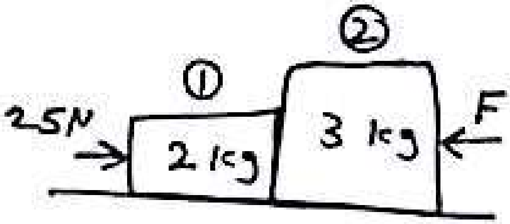
$$\Sigma F_x = m a_x$$

$$20 * \cos(37) - T = 3 * 4$$

$$\boxed{T = 4N} \#$$

« جسمين بجانب بعض »

E.X: IF $F = 5N$, what is the magnitud of the Force exerted by block ② on block ①.



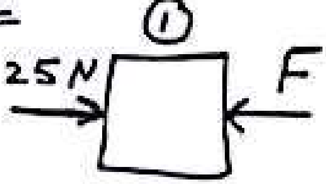
Solu: All system

$$\Sigma F_x = m a_x$$

$$25 - 5 = 5 a_x$$

$$a_x = 4 m/s^2$$

Now



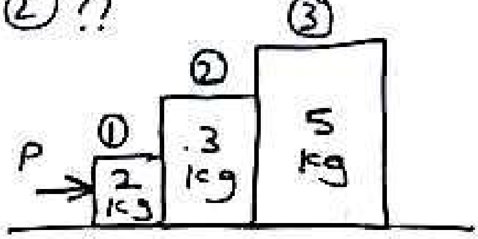
$$\Sigma F_x = m a_x$$

$$25 - F = 2 * 4$$

$$F = 17N \#$$

H.W «ثلاثة اجسام بجانب بعض»

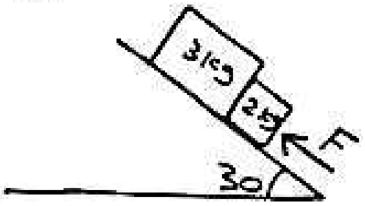
E.x IF $P = 6N$, What is the magnitude of the Force exerted on block ① by block ②??



Solu: 4.8 N

«سطح مائل + جسمين بجانب بعض»

E.x The surface of the incline plane shown is Frictionless if $F = 30N$, what is the magnitude of the Force exerted on the 3-kg block by the 2 kg block?



Solu: All system

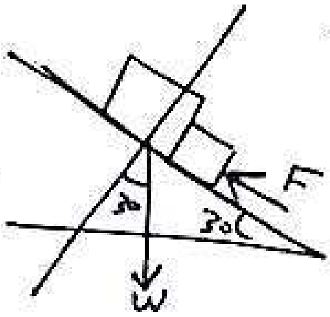
$\Sigma F_x = m a_x$

$30 - mg\sin(30) = (m_1 + m_2) a_x$

$30 - 5 \times 10 \sin(30) = 5 a_x$

$30 - 25 = 5 a_x$

$a_x = 1 \, m/s^2$

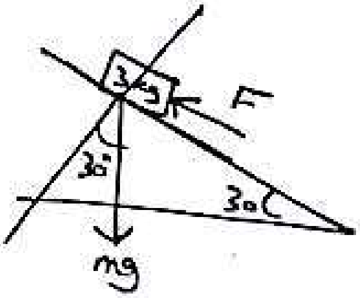


Now:

$\Sigma F_x = m a_x$

$F - 3 \times 10 \times \sin(30) = 3 \times 1$

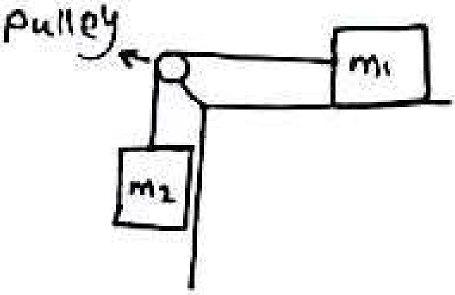
$F = 18N$ #



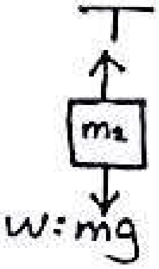
«بكرات + مصاعد + حالة اتزان»

بكرات

E.X For the system shown aside, $m_1 = 3$ kg and $m_2 = 1$ kg. If Friction is ignored, the magnitude of their acceleration is :-



Solu



$\Sigma F_x = 0$

$\Sigma F_y = ma$

$1*10 - T = 1*a$

$\boxed{10 - T = a}$ ... ①

$\Sigma F_y = 0$

$\Sigma F_x = ma_x$

$\boxed{T = 3*a}$ ... ②

الحل الأسهل

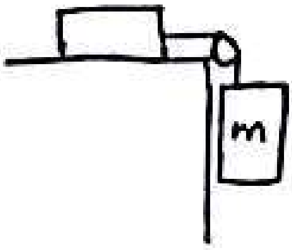
OR $\Sigma F = ma$ «All system»

$m_2 g = (m_1 + m_2)a$

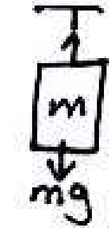
$1*10 = (1+3)a \longrightarrow a = 2.5 m/s^2$

بكرات

E.X If the tention $\underline{T}$ = 15N, and the magnitude of the acceleration is a: 3m/s², what is the mass $\underline{m}$, of the معلق suspended object, assuming that all surfaces and the pulley are frictionless?



Solu



$$\Sigma F_y = m a_y$$

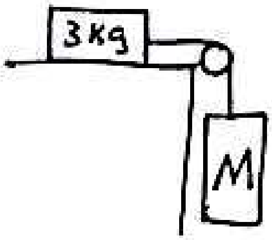
$$m*10 - T = m*a_y$$

$$10m - 15 = 3m$$

$$7m = 15 \rightarrow m = \frac{15}{7} = 2.14 \text{ Kg} \ \#$$

تمرين

E.X The system shown is released from rest, and moves 50 cm in 1 second, What is the Value of M ? All surfaces are Frictionless.



Solu: $V_i = 0$, $\Delta y = 0.5\text{ m}$, $t = 1$ sec

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

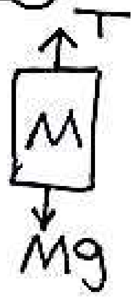
$$0.5 = 0 + \frac{1}{2} a * (1)^2$$

$$a = 1\text{ m/s}^2$$

Now: $\Sigma F_y = m a_y$

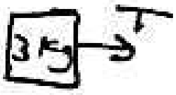
$10M - T = M*1$ ...①

$10M - 3 = M \rightarrow M = \frac{3}{9} = 0.33$



$$\Sigma F_x = m a_x$$

$$T = 3*1 = 3N$$



OR All System:

$$Mg = (3+M)*1$$

$$10M = 3 + M$$

$$M = 0.33 \text{ Kg}$$

#

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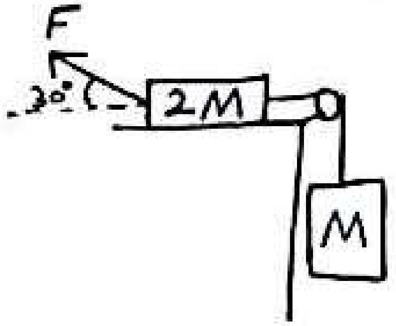
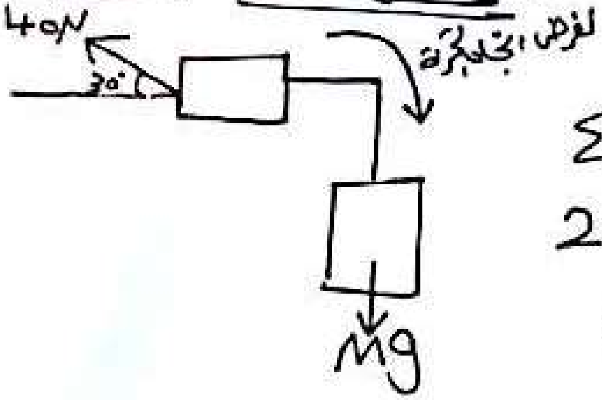
بكرات

E.X IF $F = 40N$ and $M = 2kg$, what is the magnitude of the acceleration of the suspended object? assume all surfaces are Frictionless.



Solu All System :



$$\Sigma F = ma$$

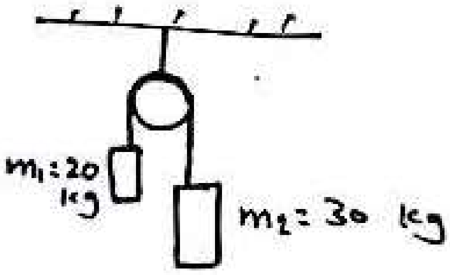
$$2*10 - 40\cos(30) = (4+2)*a$$

$$a = -2.44\ m/s^2$$

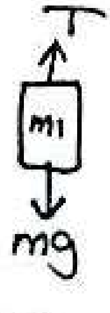
اشارة السالب تعني ان الاتجاه الصحيح هو للأعلى وليس للأسفل.

بكرات.

e.x From the Figure shown, calculate the tension in the string (The Pulley is Frictionless)?



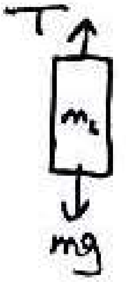
Solu



$$\Sigma F_y = ma$$

$$T - 20*10 = 20a$$

$$T - 20a = 200 \cdots ①$$



$$\Sigma F_y = ma$$

$$mg - T = ma$$

$$30*10 - T = 30a$$

$$30a + T = 300 \cdots ②$$

معادلتين بمجهولين.

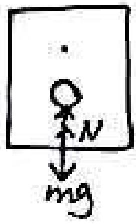
$$T = 240N$$

مهمة

مصعد

E.X A person of mass 70 Kg is inside an elevator moving up with acceleration of $2 m/s^2$, what is the magnitude of the Force of the elevator Floor on the person?

Solu:



$$\sum F_y = m a_y$$

$$N - 70*10 = 70*2$$

$$N = 840 N \#$$

مهمة

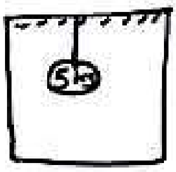
حبل

E.X: A 5 Kg object is suspended by astring From the Ceiling of an elevator, that is accelerated downword at arate of $2.6 m/s^2$, what is the tention in the string

سقف

حبل

Solu



$$\sum F_y = m a_y$$

$$mg - T = ma$$

$$5*10 - T = 5*2.6$$

$$T = 37 N \#$$

H.W

مهمة

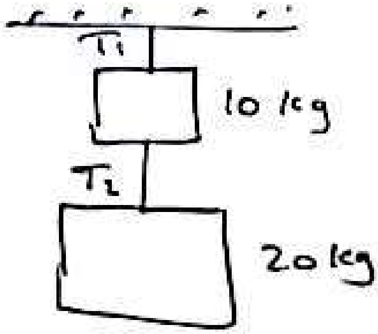
E.X: A 5 Kg mass is suspended by astring from the ceiling of an elevator that is moving upword with aspeed wich is decreasing at aconstant rate of $2 m/s^2$. What is the tention is the String supporting the mass??

تتناقص

Solu 40 N

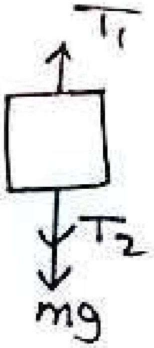
اتزان

E.X: What is the tention (T_1) shown in the figer?



Soln

object ①:

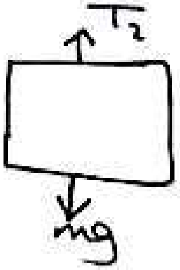


$\sum F_y = 0$ « متزن »

$T_1 = T_2 + 10 * 10$

$\therefore T_1 = T_2 + 100 \quad \dots ①$

object ②:



$\sum F_y = 0$ « متزن »

$T_2 = 20 * 10$

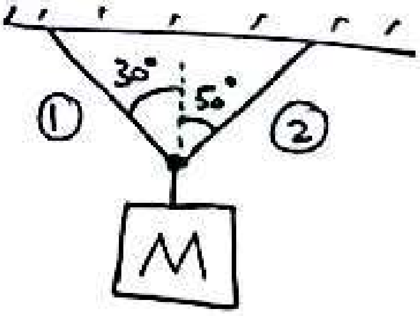
$\therefore T_2 = 200 N$

So $T_1 = 200 + 100$

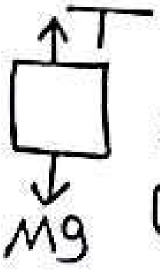
$= 300 N$

اتزان

E.X: In the Figure, if the tention in String $\underline{1}$ is 23N What is the mass of the object shown??

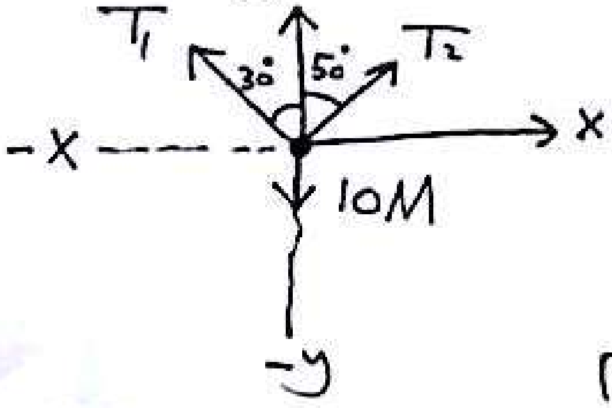


Soln:



$\sum F_y = 0$ « متزن »

$\boxed{T = 10M}$ #



$\sum F_x = 0$

$T_1 * \sin(30) = T_2 \sin(50)$

$23 * \sin(30) = T_2 \sin(50) \rightarrow T_2 = 15 N$

تكملة السؤال # →

$\Sigma F_y = 0$

$T_1 \cos(30) + T_2 \cos(50) = 10M$

$23 \cos(30) + 15 \cos(50) = 10M \longrightarrow M = 2.95\ Kg$ #

---

* Friction: Exist only between two sliding surfaces

2 - Types →
نوعين

① Static Friction « No motion » احتكاك سكوني

② Kinetic Friction « motion » احتكاك حركي

① Static Friction: " F_s "

هذه القوة تنشأ بين جسمين ملامسين ولكن لا توجد حركة وتكون دائماً عكس اتجاه القوة.

$$\boxed{F_{s(max)} = \mu_s N}$$

N: Normal Force

μ_s: coeficient of static Friction
« معامل الإحتكاك السكوني »

*Note: $F_s \leq \mu_s N$

② Kinetic Friction: " F_k "

هذه القوة تنشأ بين جسمين ملامسين وتوجد حركة وتكون دائماً عكس اتجاه الحركة

$$\boxed{F_k = \mu_k N}$$

N: Normal Force.

μ_k: Coeficient of kinetic Friction
« معامل الإحتكاك الحركي »

*Note ① μ_s & μ_k are dimentionless بدون وحدة

② $(\mu_s \ \& \ \mu_k) < 1$

③ $\mu_s > \mu_k$

طبق

*__question:__ A horizontal Force F is applied to a block that rests on a flat rough floor. The Force of friction that the Floor exerts on the block will be maximum when:

a) The block is moving with constant acceleration.

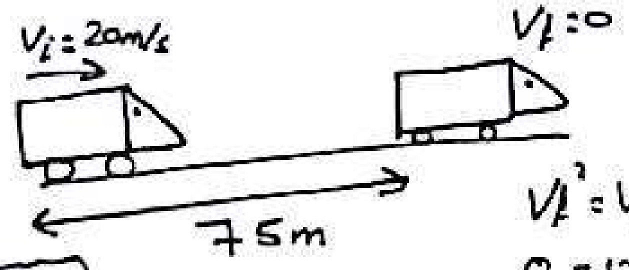
b) The block remains at Rest

c) The block is moving with constant Velocity.

d) The block is about to move

__E.X:__ A car of speed of 20 m/s moves on a rough horizontal surface. If the engine is turned off, what is the coficient of Friction with the road if the car moves (75) m, befor it stopes ??

__Solu:__



$V_f^2 = V_i^2 + 2a\Delta x$

$0 = (20)^2 + 2(75)a$

$a = -2.66 \; m/s^2$

$\boxed{F_K = \mu_K N}$

$N = mg$

$= 10m$ #

$\Sigma F_x = ma$

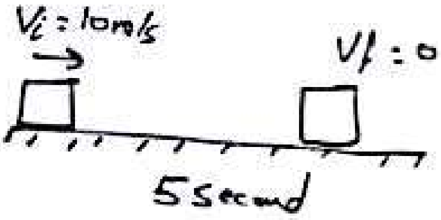
$-F_K = ma$

$-\mu_K * 10 * \cancel{m} = \cancel{m} * -2.66$

$\mu_K = \frac{2.66}{10} = 0.266$

e.x An object of mass 2 Kg moves on arough horizontal surface at aspeed of 10 m/s, then it took 5 second to Stop due to Friction. Find the cooficient of Friction between the object and the surface??

Solu:



$V_f = V_i + at$

$0 = 10 + 5a$

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

$-F_k = ma$

$-\mu_k * N = ma$

$N = mg$

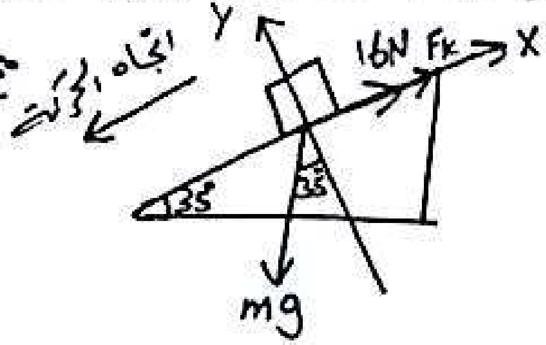
$= 2*10 = 20 N$

$-\mu_k * 20 = 2*(-2)$

$\mu_k = \frac{4}{20} = 0.2$

e.x A 4 kg block slides down a 35° incline at aconstant speed. when a 16 N Force is applied acting up and parallel to the incline. What is the cooficent of Kinetic Friction between the block and the surface of the incline??

Solu:



$\sum F_x = m a_x$ «const speed» → a = 0

$\sum F_x = 0$

$F_k + 16 = 4*10*\sin(35)$

$F_k = 6.94 N$

$N = mg\cos 35$

$= 4*10*\cos 35$

$= 32.76$

$F_k = \mu_k * N$

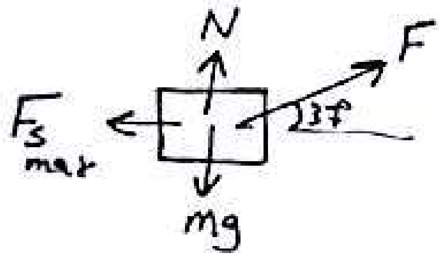
$6.94 = \mu_k * 32.76$

$\mu_k = 0.2$ #

*

E.X In the Figure shown what is the maximum Value of the Force «F» that can be applied befor the block Starts to move?? (μ_s:0.5, μ_k:0.3)

Solu



$\Sigma F_y = 0 \longrightarrow mg = N + F\sin 37°$

$\boxed{N = 50 - \sin(37)\,F}$

$\Sigma F_x = 0$

$F\cos(37) = \mu_s * N$

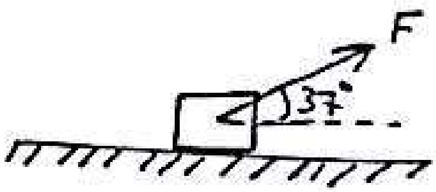
$F\cos(37) = 0.5 * (50 - \sin(37)F)$

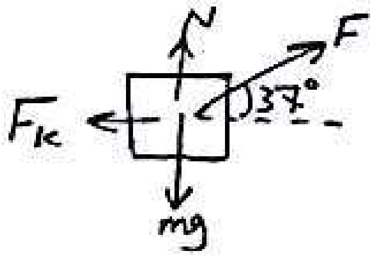
$0.8F + 0.3F = 25$

$F_{max} = 22.7N$

**

e.X In the Figure shown, what is the Value of the Force that accelerates the 5 kg on the rough surface (μ_s=0.5, μ_k=0.3) With constant acceleration of 2 m/s².





$\Sigma F_y = 0 \rightarrow mg = N + F\sin 37°$

$\therefore \boxed{N = 50 - \sin(37°)F}$

$\Sigma F_x = ma$

$F\cos(37°) - \mu_k N = ma$

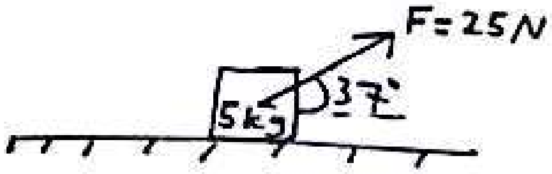
$F\cos(37) - 0.3(50 - \sin(37)F) = 5*2$

$0.8F + 0.18F = 10 + 15$

$F = 25.5$

***

E.X: In the Figure shown, what is the Friction force if the block at rest?? (μ_s:0.5, μ_k:0.3)



Solu $\Sigma F_x = 0$

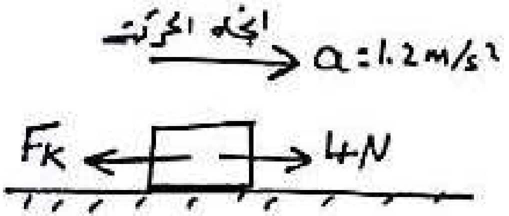
$25 * \cos(37) = F_s$

$F_s = 19.96\ N$

E.X A 2 kg block slides on arough horizontal surface aForce $P = 4N$ acting parallel to the surface is applied to the block. The magnitude of the block's acceleration $a = 1.2\,m/s^2$

IF $\underline{P}$ is increased to 5N, determine the magnitude of the block's acceleration??

Solu

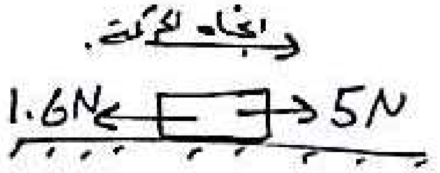


$\therefore \sum F_x = m a_x$

$4 - F_k = 2 * 1.2$

$F_k = 1.6N$

Now

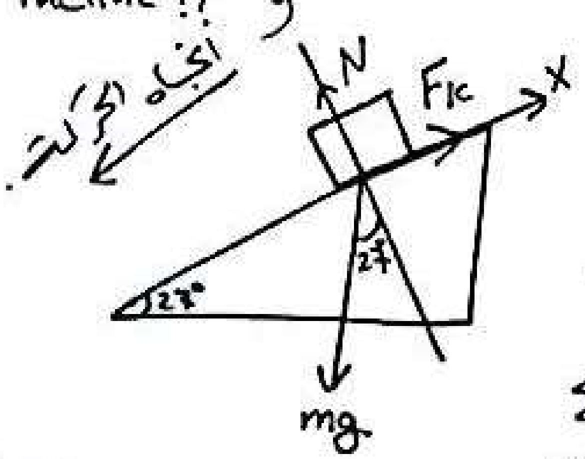


$\sum F_x = m a_x$

$5 - 1.6 = 2 * a_x$

$a_x = 1.7\ m/s^2$

E.X: A block is released from rest on a $27°$ incline, and moves 6 m during the next 2 sec. What is the coeficient of kinetic Friction between the block and the surface of the incline??



$V_i = 0$, $\Delta x = 6m$, $t = 2$ sec

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

$6 = 0 + \frac{1}{2} * a * (2)^2$

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

$\sum F_x = m a_x$

$mg \sin(27) - M_k * N = m * 3$

$\cancel{m} g \sin(27) - M_k * \cancel{m} g \cos(27) = 3 \cancel{m}$

$M_k = 0.17$ #

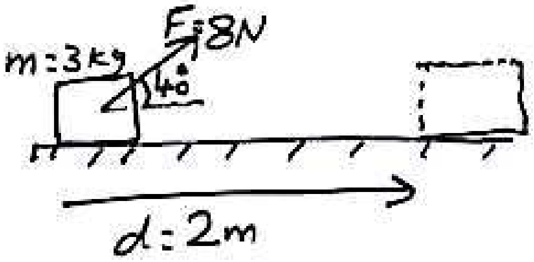
$\sum F_y = 0$

$N = mg\cos(27)$

دفتن

H.W

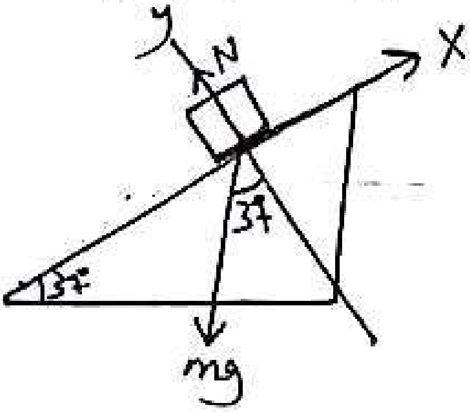
E.X : A 3 Kg block is pulled from rest along a horizontal rough surface ($\mu_k = 0.2$) by a Force of ($F = 8N$) as shown in the figure, The speed of the block after it moves $d = 2m$ in (m/s) is :



Solu 1.24 m/s

E.X An object of mass (10 kg) is set on an incline plane of angle 37° with the horizontal. Find the Force of Friction on the object if the surface are rough. ($\mu_s = 0.9$, $\mu_k = 0.8$) ?

Solu



① assume the object at rest :

$\Sigma F_x = 0$

$mg \sin 37 = F_s$

$F_s = 60 N$ وتكتب بالسالب

$F_{s_{max}} = \mu_s * N$

$F_{s_{max}} = 0.9 * mg \cos 37$

$= 0.9 * 10 * 10 * \cos 37$

$= 71.8$

Since $60 < 71.8$

$\therefore$ الفرضية صحيحة

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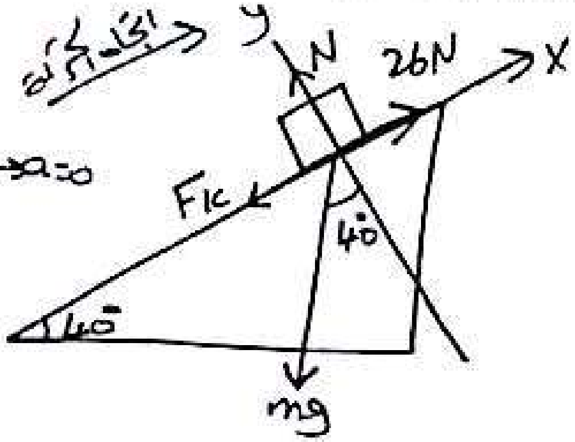
E.X A 3 kg block moves up a 40° incline with const speed under the action of 26N Force acting up and parallel to the incline. What is the magnitude of the Force acting up and parallel to the incline required to allow the block to move down the incline at const speed?? New F

Solu:

const speed → a = 0



$\Sigma F_y = 0$

$N = mg\cos 40$

$= 3 \times 10 \times \cos 40$

$= 23N$

$\Sigma F_x = ma_x$

$\Sigma F_x = 0$

$26 - mg\sin(40) - F_k = 0$

$26 - 3 \times 10\sin(40) = F_k$

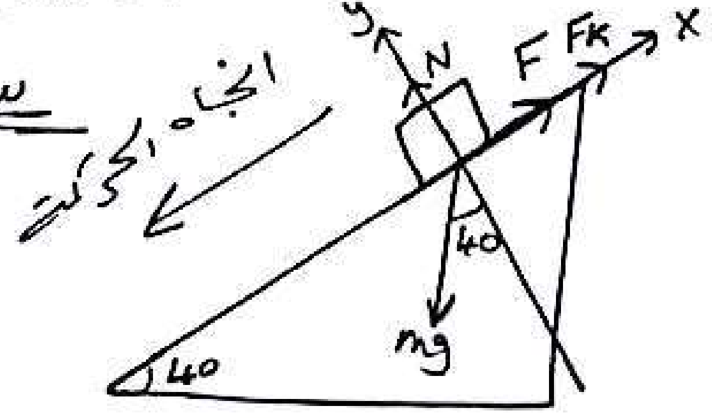
$F_k = 6.71N$

$F_k = \mu_k * N$

$6.71 = \mu_k * 23$

$\mu_k = 0.3$

Now



$N = 23N$

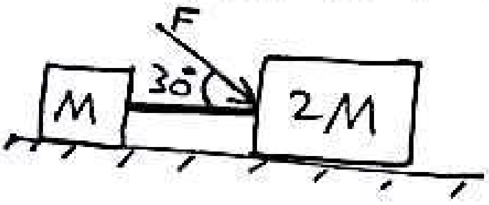
$\Sigma F_x = 0$

$F_k + F = mg\sin(40)$

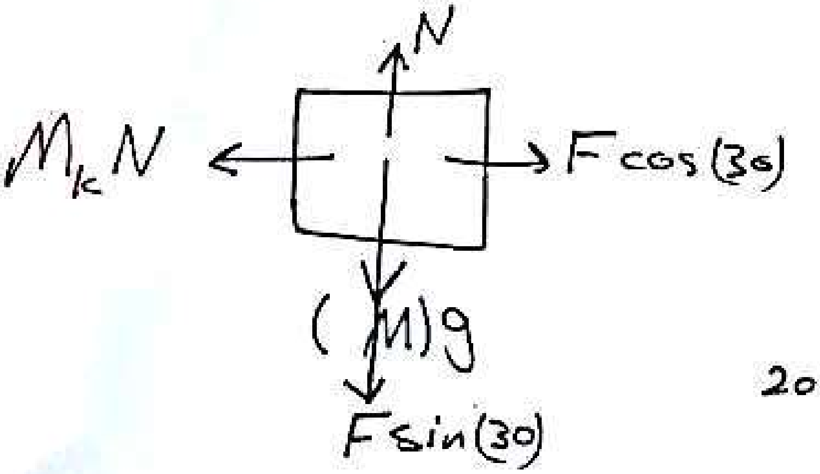
$0.3 \times 23 + F = 3 \times 10\sin(40)$

$F = 12.38N$ #

E.X: Two blocks connecting by a string are pushed across a horizontal surface by a Force applied to one of the blocks as shown in the figure. The cooficient of kinetic friction between the blocks and the surface is 0.2. IF $F = 20N$, $M = 1.5$ Kg, what is the tension in the connecting string ??



Solu **All system**



$\Sigma F_y = 0$

$N = 4 \times 1.5 \times 10 + 20 \times \sin 30$

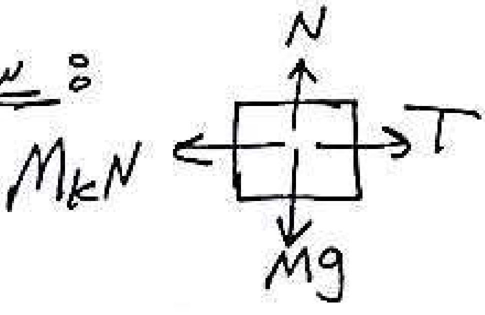
$= 55N$

$\Sigma F_x = ma_x$

$20\cos(30) - 0.2 \times 55 = 4.5 \times a_x$

$a_x = 1.4 \ m/s^2$

Now :



$\Sigma F_y = 0$

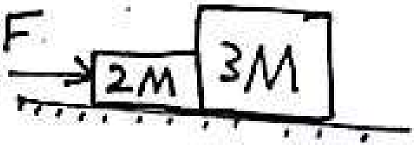
$N = 1.5 \times 10 = 15N$

$\Sigma F_x = ma_x$

$T - 0.2 \times 15 = 1.5 \times 1.4$

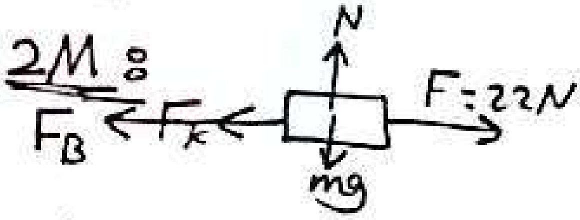
$T = 5.1 \ N$

surface and the larger block is 0.25 and the coefficient of kinetic friction between the surface and the smaller block is 0.4 if F = 22N, M = 1 kg, in the Figure, what is the magnitude of the acceleration of either block?



Solu:

2M:



$\Sigma F_y = 0$

$N = mg = 2*1*10$
$= 20N$

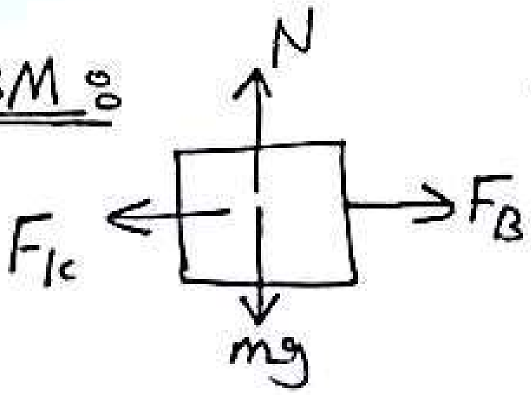
$\Sigma F_y = ma$

$22 - 0.4*20 - F_B = 2a$

$2a = 14 - F_B$

$\boxed{2a + F_B = 14}$ ... ①

3M:



$\Sigma F_y = 0$

$N = mg$
$N = 3*10$
$= 30N$

$\Sigma F_x = ma_x$

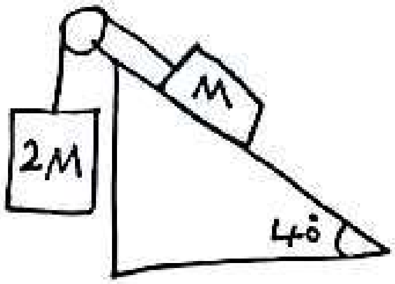
$F_B - 0.25*30 = 3a$

$\boxed{3a - F_B = -7.5}$ ... ②

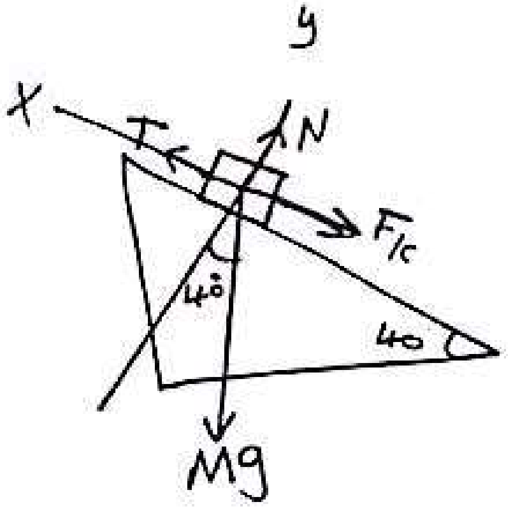
$\therefore\ a = 1.3\ m/s^2$

$F_B = 11.4 N$ " قوة تأثير كل منهم على الآخر "

E.X: In the Figure shown. The cooficient of Kinetic Friction between the block and the incline is 0.4. What is the magnitude of the acceleration of the suspended block as it Falls? (pully is Frictionless)



Solu:



$\Sigma F_y = 0$

$N = 10M\cos40$

$= 7.66M$

$\Sigma F_x = ma$

$T - 0.4 * 7.66M - 64M = Ma$

$\boxed{-9.48M + T = Ma}$ ②

$\Sigma F_y = ma$

$2M * 10 - T = 2Ma$

$\boxed{20M - T = 2Ma}$ ①

add ① + ②

$10.52\cancel{M} = 3\cancel{M}a$

$a = 3.5\ m/s^2$

OR: All system:

$2M*10 - 10M\sin(40) - 0.4*7.66M = 3Ma$

$a = 3.5\ m/s^2$

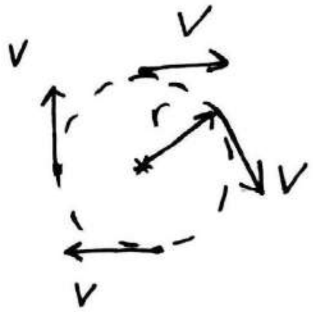
#

The END

* Chapter $\boxed{6}$: Circular motion

سابقاً كنا نتعامل مع الحركة الدائرية من حيث وصف كيفية الحركة مثل السرعة والتسارع ... الخ . ولكن هنا سوف ندرس مسببات الحركة الدائرية والقوة التي ادت الى هذه الحركة .

* قبل ان نبدأ بالجديد لا بد من مراجعة سريعة لما يهمنا من مادة الفيرست ده :



r: radius « نصف القطر »

V: Velocity « السرعة »

a_t: tangentional acceleration « التسارع المماسي »

a_r: Centripetal acceleration « التسارع المركزي »

* Note: السرعة والتسارع المماسي دائماً باتجاه المماس .

* Note: التسارع المركزي دائماً باتجاه المركز .

$$\boxed{a_t = \frac{dv}{dt}} \qquad \boxed{a = \sqrt{a_t^2 + a_r^2}}$$

$$\boxed{a_r = \frac{V^2}{r}}$$

$$\boxed{T = \frac{2\pi r}{V}} \rightarrow$$ الزمن الدوري: الزمن الذي يستغرقه الجسم حتى يكمل دورة واحدة .

$$\boxed{F = \frac{1}{T}} \rightarrow$$ التردد: عدد الدورات التي يكملها الجسم في الثانية الواحدة .

* Newton's laws and Circular motion :-

$$\boxed{\sum F = ma}$$ .... ①

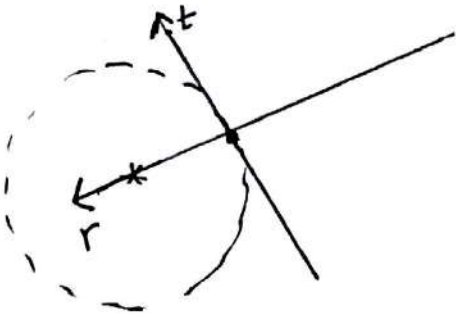
$$\boxed{a_r = \frac{V^2}{r}}$$ --- ②

بتعويضنا معادلة 2 في معادلة 1 ينتج :-

$$\boxed{\sum F_r = \frac{mV^2}{r}}$$ #

قانون مهم جداً جداً

* ملاحظة: في الحركة الدائرية سنتعامل مع نوع جديد من المحاور بحيث يكون احد المحاور باتجاه المماس والآخر باتجاه المركز :-



والقوى التي توجد على محور r تسمى Fr وتكون موجبة اذا كانت باتجاه المركز وسالبة اذا كانت عكس اتجاه المركز.

F_r

$\boxed{+}$: باتجاه المركز

$\boxed{-}$: عكس اتجاه المركز

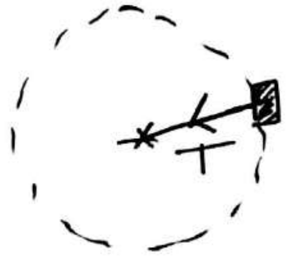
① Uniform Circular motion :

Ⓐ The horizontal circle :

* الدائرة الموجودة في المستوى الأفقي ، تخيل حجر مربوط بخيط وامسك الخيط وقم بتدويره على الطاولة جنده ، الحركة هي حركة دائرية في المستوى الأفقي ولكن لو قمت بتدويره في الهواء فإنها تصبح Vertical cycle وسنتكلم عنها لاحقاً .

* في هذا النوع من الحركة لا يوجد الا قانون واحد وهو :.

$$\sum F_r = \frac{mv^2}{r} \rightarrow \boxed{T = \frac{mv^2}{r}} \#$$



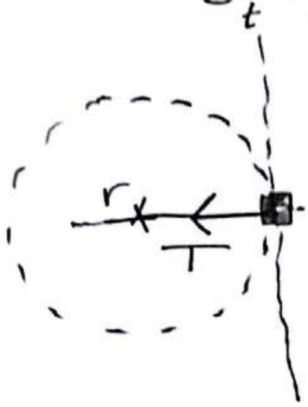
T : Tension Force

«قوة الحبل»

← لاحظ ان T باتجاه المركز لذلك اعتبرناها Fr .

E.X : A (4 Kg) mass on the end of String rotates in acircular motion on ahorizontal Frictionless. The mass has constant speed of 2m/s, and the radius of the circle is (0.8m). What is the magnitude of the resultant Force acting on the mass ??

Solution: m = 4 kg , horizontal , V = 2 m/s , r = 0.8 m , F_r = ??



$$T = \frac{mV^2}{r} = \frac{4 * (2)^2}{0.8}$$

$$T = 20N \ \#$$

E.X: A block of mass (2Kg) is connected to a (1m) cord حبل, which can break if the tension in the cord exceeds يزيد (200N), What is the maximum speed of the mass if it rotates uniformly in horizontal circle ??

Solution: m = 2Kg , r = 1m , T = 200N, horizontal , V = ??

ربط جسم كتلته (2Kg) بحبل طوله (1m) و يجب ان تكون قوة الحبل 200N
او اكثر لكي لا يطير الجسم ويبقى محافظ على مساره، احسب اقصى
سرعة يمكن للجسم ان يتحرك بها.

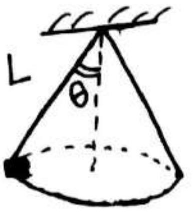
$$T = \frac{mV^2}{r} \rightarrow 200 = \frac{2 * V^2}{1} \rightarrow V = 10 \text{ m/s}$$

H.W

E.X: An object moves around a circle, IF the radius is doubled, Keeping the speed the same, then the magnitude of the centripetal Force must be:

ⓐ twice as great. ⓒ half as great
ⓑ The Same ⓓ Four times as great

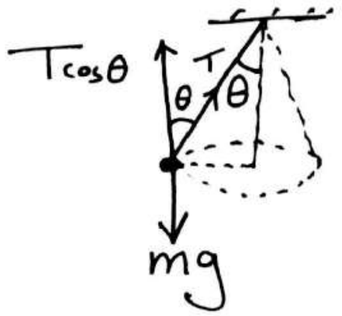
(B) Conical Pendulum: "البندول المخروطي"



جسم مربوط من اعلى ويدور بدائرة على المستوى الأفقي

L : طول الحبل

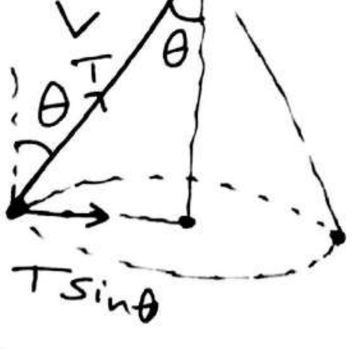
Vertical:



So : $\boxed{mg = T\cos\theta}$ #

لأن الجسم لا يتحرك للأعلى والأسفل بل هو يدور في دائرة على المستوى الأفقي فإن القوة للأعلى تساوي القوة للأسفل

horizontal:



$$\boxed{T\sin\theta = \frac{mv^2}{r}}$$ #

* اذاً يجب معرفة القانونين والتعامل معهم حسب معطيات السؤال. ولكن بقي مشكلة وهي ايجاد r لأن السؤال يعطيني قيمة L فكيف استطيع ايجاد r ؟؟ :O

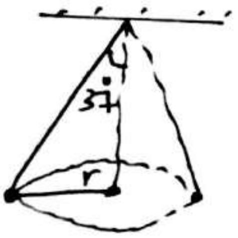
طريقة ايجاد r :

$$\sin\theta = \frac{\text{المقابل}}{\text{الوتر}}$$

$$\boxed{\sin\theta = \frac{r}{L}}$$ #

E.X : A mass (m) is suspended by a string of length (L = 0.8m). Find the speed of the mass, if it to be rotated as conical Pendulum makes ano angle ($\theta : 37°$) with the Vertical ??

Solu :



$$mg = T\cos(37) \quad \text{----} \; ①$$

$$\boxed{T = \frac{10\,m}{\cos(37)}}$$

$$② \text{---} T * \sin\theta = \frac{mv^2}{r}$$

but $T = \frac{10m}{\cos(37)}$

So : $\frac{10\cancel{m}\sin(37)}{\cos(37)} = \frac{\cancel{m}v^2}{r}$

& $r = L\sin\theta$

$= 0.8\sin(37) = 0.481$

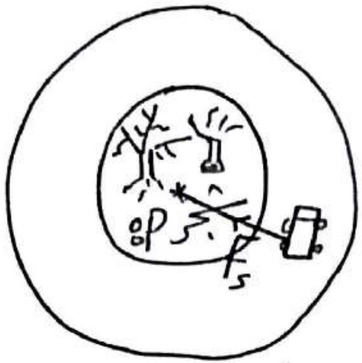
$V = 1.9\ m/s$ #

عبدالرحمن مؤذن
0786966993

6

Ⓒ Car around a flat «un-banked» Curve:

سيارة تدور في دوّار غير مائل .



⊛ هنا القوة التي حافظت على السيارة داخل الدوار هي قوة الإحتكاك السكوني فلولا قوة الإحتكاك لسارت السيارة في خط مستقيم وخرجت عن الشارع .

⊛ لماذا قوة الإحتكاك السكوني وليس الحركي ؟؟

تخيل عجل السيارة وضع نقطة من الدهان عليه واترك السيارة تسير ستجد اثر الدهان على الشارع على شكل نقاط كل مسافة معينة ولن تجده على شكل خط متواصل لذلك فإن هذه النقطة ساكنة وانما العجل يدور ، لو كان الأثر هو خط متواصل لكانت السيارة تنزلق ويصبح الإحتكاك حركي . اذا هنا في موضوعنا الإحتكاك سكوني .

$$\boxed{F_s = \frac{mv^2}{r}}$$ ##

وبس :D

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E.X: What is the maximum speed, with which acar can round aflat horizontal curve of radius (r: 60m), if the coefficent of static friction is 0.4 ??

Solution: $V:??$, $r: 60m$, $\mu_s = 0.4$

$$F_s = \frac{mV^2}{r}$$

$$4\cancel{m} = \frac{\cancel{m}V^2}{60} \rightarrow V = 15.5 m/s$$

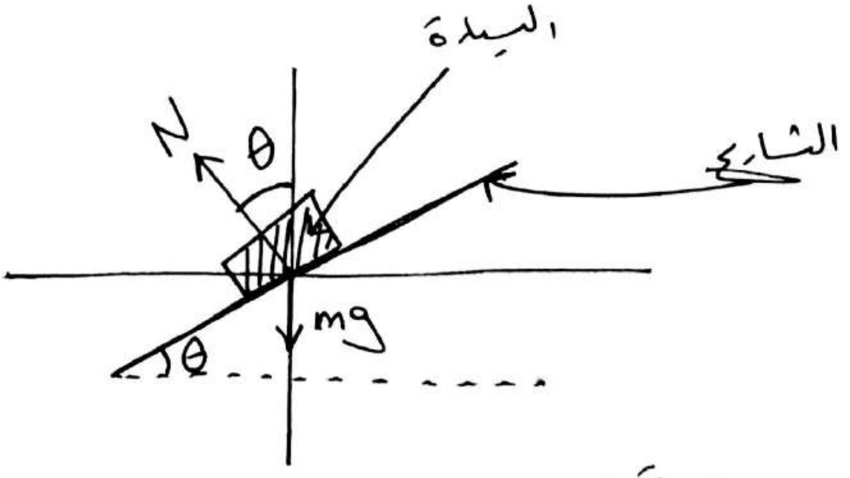
$$F_s = \mu_s N$$

$$= \mu_s mg = 0.4 * 10m$$

$$= 4m$$

Ⓓ Banked curves:

" سيارة تدور في دوّار مائل "



⊛ هذه الرسمة دائماً ثابتة، عند رؤية السؤال على (Banked curve)
نرسمها ونحدد القوى عليها، θ هي زاوية ميلان الشارع، سبب
الحركة الدائرية وعدم الإنزلاق هنا هو مركبة N باتجاه المركز
$(N \sin\theta)$

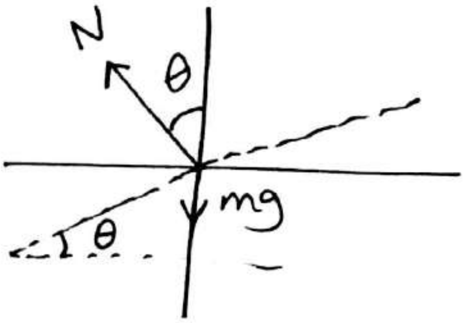
$$\boxed{N \sin\theta = \frac{mv^2}{r}} \quad \#$$

$$\boxed{N \cos\theta = mg} \quad \#$$

أُفضل عدم حفظهم وانما التعامل
مع الرسمة السابقة، ولكن إذا
اردت حفظهم فيجوز !!.

E.X: What is the maximum speed of a car travels around a frictionless Banked road of an inclination angle ($\theta = 10°$) and radius ($r = 150m$)?

Solution:



$$N\cos(10) = mg \rightarrow N = \frac{10m}{\cos(10)} \quad \text{---} ①$$

$$N\sin(10) = \frac{mV^2}{r} \rightarrow N\sin(10) = \frac{mV^2}{150} \quad \text{---} ②$$

عوّض معادلة ① في معادلة ② :

$$\left(\frac{10\cancel{m}}{\cos(10)}\right)\sin(10) = \frac{\cancel{m}V^2}{150} \Rightarrow V = 16.26 \ m/s$$

عبدالرحمن فوزي
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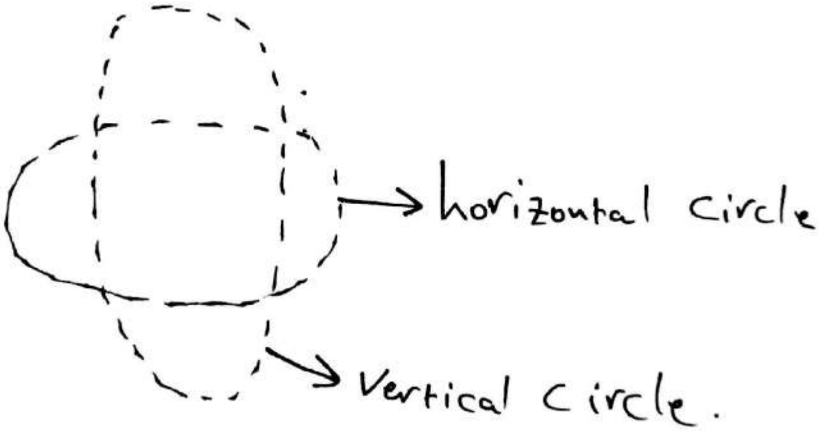
② Non-uniform Circular motion:

$$\boxed{a_t \neq 0}$$

* تحصل هذه الحركة في الدائرة العمودية :

⊛ The Vertical Circle:

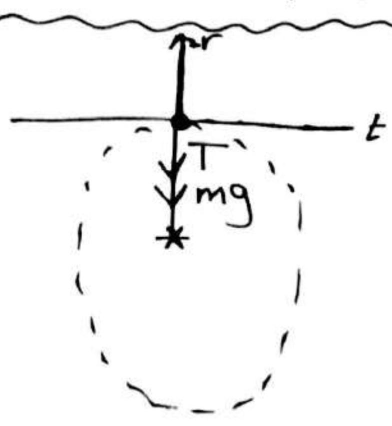
لتسهيل التخيل، تخيل انك تمسك بحبل مربوط به حجر وتلوّح به في الهواء على شكل دائرة على عكس "horizontal circle" حيث كنّا نلوح به على سطح الطاولة "سطح افقي".



ويوجد 5 حالات اساسية لهذه الحركة وهي :

حالة

① Case ①: at the top:



$\Sigma F_r = m a_r$

$$\boxed{T + mg = \frac{mv^2}{r}} \#$$

"موجبات الثنتين لأنهم باتجاه المركز"

$\sum F_t = ma_t$ #

$0 = ma_t \rightarrow \boxed{a_t = 0}$

: عندما يكون الجسم على أعلى نقطة (top) يكون تسارعه المماسي a_t يساوي صفراً

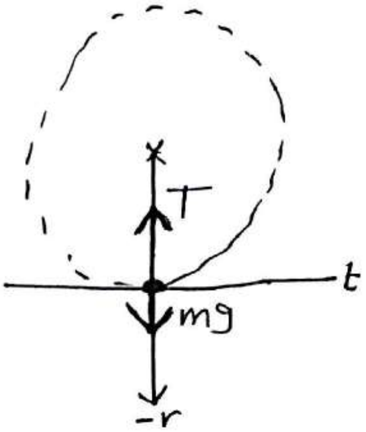
لا يوجد أي قوة باتجاه المماس لكي تكسبه تسارعاً مماسياً .

② Case ②: at the Bottom:

$\sum F_r = ma_r$

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

الشد موجبة لأنها باتجاه المركز والوزن سالبة لأنها عكس اتجاه المركز



$\sum F_t = ma_t$

$0 = ma_t \longrightarrow \boxed{a_t = 0}$ #

: عندما يكون الجسم على ادنى نقطة يكون تسارعه المماسي صفراً .

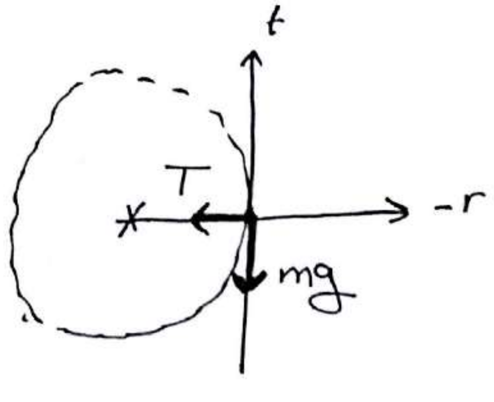
③ Case ③: at the right:

$\sum F_r = ma_r$

$\boxed{T = \frac{mv^2}{r}}$ #

$\sum F_t = ma_t$

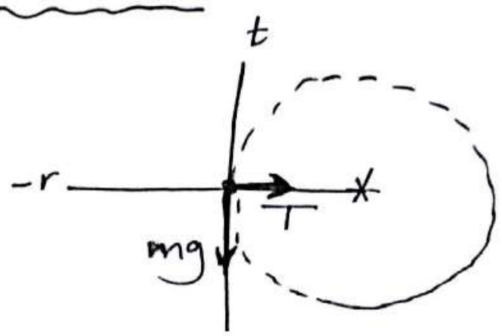
$\boxed{mg = ma_t}$ #



④ Case ④: at the Left:

$\sum F_r = m a_r$

$\boxed{T = \frac{mv^2}{r}}$ #

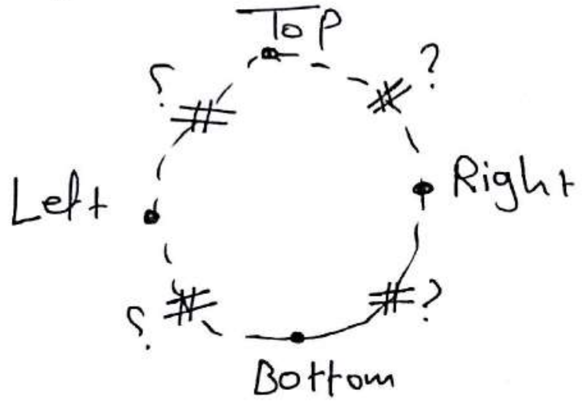


$\sum F_t = m a_t$

$\boxed{mg = m a_t}$ #

#⑤# Case ⑤: In between:

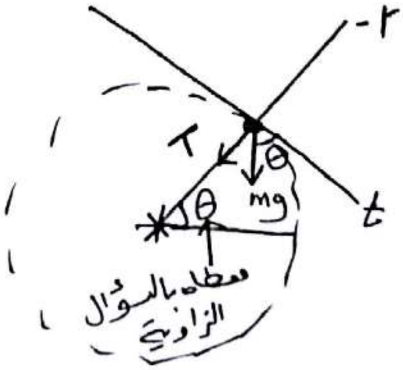
هذه الحالة الأصعب من بين جميع الحالات ؛؛



سأشرح واحدة منهم ولكن بالأسئلة تتمرن على باقي الأماكن.

$\sum F_r = m a_r$

$\boxed{T + mg\sin\theta = \frac{mv^2}{r}}$ #

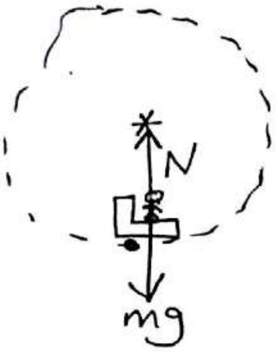


$\sum F_t = m a_t$

$\boxed{mg\cos\theta = m a_t}$ #

E.X: An airplane (طائرة) moves with aspeed of (140 m/s) as it traveles avertical circular loop (حلقة) which has a(1 Km) radius. ⓐ What is the magnitude of the resultant Force on the (70 Kg) Pilot (طيار) of this plane at the bottom of this loop?

Solution: Vertical, case 2 bottom



V = 140 m/s
$r = 1 * 10^3$ m　　حوّلنا من Km الـ m
m = 70 kg
$\sum F_r = ??$

$$\sum F_r = m\underset{\frac{v^2}{r}}{\cancel{a_r}} \rightarrow \sum F_r = \frac{70*(140)^2}{1*10^3} = 1.372 \text{ KN}$$

ⓑ What is the normal Force on the pilot??

$$N - mg = \frac{70*(140)^2}{10^3} = 1.372 \rightarrow N = 2.07 \text{ KN}$$

ⓒ What is the tangentional accěleration when the pilot at bottom?

$$\boxed{a_t = 0} \#$$

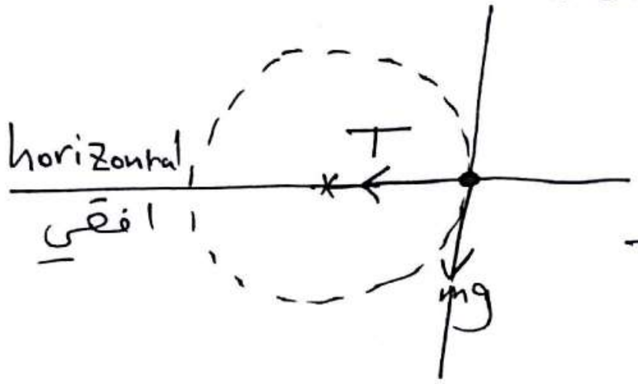
حل

E.X : A (5 Kg) mass attached to the end of String Swings (يتأرجح) in a vertical circle (r = 2m), when the String is horizontal, the speed of the mass is (8 m/s) ⓐ what is the magnitude of the Force of the String on the mass at this position??

Solution : Vertical, $\underbrace{\text{Case ③ OR ④}}_{\text{horizontal من كلمة}}$, V = 8 m/s

r = 2 m

m = 5 kg



$$\Sigma F_r = \frac{mv^2}{r}$$

$$T = \frac{5 * (8)^2}{2} = 160\ N$$

ⓑ Find the tangentional acceleration at this position?

$$\Sigma F_t = m a_t$$

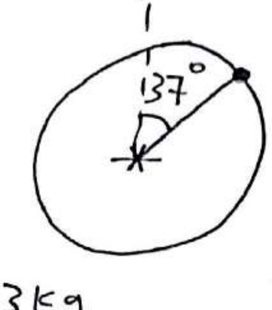
$$\cancel{m}g = \cancel{m}\, a_t \longrightarrow \boxed{a_t = 10\ m/s^2}\ \#$$

« اطلبوا العلم ولو في الصين »

أخوكم عبدالرحمن موافي
0786966993

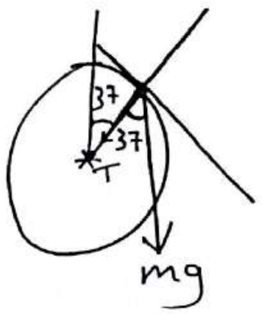
14

E.X: A (3kg) mass attached to the end of String swings in the Vertical Circle, With radius of (2m) as shown in figure. IF at the Position shown ($\theta = 37°$) and the Speed of the mass is (5m/s), what is the tension of the string ??



Solution: Vertical, case ⑤,

m = 3kg
V = 5m/s
r = 2m.



$$\sum F_r = m a_r \qquad \frac{V^2}{r}$$

$$T + mg\cos(37) = m\cancel{a_r}$$

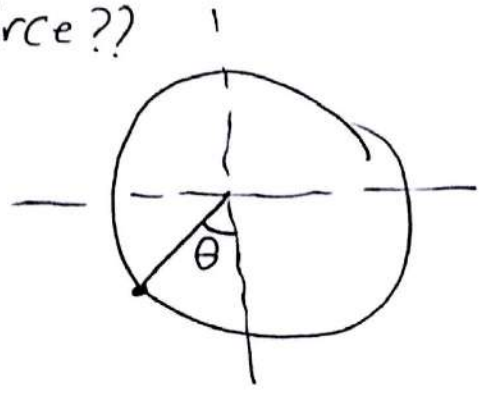
ملاحظة →

$$T + 3*10*\cos(37) = \frac{3*(5)^2}{2}$$

$$T = 13.54N \ \#$$

H.W

E.X: A (0.4 kg) mass attached to the end of String swings in a vertical circle of radius ($r = 0.4m$) as shown. At the instant (لحظة) when ($\theta = 37°$), the speed is (2m/s), what is the magnitude of the tension Force ??



Solu:

$$T = 7.2N \ \#$$

The END

* اسئلة اضافية على chapter [6] :

*** problem ①:** Achiled of mass (m:40 kg) is on aswing of length (2.25m). At the lowest point of this path, his speed is (1.5 m/s), The Force exerted by the كرسي seat on the child is :-

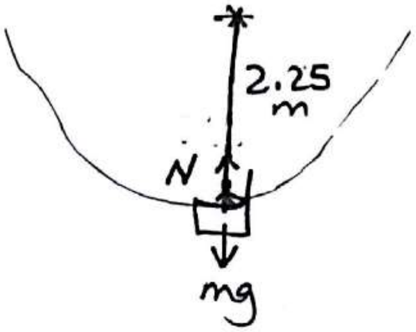
Solu : m:40 kg , r: 2.25m , V: 1.5m/s

$$\Sigma F_r : m a_r$$

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

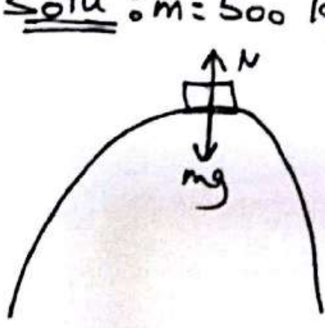
$$N = \frac{40*(1.5)^2}{2.25} + 40*10$$

$$N : 440N \#$$



*** problem ②:** Aroller- coster car has amass of (500 kg) when Fully loaded with ركاب passengers. The car Passes over a تلة hill of radius (15m) as shown. At the top of the hill the car has aspeed of (8m/s). What is the Force of the track on the car ab the top of the hill ?? « in kN ».

Solu : m: 500 kg , r: 15m , V: 8m/s , N:?



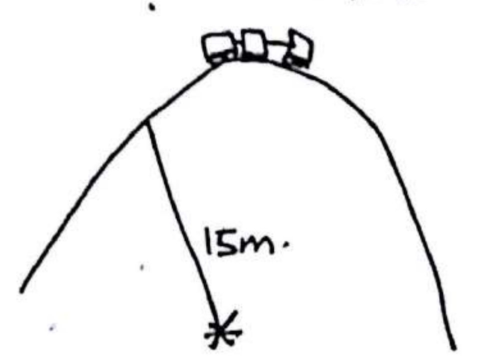
$$\Sigma F_r : m a_r$$

$$mg - N : \frac{mV^2}{r}$$

$$N : 500*10 - \frac{500*(8)^2}{15}$$

$$N : 2.86 \ N$$

.up



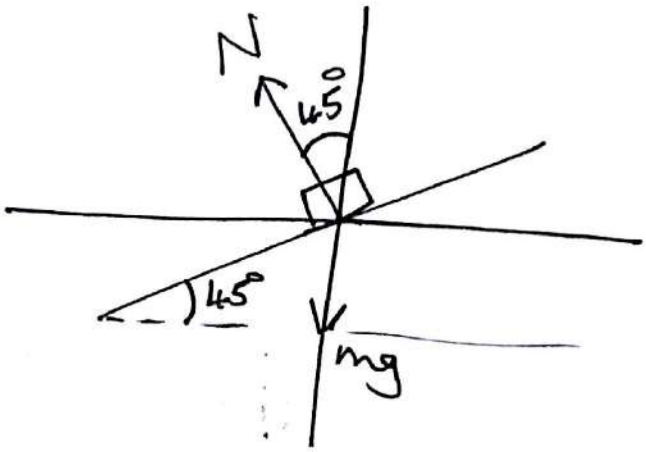
***Problem ③:** A car travels with aspeed of (40 m/s) around abanked track of radius ($r: 0.2$ km), IF the inclination angle is ($\theta: 45^\circ$), what is the magnitude of the resultant Force on the (80 kg) driver of this car??

Solu: $V: 40 m/s$, $r: 0.2$ km, $\theta: 45^\circ$, $F: ?$, $m: 80$ kg.

$$\Sigma F_r = ma_r$$

$$N \sin(45) = \frac{mV^2}{r}$$

$$F = \frac{80 * 40^2}{200} = 640N$$



***Problem ④:** An object moves in acircle, if the mas is tripled and the speed halfed, and the radius unchanged, then the magnitude of the centripeatal Force must be multipled by aFactor of :

A. $\frac{3}{2}$ b- $\frac{3}{4}$

c. $\frac{9}{4}$ d- 6

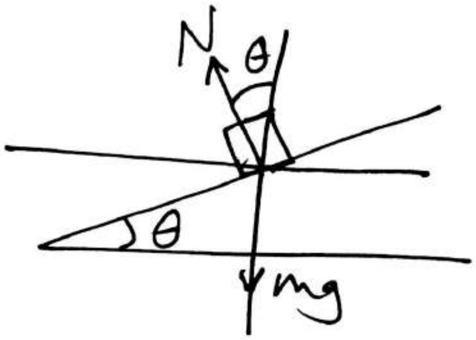
Solu: $F_{r_1} = \frac{m_1 V_1^2}{r_1}$

$$F_{r_2} = \frac{3m_1(\frac{1}{2}V_1)^2}{r_1} = \frac{3m_1 V_1^2}{4r_1}$$

$$\frac{F_{r_1}}{F_{r_2}} \rightarrow \frac{3}{4} \#$$

*Problem ⑤: A curved of radius (60m) is banked at an angle(θ), what is the magnitude of (θ), For which a car can round the curve at a speed of (12 m/s) even if the road is Frictionless??

Solu $r: 60m.,\ V: 12m/s$



$$\Sigma F_r = \frac{mV^2}{r}$$

$$N\sin\theta = \frac{m(12)^2}{60}$$

$$\frac{10\cancel{m}}{\cos\theta} \times \sin\theta : \frac{\cancel{m}(12)^2}{60}$$

$$N\cos\theta = mg$$

$$N = \frac{10m}{\cos\theta}$$

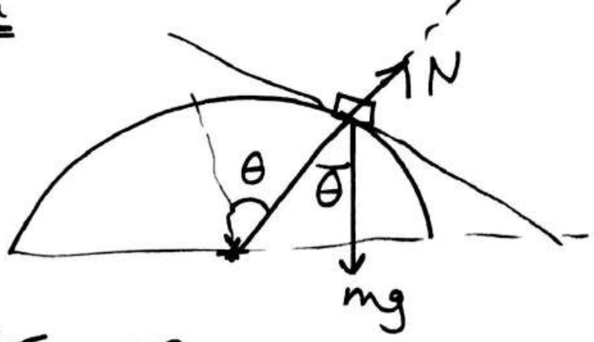
$$\tan\theta = \frac{144}{600}$$

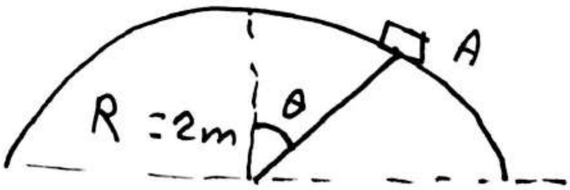
$$\theta : 13.5° \ \#$$

سؤال

*Problem ⑥: IF the Velocity of the (2kg) block at point A is (4 m/s), Find the Normal Force acting on the block when the angle(θ = 37)??

Solu





$$\Sigma F_r = ma_r$$

$$mg\cos\theta - N = \frac{mV^2}{r}$$

$$2*10\cos(37) - N : \frac{2*4^2}{2} \rightarrow N : 0$$

$\overline{18}$ $\boxed{18}$

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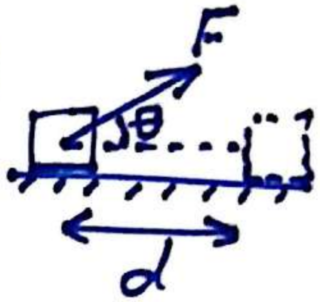
"الشغل والطاقة"

* Chapter $\boxed{7}$: Work and energy:

① Work done by a constant Force:

الشغل المبذول بواسطة قوة ثابتة.

$$\boxed{W = \vec{F} \cdot \Delta\vec{r}} \rightarrow \boxed{W = Fd\cos\theta} \; \#$$



W: Work « الشغل » «Joul»
d: distance.
θ: angle between Force & distance.

*** Note:**

① θ = 90° → W = 0
② θ = 0° → W is positive موجب
③ θ = 180° → W is negative سالب
④ d = 0 $\xrightarrow{}$ W = 0

E.X: A boy احتفظ holds a (40N) Weight at arm's length For (10 second), his arm is (1.5m) above the ground. The work done by the Force of the boy on the Weight is:

Solu: $W = Fd\cos\theta$

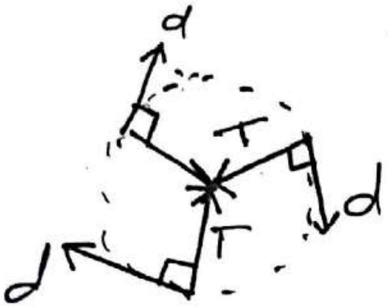
$W = F * \text{Zero} \cos\theta$

$= 0 \; \#$

ولكن هنا لم تتحرك الوزنة
لذلك فإن المسافة المقطوعة
تساوي صفراً $\boxed{d = 0}$

E.X: An object of mass (1 g) is whirled in ahorizontal circle of radius (0.5m) at aconst speed of (2m/s) the work done on the object during one revolution is:

Solu



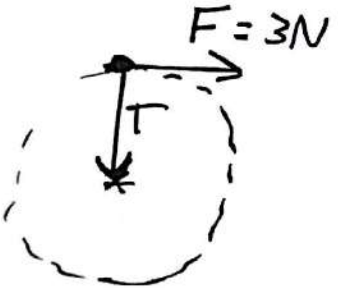
$W = Fd\cos\theta$

$= Fd\cos 90 = 0$

دائماً تكون الإزاحة عمودية على القوة

E.X A (0.5 kg) object moves in ahorizontal circle with aradius of (2.5m). An external Force of (3N), always tangent to the track, couses the object to speed up as it goes around. The work done by the external Force as the mass makes one revolution is:-

Solu:



$d = 2r\pi$ «محيط الدائرة»

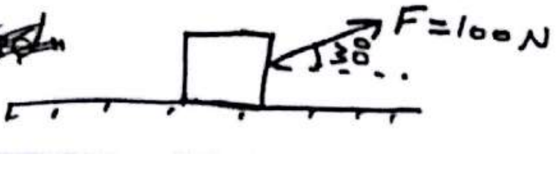
$= 2 * 2.5 * \pi$

$= 15.7m$

$W = Fd\cos\theta$

$= 3 * 15.7\cos(0) = 47.1\ J$ #

E.X: A Force (F=100N) is applied to an object (m=10kg), IF the object is moved adistance (d=10m) on arough horizontal surface ($\mu_K = 0.1$). Find the work done by the Frictinal Force ?? ~~[illegible] speed~~



Solu: $W = F_k d \cos\theta$

$F_k = \mu_k * N$

$= 0.1 * 50 = 5N$

$F \sin\theta + N = mg$

$N = 10*10 - 100 \sin(30)$

$= 50$

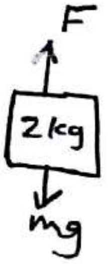
$\therefore W = 5 * 10 * \cos(180)$

$= -50 J$ #

الإشارة السالبة تعني ان القوة عكس الإزاحة .

E.X How much Work is done by aperson lifting a (2 kg) object from the Bottom at aconst speed of (2 m/s) For 5 sec ??

Solu $\boxed{W = Fd\cos\theta}$



const speed
$a = 0$

$\sum F_y = 0$

$F = mg$
$= 20N$

$V = \frac{\Delta y}{t} \rightarrow 2 = \frac{\Delta y}{5} \rightarrow d = 10 m$

$\therefore W = 20 * 10 * \cos(0) = 200 J$

E.X A Force $\vec{F} = 2\hat{i} - 6\hat{j}$ is applied on an object of mass (m = 2 kg), What is the Work done by this Force as the mass moves from the origine to the point (2, 3) ??

Solu $F = 2\hat{i} - 6\hat{j}$, $\Delta r = 2\hat{i} + 3\hat{j}$

$W = \vec{F} \cdot \vec{\Delta r} = (2\hat{i} - 6\hat{j}) \cdot (2\hat{i} + 3\hat{j}) = (2*2) + (-6*3)$

$= 4 - 18 = -14 J.$

② Work done by avariable Force:

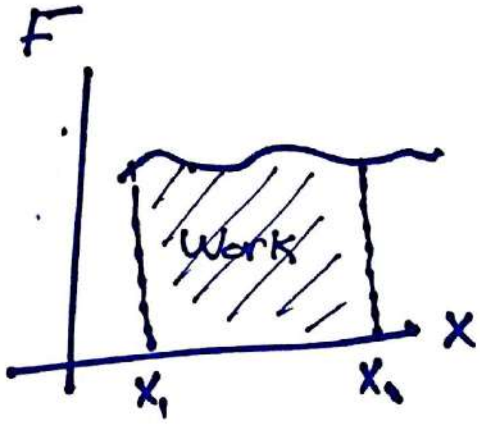
الشغل المبذول بواسطة قوة متغيرة .

$$W = \int_{x_1}^{x_2} F(x)\, dx$$

اذاً اذا اعطيت القوة بالسؤال على شكل اقتران بدلالة x على الصورة F(x)= فاننا نجد الشغل من طريق هذا القانون .

ايضاً

Also:



ايضاً هنالك شكل ٢ ظهر في الأسئلة وهو ان يعطى مثل هذا الشكل بحيث على محور x يكون المسافة (X) وعلى محور y يكون القوة (F) والمساحة تحت المنحنى تمثل الشغل .

* ملاحظة : في اسئلة الرسم يكون المنحنى على شكل منتظم يسهل ايجاد المساحة تحت المنحنى مثل مستطيل او مثلث .

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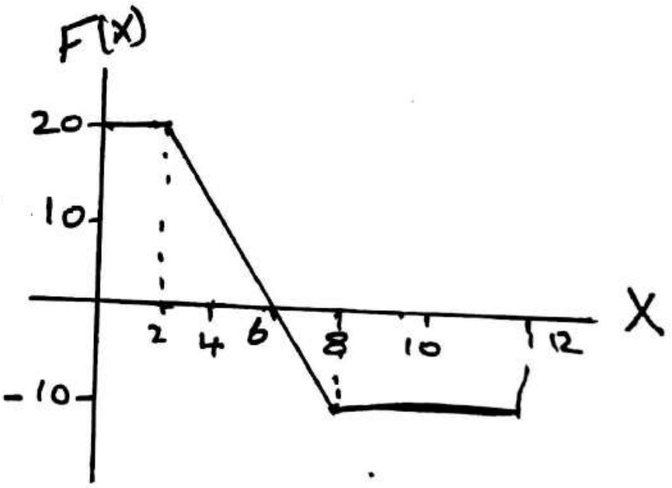
E.X : IF an object moves in asraight line From the origin to $(X=2)$ by a Force $(F=3X)N$. Find the Work done by the variable Force on the object??

Solu $W=\int_{X_1}^{X_2} F(x)\,dx = \int_0^2 3x\,dx = \frac{3}{2}x^2\Big]_0^2$

$= \frac{3}{2}*(2)^2 - 0$

$= 6J$ #

E.X : An object moving along the X-axis is acted uppon by a Force F_x that Varies With position as shown. What Work is done by this Force as the object moves from $(X=2m)$ to $(X=8m)$??



Solu W = Area under the curve.

$W=\left(\frac{1}{2}*4*20\right)-\left(\frac{1}{2}*2*10\right)$

$=40-10=30J$

b) What Work done by this Force as the object moves from $X=8$ to $X=2$.??

Solu $W=\left(\frac{1}{2}*2*10\right)-\left(\frac{1}{2}*4*20\right)=-30J$.

* Spring : النابض "الزنبرك"

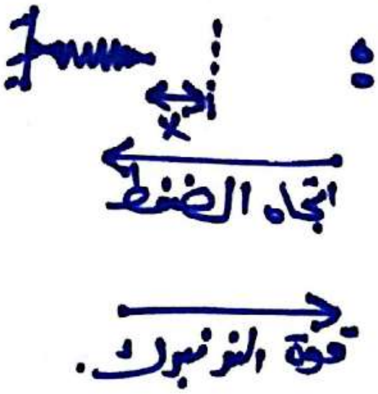
$$\boxed{F_s = -KX}$$

F_s : Spring Force.

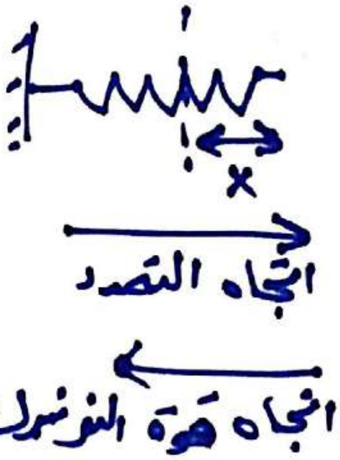
X : $\overset{\text{ضغط}}{\text{compressed}}$/or $\overset{\text{تمدد}}{\text{streched}}$ distance

K : spring const. ثابت النابض

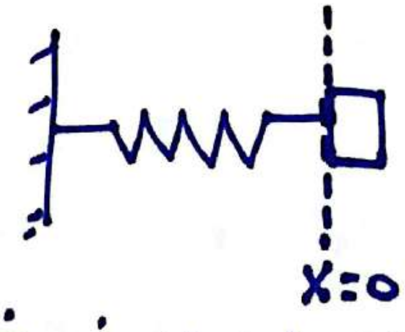
*ملاحظة: الإشارة السالبة لأن قوة الزنبرك دائماً تكون عكس اتجاه تمدده او انضغاطه. فلو ضغط هكذا:



OR



*** Note :**



عندما تكون (X = 0) أي ان الزنبرك غير مضغوط ولا متمدد

تسمى هذه النقطة (equilibrium point).

نقطة التعادل.

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* يوجد نوعين من الطاقة في هذا الشابتر :-

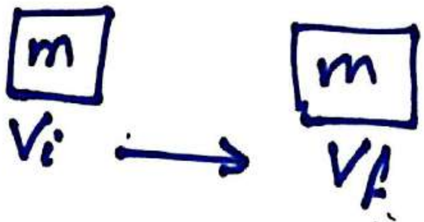
① Kinetic Energy: الطاقة الحركية

- **Energy**: The ability to do work. القدرة على بذل شغل.

- **Kinetic energy**: The energy of motion. $\boxed{K = \frac{1}{2}mV^2}$ #

* Work - Kinetic energy theorem: نظرية الشغل والطاقة الحركية.

$$\boxed{W_{net} = \frac{1}{2}mV_f^2 - \frac{1}{2}mV_i^2}$$



*Note:

① يجوز ان يكون ناتج W_{net} قيمة سالبة.

② وحدة الشغل (Joule) وكذلك الطاقة (Joule).

*Question: The amount of work required to stop amoving object is equal to :-

a. The velocity of the object.

<u>b</u>. The Kinetic energy of the object.

c. The squar of the velocity of the object.

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E.X : When anet Force acts on a (2 kg) mass, the mass changes it's Velocity From $\vec{V_i} = 2\hat{i} - 3\hat{j}$ to $\vec{V_f} : \hat{i} - 5\hat{j}$. What is the net Work done by this Force ??

Solu $W_{net} = \Delta k = \frac{1}{2} m V_f^2 - \frac{1}{2} m V_i^2$

$= \frac{1}{2} * 2 * 5.1^2 - \frac{1}{2} * 2 * 3.6^2$

$= 13 \text{ J}.$

$|V_i| = \sqrt{2^2 + 3^2}$

$= 3.6$

$|V_f| = 5.1$

E.X : A (0.5) kg object moves on ahorizontal circular track With radius of (2.5 m), An external Force of (3 N), Always tangent to the track, causes the object to speed up. as it goes around. IF it starts From rest what is it's speed ab the end of one revolution ??

Solu : $W_{net} = \frac{1}{2} m V_f^2 - \cancel{\frac{1}{2} m V_i^2}$

rest

$W_{net} = \frac{1}{2} m V_f^2$, $W_{net} = F d \cos\theta = 47.1 \text{ J}$

"مثال سابق"

$47.1 = \frac{1}{2} * 0.5 * V_f^2$

$V_f = 13.7 \text{ m/s}$

E.X : An object on ahorizontal surface moving with initial Velocity ($V_i = 10$ m/s) stops due to Friction after it has moved adistance ($d = 10$m), Find the coefficent of Kinetic Friction.??

solu : $*W_{net} = \Delta K = \frac{1}{2} m V_f^2 - \frac{1}{2} m V_i^2$

$$= \frac{1}{2} * m * 0 - \frac{1}{2} * m * 10^2$$

$$W_{net} = -50m$$

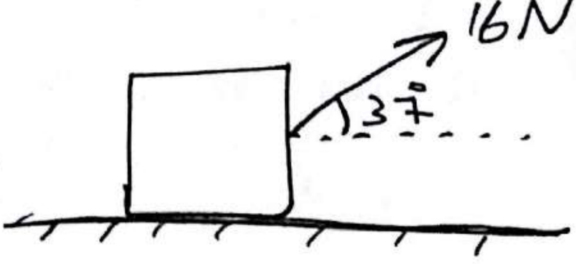
$*W_{net} = F d \cos\theta$

$-50m = F * 10 \cos(180) \rightarrow F = 5m$

$* F = \mu_k * N$

$5\cancel{m} = \mu_k * \cancel{m}g \rightarrow \mu_k = \frac{5}{10} = 0.5$ #

E.X A (3kg) block is dragged over arough horizontal surface by aconstant Force of ($F = 16N$) acting at an angle of (37°) above the horizontal as shown. the speed of the block increases from (4 m/s) to (6 m/s) in adisplacement of (5m). What Work was done by the Friction Force during this displacement?



solu : $W_{net} = \Delta K$

$W_F + W_k = \frac{1}{2} m V_f^2 - \frac{1}{2} m V_i^2$

$16 * 5 * \cos(37) + W_k = \frac{1}{2} * 3 * 6^2 - \frac{1}{2} * 3 * 4^2$

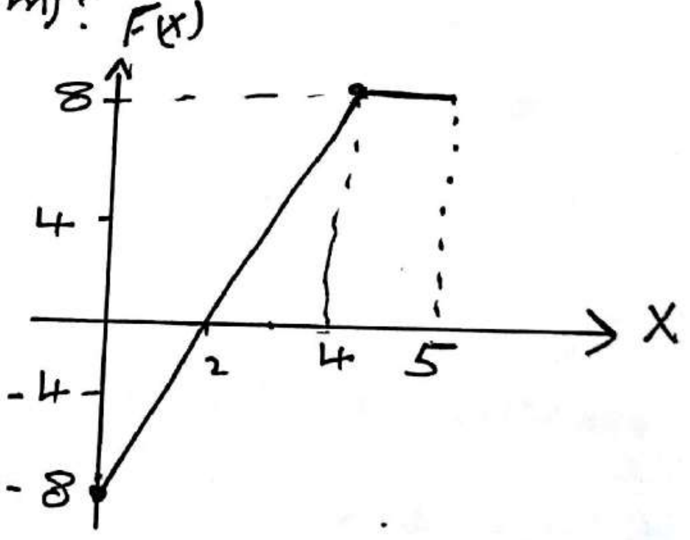
$WK = -34 J.$ #

E.X: IF the resultant Force acting on a (2 kg) object equals to $\vec{F} = \hat{i} + 4\hat{j}$, What is the change in the Kinetic energy as the object moves a displacement $d = 4\hat{i} - 13\hat{j}$??

Solu $W_{net} = \Delta k$

$$W_{net} = \vec{F} \cdot \vec{d} = (\hat{i} + 4\hat{j}) \cdot (4\hat{i} - 13\hat{j}) = 4 - 52 = -48 J$$

E.X: The only Force acting on a (1.6 kg) body as it moves along X axis is given in the figure. IF the Velocity of the body at (X = 2m) is (5 m/s), what is the kinetic energy at (X = 5m)?



Solu: $W_{net} = \Delta k$

$$\frac{1}{2} * 2 * 8 + (1 * 8) = K_f - \frac{1}{2} * 1.6 * 5^2$$

$$K_f = 36 J \ \#$$

E.X A (2 kg) body moving along the X-axis has a velocity (V = 5) at (X = 0), the only Force acting on the object is given by F = −4X , For What Value of X will this object First come momentarily to rest??

$$W_{net} = \Delta k = 0 - K_i$$

$$\int_0^X -4X = -\frac{1}{2} * m * V_i^2$$

$$\left\{ \ 4\frac{X^2}{2} \Big|_0^X = 25 \rightarrow X^2 = \frac{25}{2} \right.$$

$$X = 3.53 \text{ m} \ \#$$

② Potential Energy:

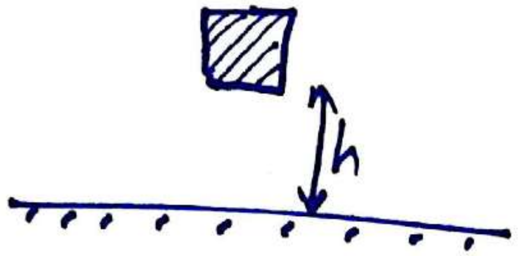
طاقة الوضع
أو الطاقة الكامنة

* Two Types:

1 Gravitational potential energy:

$$\boxed{U_g = mgh}$$ #

- m: mass
- g: ⑩ m/s²
- h: distance above reference point نقطة مرجعية



* أي أن أي جسم موجود على ارتفاع معين فإنه يملك طاقة وهذه الطاقة تسمى بطاقة الوضع.

2 Elastic Potential energy (spring):

$$\boxed{U_s = \frac{1}{2} K X^2}$$ #

K: spring const.

X: compressed or streched distance.

$$\boxed{W_s = -\Delta U_s = \frac{1}{2} K X_i^2 - \frac{1}{2} K X_f^2}$$ الشغل الذي تبذله قوة الزنبرك

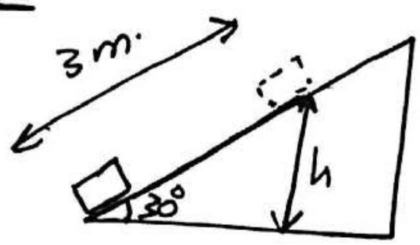
$$\boxed{W_F = \Delta U_s = \frac{1}{2} K X_f^2 - \frac{1}{2} K X_i^2}$$ الشغل الذي تبذله القوة الخارجية

*Q: In raising an object to a given hight by means of an incline plane, as compared with raising the object vertically, there is a reduction in:

a. work required. b. Friction <u>c.</u> Force required d. distance pushed.

E.X : A (5 kg) block is set into motion up an incline plane. The block comes to rest after travelling (3m) along the incline plane which is inclined at ($\theta = 30^\circ$) Determine the change in the Potential Energy ??

Solu



$\boxed{\Delta U = mgh.}$

$\sin\theta = \frac{h}{3} \rightarrow h = \sin(30) * 3$
$= 1.5m.$

$\therefore \Delta U = 5*10*1.5 = 75 J.$

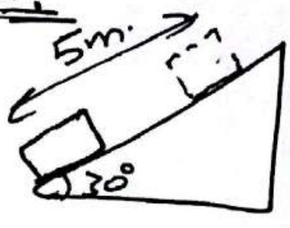
E.X : A (1 kg) block is lifted Vertically (1m) by aboy, What is the Work done by aboy ?? «const speed.»

Solu: $W = Fd\cos\theta$
$= mg*h\cos(0) = 1*10*1 = 10 J.$

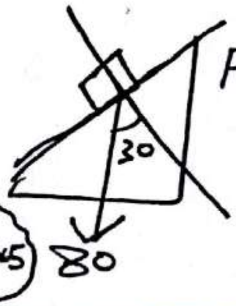
وزن

E.X : A man pushes an (80N) crate adistance of (5m) upword along africtionless slope that makes (30°) with the horizontal The Force he exerts is parallel to the slope. IF the speed of the crate is constant. What is the work done by the man?

Solu:



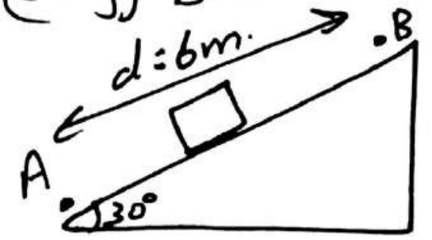
$W: Fd\cos\theta$
$= 40*5\cos(0)$
$= 200 J$



$F = 80\sin30$
$= 40N$

OR $W = mgh$
$= 80*\sin(30)*5$
$= 200 J$

E.X : In the figure shown, the Work done by the gravitantional Force to move a (3 kg) block from Point **A** to Point **B** is:



Solu: $\boxed{W_g = -mgh.}$

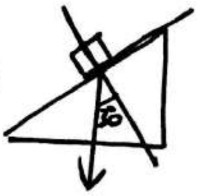
$= -3*10*\sin(30)*6$

$= -90\ J$ #

OR $W = Fd\cos\theta$

$= mg\sin 30*6\cos(180)$

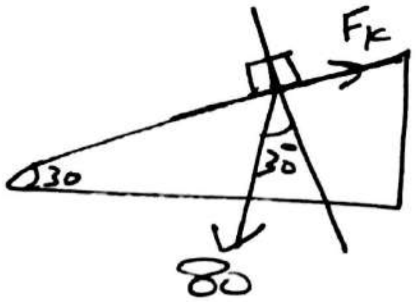
$= -90\ J.$



E.X : An (80 N) slides with a const speed distance of (5 m) downward along a rough slope, that makes an angle ($\theta = 30°$) With the horizontal, What is the Work done by the Force of gravity??

Solu: $W_g = mgh = 80*5*\sin30 = 200\ J.$

OR



$W = Fd\cos\theta.$

$= 80\sin(30)*5*\cos(0)$

$= 200\ J.$

E.X The Force an ideal spring exerts on an object is given by ($F_x = -kx$), Where x measures the displacement of the object from it's equilibrium Position. IF $k = 60\,N/m$ how much Work is done by this Force as the object moves from ($x = -0.2m$) to ($x = 0$)??

Solu Variable Force.

$$W = \int_{x_i}^{x_f} F(x)\,dx = \int_{-0.2}^{0} -60x = \frac{1}{2}*60*(-0.2)^2 - \overset{0}{\cancel{\frac{1}{2}*60*(0)^2}}$$

$$= 30 * 0.04$$

$$= 1.2\,J.$$

E.X: An Ideal spring is hung Vertically from the ceilling When a (2 kg) mass $\overset{\text{معلق}}{\text{hangs}}$ at rest from it, the spring is $\overset{\text{تمدد}}{\text{extended}}$ (6cm) from it's relaxed length. A downward external Force is now applied to the mass to extend the spring an additional (10cm), The Work done by the spring is: While the spring is being extended by the Force

Solu

$$W_s = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$$

$$= \frac{1}{2}*333.33*(0.06^2) - \frac{1}{2}*333.33*(0.16)^2$$

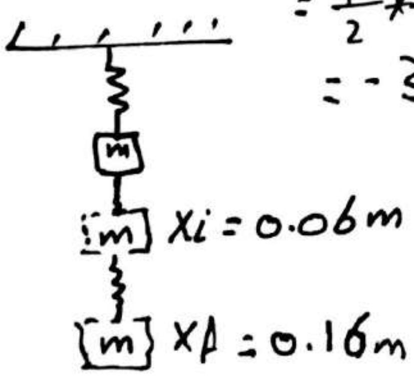
$$= -3.666\,J. \#$$

$F_s = -mg = -20\,N$

$F_s = -k\Delta x$

$-20 = -k*(0.06-0)$

$k = 333.333\,N/m$



Ch. 8

Conservation of energy.

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* بسم الله الرحمن الرحيم *

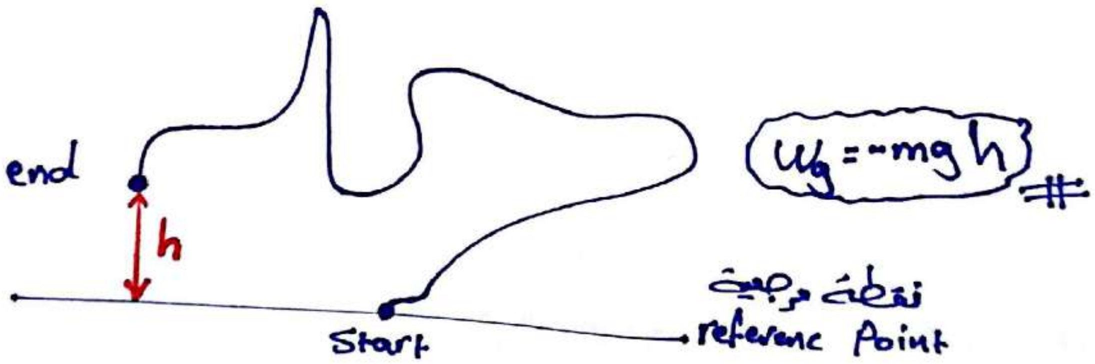
* Chapter $\boxed{8}$: Conservation of energy: مبدأ حفظ الطاقة

→ Conservative and non-conservative Forces:

$\boxed{1}$ Conservative Forces: القوى المحافظة

— The work done is independant of the Path, Just depends on start & end points.

* هذا النوع من القوى، لا يعتمد على المسار الذي يسلكه الجسم، انما يعتمد الشغل فقط على نقطة البداية والنهاية .

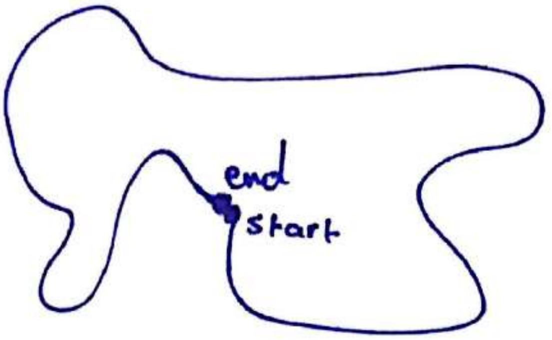


$\boxed{U_g = -mgh}$ #

* الرسمة السابقة توضح ان قوة الجاذبية الأرضية هي قوة محافظة وبالتالي فإن الشغل الذي تبذله لا يعتمد على المسار وانما على نقطة البداية والنهاية وبالتالي (h) .

— The work done throw any closed path is Zero.

* اذا سلك الجسم مسارا مغلقاً فإن الشغل الذي تبذله القوة المحافظة يكون صفراً .



$\boxed{W_g = Zero}$

* اهم الأمثلة على القوى المحافظة (Conservative Forces) :-

① gravitational Force « قوة الجاذبية الأرضية »

② Spring Force « قوة النابض »

2 non-Conservative Force: القوى غير المحافظة

- Depends on the Path.
- The work done throw any closed Path is not Zero

* من اهم الأمثلة على هذا النوع من القوى :-

. « Friction Force »

* Mechanical energy and it's conservation:

$$\boxed{E = K + U}$$ #

E : mechanical energy.

K : Kinetic energy.

U : Potential energy.

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*Law of conservation of Energy: قانون حفظ الطاقة

Energy can be transformed from one to another and From one body to another, but the total amount remains constant.

الطاقة لا تنفذ ولا تُستحدث ولكن تتحول من شكل الى آخر.

① For conservative Force only:

$$\boxed{E_f = E_i}$$

$$K_f + U_f = K_i + U_i \longrightarrow \boxed{\frac{1}{2}mv_f^2 + \overset{mgh_f}{\frac{1}{2}kx_f^2} = \frac{1}{2}mv_i^2 + \overset{mgh_i}{\frac{1}{2}kx_i^2}}$$

*ملاحظة :. اذا وجد بالسؤال فقط قوة جاذبية ولم يكن يحتوي على زنبرك فإن القانون يكون $\left(\frac{1}{2}mv_f^2 + mgh_f = \frac{1}{2}mv_i^2 + mgh_i\right)$ واذا وجد فقط زنبرك فإن القانون يصبح $\left(\frac{1}{2}mv_f^2 + \frac{1}{2}kx_f^2 = \frac{1}{2}mv_i^2 + \frac{1}{2}kx_i^2\right)$ وقد يكون السؤال يحتوي على القوتين معاً يصبح القانون $\left(\frac{1}{2}mv_f^2 + \frac{1}{2}kx_f^2 + mgh_f = \frac{1}{2}mv_i^2 + \frac{1}{2}kx_i^2 + mgh_i\right)$

مهم

*NOTE: This applies only on system in which only conservative Forces act !!

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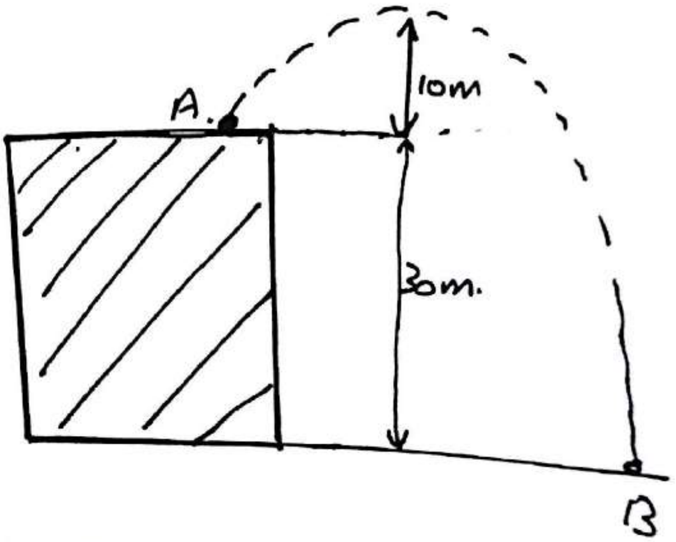
E.X : A 0.04 kg ball is thrown from the top of (30m) building point **A.**, at an unkown angle above the horizontal. AS shown in the Figure. The ball attains amaximum hight of (10m) above the top of the building befor striking the ground at Point B, What is the Value of the kinetic energy of the ball at **B** minus the kinebic energy at point A.?



Solu : $E_i = E_f$

$\frac{1}{2}mV_i^2 + mgh_i = \frac{1}{2}mV_f^2 + mgh_f$

$\Delta K = mgh_i - mgh_f$

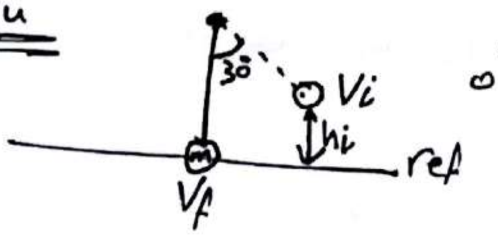
$= 0.04 * 10 * 30 - 0.04 * 10 * 0$

$= 12 J.$

''1P.Pe

E.X : A Pendulum is made by letting a (2kg) object swing at the end of astring that has alength of (1.5m). The maximum angle the string makes with the Vertical as the pendulum swings is (30°). What is the speed of the object at the lowest point?

Solu

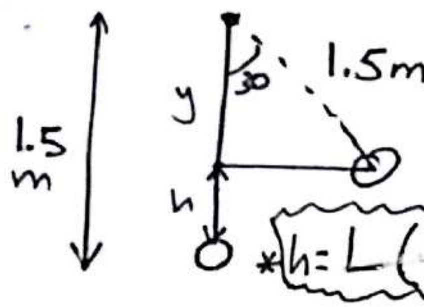


$E_i = E_f$

$\overset{0}{\cancel{\frac{1}{2}mV_i^2}} + mgh_i = \frac{1}{2}mV_f^2 + \overset{0}{\cancel{mgh_f}}$

$0 + 2 * 10 * h_i = \frac{1}{2} * 2 * V_f^2 + 0$

يلزمنا حساب hi



$\cos(\theta) = \frac{\text{المجاور}}{\text{الوتر}}$

$\cos(30) = \frac{y}{1.5} \rightarrow y = 1.3\,m.$

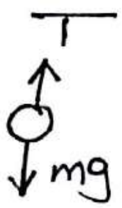
#

$*\,h = L(1-\cos\theta)$ $\therefore h = 1.5 - 1.3 = 0.2\,m.$

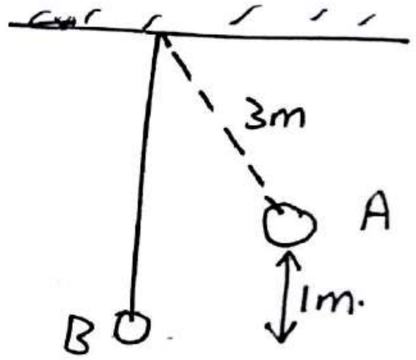
$\therefore 20 * 0.2 = V_f^2$ $V_f = 2\,m/s$ #

E.X : A (0.15 kg) ball is attached to the end of astring as shown. Find the tension in the string at the lowest point (Point B) if it released from rest at point A

Soln



circular motion



$\cdot \sum F_r = \frac{mV^2}{r}$

$T - mg = \frac{mV^2}{r}$ we need V.

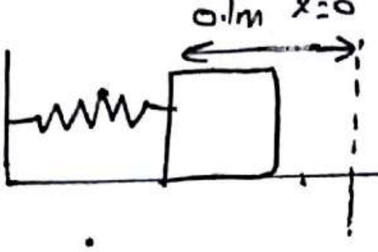
$E_i = E_f \rightarrow \cancel{\frac{1}{2} m V_i^2} + mgh_i = \frac{1}{2} m V_f^2 + mgh_f$

$0 + 0.15 * 10 * 1 = \frac{1}{2} * 0.15 V_f^2 + 0$

$V_f = 4.47\,m/s$

Now : $T - (0.15 * 10) = \frac{0.15 * 4.47^2}{3}$ $T = 2.5N$ #

E.X : A horizontal spring (k=360 N/m) is compressed (10cm) and ablock of Wood With mass (0.4 kg) is then placed against the Free end of the spring. If the spring is released, What will be the velocity of the block when it separates from the spring at (X=0 cm)?!



$$E_i = E_f \quad \#$$

$$\frac{1}{2}mV_i^2 + \frac{1}{2}kX_i^2 = \frac{1}{2}mV_f^2 + \frac{1}{2}kX_f^2$$

$$0 + \frac{1}{2}*360*0.1^2 = \frac{1}{2}*0.4*V_f^2 + 0$$

$V_f = 3 m/s$ #

H.W

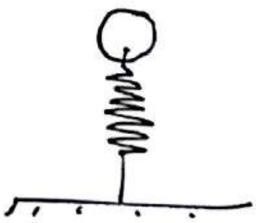
E.X: A (2 kg) block is attached to ahorizontal ideal spring With aspring const of (200 N/m), When the spring has it's equilibrium length the block is given aspeed of 5m/s, What is the maximum Job elongation of the spring?

Solu: 0.5m

E.X: A (0.2 kg) ball is shot from aspring from aspring of (K=400N/m), if the spring is compressed by (0.05m). How hight can the ball reach if the spring Vertically?

Solu $E_i = E_f$

$$\frac{1}{2}mV_i^2 + \frac{1}{2}kX_i^2 + mgh_i = \frac{1}{2}mV_f^2 + \frac{1}{2}kX_f^2 + mgh_f$$



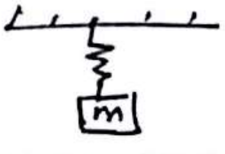
$$0 + \frac{1}{2}*400*0.05^2 + 0 = 0 + 0 + 0.2*10*h_f$$

$h_f = 0.25m$ #

H.W

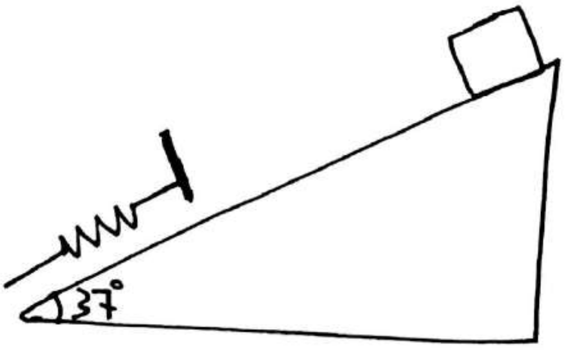
E.X: A spring (K = 200N/m) as shown. An object is attached to the lower end and released from rest. What is the speed of the object after it has Fallen (4 cm)?

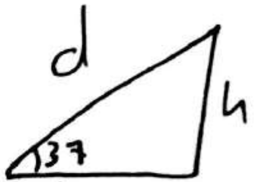
Solu: $V_f = 0.8 m/s$



E.X A (1kg) block is released from rest, at the top of frictionless incline, that makes an angle of (37°). An unkown distance down the incline from the point of release, there is aspring with (k = 200 N/m). It is observed that the mass is brought momentarily to rest after compressing the spring (0.2 m), What distance does the mass slide from the point of release to rest.??

Solu:





$h = d\sin(37)$

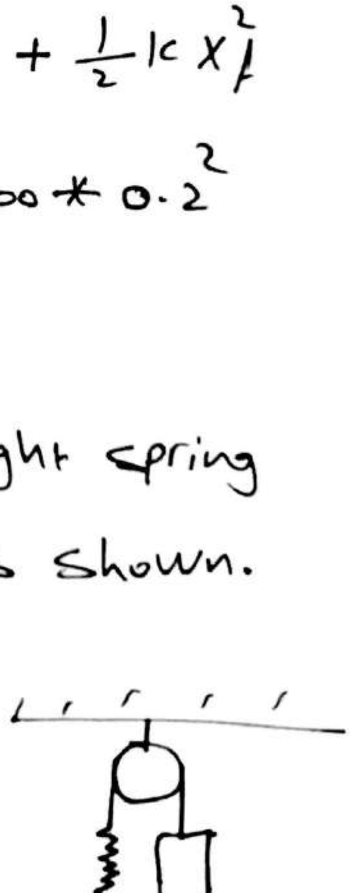
$$E_i = E_f$$

$$\cancel{\frac{1}{2}mV_i^2} + mgh_1 + \frac{1}{2}kX_i^2 = \cancel{\frac{1}{2}mV_f^2} + mgh_f + \frac{1}{2}kX_f^2$$

$$0 + 1*10*d\sin(37) + 0 = 0 + 0 + \frac{1}{2}*200*0.2^2$$

$$d = 0.67m. \#$$

E.X: A (20 kg) mass is fastened to alight spring (k = 380 N/m) that passes over apully as shown. The pulley is frictionless, and the mass is released from rest, when the spring unstretched, After the mass has dropped (0.4 m), What is it's speed??



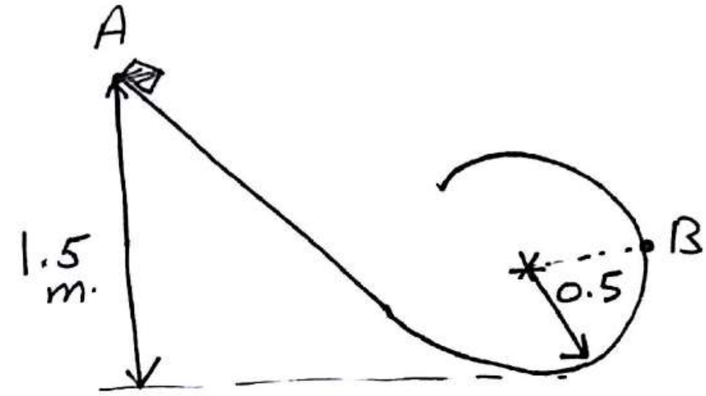
$$E_i = E_f \rightarrow \cancel{\frac{1}{2} m V_i^2} + mgh_i + \frac{1}{2} k x_i^2 = \frac{1}{2} m V_f^2 + mgh_f + \frac{1}{2} k X_f^2$$

$$0 + 20*10*0.4 + 0 = \frac{1}{2}*20 V_f^2 + 0 + \frac{1}{2}*380*0.4^2$$

$V_f = 2.22$ m/s #

سنوات.

E.X : In the Figure shown, the 2 kg block slides From rest at **A** on a smoth truck of radius = 0.5 m, Find the Normal Force acting on the block at **B.**



Solu : $\Sigma F_r = \frac{mV^2}{r}$

$N = \frac{mV^2}{r}$

$N = \frac{2 * 4.47^2}{0.5}$

$= 80 N.$

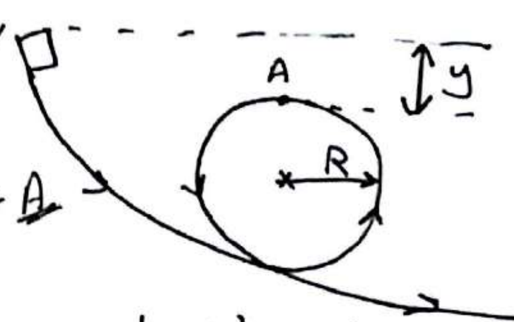
$E_i = E_f$

$\frac{1}{2} m V_i^2 + mgh_i = \frac{1}{2} m V_f^2 + mgh_f$

$0 + 2*10*1 = \frac{1}{2}*2 V_f^2 + 0$

$V_f = 4.47$ m/s

E.X : A small object of mass (m), starts From rest at the Position shown, and slides along Frictionless circular truck, of radius (R), What is the smallest value of (Y) such that the object will slide without lossing contact with the truck?] at Point A



Solu : $\Sigma F_r = \frac{mV^2}{r}$ $\quad n + mg = \frac{mV^2}{r}$ $\quad n = 0$

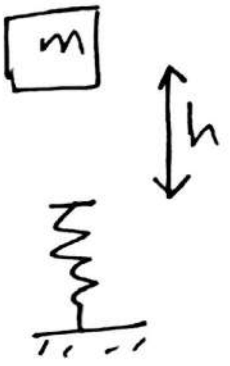
$\cancel{m}g = \frac{\cancel{m}V^2}{R}$ $\quad V^2 = gR$

$\frac{1}{2} m V_i^2 + mgh_i = \frac{1}{2} m V_f^2 + mgh_f$

$0 + mgy = \frac{1}{2} mgR + 0 \rightarrow \boxed{y = \frac{1}{2} R}$

سنوات

E.X: In the Figure shown, if amass $m = 2\,kg$, is dropped downward from ahight $h = 0.2\,m$. above the spring and compressed the spring with maximum distance 5 cm, calculate the spring constant k?



Solu: $E_i = E_f$

$$\frac{1}{2}mV_i^2 + mgh_i + \frac{1}{2}kx_i^2 = \frac{1}{2}mV_f^2 + mgh_f + \frac{1}{2}kx_f^2$$

$$0 + 2*10*0.25 + 0 = 0 + 0 + \frac{1}{2}*K*0.05^2$$

$K = 4000\ N/m.$ #

سنوات

E.X: A (0.5 kg) block slides along ahorizontal frictionless surface at (2m/s). It is brought to rest by compressing avery long spring of spring constant (800 N/m). The max spring compression is:

Solu $E_i = E_f$

$$\frac{1}{2}mV_i^2 + \frac{1}{2}kx_i^2 = \frac{1}{2}mV_f^2 + \frac{1}{2}kx_f^2$$

$$\frac{1}{2}*0.5*2^2 + 0 \quad = 0 + \frac{1}{2}*800*x_f^2$$

$x_f = 5\ cm.$ #

② For conservative & non-conservative Forces:

$$\boxed{E_f = E_i + W_F}$$

W_F : Work done by non-conservative Forces

* Note : W_F يمكن ان تكون رقم موجب او سالب .

حالة خاصة

⊛ Special case : Problem with Friction.

$$\boxed{E_f = E_i - F_k d}$$

* Note : ماذا نقصد بـ "non-conservative" : —

① Friction Force. قوة الاحتكاك

② external Force. قوة خارجية

* Note : ماذا نقصد بـ "conservative" : —

① gravitational Force. قوة الجاذبية

② Spring Force. قوة النابض .

"من جدَّ وَجدَ ، ومن سار على الدرب وصل"

E.X: In agiven displacement of aparticle, it's Kinetic Energy increases by (25J), while it's Potential Energy decreases by (10J). Determine the Work of non-conservative Forces acting on the Particle during this displacement?

Solu:

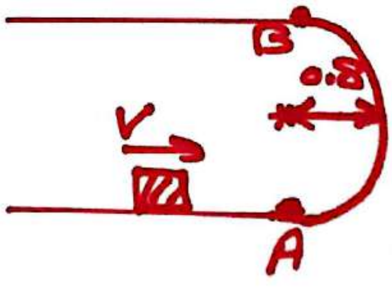
$$E_f = E_i + W_F$$

$$K_f + U_f = K_i + U_i + W_F$$

$$(K_f - K_i) + (U_f - U_i) = W_F \rightarrow 25 - 10 = W_F$$

$$\therefore W_F = 15\text{ J}.$$

E.X: (A1.2 kg) mass is projected up arough acircular track (r = 0.8m) as shown. The speed of the mass at point A is (8.4 m/s) & at B is (5.6 m/s). How much Work is done on the mass between A & B by the Force of Friction??



Solution:

$$E_f = E_i + W_F$$

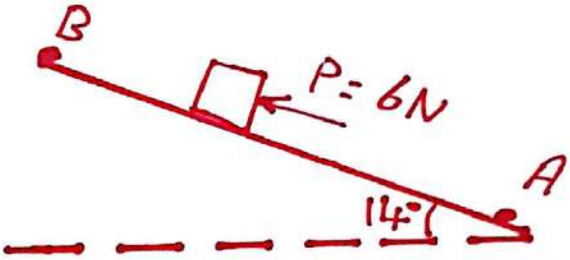
$$\frac{1}{2} m V_f^2 + mgh_f = \frac{1}{2} m V_i^2 + \overset{0}{\cancel{mgh_i}} + W_F$$

$$\frac{1}{2} * 1.2 * (5.6)^2 + 1.2 * 10 * (0.8 + 0.8) = \frac{1}{2} * 1.2 * (8.4)^2 + 0 + W_F$$

$$W_F = -4.32\text{ J}$$

E.X: A (1.4 kg) block is pushed up Frictionless (14°) incline From point A to B by a Force (P=6N) as shown. Points A&B are (1.2m) apart. IF the Kinetic energy of the block at A&B are (3 J) , (4 J) respectively على الترتيب . HoW much work is done by the Force P between A&B ??

Solution:



$$E_f = E_i + \underline{\underline{W_F}}$$

مطلوب.

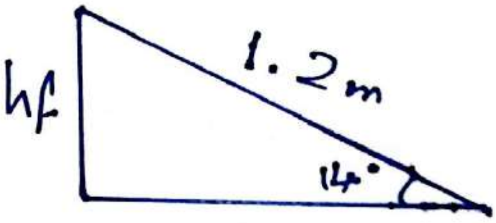
$$\frac{1}{2}mv_f^2 + mgh_f = \frac{1}{2}mv_i^2 + \overset{0}{\cancel{mgh_i}} + W_F$$

دائماً اوطى نقطة بالسؤال نعتبر عندها $\boxed{h=0}$ #

$$4 + mgh_f = 3 + 0 + W_F$$

يجب ان نجد قيمة hf ولكن كيف ؟؟

$$\sin(14) = \frac{h_f}{1.2} \rightarrow h_f = 0.3m.$$



$$\therefore 4 + 1.4 * 10 * 0.3 = 3 + W_F$$

$$W_F = 5.2 \text{ J} \ \#$$

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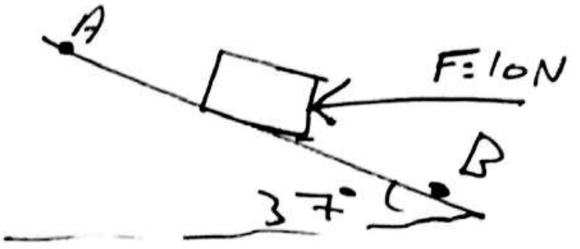
E.X: (4 kg) block is lowered down a (37°) incline a distance of (5m) From point A to Point B. a horizontal Force (F = 10N) is applied to the block between A & B as shown. The kinetic energy of the block at A is (10J) and at B is (20J), How much Work is done on the block by the Force of Friction between A & B?

$E_f = E_i + \sum W_F$

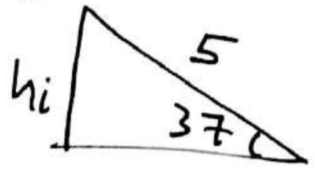


$K_f + U_F = K_i + U_i + W_F + W_{F_k}$

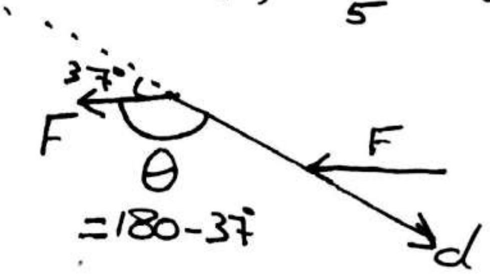
$20 + 0 = 10 + mgh_i + Fd\cos\theta + W_{F_k}$

$20 = 10 + (4*10*3) + (10*5\cos(180-37)) + W_{F_k}$

$W_{F_k} = -70J$ #

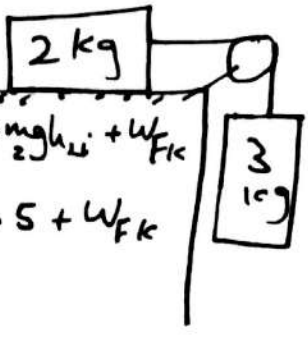


$\sin(37) = \frac{h_i}{5} \rightarrow h_i = 3m$



E.X: The two masses in the Figure are released From rest, after the (3kg) mass has Fallen (1.5m), it is moving with a speed (3.8 m/s) How much Work is done during this time interval by the Frictional Force on the (2kg) mass ??

Solu: $E_f = E_i + W_{F_k}$

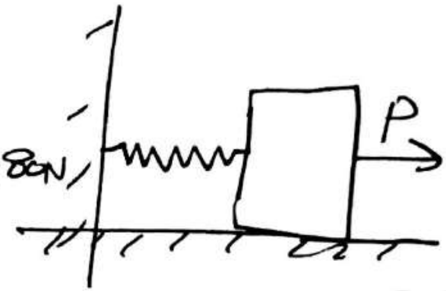


$\frac{1}{2}m_1V_{1f}^2 + \cancel{m}\frac{1}{2}m_2V_{2f}^2 + mgh_{1f} + mgh_{2f} = \frac{1}{2}m_1V_{1i}^2 + \frac{1}{2}m_2V_{2i}^2 + m_1gh_{1i} + m_2gh_{2i} + W_{F_k}$

$\frac{1}{2}*2*3.8^2 + \frac{1}{2}*3*3.8^2 + 0 + 0 = 0 + 0 + 0 + 3*10*1.5 + W_{F_k}$

$W_{F_k} = -8.9 J$ #

E.X: A (10 kg) block on ahorizontal Frictionless surface is attached to the spring (k = 0.8 kN/m). The block is initially at rest at it's equilibrium position when aForce (P = 80N) acting Parallel to the surface is applied to the block. As shown, what is the speed of the block when it's (13 cm) from it's equilibrium position??



Solu: $m = 10\ kg$, $K = 800\ N/m$, $V_i = 0$, $X_i = 0$, $P = 80N$,
$X_f = 0.13m$. $V_f = ??$

$K = 0.8 * 1000$
$= 800\ N/m$ #

$$E_f = E_i + W_p$$

$$\frac{1}{2} m V_f^2 + \frac{1}{2} k X_f^2 = \frac{1}{2} m V_i^2 + \frac{1}{2} k X_i^2 + F d \cos\theta$$

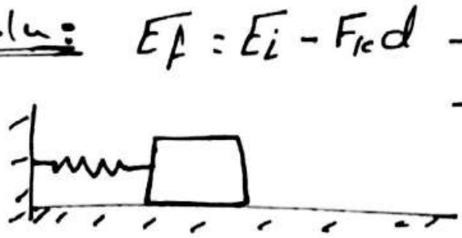
$$\frac{1}{2} * 10 * V_f^2 + \frac{1}{2} * 800 * (0.13)^2 = 0 + 0 + 80 * 0.13 * \cos(0)$$

$$V_f = 0.85\ m/s \ \#$$

E.X: A (1.5 kg) block sliding on arough (خشن) horizontal surface is attached to one end of ahorizontal spring (k = 200N/m) which has it's other end Fixed. IF this system is displaced (20 cm) horizontally From the equilibrium point. and released From rest the block First reaches the equilibrium position with aspeed of (2m/s) What is the coefficient of kinetic Friction between the block & the horizontal surface??

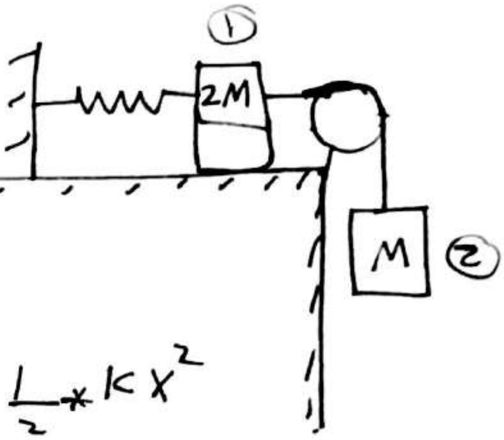
Solu: $E_f = E_i - F_k d \rightarrow \frac{1}{2} m V_f^2 + \frac{1}{2} k X_f^2 = \frac{1}{2} m V_i^2 + \frac{1}{2} k X_i^2 - \mu_k * m g * d$

$$\frac{1}{2} * 1.5 * (2)^2 + 0 = 0 + \frac{1}{2} * 200 * (0.2)^2 - \mu_k * 1.5 * 10 * 0.2$$



$$\boxed{\mu_k = 0.333} \ \#$$

E.X : The block shown are released From rest with the spring unstreched. The pully and the horizontal surface are Frictionless. IF $(k = 400 N/m)$ and $(M = 4.5 kg)$, what is the the maximum extention of the spring??



Solu: $E_f = E_i$

$$\left(\frac{1}{2}m_1 V_1^2 + \frac{1}{2}m_2 V_2^2 + m_1 g h_1 + m_2 g h_2 + \frac{1}{2}k x_1^2\right)_i$$

$$= \left(\frac{1}{2}m_1 V_1^2 + \frac{1}{2}m_2 V_2^2 + m_1 g h_1 + m_2 g h_2 + \frac{1}{2}k x^2\right)_f$$

$$\rightarrow 0 + 0 + 0 + m_2 g h_2 + 0 = 0 + 0 + 0 + 0 + \frac{1}{2} * k x^2$$

$$4.5 * 10 * h = \frac{1}{2} * 400 * h^2$$

$$200h^2 - 45h = 0 \qquad h = 0.225 m$$ #

---

* Relationship between Conservative Forces and Potential energy :

$$\boxed{\Delta U = -\int_{x_i}^{x_f} F(x)\, dx}$$

$$\boxed{F = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} - \frac{\partial U}{\partial z}\hat{k}}$$

E.X : A Potential energy Function For 2-Dimentional Force is of the Form $U(x,y) = 3x^3y - 7x$. Find the Force that acts at the point $(x = 1m, y = 0)$??

Solu: $F = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j}$

$$= -(9yx^2 - 7)\hat{i} - (3x^3)\hat{j}$$

$$\therefore F = 7\hat{i} - 3\hat{j}$$

#

E.X: As aparticle moves along the x-axis it is acted upon by asingle conservative Force given by $F(x) = 20 - 4X$. The Potential energy associated with this Force has the value $(-30\,J)$ at the origin $(x=0)$, What is the value of the potential Energy at $(x = 4\,m)$??

Solu: $\Delta U = -\int_{x_i}^{x_f} F(x)\,dx$

$$= -\int_{0}^{4} 20 - 4X \quad = \quad 20X - 2X^2 \Big|_{4}^{0}$$

$$= -(20*4 - 2*16)$$

$$= -48$$

$$U_f - (-30) = -48 \quad \rightarrow U_f = -78J \ \#$$

سنوات

E.X: The potential energy of (a 2 kg) Particle moving along the x-axis is given by $U(x) = 4X^2 - X^4$. When the particle is at $(x = 2m)$ The magnitude of it's acceleration is:.

Solu: $\sum F = ma$ so we need F

$$F = -\frac{dU}{dX}\Big|_{X=2m} = 8X - 4X^3 \Big|_{X=2} = 16 - 32 = +16\,N$$

$$+16 = 2*a \rightarrow a = +8\,m/s^2 \ \#$$

---

* **Power:** Rate at wich Work is done or rate at which enrgy is transformed.

معدل الشغل المبذول في وحدة الزمن.

أي معدل انتقال الطاقة في وحدة الزمن.

\#

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$$* \boxed{P_{avg} = \frac{W}{\Delta t}} \qquad \frac{J}{s} \ \# \quad \text{"Watt"}$$

$$* \boxed{P = \vec{F} \cdot \vec{V} = F V \cos\theta} \ \#$$

E.X : A Worker raised aconstruction material of mass ($m: 1000$ kg) to ahight ($h: 10$m) during 30 min, with constant speed. The Power delivered by the worker is:-

Solu : $P = \frac{W}{\Delta t} = \frac{mgh}{\Delta t} = \frac{1000 * 10 * 10}{30 * 60} = 55.55$ Watt.

E.X : A motor $\overset{\text{يسحب}}{\text{pulls}}$ blocks of mass (300 kg) each time with constant speed of 2m/s up word. The power deliverd by this motor to lift the blocks is :

Solu : $P = FV\cos\theta = 300 * 10 * 2 * \cos(0)$

$= 6000$ Watt.

E.X : A Force $\vec{F} = 2\hat{\imath} + 6\hat{\jmath}$ acting on aparticle. What is the power when the speed of this particle is $\vec{V} = 5\hat{\imath} + \hat{\jmath}$??

Solu : $P = \vec{F} \cdot \vec{V} = (2\hat{\imath} + 6\hat{\jmath}) \cdot (5\hat{\imath} + \hat{\jmath})$

$P = 10 + 6 = 16$ Watt.

صوفي

E.X : A (5 N) Force is the only Force acting on the (2 kg) block that starts from rest. At the instant the object has gone (5 m) the rate at Which the Force is doing work is:

Solu : $P = F V \cos\theta$ We need $\underline{V}$ $\begin{cases} \Sigma F = ma \\ 5 = 2a \rightarrow a = 2.5\ m/s^2 \\ V_f^2 = V_i^2 + 2a\Delta x \\ V_f^2 = 0 + 2*2.5*5 \\ V_f = 5\ m/s \end{cases}$

$\therefore P = 5*5*\cos(0)$

$= 25$ Watt.

E.X : A (6 kg) block slides along ahorizontal surface. IF ($\mu_k = 0.2$), at What rate is the Friction Force doing the work at an instant when it's speed is (4m/s)?

Solu : $P = F_k * V * \cos\theta$

$P = \mu_k * N * V * \cos\theta$

$P = 0.2 * 6 * 10 * 4 * \cos(180)$

$= -48$ Watt.

H.W

E.X : A (2 kg) block slides down aplane (inclined at 40°) at aconstant speed of (5 m/s). At What rate is the gravitational Force on the block doing Work?)

Solu : 64 Watt.

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[illegible]

Chapter $\boxed{9}$: Linear momentum and collisions:

"الزخم الخطي والتصادمات"

* $\boxed{\vec{P} = m\vec{V}}$

$\vec{P}$: linear momentum.

m: mass of the object.

$\vec{V}$: Velocity of the object.

الزخم.

* momentum: هو مقاومة الجسم لتغير اتجاه حركته.

* Note: ① $\vec{P}$ is a vector parallel to $\vec{V}$

② unit of $\vec{P}$ is: $\frac{kg.m}{s}$ = N.S "unit".

* In 3-dimentions, momentum has 3-component:

$\boxed{P_x = mV_x}$ $\boxed{P_y = mV_y}$ $\boxed{P_z = mV_z}$

* Conservation of linear momentum: "حفظ الزخم"

- For isolated system:
معزول

$$\boxed{\vec{P}_{1i} + \vec{P}_{2i} = \vec{P}_{1f} + \vec{P}_{2f}}$$

$$\boxed{m_1\vec{V}_{1i} + m_2\vec{V}_{2i} = m_1\vec{V}_{1f} + m_2\vec{V}_{2f}}$$

Question:- A Car of mass m_1 traveling at avelocity V Passes acar of mass m_2 Parked at the side of the road. The momentum of the system of two cars is:-

Solu: $P = m_1V_1 + m_2V_2$

$P = m_1V_1 + 0 \qquad \therefore P = m_1V_1$ #

* The total Force acting on amass = The time rate of change in the momentum.

$$\boxed{\sum F_{tot} = \frac{dP}{dt}}$$

E.X: A 2.5 kg stone is released from rest and falls toword Earth, after (4 s), The magnitude of it's momentum is:- "Final momentum"

$V_i : 0 \,,\; g : -10\,m/s^2 \,,\; t : 4\,s.$

$V_f : V_i + gt$

$V_f : 0 - 40 : -40\,m/s$

Solu: $\vec{P} = m\vec{V}$

$\vec{P} = 2.5 * -40$

$= -100 \; \frac{kg.m}{s}$

magnitude is: "100" $\frac{kg.m}{s}$ #

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X : Two bodies A & B, have equal Kinetic energies The mass of A is nine times that of B. The ratio of the momentum of A to that of B is :-

Solu: $K_A = \frac{1}{2} m_A V_A^2$ $\boxed{m_A = 9 m_B}$

$K_B = \frac{1}{2} m_B V_B^2$ **So:** $K_A = \frac{1}{2} * 9 m_B V_A^2$

$K_B = \frac{1}{2} m_B V_B^2$

$$K_A = K_B \rightarrow \cancel{\frac{1}{2}} * 9 * \cancel{m_B} V_A^2 = \cancel{\frac{1}{2}} \cancel{m_B} V_B^2$$

$$\boxed{V_A = \frac{V_B}{3}}$$

So $\frac{P_A}{P_B} = \frac{m_A V_A}{m_B V_B} = \frac{9 \cancel{m_B} * \frac{1}{3} \cancel{V_B}}{\cancel{m_B} \cancel{V_B}}$

$= 3$

$\therefore P_A : P_B = 3 : 1$ #

E.X : A (64 kg) Woman stands on frictionless level ice with a (0.1 kg) stoon at her Feet. She kicks the Ston with her Foot so that she acquires اكتسب a velocity of 0.0017 in the Forward direction. The Velocity ecquired by stone is

Solu $m_1 = 64$ kg

$m_2 = 0.1$ kg

$$P_{1i} + P_{2i} = P_{1f} + P_{2f} \longrightarrow m_1 V_i + m_2 V_{2i} = m_1 V_{1f} + m_2 V_{2f}$$

$$m_1 * 0 + m_2 * 0 = 64 * 0.0017 + 0.1 V_{2f}$$

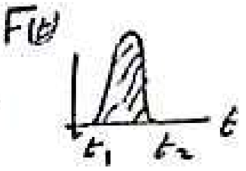
$$V_{2f} = -1.1 \text{ m/s}.$$

Impulse and momentum: "الزخم والإندفاع"

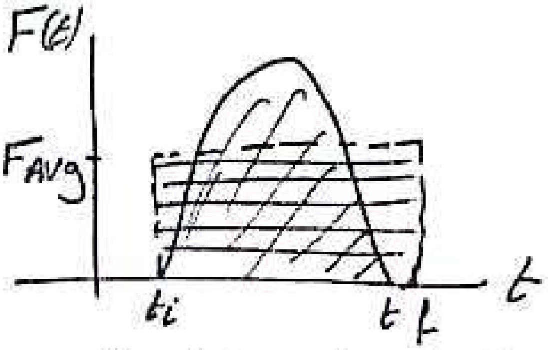
Impulse: . أثر الدفع

$$\boxed{\vec{I} = \Delta\vec{P} = mV_f - mV_i}$$ $\vec{I}$: Impulse.

$$\boxed{I = \int_{t_i}^{t_f} F(t)\,dt} = \text{Area under the curve}$$



So: $\boxed{\vec{I} = \Delta P = F_{Avg}\,\Delta t}$ #

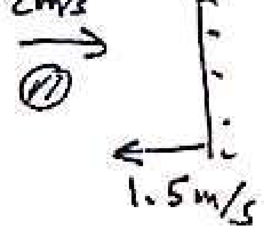


E.X: What magnitude impulse will give a (2 kg) object amomentum change of magnitude $\left(50\ \frac{kg.m}{s}\right)$??

Solu: $I = \Delta P = 50\ \frac{kg.m}{s.}$

E.X: A (1 kg) ball moving at (2 m/s) perpendicular (عمودي) to awall, rebounds (ارتدت) from the wall at (1.5m/s). The change in the momentum of the ball is:

Solu $\Delta P = P_f - P_i = mV_f - mV_i = 1(-1.5 - 2)$
$= -3.5\ m/s.$ #



1 A (1 Kg) object moving with aspeed of (8m/s) collides perpendiculary with awall and emerges with aspeed of (6m/s) in the opposite direction. If the obje is in contact with the wall for (2 ms), what is the magnitude of the average Force on the object by the wal

Solu: $\vec{I} = \Delta P = F_{Avg} \Delta t$

$$\Delta P = m(V_f - V_i) = 1(-6-8) = -14 \ \frac{Kg.m}{s}$$

$$\Delta P = F_{Avg} \Delta t \longrightarrow F_{Avg} = \frac{-14}{2*10^{-3}} = -7 \ KN$$

magnitude is: 7 KN #

=7000N #

E.X: A(1.5 Kg) ball is moving with avelocity of (3m/s) directed (30°) below the horizontal just befor it strickes avertical surface. The ball leaves this surface (0.5 sec) later with avelocity of (2m/s) directed (60°) above the horizontal. What is the magnitude of the average resultant Force on the ball??

$$\Delta P = F_{Avg} \Delta t$$

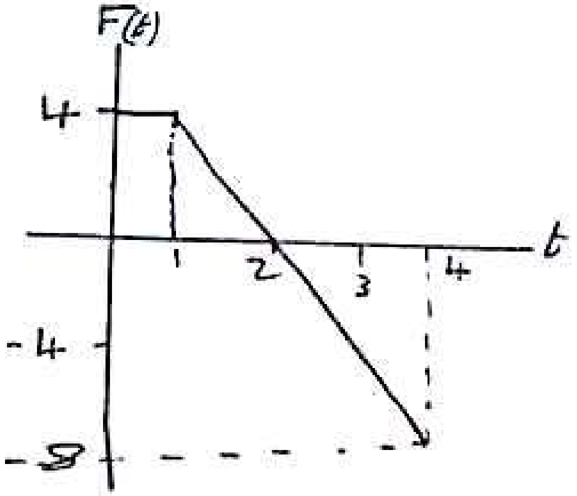
$$(1.5\hat{i} + 2.6\hat{j}) - (3.9\hat{i} - 2.25\hat{j}) = F_{Avg} * 0.5$$

$$F_{Avg} = -4.8\hat{i} + 9.7\hat{j}$$

$$= 10.82 \ N.$$

$$\left\{ \begin{aligned} P_i &= m * V_i \\ &= 1.5(3\cos(30)\hat{i} - 3\sin(30)\hat{j}) \\ &= 3.9\hat{i} - 2.25\hat{j} \\ P_f &= m * V_f \\ &= 1.5(2*\cos(60)\hat{i} + 2\sin(60)\hat{j}) \\ &= 1.5\hat{i} + 2.6\hat{j} \end{aligned} \right.$$

: The only Force acting on a (2 kg) object moving along the X-axis is shown. If the Velocity $V_i = -2 m/s$ at $t = 0$, What is the Velocity at $t = 4$ sec.??



I = Area under the curve

$I = (4 * 1) + (\frac{1}{2} * 1 * 4) - (\frac{1}{2} \times 2 * 8)$

$= 4 + 2 - 8 = -2$ N.s

$I = \Delta P = m(V_f - V_i)$

$-2 = 2(V_f + 2)$

$2V_f = -6 \quad V_f = -3 m/s$ #

E.X: The Force on a particle of mass (2 kg) as a functi of time is given by: $F = (26)\hat{i} - (12t^2)\hat{j}$. What is the magnitude of the impulse given to the particle between $t=1$ & $t=2$?

Solu: $I = \int_{t_1}^{t_2} F(t)\,dt = \int_1^2 26\,\hat{i} - 12t^2\,\hat{j}\,dt$

$= 26t\,\hat{i} - 4t^3\,\hat{j}\Big|_1^2$

$= (52\hat{i} - 32\hat{j}) - (26\hat{i} - 4\hat{j})$

$= 26\hat{i} - 28\hat{j}$

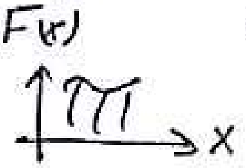
$\therefore I = \sqrt{26^2 + 28^2}$

$= 38.2$ N.s

* ملاحظة:

① $W = \int_{x_i} F(x)\,dx$, $\Delta U = -\int_{x_i} F(x)$

Area under the curve



② $I = \int_{t_i}^{t_f} F(t)\,dt$

Area under the curve

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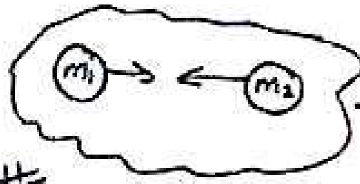
* Collisions: التصادمات

— Momentum is Always conserved For all collisions.

① One dimentional collisions: (Head on):

— In-elastic collisions:

$$m_1 V_{1i} + m_2 V_{2i} = m_1 V_{1f} + m_2 V_{2f}$$ #



* Note: in this Kind of collisions, Some Kinetic energy is lost. $\Delta K \neq 0$, $K_i > K_f$.

— Perfectly in-elastic collisions: ⊛

في هذا النوع من التصادمات يصبح الجسمين بعد التصادم جسماً واحداً.

* Note: in this Kind of collisions, Some Kinetic energy is lost. $\Delta K \neq 0$, $K_i > K_f$.

$$\boxed{m_1 V_{1i} + m_2 V_{2i} = (m_1+m_2) V_f} \#$$

—Elastic collisions :

*-Both Kinetic energy and momentum are conserved.

$$\boxed{m_1 V_{1i} + m_2 V_{2i} = m_1 V_{1f} + m_2 V_{2f}} \#$$

$$\boxed{\frac{1}{2} m_1 V_{1i}^2 + \frac{1}{2} m_2 V_{2i}^2 = \frac{1}{2} m_1 V_{1f}^2 + \frac{1}{2} m_2 V_{2f}^2} \#$$

$$V_{1f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right)\vec{V}_{1i} + \left(\frac{2m_2}{m_1+m_2}\right)\vec{V}_{2i}$$

hsp

$$V_{2f} = \left(\frac{2m_1}{m_1+m_2}\right)\vec{V}_{1i} + \left(\frac{m_2 - m_1}{m_2+m_1}\right)\vec{V}_{2i}$$

*Examples about collisions in one dimention:

E.X: A sphere A has mass m and is moving with Velocity V. It makes ahead-on elastic collision with astationary sphere B of mass 2m. After the collision their speeds are :

Solu: $V_{Af} = \left(\frac{m-2m}{m+2m}\right) V + 0 = \frac{-\cancel{m}}{3\cancel{m}} V = \frac{-1}{3} V \#$

$$V_{Bf} = \frac{2m}{m+2m} V + 0 = \frac{2\cancel{m}}{3\cancel{m}} V = \frac{2}{3} V \#$$

.X : A (6 kg) object moving (5 m/s) collides with and sticks to a (2 kg) object. After the collision the composite (تركيب) object is moving (2 m/s) in adirection that opposite to the initial direction of motion of the (6 kg) object. Determin the speed of the (2 kg) befor the collision;

Solu : Perfectly inelastic : $m_1V_{1i}+m_2V_{2i}=(m_1+m_2)V_f$

$6*5+2*V_{2i}=(6+2)*-2$

$V_{2i}=-23$ m/s #

E.X : An (8 kg) object moving (4 m/s) in the positive x-axis has a one-dimentional collision with a (2 kg) object (3 m/s) in the opposite (عكس) direction. The Final Velocity of the (8 kg) is (2 m/s) in the positive x-axis. What is the total kinetic energy of the two masses after the collision??

Solu : $m_1V_{1i}+m_2V_{2i}=m_1V_{1f}+m_2V_{2f}$ (in-elastic collisions)

$8*4+2*-3=8*2+2*V_{2f}$

$V_{2f}=5$ m/s

$K_{tot\,f}=\frac{1}{2}m_1V_{1f}^2+\frac{1}{2}m_2V_{2f}^2$

$=\frac{1}{2}*8*2^2+\frac{1}{2}*2*5^2$

$=41$ J #

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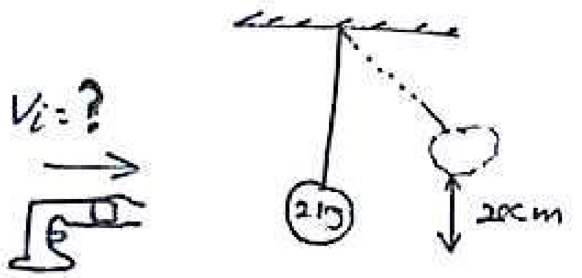
رصاصة

E.X : A (10g) bullet is fired into a (2kg) ballestic Pendulum The bullet remains in the block after the collision and the system rises to maximum hight of (20 cm). Find the initil speed of the bullet !?

Solu



* الحل يكون على خطوتين :

① الخطوة الأولى على مبدأ حفظ الزخم عندما اصطدمت الرصاصة بالكتلة .

② الخطوة الثانية على مبدأ حفظ الطاقة عندما تحرك البندول من النقطة الأولى الى أعلى ارتفاع .

$P_i = P_f$

$m_1 V_{1_i} + m_2 V_{2_i} = (m_1 + m_2) V_f$

$0.01 * V_i + 0 = 2.01 V_f$ ...①

$E_i : E_f$

$\frac{1}{2} m V_f^2 + mgh_i = \frac{1}{2} m V_{ff}^2 + mgh_f$

$\frac{1}{2} * 2 * V_f^2 + 0 : 0 + 2*10*0.2 \rightarrow V_f : 2 \ m/s$

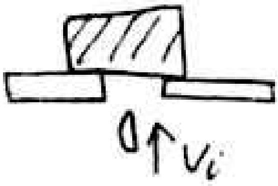
$\therefore 0.01 V_i = 2.01 V_f \longrightarrow V_i = 402 \ m/s$ #

Hw

E.X : A (15 g) bullet moving horizontally with a speed of (500m/s) strikes a (3 kg) block. and embedded in it. if the block is initially at rest on horizontal rough surface ($\mu_k = 0.2$). The horizontal distance that the block and the bullet will move after the collision, befor they come to rest is :

Solu : 1.55 m

E.X : A (10 g) bullet moving (1000m/s) strikes and passes through a (2 kg) block initially at rest as shown. The bull emerges from the block with aspeed of (400 m/s). To what maximum hight will be the block rise above it's initial Position ??



Solu : $P_i = P_f$

$$m_1V_{1i} + m_2V_{2i} = m_1V_{1f} + m_2V_{2f}$$

$$0.01*1000 + 2*0 = 0.01*400 + 2*V_{2f}$$

$$V_{2f} = 3\ m/s$$

Now : $E_i = E_f$

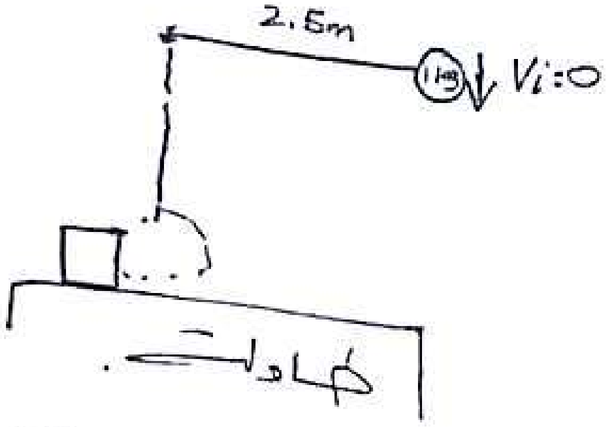
$$\frac{1}{2}mV_i^2 + mgh_i = \frac{1}{2}mV_f^2 + mgh_f$$

$$\frac{1}{2}*2*(3)^2+0 = 0 + 2*10*h_f \rightarrow h_f = 0.45m$$

E.X : A (1 kg) ball is attached to the end of a(2.5m) String to form pendulum. This Pendulum is released from rest with the string horizontal. At the lowest point, the ball collids elastically with a(2 kg) block initially at rest on ahorizontal Frictionless surface. What is the speed of the block Just after the collision??

π

Solu:



$$V_{2f} = \frac{2m_1}{m_1+m_2}\vec{V_{1i}} + \left(\frac{m_2 - m_1}{m_1+m_2}\right)\vec{V_{2i}}$$

و $V_{2i} = 0$

* لإيجاد V_{1i} يجب تطبيق قانون حفظ الطاقة :

$$E_i = E_f \rightarrow \cancel{\tfrac{1}{2}mV_i^2}_{0} + mgh_i = \tfrac{1}{2}mV_f^2 + \cancel{mgh_f}_{0}$$

$$1 * 10 * 2.5 = \tfrac{1}{2} * 1 * V_f^2 \rightarrow V_f = 7.07\ m/s$$

$= V_{1i}$ قبل التصادم

$\therefore V_{2f} = 4.7\,m/s$. #

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② Collisions in 2-Dimention: التصادمات في بعدين

- Same as in one dimention.

⊛ in elastic collision:

$$m_1V_{x_1i} + m_2V_{x_2i} = m_1V_{x_1f} + m_2V_{x_2f}$$

$$m_1V_{y_1i} + m_2V_{y_2i} = m_1V_{y_1f} + m_2V_{y_2f}$$

⊛ Perfectbly inelastic collision:

$$m_1V_{x_1i} + m_2V_{x_2i} = (m_1+m_2)V_{xf}$$

$$m_1V_{y_1i} + m_2V_{y_2i} = (m_1+m_2)V_{yf}$$

⊛ Elastic collision:

$$m_1V_{x_1i} + m_2V_{x_2i} = m_1V_{x_1f} + m_2V_{x_2f}$$

$$m_1V_{y_1i} + m_2V_{y_2i} = m_1V_{y_1f} + m_2V_{y_2f}$$

$$\tfrac{1}{2}m_1V_{1i}^2 + \tfrac{1}{2}m_2V_{2i}^2 = \tfrac{1}{2}m_1V_{1f}^2 + \tfrac{1}{2}m_2V_{2f}^2$$

E.X: A (2 kg) object of Velocity $(3\hat{i}+5\hat{j})$ m/s, collides with (50 kg) object of velocity $(6\hat{i}-4\hat{j})$ m/s, and form one object after the collision, what is the Velocity of the combined object??

Solu: —Perfectly inelastic collision:

$$P_i = P_f \rightarrow m_1V_{1i} + m_2V_{2i} = (m_1+m_2)V_f$$

$$2(3\hat{i}+5\hat{j})+50(6\hat{i}-4\hat{j}) = (50+2)V_f$$

$$V_f = \frac{(6\hat{i}+10\hat{j})+(300\hat{i}-200\hat{j})}{52} \Rightarrow \boxed{V_f = 5.88\hat{i}-3.65\hat{j}} \#$$

E.X: A (2 kg) object moving (3 m/s) Strickes (1 Kg) object initially at rest, After the collision, the (2 kg) object has a velocity of 1.5 m/s directed (30°) from it's initial direction of motion. What is the speed of the (1 kg) object just after the collisi «The collision is inelastic».

Solu: $m_1V_{1i} + m_2V_{2i} = m_1V_{1f} + m_2V_{2f}$

$$2*(3\hat{i}) + 1(0) = 2(1.5\cos(30)\hat{i} + 1.5\sin(30)\hat{j}) + 1(\underset{?}{\underline{\underline{V_{2f}}}})$$

$$6\hat{i} = 2.598\hat{i} + 1.5\hat{j} + V_{2f}$$

$$\therefore V_{2f} = 3.4\hat{i} - 1.5\hat{j}$$

$$|V_{2f}| = \sqrt{(3.4)^2+(-1.5)^2} = 3.7 \text{ m/s}$$

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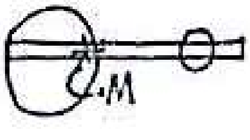
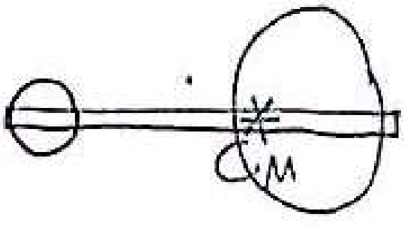
* The Center of mass:





$$* \quad X_{C.M} = \frac{m_1 X_1 + m_2 X_2 + m_3 X_3 + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

***Note :**

$M = m_1 + m_2 + \cdots$

total mass.

$$* \quad Y_{C.M} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3 + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

$$* \quad Z_{C.M} = \frac{m_1 Z_1 + m_2 Z_2 + m_3 Z_3 + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

$$* \quad V_x\,C.M = \frac{m V_{x_1} + V_{x_2} m_2 + V_{x_3} m_3 + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

$$* \quad V_y\,C.M = \frac{m_1 V_{y_1} + m_2 V_{y_2} + m_3 V_{y_3} + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

$$* \quad V_z\,C.M = \frac{m_1 V_{z_1} + m_2 V_{z_2} + m_3 V_{z_3} + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

$$* \quad a_x\,C.M = \frac{m_1 a_{x_1} + m_2 a_{x_2} + m_3 a_{x_3} + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

$$* \quad a_y\,C.M = \frac{m_1 a_{y_1} + m_2 a_{y_2} + m_3 a_{y_3} + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

$$* \quad a_z\,C.M = \frac{m_1 a_{z_1} + m_2 a_{z_2} + m_3 a_{z_3} + \cdots}{m_1 + m_2 + m_3 + \cdots}$$

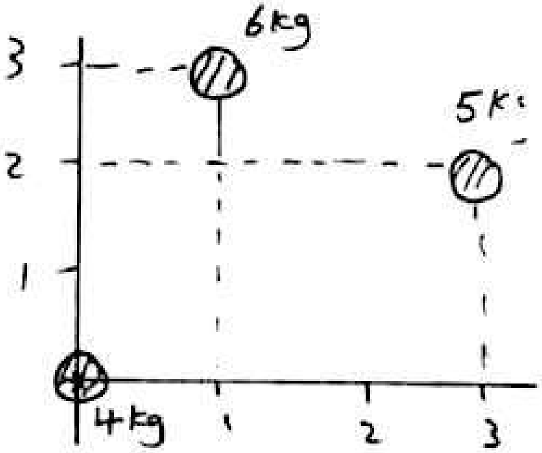
$$* \quad \sum F_{ext} = M a_{c.m} \;\#$$

* **Question:** A projectile of mass (10 kg) was fired with initial Velocity of magnitude 100 m/s with angle (30°). At acertain point it explodes (انفجر) into 10 Pieces of different masses and different directions, The magnitude of the acceleration of the center of mass is:

Solu: $a : g = 10\,m/s^2$ #

* **Note:** ما دام لقوة التي ادت لى انشارهم هي قوة داخلية فإن مركز جميع الكتل سيبقى نفسه وأيضاً السرعة والتسارع .

E.X: The X & Y coordinates of the center of mass of the 3-Particles shown below are:



Solu:

$$X_{CM} = \frac{m_1 X_1 + m_2 X_2 + m_3 X_3}{m_1 + m_2 + m_3}$$

$$= \frac{4 * 0 + 6 * 1 + 5 * 3}{15}$$

$$= 1.4\,m$$

$$Y_{cm} = \frac{m_1 y_1 + m_2 y_2 + m_3 y_3}{m_1 + m_2 + m_3}$$

$$= \frac{4 * 0 + 6 * 3 + 5 * 2}{15} = 1.86\,m.$$

E.X: Block **A** with amass of (4 kg), is moving with aspeed of (2m/s) while Block **B** with amass of (8kg) is moving in the opposite direction with aspeed of (3m/s). The Center of mass of the two block is moving with avelocity of:

Solu: $V_{cm} = \frac{m_1 V_1 + m_2 V_2}{m_1 + m_2} = \frac{(4*2)+(8*-3)}{12} = -1.33\ m/s$

E.X: A (3 kg) mass sliding on africtionless surface explode into 3-(one kg masses), After the explosion the Velocity of the three masses are: (9 m/s, north) (4 m/s, 30° south of west) and (4 m/s, 30° South of east). What was the magnitude of the original Velocity of the 3-kg ??

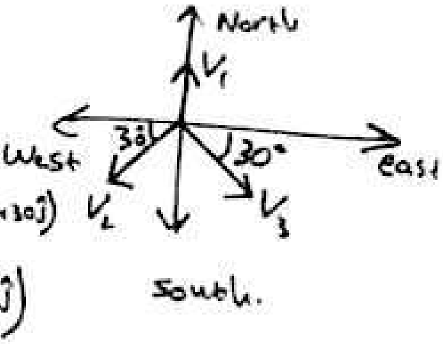
Solu:

$$\boxed{P_i = P_f}$$

$$M V_{cm\,i} = m_1 V_{1f} + m_2 V_{2f} + m_3 V_{3f}$$

$$= m_1 * (9\hat{j}) + m_2 * (4\cos(30)\hat{i} - 4\sin 30\hat{j})$$

$$+ m_3 (4\cos 30\,\hat{i} - 4\sin 30\,\hat{j})$$



$$3 V_{cm} = 5\hat{j} \rightarrow V_{cm} = 1.7\ m/s \ \#$$

E.X: At an Instant when aparticle of mass (50 g) has an accelerati (80 m/s²) in the Positive X-direction, a (75 g) particle has an accelerati of (40 m/s²) in the positive y-direction, What is the magnitude of the acceleration of the center of mass at this instant ??

Solu: $m_1 = 0.05\ Kg,\ a_1 = 80\hat{i},\ m_2 = 0.075\ kg,\ a_2 = 40\hat{j}$

$$a_x C.M = \frac{m_1 a_{x_1} + m_2 a_{x_2}}{m_1 + m_2} = \frac{0.05*80+0}{0.125} = 32$$

$$a_y C.M = \frac{m_1 a_1 y + m_2 a_2 y}{m_1 + m_2} = \frac{0 + 0.075 * 40}{0.125} = 24$$

$$\therefore a_{CM} = 32\hat{i} + 24\hat{j} \longrightarrow |a_{C.M}| = \sqrt{32^2 + 24^2} = 40\ m/s^2 \ \#$$

E.X: Three particles: $(m_1 = 3\,kg)$ $(m_2 = 2\,kg)$ $(m_3 = 1\,kg)$, if the Forces acting on the 3-particles respectively are: $(F_1 = 5\hat{i} + 4\hat{j})$, $(F_2 = -2\hat{i} + 5\hat{j})$, $(F_3 = 3\hat{i})$, What is the acceleration of the center of mass of the 3-particles??

Solu

$$\Sigma F_{ext} = M a_{cm}$$

$$(5\hat{i} + 4\hat{j}) + (-2\hat{i} + 5\hat{j}) + (3\hat{i}) = (3 + 2 + 1)\, a_{cm}$$

$$a_{cm} = \frac{6\hat{i} + 9\hat{j}}{6} = \hat{i} + 1.5\hat{j}$$

$$|a_{cm}| = 1.8\, m/s^2 \quad \#$$

DoNe

مع تمنياتي لكم بالنجاح

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