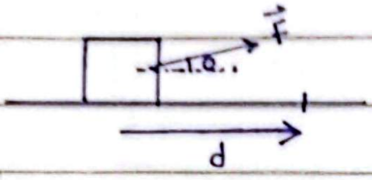
Monday 8/12/2025

$W = \vec{F} \cdot \vec{d}$

$W = Fd\cos\theta$

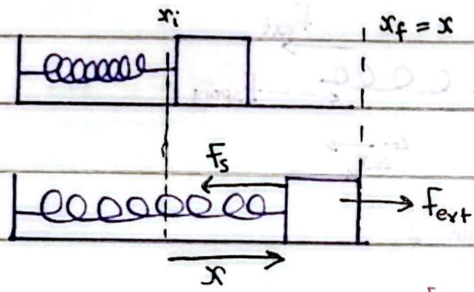


$$\boxed{W_{ext} = \frac{1}{2}k\left(x_f^2 - x_i^2\right)}$$

if $x_f = x$ / $x_i = 0$

$$\boxed{W_{ext} = \frac{1}{2}kx^2}$$ → لو كاتبينها W لحالها يعني W_{ext}

spring



$F_{ext} = kx$ — *موجبة لأنها بنفس اتجاه الإزاحة*

$F_s = -kx$ — *سالبة لأنها بعكس اتجاه الإزاحة*

$$W = \int_{x_i}^{x_f} F_s\, dx$$

$$W = \int_{x_i}^{x_f} -kx\, dx = -k\int_{x_i}^{x_f} x\, dx$$

$$= -k\frac{x^2}{2}\Big|_{x_i}^{x_f}$$

$$\boxed{W_s = -\frac{1}{2}k\left(x_f^2 - x_i^2\right)}$$

*وحدة [k] :-

$F = kx$

$N = [k]\, m$

$[k] = \frac{N}{m}$

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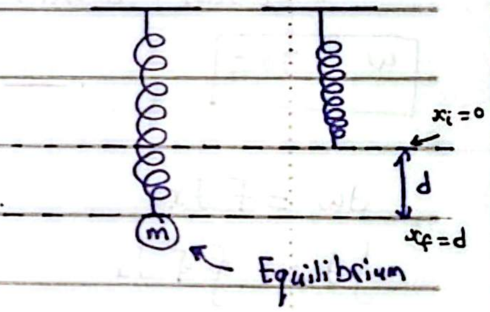
Ex 7.5 :

$d = 2\times10^{-2}$ m

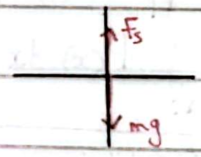
$m = 0.55$ kg

$k = ??$

$W_s = ??$



Sol: $\Sigma F = 0$



*الاتجاه يمثل السالب بما انو معناه ما بنحطه في المعادلة

*$F_s - mg = 0$

$kx = mg$

$$k = \frac{mg}{x} = \frac{mg}{d} = \frac{(0.55)(9.8)}{2\times10^{-2}} = \boxed{2.7\times10^{2}\ \frac{N}{m}}$$

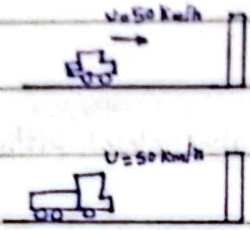
$$*\ W_s = -\frac{1}{2}k\left(x_f^2 - x_i^2\right) = -\frac{1}{2}\left(2.7\times10^{2}\right)\left(2\times10^{-2}\right)^2$$

$$\boxed{W_s = 5.4\times10^{-2}\ J}$$

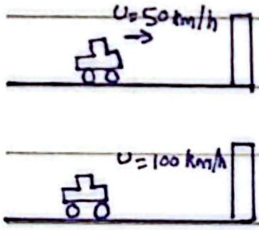
* السالب والموجب في Work معناه زيادة في كمية الطاقة أو نقصها في كمية الطاقة *

$PE = U$ = Potential Energy

Kinetic Energy (K) الطاقة الحركية



* تأثير الشاحنة على الحائط أقوى من تأثير السيارة على الحائط؛ لأن كتلتها أعلى *



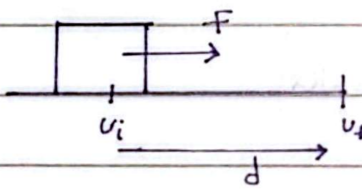
* السيارتين نفس الكتلة لأن السيارة الثانية سرعتها أعلى فيكون تأثيرها على الحائط أقوى من تأثير السيارة الأولى *

$$K = \frac{1}{2} m v^2$$

$$\Delta K = K_f - K_i$$

$$= \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$\boxed{\Delta K = \frac{1}{2} m (v_f^2 - v_i^2)}$$

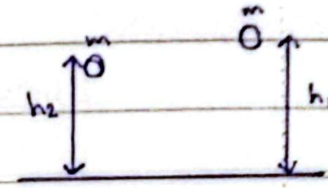


$$\boxed{W = \Delta K}$$

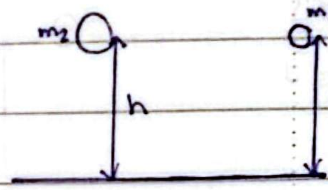
Potential Energy (U) طاقة الوضع

1 by Gravity (U_g)

* الكرتين نفس الكتلة لكن الكرة الأولى المسافة عن الأرض أكبر فـ تأثيرها في الأرض أقوى .



* الكرتين نفس المسافة لكن الكرة الثانية كتلتها أعلى فـ تأثيرها هيكون أقوى .



$$\boxed{U_g = mgh}$$

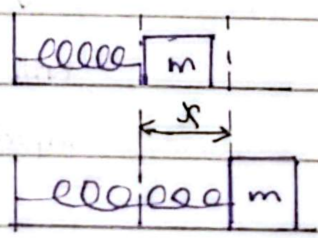
$$\Delta U_g = U_{g_f} - U_{g_i}$$

$$= mgh_f - mgh_i$$

$$= mg(h_f - h_i)$$

$$\boxed{\Delta U_g = mg\Delta h}$$

2 by a spring (U_s)



$$U_s = \frac{1}{2} k x^2$$

$$\boxed{\Delta U_s = \frac{1}{2} k (x_f^2 - x_i^2)}$$

$$\boxed{W = -\Delta U}$$

لأن الطاقة المخزنة

$$\Delta K + \Delta U$$
$$= W + (-W) = 0$$

$$\boxed{\Delta K + \Delta U = 0}$$

النظام معزول [محفوظ]

* النظام (غير محافظ) ← فيه احتكاك *

$h = h$
السرعة $v = 0$
$KE = 0$
$U = 100\,J$

$KE = 30$
$U = 70$

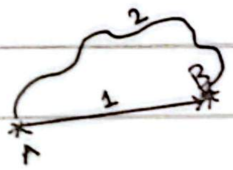
$E = 100\,J$

$KE = 60$
$U = 40$

$KE = 100$, $U = 0$, $h = 0$

system

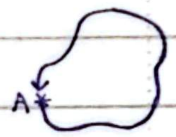
- Conservative محافظ → Path is not important
- non-Conservative غير محافظ → Path is important



⊛ Conservative system

1. independent of path. لا يعتمد
2. if the particle move along closed path. مسار مغلق

$$\Rightarrow \boxed{W_{\text{closed path}} = 0}$$



⊛ non-Conservative

$$\boxed{F_x = -\frac{dU}{dx}}$$

Ex: $U_s = \frac{1}{2} k x^2$

$$F_x = -\frac{dU_s}{dx} = -\frac{d}{dx}\left(\frac{1}{2} k x^2\right)$$

$$= -\frac{1}{2} k (2x)$$

$$\boxed{F_x = -kx}$$

$$\boxed{\Delta K + \Delta U_g + \Delta U_s = -f_k d + W_{app}}$$

f_k: $\mu_k n$ friction

W_{app}: $\vec{F}_{ext}\cdot d$ or $F d \cos\theta$

$$\boxed{(K_f - K_i) + (U_{g_f} - U_{g_i}) + (U_{s_f} - U_{s_i}) = -\mu_k n d + \vec{F}\cdot\vec{d}}$$

$\rightarrow W_s = -\frac{1}{2}k(x_f^2 - x_i^2)$

$\rightarrow W_{ext} = \frac{1}{2}k x^2 \leftarrow x_i = 0,\ x_f = x$

$\rightarrow \Delta K = \frac{1}{2}m(v_f^2 - v_i^2)$

$\rightarrow \Delta K = W$

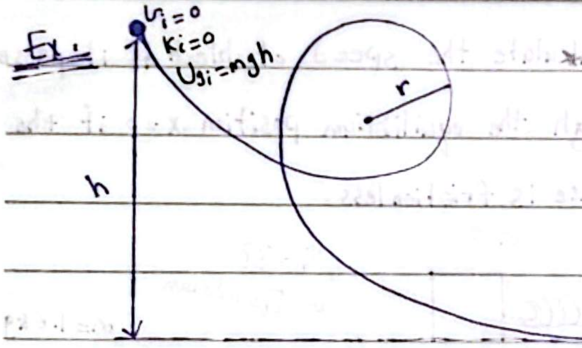
$\rightarrow \Delta U_g = mg\Delta h$

$\Delta U_s = \frac{1}{2}k(x_f^2 - x_i^2)$

$W = -\Delta U$

$\Delta K + \Delta U = 0$

Ex.



$K = \frac{1}{2}m v_f^2$

$v_f = ??$

$U_{gf} = 0$

$h = 0$

* بطلع كل نقطة الحلقة الكلية *

$$\Delta K + \Delta U_g + \cancel{\Delta U_s} = -\cancel{f_k d} + \cancel{W_{app}}$$

$$(K_f - \cancel{K_i}) + (\cancel{U_{gf}} - U_{gi}) = 0$$

$$\frac{1}{2}m v_f^2 - mgh = 0$$

$$\frac{1}{2}\cancel{m} v_f^2 = \cancel{m}gh$$

$$\boxed{v_f = \sqrt{2gh}}$$

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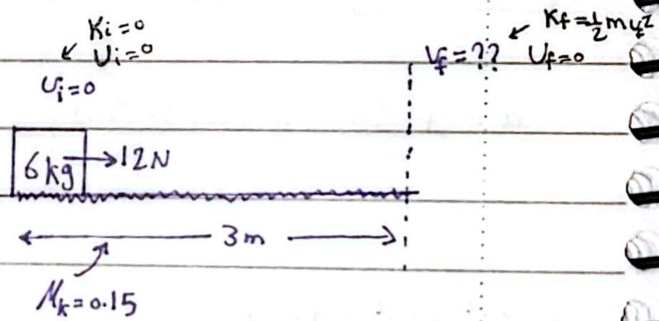
EX 8.4: A 6 kg block initially at rest is pulled to the right along a horizontal surface by a constant horizontal force of 12 N.



$$\Delta K + \Delta U_g + \cancel{\Delta U_s} = -f_k d + \cancel{W_{app}}$$

$$(K_f - \cancel{K_i}) + (\cancel{U_{f_g}} - \cancel{U_{i_g}}) = -\mu_k n d + F d \cancel{\cos\theta}$$

لأنه اذا ما في تغير في الارتفاع = 0

$$\frac{1}{2}m v_f^2 = -\mu_k m g d + F d$$

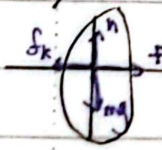
$$\boxed{v_f = \sqrt{\frac{2(-\mu_k m g d + F d)}{m}}}$$

to calculate n

$\Sigma F_y = 0$

$n - mg = 0$

$\boxed{n = mg}$



$$\boxed{v_f = 1.78\ m/s}$$

حل بطريقة ثانية

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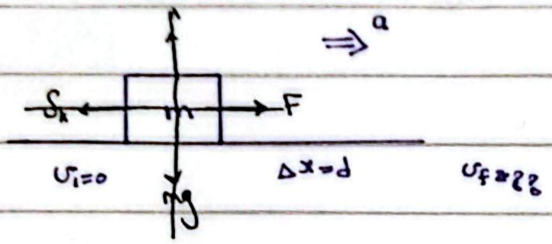
Ex: 8.4] Solve by Newton's law.



$\sum F_y = 0 \Rightarrow \boxed{n = mg}$

$\sum F_x = ma$

$F - f_k = ma$

$\boxed{F - \mu_k n = ma}$

$a = \dfrac{F - \mu_k n}{m} \Rightarrow \boxed{a = \dfrac{F - \mu_k mg}{m}}$

$\rightarrow v_f^2 = \cancel{v_i^2} + 2a\Delta x$

$v_f^2 = 2\left(\dfrac{F - \mu_k mg}{m}\right) d$

$v_f = \sqrt{\dfrac{2(Fd - \mu_k mgd)}{m}}$ نعض القبل

* بس الطريقة (1) اسهل.

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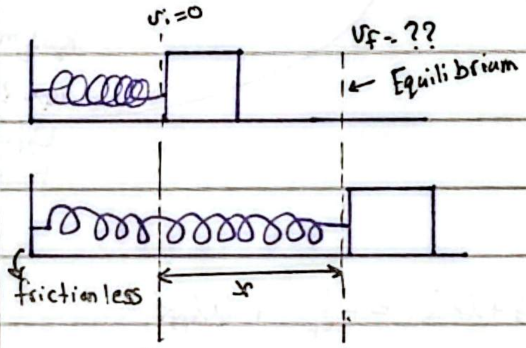
Ex 8.6: A block of mass 1.6 kg is attached to a horizontal spring that has a force constant of 1000 N/m as shown in Figure②. The spring is compressed 2 cm and is the released from rest ($v_i=0$) as in figure.①

(A) Calculate the speed of block as it passes through the equilibrium position $x=0$ if the surface is frictionless.



$m = 1.6\,kg$

$k = 10^3\,N/m$

$x = 2 \times 10^{-2}\,m$

$K_i = 0$ $\qquad$ $K_f = \frac{1}{2} m v_f^2$

$U_s = \frac{1}{2} k x^2$ $\qquad$ $U_s = 0$

لأن الجسم مضغوط

$\Delta K + \cancel{\Delta U_g} + \Delta U_s = -\cancel{f_k d} + \cancel{W_{app}}$

$(K_f - \cancel{K_i}) + (\cancel{U_{sf}} - U_{si}) = 0$

$\frac{1}{2} m v_f^2 - \frac{1}{2} k x^2 = 0$

$\cancel{\frac{1}{2}} m v_f^2 = \cancel{\frac{1}{2}} k x^2 \Rightarrow v_f^2 = \dfrac{kx^2}{m}$

$\boxed{v_f = \sqrt{\dfrac{kx^2}{m}}}$ $\qquad$ $\boxed{v_f = 0.5\,m/s}$

$f_k = \mu_k n d$

* d: المسافة التي يتحرك فيها الجسم بالاحتكاك فقط *

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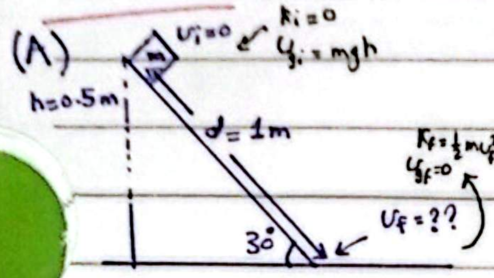
Ex 8.7:

(A)



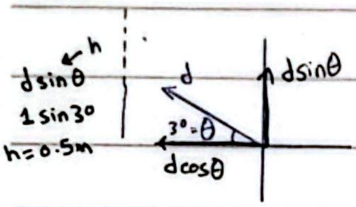
$m = 3 kg$

$v_i = 0$

$f_k = 5N$

$d = 1m$ / $\theta = 30°$

$v_f = ??$



*كيف اوجدنا [h] ؟:

$$\Delta K + \Delta U_g + \cancel{\Delta U_s}^{0} = -f_k d + \cancel{W_{app}}^{0}$$

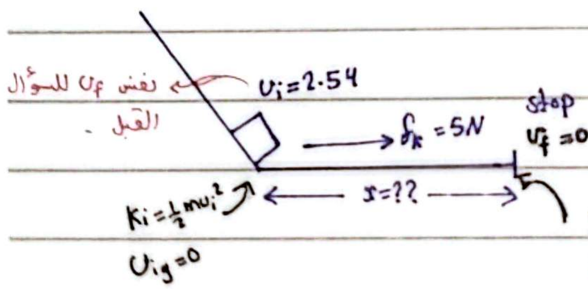
$$(K_f - \cancel{K_i}^{0}) + (\cancel{U_{gf}}^{0} - U_{gi}) = -f_k d$$

$$\frac{1}{2} m v_f^2 - mgh = -f_k d$$

$$\frac{1}{2} m v_f^2 = mgh - f_k d$$

$$\boxed{v_f = \sqrt{\frac{2(mgh - f_k d)}{m}}} \qquad \boxed{v_f = 2.54 \ m/s}$$

(B) if the object moves horizontally until stop.



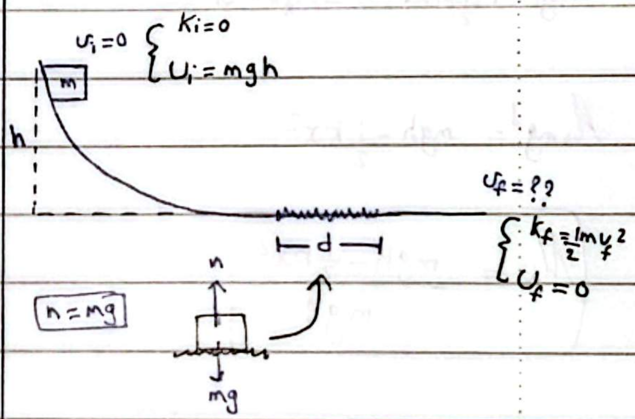
$$\Delta K + \Delta U_g + \cancel{\Delta U_s}^{0} = -f_k d + \cancel{W_{app}}^{0}$$

$$(\cancel{K_f}^{0} - K_i) + (\cancel{U_f}^{0} - \cancel{U_i}^{0})_g = -f_k d$$

$$-\frac{1}{2} m v_i^2 = -f_k d$$

$$\boxed{d = \frac{m v_i^2}{2 f_k}} \qquad \boxed{d = 1.93 \ m}$$

Ex:



$$\Delta K + \Delta U_g + \cancel{\Delta U_s}^{0} = -f_k d + \cancel{W_{app}}^{0}$$

$$(K_f - \cancel{K_i}^{0}) + (\cancel{U_f}^{0} - U_i)_g = -\mu_k n d$$

$$\frac{1}{2} m v_f^2 - mgh = -\mu_k mg d$$

$$\frac{1}{2} \cancel{m} v_f^2 = \cancel{m} gh - \mu_k \cancel{m} g d$$

$$\boxed{v_f = \sqrt{2(gh - \mu_k g d)}}$$

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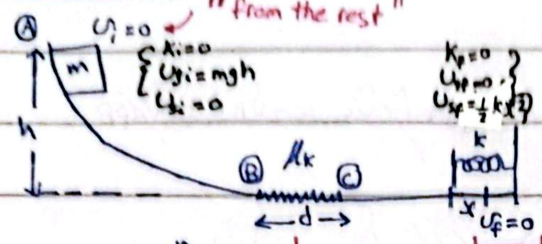
chapter 8 problems



"befor coming to rest momentarily"

قبل أن تتوقف لحظيا .

$h=3m$

$m=10kg$

$d=6m$

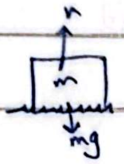
$k=2250\,N/m$

$x=0.3m$

$\mu_k=??$

$\Sigma F_y=0$

$\boxed{n=mg}$



$$\Delta K+\Delta U_g+\Delta U_s=-f_k d+\cancel{W_{app}}^{\,0}$$

$$(\cancel{K_f}-\cancel{K_i})+(\cancel{U_f}-U_i)_g+(U_f-\cancel{U_i})_s=-\mu_k n\,d$$

$$-mgh+\frac{1}{2}kx^2=-\mu_k mg\,d$$

$$\mu_k mgd=mgh-\frac{1}{2}kx^2$$

$$\boxed{\mu_k=\frac{mgh-\frac{1}{2}kx^2}{mgd}}$$

$$\boxed{\mu_k=0.48}$$