Civilittee

اللجنة الأكاديمية للهندسة المدنية

دفتر

فيزياء 1

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physics I - Lesson 1

mass	M	Kg
time	T	Sec
length	L	meter
Temperature	K	Kelven
Charge	e,	Columb
pressure		pascal

Dimensional analysis
تحليل وحدات القياس

* Extra Notes:-

- angle is measured in rad → θ
- $\sin\theta$, $\cos\theta$, $\tan\theta$ ---- → unite less
لا وحدة قياس

$$Speed = \frac{\Delta x}{\Delta t} \Longrightarrow \frac{m}{s} = ms^{-1}$$

$$acceleration = \frac{\Delta V}{\Delta t} \Longrightarrow \frac{\frac{m}{s}}{s} = \frac{m}{s} \cdot \frac{1}{s} = \frac{m}{s^2} = ms^{-2}$$

$$Force = ma \Longrightarrow Kg \cdot m/s^2 = Kg \cdot m \cdot s^{-2}$$

$$pressure = \frac{F}{A} \longrightarrow \frac{N}{m^2} = N \cdot m^{-2}$$

$$\frac{N}{m^2} = \frac{Kg \cdot \frac{m}{s^2}}{m^2} = Kg \cdot \frac{\cancel{m}}{s^2} \cdot \frac{1}{\cancel{m^2}} = \frac{Kg}{ms^2} = Kg \cdot m^{-1} \cdot s^{-2}$$

$$density = \frac{mass}{Volume} \Longrightarrow \frac{Kg}{m^3} = Kg \cdot m^{-3}$$

$$g \cdot cm^{-3}$$

Left hand side (LHS) = Right hand side (RHS)

$$V_f = V_i + at$$

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

$$m/s = m/s + m/s \ ✓$$

* each one of them is a term.

* for the equation to be dimensionally correct it must have equal terms in both sides.

Examples:-

1)

$$x = v_i t + \overset{\text{constant}}{\boxed{1/2}}\, a t^3$$

$$\downarrow \qquad \downarrow \qquad \downarrow$$

$$m = \frac{m}{\cancel{s}} \cdot s + \frac{m}{s^2} \cdot s^3$$

$$\downarrow \qquad \downarrow$$

$$\cancel{m = m + ms}$$

Dimensionally uncorrect.

2) Let the distance for some object given by $x = c_0 + c_1 t + c_2 t^2 + c_3 t^3$ Find the dimensions of $c_1 + c_2 \cdots$

they must be equal

يعني ماهي c_1 ..... اللي بتخلي المعادلة موزونة صحيحة الأبعاد.

$$x = c_0 + c_1 t + c_2 t^2 + c_3 t^3$$

$$\downarrow$$

$$m = m + \frac{m}{\cancel{s}} \cdot \cancel{s} + \frac{m}{\cancel{s^2}} \cdot \cancel{s^2} + \frac{m}{s^3} s^3$$

$c_0 = m$ $\quad c_2 = m/s^2$

$c_1 = m/s$ $\quad c_3 = m/s^3$

3) let the distance for some object given by $x = \frac{1}{2} a^k t^h$ find the value of k & h that fits the equation.

$$x = \overset{\text{constant}}{\boxed{\tfrac{1}{2}}} a^k t^h$$

$$\downarrow$$

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

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

$$m = m^k \cdot s^{-2k} \cdot s^h = 1 = s^0 = 1$$

$$\boxed{k=1}$$

$$-2k + h = 0$$

$$\underset{+2}{-\cancel{2}} + h = \underset{+2}{0}$$

$$\boxed{h=2}$$

4) the acceleration of the circular motion is givin by $a = v^k r^h$. find k & h.

$$a = v^k r^h$$

$$\downarrow$$

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

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

$$\boxed{k=2}$$

$$= m^1 = m$$

$$k + h = 1$$

$$\underset{-2}{\cancel{2}} + h = \underset{-2}{1}$$

$$\boxed{h=-1}$$

HW

1) Find h & K in $t = g^K l^h$ → g = gravity acceleration

$$t = g^K l^h$$

↓

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

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

$$s = s^{-2K} \cdot \underbrace{m^K \cdot m^h}_{= 1 = m^0 = 1} \rightarrow K + h = 0$$

$$-2K = 1$$

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

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

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

9) ⓐ $v_f = v_i + ax$

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

dimentionally uncorrect

ⓑ $y = (2m)\cos(kx) \rightarrow k = \frac{2}{m}$

↓

$$m = m \cdot \cos\left(\frac{2}{\cancel{m}} \cdot \cancel{m}\right)$$

$$m = m \cdot \cancel{\cos 2}$$

$$m = m$$

dimentionally correct

11) $K = \frac{kg \cdot m^2}{s^2}$, $K = \frac{p^2}{2m}$ → momentum, → mass

ⓐ

$$\frac{p^2}{\cancel{2} \cdot kg} = \frac{kg \cdot m^2}{s^2}$$

constant

$$p^2 = \frac{kg^2 \cdot m^2}{s^2}$$

$$p^2 = \left(\frac{kg \cdot m}{s}\right)^2$$

$$p = \frac{kg \cdot m}{s}$$

ⓑ

$$N = kg \cdot \frac{m}{s^2} = \underbrace{kg \cdot \frac{m}{s}}_{p} \cdot \frac{1}{s}$$

$$N = \frac{p}{s}$$

$$p = N \cdot s$$

integration $[\, a \longrightarrow v \longrightarrow x$

derivative $[\, a \longleftarrow v \longleftarrow x$

12)

$$\underset{ma}{\boxed{F}} = \frac{G M_1 m_2}{r^2}$$

$$m^2 \cdot kg \cdot \frac{m}{s^2} = G \cdot \frac{\cancel{kg} \cdot kg}{\cancel{m^2}} \cdot m^2$$

$$\frac{m^3}{s^2} = G \cdot kg$$

$$G = \frac{m^3}{kg \cdot s^2}$$

1) ⓐ

$$x = At^3 + Bt$$

$$m = A \cdot s^3 + B \cdot s$$

$$A = \frac{m}{s^3}, \quad B = \frac{m}{s}$$

ⓑ

$$\boxed{\frac{dx}{dt}} = 3At^2 + B$$

$$\boxed{V} = 3 \cdot \frac{m}{s^3} \cdot s^2 + \frac{m}{s}$$

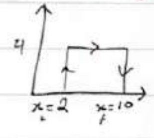
$$\frac{m}{s} = \frac{m}{s} + \frac{m}{s}$$

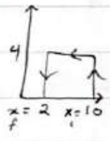
19/10/2020

motion in one dimension - L2

position:- الموضع

Displacement الإزاحة $\Delta x = x_f - x_i$
Change in position





$\Delta x = 10-2$
$= \textcircled{+}8$
$D = 4+8+4$
$= 16$

$\Delta x = 2-10$
$= \textcircled{-}8$
$D = 4+8+4$
$= 16$

Distance المسافة
total distance traveled

- * Displacement is a vector quantity.
- * Distance is a scalar quantity.

* Displacement has a magnitude & direction & it could be +ve, -ve, zero.

* Distance has only magnitude & it is allways +ve.

* Distance $\geq \Delta x$

Average velocity
displacement per unite of time

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

* Could be (+, -, 0) cause Δx could be that & it affects it.

Average speed
distance per unite of time

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

* has only magnitude & allayse (+).

Instantaneouse velocity - السرعة اللحظية

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$ is the diffenition of derivative.

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

slope of the tangent line

average acceleration
change in velocity per unite of time

$$\bar{a} = \frac{\Delta \bar{v}}{\Delta t}$$ could be (+, -, 0) so the $\bar{a}$ could be that too.

Instantaneous acceleration

$$a = \lim_{\Delta t \to 0} \frac{\Delta \bar{v}}{\Delta t} = \frac{dv}{dt} = \frac{d}{dt}(v)$$
$$= \frac{d}{dt}\left(\frac{dx}{dt}\right) = \frac{d^2x}{d^2t}$$

لأن التسارع هي المشتقة 2 لل x -

19/10/2020 Equations of motion with Constant acceleration

* To drive Equations of motion we must consider that the acceleration & the mass are constant

STEPS

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

2) $a \cdot dt = dv$
$dv = a dt$

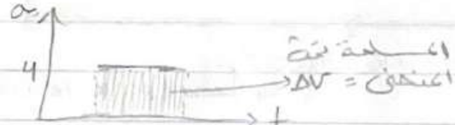
3) $\int_{v_i}^{v_f} dv = \int_{t_i}^{t_f} a dt$

4) $v\Big|_{v_i}^{v_f} = at\Big|_{t_i}^{t_f}$

$$\overbrace{v_f - v_i}^{\Delta v} = \overbrace{\text{Area under the graph of } a \overset{vs}{\&} t}^{a \cdot dt}$$

$(v_f - v_i) = a(t_f - \cancelto{0}{t_i})$

$\boxed{v_f = v_i + at_f}$



$\int v = \Delta v$
$\Delta v = \int at$

Δv = Area under the graph
$= 4 \times 10$
$= 40$ m/s

Suppose that v_0 = const
a = const

~~*Constant acceleration = Constant velocity.~~

because [illegible]

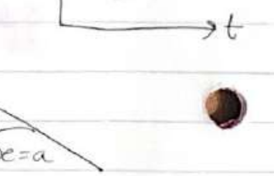
constant

constant because it is the gravity

* $v_f = v_i + at$

علاقة طردية
direct propotional

* $y = \textcircled{m}x + \textcircled{b}$
slope
y-int.



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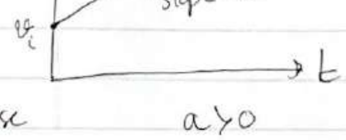
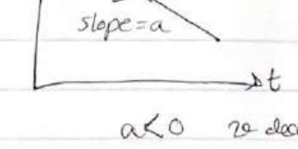


v increase a>0



a<0 v decrease

21/10/2020

physics I - Sec2-L3

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

$* \; v_f = \frac{dx}{dt}$

$dt \times \left(\frac{dx}{dt}\right) = (v_i + at) \times dt$

$$dx = (v_i + at)\, dt$$

$$\int_{x_i}^{x_f} dx = \int_{t_i}^{t_f} (v_i + at)\, dt.$$

$$x \Big|_{x_i}^{x_f} = v_i t + \frac{at^2}{2} \Big|_{t_i \to 0}^{t_f}$$

$$x_f - x_i = v_i (t_f) + \frac{a(t_f)^2}{2}$$

$$\boxed{\Delta x = v_i t + \tfrac{1}{2} a t^2}$$ → just like a parabola

constant

$$x \Big|_{x_i}^{x_f} = \int_{t_i}^{t_f} (v_i + at)\, dt$$

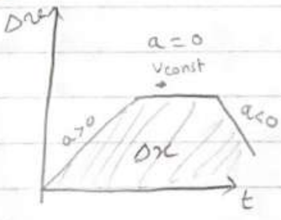
$$\underbrace{x_f - x_i}_{\Delta x} = \underbrace{\int_{t_i \to 0}^{t_f} (v_i + at)\, dt}$$

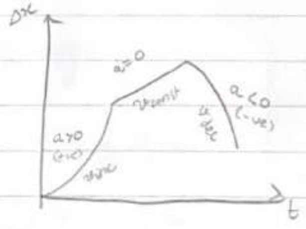
= area under v vs t graph

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

area $= \int v = \Delta x$

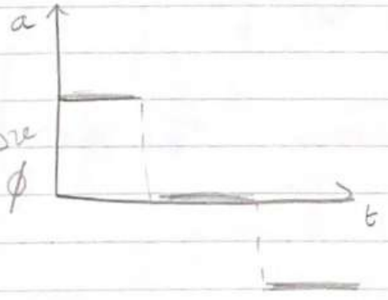
slope $= \frac{dv}{dt} = a$





area $= \int x \neq \emptyset$

slope $= \frac{dx}{dt} = v$



area $= \int a = \Delta v$

Slope $= \frac{da}{dt} \neq \emptyset$

* Since we have constant acceleration then we have change in velocity
ex:- gravity = 10

so we can write that the average velocity is:- $\left[\bar{v} = \frac{v_f + v_i}{2}\right]$

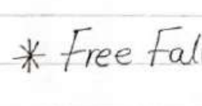
But $\left[\bar{v} = \frac{\Delta x}{\Delta t}\right]$, SO :- $\left[\frac{\Delta x}{\underset{t_f - \cancel{t_i}^{\,0}}{\boxed{\Delta t}}} = \frac{v_f + v_i}{2}\right] \Rightarrow \left[\Delta x = \frac{1}{2}(v_i + v_f)t\right]$

* Equations of motion:-

$$\left.\begin{aligned} v_f &= v_i + at \\ \Delta x &= v_i t + \tfrac{1}{2}at^2 \\ v_f^2 &= v_i^2 + 2a\Delta x \\ \Delta x &= \tfrac{1}{2}(v_i + v_f)t \end{aligned}\right]$$

$F = \boxed{m}a$
$\boxed{\text{constant}}$
changes together

* Free Falling:-



instead of:-
$\Delta x \longrightarrow \Delta y$
$a \longrightarrow g$

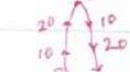
$$\left.\begin{aligned} v_f &= v_i - gt \\ \Delta y &= v_i t \;\tfrac{1}{2}gt^2 \\ v_f^2 &= v_i^2 - 2g\Delta y \\ \Delta y &= \tfrac{1}{2}(v_f + v_i)t \end{aligned}\right] \quad g = 10\ m/s^2$$

*Equations of free falling:-

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

allways g is downward accelerate even if it was going ↑ or ↓ so it is allways (-10), BUT the things that change is the direction of $\bar{v}$ & $\bar{\Delta x}$

$\therefore \uparrow \quad \Delta v +$
$\therefore \downarrow \quad \Delta v -$



1) $v_{x,avg} = \frac{\Delta x}{\Delta t}$

ⓐ $v = \frac{10-0}{2-0} = 5$ m/s

ⓑ $v = \frac{5-0}{4-0} = 1.2$ m/s

ⓒ $v = \frac{5-10}{4-2} = -2.5$ m/s

ⓓ $v = \frac{-5-5}{7-4} = -3.33$ m/s

ⓔ $v = \frac{0-0}{8-0} = 0$

2) $v = \frac{\Delta x}{t}$

$t = \frac{\Delta x}{v} = \frac{2}{100} = 0.02$ sec

3) ⓐ $\text{avg speed} = \frac{d_{AB} + d_{BA}}{t_{AB} + t_{BA}}$ ⓑ $v_{x\,avg} = 0$

$d_{AB} = d_{BA}$, $t_{AB} = \frac{d_{AB}}{\boxed{v_{AB}} \rightarrow 5\text{ m/s}}$

$$\text{avg speed} = \frac{2d}{\frac{v_{BA}}{v_{BA}} \cdot \frac{d}{v_{AB}} + \frac{d}{v_{BA}} \cdot \frac{v_{AB}}{v_{AB}}} = 2\cancel{d} \cdot \frac{v_{AB} v_{BA}}{\cancel{d}(v_{BA} + v_{AB})}$$

$$= \frac{2(v_{AB} v_{BA})}{v_{BA} + v_{AB}} = \frac{2(5 \times 3)}{3+5} = 3.75\text{ m/s}$$

4) ⓐ $v_{x\,avg} = \frac{\Delta x}{\Delta t} = \frac{10(3)^2 - 10(2)^2}{3-2}$

$= 50$ m/s

ⓑ $x_{x\,avg} = \frac{\Delta x}{\Delta t} = \frac{10(2)^2 - 10(2.10)^2}{2 - 2.10}$

$= 41$ m/s

Section 2 :-

5) ⓐ $v_{x\,avg} = \frac{2.3-0}{1-0} = 2.3$ m/S

ⓑ $v_{x\,avg} = \frac{57.5 - 9.2}{5-2} = 16.1$ m/s

ⓒ $v_{x\,avg} = \frac{57.5-0}{5-0} = 11.5$ m/s

6) ⓐ $x = 3(3)^2 = 27$ m

ⓑ $x = 3(3+\Delta t)^2$

$= 3(9 + 6\Delta t + \Delta t^2)$

$= 27 + 18\Delta t + 3\Delta t^2$

ⓒ $\lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = v \Rightarrow \frac{dx}{dt} = 6t$

$\text{at}_{t=3} = 6(3)$

$= 18$

7) ⓐ $t=1.5 \rightarrow x=8$

$t=4 \rightarrow x=2$

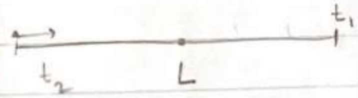
$$v_{x\,avg} = \frac{2-8}{4-1.5} = -2.4\,m/s$$

ⓑ $(t_c = 1.5, x=8)$ $(t_D = 3.5, x=0)$

$$v = \frac{0-8}{3.5-1.5} = -4\,m/s$$

ⓒ $v=0$ at $t=4$ cause the tangent line is horizontal & it's slope $=0$,

8)



ⓐ $$v_{x\,avg} = \frac{L/2 - 0}{t_1/2 - 0} = \frac{L}{t_1}$$

ⓑ $$v_{x\,avg} = \frac{2\cdot L - \frac{L}{2}}{2\cdot t_1 - \frac{t_1}{2}} = \frac{\frac{2L-L}{2}}{\frac{2t_1-t_1}{2}} = \frac{L}{t_1}$$

ⓒ $v_{x\,avg} = 0$

ⓓ $$\text{avg. speed} = \frac{L+L}{t_1+t_2} = \frac{2L}{t_1+t_2}$$

9) ⓐ $$v = \frac{5-0}{1-0} = 5\,m/s$$

ⓑ $$v = \frac{5-10}{4-2} = -2.5\,m/s$$

ⓒ $$v = \frac{5-5}{5-4} = 0\,m/s$$

ⓓ $$v = \frac{0--5}{8-7} = 5\,m/s$$

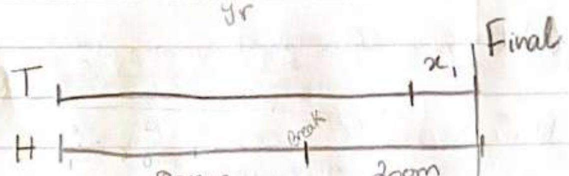
section 3:-

10) $$v = \frac{25\,mm}{yr}$$

$d = 2.9\times10^{3}\,mi$
$= 4.7\times10^{9}\,mm$

$$\Delta t = \frac{d}{v} = \frac{4.7\times10^{9}\,mm}{25\,\frac{mm}{yr}} = 1.9\times10^{8}\text{ years}$$

11)



$$v_T = \frac{x_1}{t_T} \qquad v_H = \frac{200}{t_H}$$

$t_T = t_H$

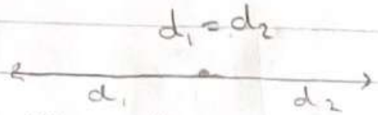
$$t_T = t_H$$

$$\frac{x_1}{V_T} = \frac{200}{V_H}$$

$$x_1 = \frac{200}{V_H} \times V_T$$

$$= \frac{200}{8} \times 0.200 = 5m$$

12)



ⓐ $v = 60 mi/h$ $v = x$

ⓑ $v_{x avg} = 0$

$v_{x avg} = 30 mi/h$

ⓒ $\underset{speed}{avg} = \frac{2v_1v_2}{v_1+v_2}$

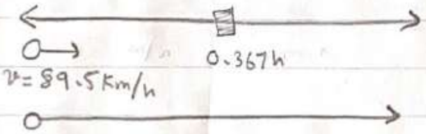
$= 30 mi/h$

$$v_{x avg} = \frac{\Delta x}{\Delta t} = \frac{d_1+d_2}{\underbrace{t_1}_{\frac{d_1}{v_1}} + \underbrace{t_2}_{\frac{d_1}{v_2}}} = \frac{2d}{\frac{d_1}{v_1}+\frac{d_1}{v_2}} = \frac{2v_1v_2}{v_1+v_2}$$

$$30 = \frac{2 \times 60 \times v_2}{60 + v_2}$$

$v_2 = 20$

13)



ⓐ

$89.5 = \frac{\Delta x}{t_1}$

$77.8 = \frac{\Delta x}{t_1 + 0.367}$

$\Delta x = \Delta x$

$89.5 t_1 = 77.8(t_1 + 0.367)$

$t_1 = 2.44h$

$t_{total} = t_1 + 0.367hr$
$= 2.81 hr$

ⓑ $\Delta x = 89.5t$ or $\Delta x = 77.8 \times (t_1 + 0.367)$

$\Delta x = 89.5(2.44)$
$= 218.415$

$\Delta x = 218.38$

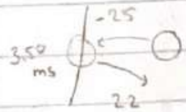
Section 4:-

14) $m = 50$

$v_1 = -25$

$v_2 = 22$

$a = ?$

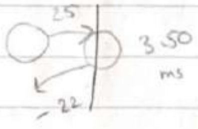


$$v_{x_f} = v_{x_i} + at$$

$$a = \frac{v_{x_f} - v_{x_i}}{t} = \frac{22-(-25)}{3.50\times10^{-3}}$$

$$= 13428.5$$

$$= 1.3428\times10^{4} \ m/s^2$$



$$a = \frac{-22-25}{3.50\times10^{-3}}$$

$$= -1.3428\times10^{4} \ m/s^2$$

15)

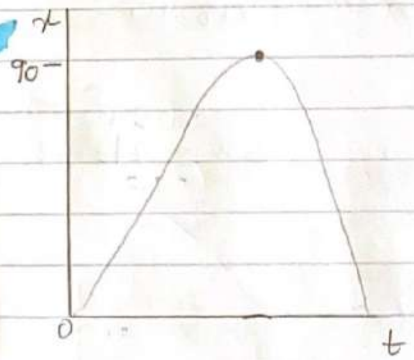
ⓐ $a = \frac{\Delta v}{\Delta t} = \frac{5--3}{13-8} = 1.6 \ m/s^2$

ⓒ $a = \frac{8--8}{20-0} = 0.8 \ m/s^2$

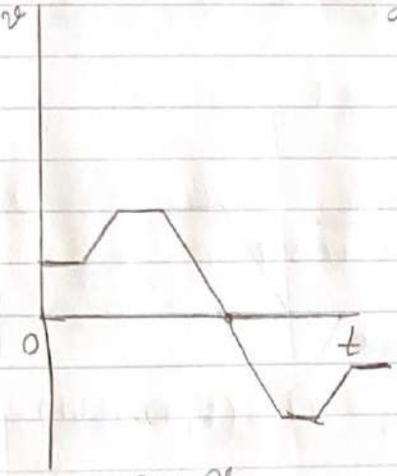
use the same slope

ⓑ $a = \frac{5--3}{13-8} = 1.6 \ m/s^2$

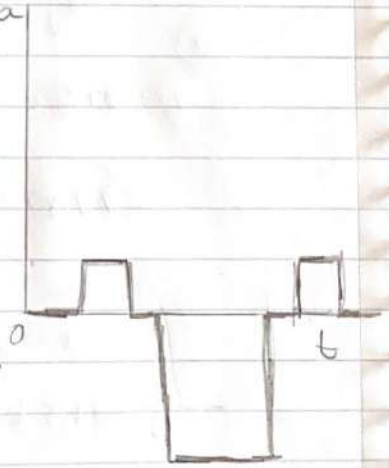
16)



$v = \frac{x}{t}$



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



$\frac{a}{t}$

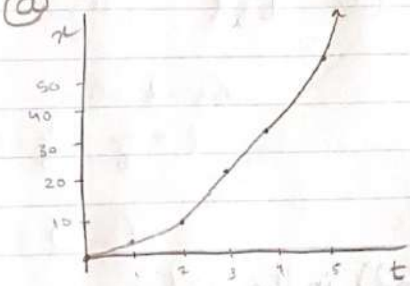
17) ⓐ $a_{avg} \doteq \frac{\Delta V}{\Delta t} = \frac{8-0}{6-0} = 1.33\ m/s^2$

ⓑ $t=3$ $a = \frac{8-0}{5-1} = 2\ m/s^2$

ⓒ $a=0$ at $t=6$
& at $t>10$

ⓓ at $t=8$
$a=-1.5\ m/s^2$

18) ⓐ



ⓑ Using a tangent line :-

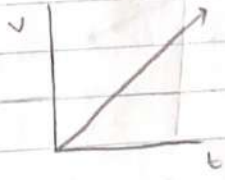
$t=5 \rightarrow V = \frac{58}{2.5} = 23\ m/s$

$t=4 \rightarrow V = \frac{54}{3} = 18\ m/s$

$t=3 \rightarrow v = \frac{49}{3.4} = 14\ m/s$

$t=2 \rightarrow V = \frac{36}{4} = 9\ m/s$

ⓒ



$a_{avg} = \frac{\Delta V}{\Delta t} = \frac{23}{5}$

$= 4.6\ m/s^2$

ⓓ $v_i = 0$

19) ⓐ $a \xrightarrow{\int} v$

$t=10 \rightarrow$ area under the curve from (0 to 10)

$A = 2\times10 = 20$

$t=20 \rightarrow$ area under the curve from (0 to 20)

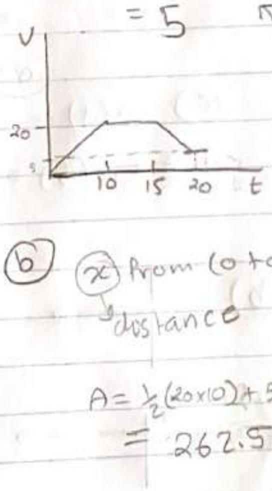
$A = \overset{A_1}{(2\times10)} + \overset{A_2}{0} + \overset{A_3}{(3\times5)}$

$= 20 + 0 + 15$

$= 20 + 0 + -15$

$= 5$

but in the -ve y axis so (-15)



ⓑ x from (0 to 20)
distance

$A = \frac{1}{2}(20\times10) + 5\times20 + \frac{1}{2}(5\times15) + 5\times5$

$= 262.5$

20) ⓐ $v = \frac{3(3)^2 - 2(3)+3 \; - \; 3(2)^2 - 2(2)+3}{3-2} = 13 m/s$

ⓑ
$v(t) = 6t - 2$
$- \; v(2) = 6(2) - 2 = 10 \, m/s$
$- \; v(3) = 6(3) - 2 = 16 \, m/s$

ⓒ $a = \frac{\Delta v}{\Delta t} = \frac{16-10}{3-2} = 6 \, m/s^2$

ⓓ $a(t) = 6$
$t = 2 \rightarrow a = 6$
$t = 3 \rightarrow a = 6$

ⓔ $t = ? \rightarrow v = 0$

$6t - 2 = 0$
$t = \frac{2}{6} = \frac{1}{3} = 0.33$

21) ⓐ $x(3) = 2 + 3(3) - 1(3)^2$
$= 2 \, m$

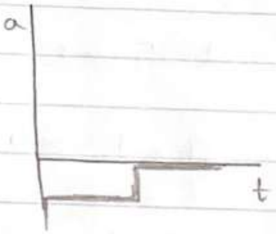
ⓑ $v(t) = 3 - 2t$

$v(3) = 3 - 2(3)$
$= -3 \, m/s$

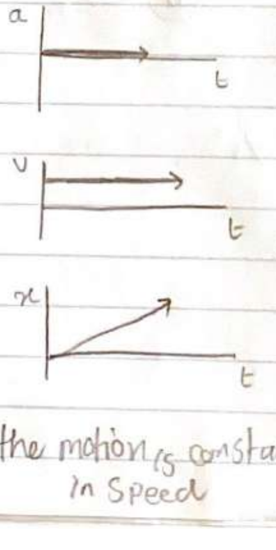
ⓒ $a(t) = -2$
$a(3) = -2 \, m/s^2$

22) in the book.

23) ⓐ

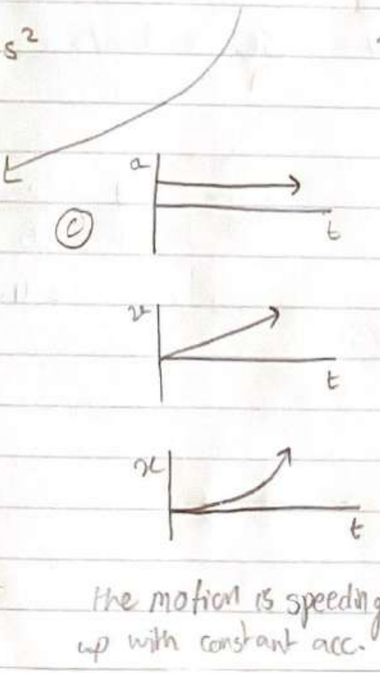


ⓑ

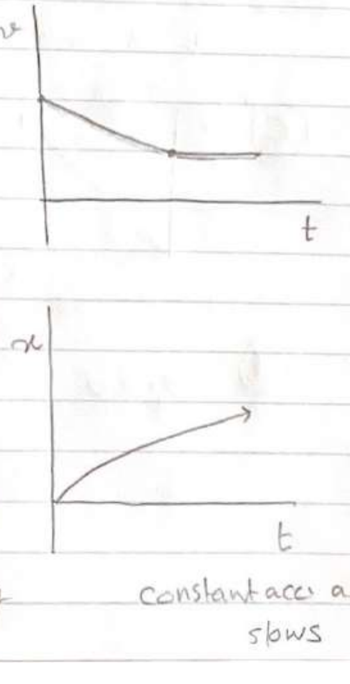


the motion is constant in Speed

ⓒ



The motion is speeding up with constant acc.



Constant acc. as object slows

Section 6:-

24) ① $\xleftrightarrow{40\ ft}$ ② $\xleftrightarrow{?}$

$v = 35 mi/hr$
$= 51.33\ ft/sec$

$v = 70 mi/hr$
$= 102.667\ ft/sec$

اخترت هاي المعادلة لحتى اتخلص من الزمن

① $\overset{0}{\cancel{v_{x_f}}}^2 = v_{xi}^2 + 2a_x(x_f - \overset{0}{\cancel{x_i}}) \rightarrow a_x = \frac{-v_{xi_1}^2}{2(x_f)_1}$

② $\overset{0}{\cancel{v_{x_f}}}^2 = v_{xi}^2 + 2a_x(x_f - \overset{0}{\cancel{x_i}}) \rightarrow a_x = \frac{-v_{xi_2}}{2(x_f)_2}$

$$\frac{-v_{xi_1}^2}{2x_{f_1}} = \frac{-v_{xi_2}^2}{2x_{f_2}}$$

$$\frac{\cancel{-}(51.33)^2}{2\times 40} = \frac{\cancel{-}(102.667)^2}{2\times x_{f_2}}$$

$$x_{f_2} = 160.0218\ ft$$

25) ⓐ $x_f = x_i - \frac{1}{2}(v_f + v_i)t$

$$t = \frac{2(x_f - x_i)}{v_f + v_i}$$

$$= \frac{2(1.50\times10^{-2} - 0)}{6\times10^6 + 2\times10^4}$$

$$= 4.98\times10^{-9}$$

ⓑ $x_f = x_i + v_{xi}t + \frac{1}{2}at^2$

$$a = \frac{(x_f - x_i - vt)\times 2}{t^2}$$

$$= 1.241\times10^{15}\ m/s^2$$

26) ⓐ $x_f = x_i - \frac{1}{2}(v_f + v_i)t$ ✗ cause v_f & t are unknown

$v_i = 30 m/s$
$v_f = ?$
$a = -3.50 m/s^2$
$x_i = 0$
$x_f = 100$
$t = ?$

$x_f = x_i + v_{ix}t + \frac{1}{2}at^2$ ✓

$100 = 0 + 30t + \frac{1}{2}(-3.50)t^2$

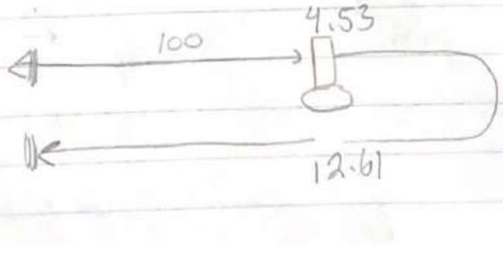
$t = 12.61\ sec$

$\boxed{t = 4.53 sec}$ ✓

ⓑ $v_f = v_i + at$

$= 30 + -3.50(4.53)$

$= 14.145\ m/s$



or

$U_f = v_i + at$

$2.8 = v_i + a(8.50)$

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

$40 = v_i(8.50) + \frac{1}{2}a(8.50)^2$

أحلهم ببعض

27) $a = -4\ m/s^2$

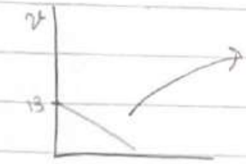
$v = 13\ m/s$

ⓐ $t = 1 \rightarrow v_f = v_i + at = 13 + -4\times1 = 9\ m/s$

ⓑ $t = 4 \rightarrow v_f = v_i + at = 13 + -4\times4 = -3\ m/s$

ⓒ $t = -1 \rightarrow v_f = v_i + at = 13 + -4\times-1 = 17\ m/s$

ⓓ



→ slope down cause (by 4) $a = -4$

ⓔ If we know velocity at any one instant & then knowing the constant acc. value gives us the velocity at other times.

28) ⓐ $x_f = 40$

$t = 8.50$

$v_f = 2.80$

$v_i = ?$

$x_f = x_i + \frac{1}{2}(v_i + v_f)t$

$40 = 0 + \frac{1}{2}(v_i + 2.80)\times8.50$

$v_i = 6.61\ m/s$

ⓑ $x_f = x_i + v_i t + \frac{1}{2}at^2$

$40 = 0 + 6.61(8.50) + \frac{1}{2}a(8.50)^2$

$a = \boxed{-}0.448\ m/s$

← سالبة تعني انه يبطئ الحركة

29) $v = 12\ cm/s$

$x = 3\ cm$

$x(2) = -5\ cm$

$a = ?$

$x_f = x_i + v_i t + \frac{1}{2}at^2$

$-5 = 3 + 12(2) + \frac{1}{2}a(2)^2$

$a = -16\ cm/s^2$

30) $v_i = 100$

$a = 5$

$v_f = 0$

ⓐ $v_f = v_i + at$

$t = \frac{v_f - v_i}{a} = \frac{0-100}{5} = 20 sec$

ⓑ compare the Δx required to the actual runway we get :-

$v_f = 0 \quad v_i = 100 \quad x_i = 0$

$a = -5 \quad x_f = ?$

$\overset{0}{v_f}^2 = \overset{100}{v_i}^2 + \overset{2x-5}{2a}(x_f - \overset{0}{x_i})$

$x_f = 1{,}000\ m$

cannot land

ⓒ لأنها راح تهبط وتمشي أكثر من المدرج

31) $v_i = 632$ mi/h $= 282$ m/s
$v_f = 0$
$t = 1.40$ s

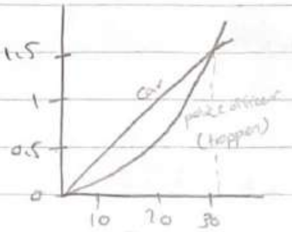
ⓐ $v_f = v_i + at$
$0 = 282 + a(1.40)$
$a = -201.42$ m/s^2

ⓑ $x_f = x_i + vt + \frac{1}{2}at^2$
$= 0 + 282\times1.40 + \frac{1}{2}(-201.42)\times1.40^2$
$= 197.408$ m

32) $x_{car} = 45 + 45t$

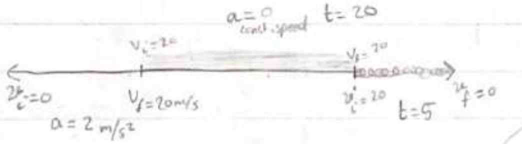
$x_{tropper} = 1.5t^2$

They intersect at $t = 31$sec



33) ⓐ $t_{total} = (\ 10\ ) + 20 + 5$
$= 35$

$\longrightarrow$ $v_f = v_i + at$
$20 = 0 + 2\times t$
$t = \underline{10}$ sec

ⓑ


$x_1 \rightarrow$ $\overset{20^2}{v_f^2} = \overset{0}{v_i^2} + 2\overset{2}{a}\overset{\Delta x}{(x_f - x_i)}$ or

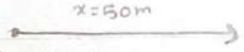
$\Delta x = 100$ m

$x_f = x_i + \frac{1}{2}(v_i + v_f)t$

x_2
$\overset{\Delta x}{(x_f - x_i)} = \frac{1}{2}(20+20)\times20$
$= 400$m

$v_{xavg} = \frac{\Delta x}{\Delta t} = \frac{100+400+50}{35}$
$= 15.71$m/s

x_3
$\overset{\Delta x}{(x_f - x_i)} = \frac{1}{2}(20+0)\times5$
$= 50$

34)


$v_f = 8$m/s
$v_i = 0$

1) $v_f = v_i + at$
$a = \frac{8}{10} \rightarrow a = 0.8$ m/s^2

2) $x_f = x_i + v_i t + \frac{1}{2}at^2$
$50 = 0 + 0\times10 + \frac{1}{2}a(10)^2$
$a = 1$m/s^2

my method

35) $a = -5.60 \text{ m/s}^2$

$t = 4.20$

$x = 62.4 \text{m}$

$v_i = ?$

$v_f = ?$

$\boxed{v_f = v_i + at}$

$v_f = v_i + -23.52$

$v_f = 26.61 - 23.52 \longleftarrow \boxed{v_i = 26.61 \text{ m/s}}$

$\boxed{v_f = 3.09 \text{ m/s}}$

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

$62.4 = v_i \cdot 4.20 + -49.39$

the book's method

$v_f = v_i + -23.52$

$v_i = v_f + 23.52 \longrightarrow$

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

$62.4 = \frac{1}{2}(v_f + \boxed{v_f + 23.52}) \times 4.20$

$v_f = 3.097 \text{ m/s}$

36) ⓐ $v_f = v_i + at \Rightarrow v_i = v_f - at$

$\underbrace{\Delta x = \frac{1}{2}(v_f + v_i)t}_{\text{work them out}}$

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

$\Delta x = \frac{1}{2}(2v_f - at)t$

$\Delta x = \frac{1}{\cancel{2}}(\cancel{2}v_f t) - \frac{1}{2}at^2$

$\Delta x = v_f t - \frac{1}{2}at^2$

ⓑ

$\Delta x = v_f t - \frac{1}{2}at^2$

$62.4 = v_f(4.20) - \frac{1}{2}(-5.60)(4.20)^2$

$v_f = 3.09 \text{ m/s}$

37)

$v_i = 20$

$v_f = 30$

$\Delta x = 200$

ⓐ $\bullet \longrightarrow_{+x}$

ⓑ inc. speed, so we will choose the constant acc.

ⓒ $v_f^2 = v_i^2 + 2a\Delta x$

ⓓ $a = \frac{v_f^2 - v_i^2}{2\Delta x}$

ⓔ $a = 1.25 \text{ m/s}^2$

ⓕ $v_f = v_i at$ or $\Delta x = v_i t + \frac{1}{2}at^2$

$t = 8 \text{sec}$ | $t = 8$ ✓

$t = -40$ ✗

لأنها حركة في خط مستقيم ما في مجال إنو ألف لازم اوقف وارجع

the book's method

38) $x(t) = 2 + 3t - 4t^2$

$x_f = x_i + v_i t + \frac{1}{2} a t^2$

compare

$x_i = 2\ m$

$v_i = 3\ m/s$

$a = -8\ m/s^2$

ⓐ

Changes direction when $(v_f = 0)$.

$v_f = v_i + at$

$0 = 3 + (-8)t$

$t = \frac{3}{8} = 0.375\ sec$

$\rightarrow x(0.375) = 2 + 3(0.375) - 4(0.375)^2$

$= 2.56 m$

ⓑ

$v_f = ?$

$x_i = x_f$

$v_i = 3$

$a = -8$

$x_f = x_i + vt + \frac{1}{2} at$

$t = 0$ begining ✗

$t = \frac{3}{4} = 0.75\ sec$ end ✓

$\rightarrow v_f = v_i + at$

$= 3 + -8 \times \frac{3}{4}$

$= -3\ m/s$

The Dr. method

ⓐ changes direction

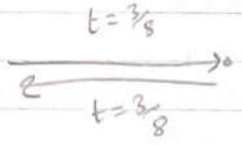
$v = 0$

$v = \frac{dx}{dt} = 3 - 8t$

$t = \frac{3}{8} = 0.325$

$\rightarrow x(\frac{3}{8}) = 2.56$

ⓑ



$t_1 + t_2 = \frac{3}{4}$

$v(\frac{3}{4}) = -3\ m/s$

43) ⓐ

$\Delta x = \frac{1}{2}(15)(50) + (40-15)(50) + \frac{1}{2}(10)(50)$

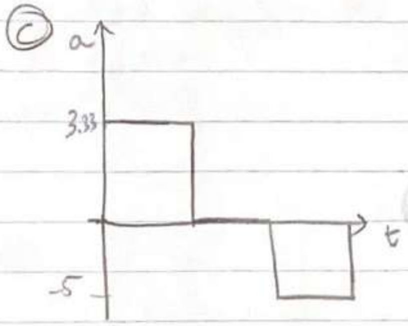
$= 1875$ m

ⓑ

$\Delta x = \frac{1}{2}(5)(50-30) + (30)(5) + (40-15)(50)$

$= 1450$m

ⓒ



$a_1 = \frac{50-0}{15-0}$

$= 3.33$ m/s²

$a_2 = 0$

$a_3 = \frac{0-50}{50-40}$

$= -5$ m/s²

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

ⓓ

0 → a :- $\Delta x = 0t + \frac{1}{2} \overset{\to 3.33}{\boxed{a}} t^2$

$= \frac{1}{2}(3.33)t^2$

$= 1.665$

area!! [illegible]

a → b :- $\Delta x = \left(50t + \frac{1}{2}(0)t^2\right) - \boxed{375}$ -

$= 50t - 375$

b → c :- $\Delta x = (\quad +) -$

$=$

ⓔ

42) $a = 2.40$
$v = -3.50$
$\bullet\!\longrightarrow$
15cm

$\circ\!\longrightarrow$
10cm
$v = 5.50$
$a = 0$

ⓐ $t = ?$ when $v_{f_1} = v_{f_2}$

$v_{f_1} = v_i + at$

$v_{f_2} = v_i + at$

$v_{i_1} + at = v_i + at$

$-3.50 + 2.40(t) = 5.50 + 0 \times t$

$t = 3.75$ sec

ⓑ

$v_{f_1} = v_i + at$

$= -3.50 + 2.40(3.75)$

$= 5.5$ cm/sec

ⓒ

$\underline{x_f = x_i + v_i t + \frac{1}{2} a t^2}$

$x_{f_1} = 15 + -3.50t + 1.2t^2$

$x_{f_2} = 10 + 5.50t + \cancel{\frac{1}{2}0t^2}$

$x_{f_1} = x_{f_2}$

$15 + -3.50t + 1.2t^2$
$= 10 + 5.50t$

$t = 6.89$

$\boxed{t = 0.604}$ ✓

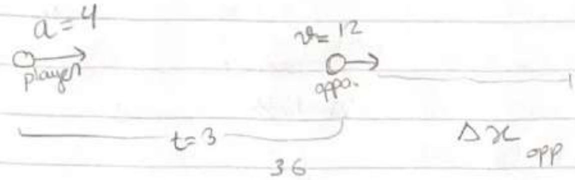
ⓓ

$x_f = 10 + 5.50(6.89)$
$= 47.895$ m

$x_f = 10 + 5.50(0.604)$

$= 13.322$ m

44)



ⓐ $\Delta x_{opp} = 12\times 3 = 36\ m$

$\Delta x_{player} = 0t + \frac{1}{2}(4)t^2 = 2t^2$

$\Delta x_{oppo.} = 12t + \frac{1}{2}(0)t^2 = 12t$

$\Delta x_{player} = \Delta x_{opp} + 36$

$2t^2 = 12t + 36$

$t = 8.19$ ✓

~~$t = -2.19$~~

ⓑ $\Delta x_{player} = 2t^2$

$= 2(8.19)^2$

$= 134.15\ m$

Section 7:-

45) $v = 2.80 \quad a = -9.80$

ⓐ $\Delta y = 2.80(0.1) + \frac{1}{2}(-9.80)(0.1)^2$

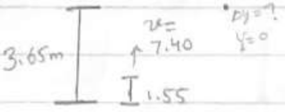
$= 0.231$

ⓑ $\Delta y = 0.364$

ⓒ $\Delta y = 0.399$

ⓓ $\Delta y = 0.175$

46)



ⓐ $v_f^2 = v_i^2 + 2a\Delta y$

$0 = (7.40)^2 + 2(-9.80)(y_f - 1.55)$

$y_f = 4.34$

it does passes the wall

ⓑ $v_f = \sqrt{v_i^2 + 2a(y_f - y_i)}$

$= \sqrt{7.40^2 + 2(-9.8)(3.65 - 1.55)}$

$= 3.687\ m/s$

ⓒ $v_f^2 = v_i^2 + 2a\Delta y$

$v_f = \sqrt{(-7.40)^2 + 2(-9.8)(1.55 - 3.65)}$

$= 9.79 \Rightarrow v_f = -9.79$

$\left|\text{change in speed}\right| = \left| -9.79 - -7.40 \right| = 2.39$

ⓓ thrown down $|v| = 2.39\ m/s$

thrown up $|v| = |7.40 - 3.687|$

$= 3.72\ m/s$

[illegible]

same elevation

48) max hight at $t=3$, $a=-9.80$

ⓐ $v_f = v_i + at$

$v_i = \overset{0}{v_f} - at$

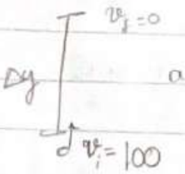
$= 0-(-9.80)(3)$

$= 29.4\ m/s$

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

$= 44.1m$

49)



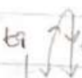
$a=-9.80$

ⓐ $v_f^2 = v_i^2 + 2a\Delta y$

$0 = 100^2 + 2(-9.80)\Delta y$

$\Delta y = 510.20$

ⓑ $510.20 = 100t + \frac{1}{2}(-9.8)t^2$



$t_1 = 10.23$

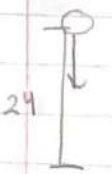
$t_2 = 10.17$

time in air $= t_1 + t_2$

$= 10.23 + 10.17$

$= 20.4 sec$

50)



$h = 3t^3$

$v = 9t^2$

$a = 18t$

$h(2) = 3(2)^3 = 24m$

$v(2) = 9(2)^2 = 36\ m/s$

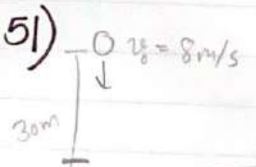
$y_f = y_i + v_i t + \frac{1}{2}at^2$

$0 = 24 + 36t + \frac{1}{2}(-9.80)t^2$

$t = 7.962$ ✓

~~$t = -0.61$~~

51)



سؤال من الكوز

$v_f = ?$

$v_f = v_i + at$

$= 8 + (-9.8)(3.42)$

$= -25.5$

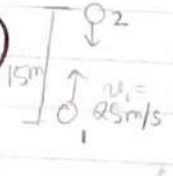
$\Delta y = v_i t + \frac{1}{2}at^2$

$0-30 = 8t + \frac{1}{2}(-9.8)t^2$

$t = 3.42$ ✓

~~$t = -1.78$~~

52)



$y_{f_1} = 0 + 25t + \frac{1}{2}(-9.8)t^2$

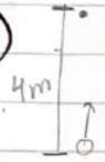
$y_{f_2} = 15 + 0t + \frac{1}{2}(-9.8)t^2$

$y_{f_1} = y_{f_2}$

$25t + -4.9t^2 = 15 - 4.9t^2$

$t = 0.6$

53)



$t = 1.50$

ⓐ

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

$$4 = 0 + v_0(1.50) + \frac{1}{2}(-9.8)(1.50)^2$$

$$v_0 = 10.01 \text{ m/s}$$

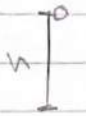
ⓑ

$$v_f = v_i + at$$

$$= 10 + -9.8 \times 1.50$$

$$= -4.7 \text{ m/s}$$

54)



ⓐ

$$v_0 = \frac{y_f - \frac{1}{2}at^2}{t}$$

$$= \frac{y}{t} \; \frac{-at}{2}$$

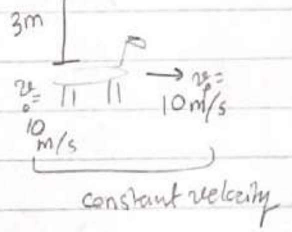
ⓑ

$$v_f = v_i + at$$

$$= \frac{y}{t} \frac{-at}{2} + at$$

$$= \frac{y}{t} + \frac{at}{2}$$

55)



ⓐ

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

$$0 = 3 + 0(t) + \frac{1}{2}(-9.8)t^2$$

$$t = 0.7824$$

free fall

$$\Delta x = v_0 t + \frac{1}{2}at^2$$

$$= 10 \times 0.7824 + \overset{0}{\cancel{\frac{1}{2}at^2}}$$

$$= 7.82 \text{m}$$

Lb's constant acc.

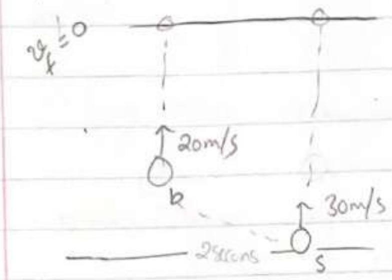
56) in the book

phys 1 - L4 + L5

Extra questions :- suppose $a=g=-10\,m/s^2$

HW1

1) a ball was thrown upward with $v_0 = 20\,m/s$, 2 seconds later a stone was thrown from the same level with ~~sp~~ $v_0 = 30\,m/s$, when the 2 objects pass each other find the ~~time~~ height & velocity :-



$v_{f_b} = v_0 + at$

$0 = 20 + (-9.8)t$

$t = 2$ sec

$v_{f_s} = v_0 + at$

$0 = 30 + (-9.8)t$

$t = 3$ sec

$\Delta y_b = v_0 t + \frac{1}{2}at^2$

$= 20(2) + \frac{1}{2}(-9.8)(2)^2$

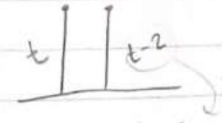
$= 20.4$ m

$\Delta y_s = v_0 t + \frac{1}{2}at^2$

$= 30(3) + \frac{1}{2}(-9.8)(3)^2$

$= 45.9$ m

hint



لأنو استغرق الزمن
تبع الأولى إلا ثانيتين

$\Delta y = 18.3$

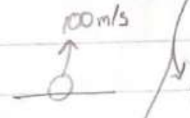
$\Delta y_1 = \Delta y_2$

$20t_b + \frac{1}{2}(-9.8)t_b^2 = 30(t_b - 2) + \frac{1}{2}(-9.8)(t_b - 2)^2$

$t_b = 2.68$, $t_s = t_b - 2 = 0.68$

HW2

2) an object was thrown upward with speed 100 m/s , at what times does it has a speed of 50 m/s ? & at what time it reaches a height of 200m?



لو كان طالع

$v_f = v_i + at$

$50 = 100 + (-9.8)t$

$t = 5.1$ sec

$\Delta y = 382$ m

$\Delta y = v_0 t + \frac{1}{2}at^2$

$200 = 100t + \frac{1}{2}(-9.8)t^2$

$t = 18.16$

$t = 2.24$

لأنو كلمة speed
بدون اتجاه
فممكن يكون
طالع أو نازل

لو كان نازل

$v_f = v_i + at$

$-50 = 100 + (-9.8)t$

$t = 15.30$

$\Delta y = 355.95$

Ch-3

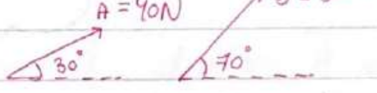
2/11/2020

phys1-sec2-L6

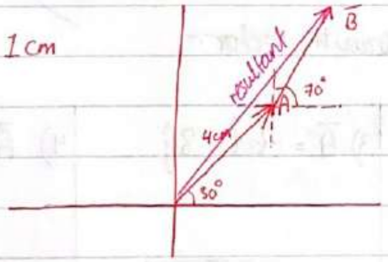
Vectors :- quantities that have both magnitude & direction
متجهة
(position, displacement, velocity, acc...)

Scalar:- quantities that have only magnitude
قياسية
(mass, time, energy-).

any vector can be represented as $\overrightarrow{A}$

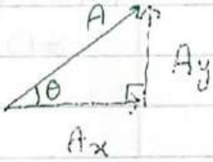


10N = 1cm



resultant $= \bar{A} + \bar{B}$

Component Method
مركّبات



$\sin\theta = \frac{A_y}{A}$

$A_y = A\sin\theta$

$\cos\theta = \frac{A_x}{A}$

$A_x = A\cos\theta$

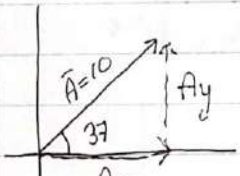
$|\bar{A}| = \sqrt{A_x^2 + A_y^2}$

$\tan\theta = \frac{A_y}{A_x}$

$\Downarrow$

$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$

Example:-



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

unit vecter on x-axis.

unite vector on y-axis.

$A_x = A\cos\theta = 10\cos(37) = 8$

$A_y = A\sin\theta = 10\sin(37) = 6$

any ~~eor~~ vector can be written interms of it's components as :-

Note that :-

$|\bar{A}+\bar{B}| < |\bar{A}|+|\bar{B}|$

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

$A_x = A\cos\theta$

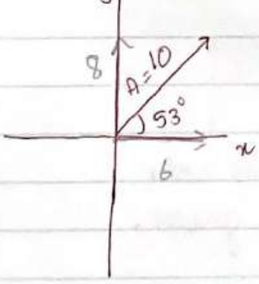
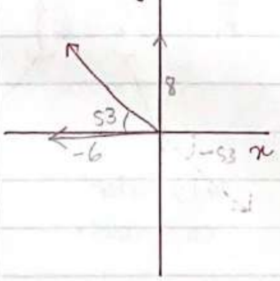
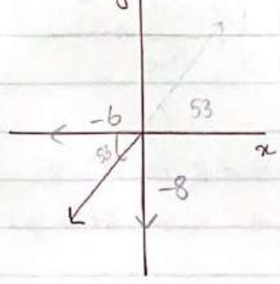
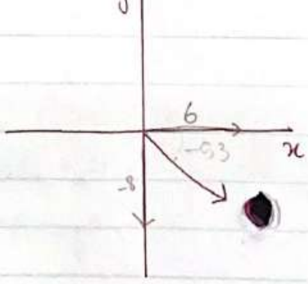
$A_y = A\sin\theta$

$|\bar{A}| = \sqrt{A_x^2 + A_y^2}$ → magnitude.

$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$ → direction.

180−θ	θ
θ+180	360−θ

Examples :- Find magnitude, direction & draw the vector :-

	1) $\bar{A} = 6\hat{i} + 8\hat{j}$	2) $\bar{A} = -6\hat{i} + 8\hat{j}$	3) $\bar{A} = -6\hat{i} - 8\hat{j}$	4) $\bar{A} = 6\hat{i} - 8\hat{j}$
magnitude :-	$\lvert A\rvert = \sqrt{6^2+8^2}$ $= 10$	$\lvert A\rvert = \sqrt{(-6)^2+8^2}$ $= 10$	$\lvert A\rvert = \sqrt{(-6)^2+(-8)^2}$ $= 10$	$\lvert A\rvert = \sqrt{6^2+(-8)^2}$ $= 10$
direction :-	$\theta = \tan^{-1}\left(\frac{8}{6}\right) = 53^\circ$ ✓	$\theta = \tan^{-1}\left(\frac{8}{-6}\right) = -53^\circ$ $\theta = 180 - 53 = 127^\circ$ or// $\tan^{-1}\left(\frac{8}{-6}\right) + 180 = 127^\circ$	$\theta = \tan^{-1}\left(\frac{\cancel{-}8}{\cancel{-}6}\right) = 53^\circ$ $\theta = 180 + 53 = 233^\circ$ or// $\tan^{-1}\left(\frac{-8}{-6}\right) + 180 = 233^\circ$	$\theta = \tan^{-1}\left(\frac{-8}{6}\right) = -53^\circ$ ✓ or// $\theta = 360 - 53 = 307^\circ$
vector :-				

Now :- $\bar{A} = A_x\hat{i} + A_y\hat{i}$
$\bar{B} = B_x\hat{i} + B_y\hat{j}$

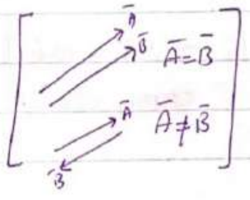
1) $\bar{A} \pm \bar{B} = (A_x \pm B_x)\hat{i} + (A_y \pm B_y)\hat{j}$

2) $\bar{A} + \bar{B} = \bar{B} + \bar{A}$

3) $\bar{A} - \bar{B} = -(\bar{B} - \bar{A})$

4) if $\bar{A} = \bar{B} \overset{so}{\Rightarrow}$ magnitud A = magnitude B & direction $\bar{A}$ = direction $\bar{B}$
$|\bar{A}| = |\bar{B}|$ $\quad \theta_A = \theta_B$

$\begin{bmatrix} A_x = B_x \\ A_y = B_y \end{bmatrix}$ &



Example :- let $\bar{A} = 3\hat{i} + 4\hat{j}$
$\bar{B} = -6\hat{i} + 2\hat{j}$

1) $|\bar{A} + \bar{B}|$

$\bar{A}+\bar{B} = (3+-6)\hat{i} + (4+2)\hat{j}$

$\bar{A}+\bar{B} = -3\hat{i} + 6\hat{j}$

$|\bar{A}+B| = \sqrt{(-3)^2+6^2}$
$= 3\sqrt{5}$
≈ 6.708

2) $|\bar{A}| + |\bar{B}|$

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

$|\bar{B}| = \sqrt{(-6)^2+2^2} = 2\sqrt{10}$
≈ 6.3

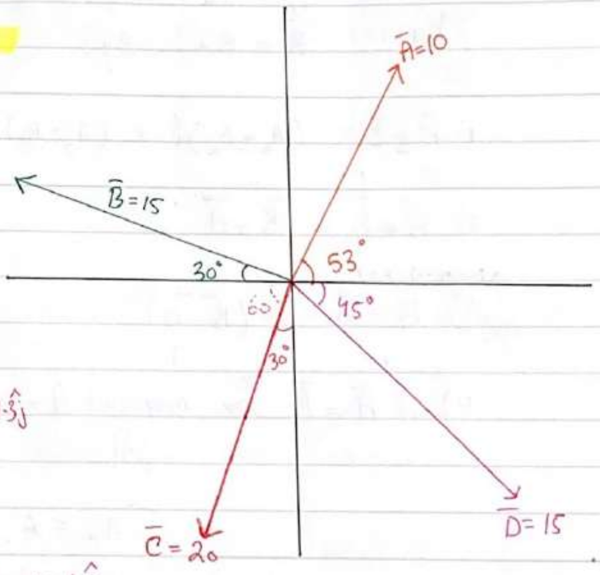
$|\bar{A}| + |\bar{B}| = 5 + 6.3$
$= 11.32$

3) $\bar{C} = 2\bar{A} - \bar{B}$

$2\bar{A} = 6\hat{i} + 8\hat{j}$
$\bar{B} = -6\hat{j} + 2\hat{j}$

$\bigcirc\!\!\!\!\!\!\;2\bar{A}+\bar{B} = (6--6)\hat{i} + (8-2)\hat{i}$
$\hookrightarrow \bigcirc\!\!\!\!\!\!\;\bar{C} = 12\hat{i} + 6\hat{j}$

Example:- find the resultant of $\bar{A}, \bar{B}, \bar{C}, \bar{D}$:-



$A_x = 10\cos 53 = 6.01$
$A_y = 10\sin 53 = \underset{\approx 8}{7.9}$
$\bar{A} = 6\hat{i} + 8\hat{j}$

$B_x = -15\cos 30 = -13$
$B_y = +15\sin 30 = 7.5$
$\bar{B} = -13\hat{i} + 7.5\hat{j}$

$C_x = -20\cos 60 = -10$
$C_y = -20\sin 60 = -17.3$
$\bar{C} = -10\hat{i} + -17.3\hat{j}$

$D_x = 15\cos 45 = 10.6$
$D_y = -15\sin 45 = -10.6$
$\bar{D} = 10.6\hat{i} + -10.6\hat{j}$

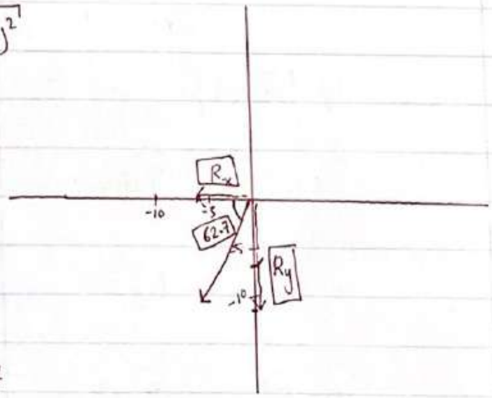
$\underset{\bar{R}}{\text{resultant}} = (6 + -13 + -10 + 10.6)\hat{i} + (8 + 7.5 + -17.3 + -10.6)\hat{j} = -6.4\hat{i} + -12.4\hat{j}$

magnitude of $\bar{R}$ is $|\bar{R}| = \sqrt{(-6.4)^2 + (-12.4)^2}$

$= 13.95$

direction of $\bar{R}$ is $\theta = \tan^{-1}\left(\frac{-12.4}{-6.4}\right)$

$= 62.7^\circ$



$\theta = 180 + 62.7$

$= 242.7^\circ$

or

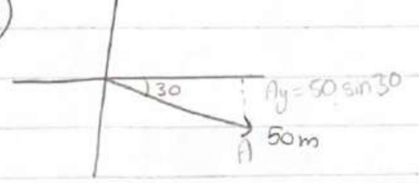
$\theta = \tan^{-1}\left(\frac{-12.4}{-6.4}\right) \boxed{+180} \rightarrow$ because the R_x is negative.

$= 242.7^\circ$

Solving problems Ch-3

* objective questions:-

12)



* problems

Section 1:-

1) $x = 5.50 \cos(240) = -2.75$

$y = 5.50 \sin(240) = -4.76$

$(-2.75, -4.76)$

2) $(2, y)$, $(r, 30°)$

$2 = r \cos 30$

$\boxed{r = 2.3}$

$y = 2.3 \sin 30$

$\boxed{y = 1.15}$

3) $(2, -4)$ $(-3, 3)$

ⓐ $d = \sqrt{(2 - -3)^2 + (-4-3)^2}$

$= 8.60$ m

ⓑ $r_1 = \sqrt{2^2 + (-4)^2} = 4.47$ | $r_2 = \sqrt{(-3)^2 + (3)^2} = 4.24$

$\theta_1 = \tan^{-1}\left(\frac{-4}{2}\right) = -63.4$ | $\theta_2 = \tan^{-1}\left(\frac{3}{-3}\right) + 18$

$\theta = 360 - \theta_1 = 296$ | $= 135$

$(4.47, 296°)$ $(4.24, 135°)$

4) $x_1 = 2.5 \cos(30) = 2.16$ | $x_2 = 3.8 \cos 120 = -1.9$

$y_1 = 2.5 \sin(30) = 1.25$ | $y_2 = 3.8 \sin 120 = 3.29$

ⓑ $d = \sqrt{\Delta x^2 + \Delta y^2} = 4.55$

5) ⓐ $(4.30\text{cm}, 214°)$

$x = 4.3 \cos 214$

$= -3.56$

$y = 4.3 \sin 214$

$= -2.40$

ⓑ $(+3.56, -2.40)$

$(4.30, -34°)$

ⓒ $(-7.12, -4.8)$

$(8.60, 34°)$

ⓓ $(-10.68, 7.2)$

$(12.9, 146°)$

6)

ⓐ $r = \sqrt{(-x)^2 + y^2}$

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

$\underbrace{\theta = \tan^{-1}\left(\frac{y}{-x}\right) + 180}$

or

$\theta = 180 - \theta$

ⓑ $r = \sqrt{(-2x)^2 + (-2y)^2}$

$= \sqrt{4x^2 + 4y^2}$

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

$\theta = \tan^{-1}\left(\frac{\cancel{-2}y}{\cancel{-2}x}\right)$

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

ⓒ $r = \sqrt{(3x)^2 + (-3y)^2}$

$= \sqrt{9x^2 + 9y^2}$

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

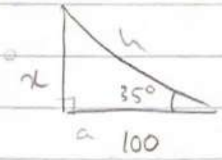
$\theta = \tan^{-1}\left(\frac{-3y}{3x}\right)$

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

Section 2:- —

Section 3:-

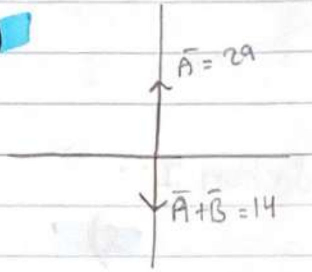
7)



$\tan 35 = \frac{x}{100}$

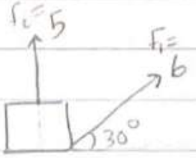
$x = 70.02$

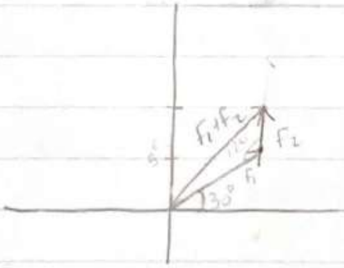
8)



9) in the book

10)





$F_1 + F_2 = R = \sqrt{6^2 + 5^2 - 2(6)(5)\cos 120}$
$= 9.539$ m

$R_x = 6\cos 30 + 0 = 5.19$
$R_y = 6\sin 30 + 5 = 8$

$\theta = \tan^{-1}\left(\frac{8}{5.19}\right) = 57^{\circ}$

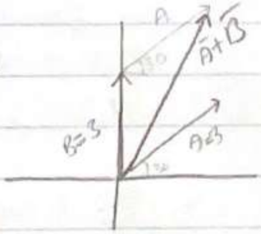
Or

$\bar{R} = \sqrt{R_x^2 + R_y^2} = \sqrt{5.19^2 + 8^2}$
$= 9.536$

$B_x = 0$
$B_y = 3$

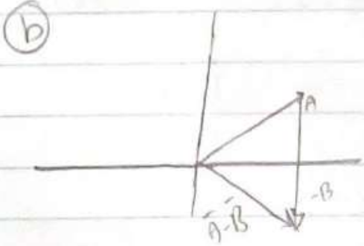
$A_x = 2.5$
$A_y = 1.5$

11) ⓐ



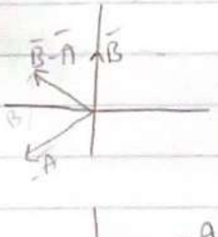
$\bar{A} + B = 5.14$
$\theta = 60$

ⓑ



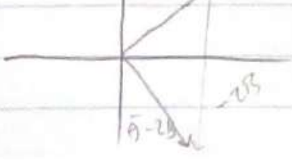
$\bar{A} - \bar{B} = 3$
$\theta = 330$

ⓒ



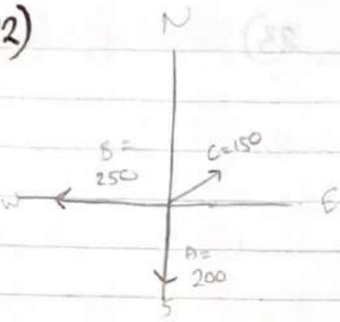
$\bar{B} - A = 3$
$\theta = 150^{\circ}$

ⓓ

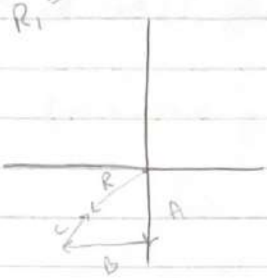


$\bar{A} - 2B = 5.2$
$\theta = 300^{\circ}$

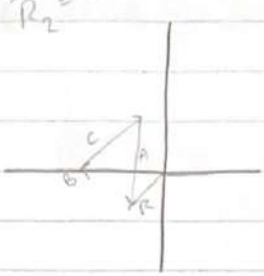
12)



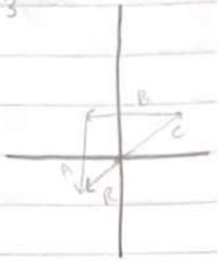
$R_1 = \overline{A}+\overline{B}+\overline{C}$



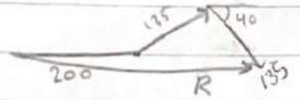
$\overline{R_2} = \overline{B}+\overline{C}+\overline{A}$



$\overline{R_3} = \overline{C}+\overline{B}+\overline{A}$

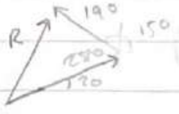


13)



$d = 420$ ft , $\theta = -3$

14)

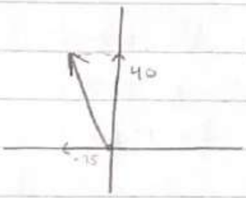


$R = 310$ km

$\theta = 57$ south of west

Section 4:-

15)



$|\overline{R}| = \sqrt{(-25)^2 + 40^2}$

$= 47.2$

$\theta = \tan^{-1}\left(\frac{40}{-25}\right) + 180$

$= 122^\circ$

16)

$A_x = 35\cos(325)$
$= 28.6$

$A_y = 35\sin(325)$
$= -20$

17) in the book

18)

$A_x = 3.10\cos 25 = 2.8$ east

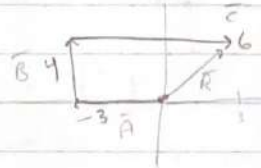
$A_y = 3.10\sin 25 = 1.31$ North

19) ⓐ $x = 12.8\cos 150 = -11.08 \underline{m}$
$y = 12.8\sin 150 = 6.4 \underline{m}$

ⓑ $x = 3.30\cos 60 = 1.65 \underline{cm}$
$y = 3.30\sin 60 = 2.8 \underline{cm}$

ⓒ $x = 22\cos 215 = -18 \underline{in}$
$y = 22\sin 215 = -12.6 \underline{in}$

20)



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

$= -3\hat{i} + 4\hat{j} + 6\hat{i}$

resultant displacement $= 3\hat{i} + 4\hat{j}$

$\overline{R} = \sqrt{3^2 + 4^2} = 5$

total distance $= 4 + 3 + 6 = 13$

$\theta = \tan^{-1}\left(\frac{4}{3}\right) = 53.1$

21) $\Delta\overline{R} = \overline{A}+\overline{B}+\overline{C}+\overline{D}$

$= \boxed{75\,j} + \underline{250\,i} + \underline{108.2\,\hat{i}} + 62.5\,\hat{j} + -150\,\hat{j}$

$\overline{C}_x = 108.2$
$C_y = 62.5$

$= 358.2\,\hat{i} + -12.5\,\hat{j}$

$\overline{\Delta R} = \sqrt{358.2^2 + (12.5)^2} = 358.4$

$\theta = -1.99$

$\theta = 180 - 75 = 105$

29) ⓐ $\overline{F_1 + F_2} = R_{1+2}$

$F_1 \; F_{1x}: F_1 \cos\theta = 60 \quad F_{1y}: F_1 \sin\theta = 103.9$

$F_2 \; F_{2x}: F_2 \cos\theta = -20.7 \quad F_{2y}: F_2 \sin\theta = 77.2$

$R_{1+2} = (60 + -20.7)\hat{i} + (103.9 + 77.2)\hat{j}$

$= (39.3\hat{i} + 181.1\hat{j})$ <u>N</u>

$|\bar{R}_{1+2}| = 185.3 \qquad \theta_{\bar{R}} = 77.7°$

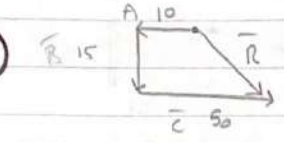
ⓑ $\underbrace{(\bar{F}_1 + \bar{F}_2)}_{} + \bar{F}_3 = 0$

$\bar{R}_{1+2} + \bar{F}_3 = 0$

$\bar{F}_3 = -R_{1+2}$

$= -(39.3\hat{i} + 181.1\hat{j})$

$= -39.3\hat{i} - 181.1\hat{j}$

30) 

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

$= -10\hat{i} - 15\hat{j} + 50\hat{i}$

$= 40\hat{i} - 15\hat{j}$

$|\bar{R}| = 42.7$ yards

31) ⓐ $\bar{D} = (3 + 1 + -2)\hat{i} + (-3 + -4 + 5)\hat{j}$

$= 2\hat{i} + -2\hat{j}$

$|D| = \sqrt{2^2 + (-2)^2} = 2.82$

$\theta = -45$

$\theta = 360 - 45 = 315$

ⓑ $\bar{E} = (-3 - 1 + -2)\hat{i} + (-(-3) - (-4) + 5)\hat{j}$

$= -6\hat{i} + 12\hat{j}$

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

$\theta = -63.4 + 180 = 116.5$

32) $\bar{A} = -8.7\hat{i} + 15\hat{j}$

$B = 13.2\hat{i} + -6.60\hat{j}$

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

$\boxed{-8.7\hat{i}} + \underline{15\hat{j}} \boxed{-13.2\hat{i}} + \underline{6.60\hat{j}} + 3\bar{C} =$

$\bar{C} = -\left(\frac{-8.7 - 13.2}{3}\right)\hat{i} + -\left(\frac{15 + 6.60}{3}\right)\hat{j}$

$= \underbrace{7.3\hat{i}}_{C_x} - \underbrace{7.2\hat{j}}_{C_y}$

33) ⓐ $\bar{A} = 8\hat{i} + 12\hat{j} + -4\hat{k}$

ⓑ $\bar{B} = \frac{1}{4}\bar{A}$

$= \frac{8}{4}\hat{i} + \frac{12}{4}\hat{j} + \frac{-4}{4}\hat{k}$

$= 2\hat{i} + 3\hat{j} + -1\hat{k}$

ⓒ $\bar{C} = -3\bar{A}$

$= -3(8)\hat{i} + -3(12)\hat{j} + -3(-4)\hat{k}$

$= -24\hat{i} - 36\hat{j} + 12\hat{k}$

34) ⓐ $|B| = \sqrt{4^2 + 6 + 3^2}$

$= 7.8$

ⓑ $\alpha = \cos^{-1}\left(\frac{4}{7.8}\right) = 59.1$

$\beta = \cos^{-1}\left(\frac{6}{7.8}\right) = 39.7$

$\gamma = \cos^{-1}\left(\frac{3}{7.8}\right) = 67.3$

35) ⓐ $\bar{A} = -3\hat{i} + 2\hat{j}$

ⓑ $|\bar{A}| = \sqrt{(-3)^2+2^2} = 3.6$

$\theta = \tan^{-1}\left(\frac{2}{-3}\right)+180$

$= 146.3$

ⓒ $\bar{B} + \bar{A} = 0\hat{i} + -4\hat{j}$

$\bar{B} = -4\hat{j} + 3\hat{i} - 2\hat{j}$

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

36)

ⓐ $\bar{C} = 3\hat{i} - 4\underline{\hat{j}} + 4\hat{k} + 2\hat{i} + \underline{3\hat{j}} \boxed{-7\hat{k}}$

$= 5\hat{i} - \hat{j} - 3\hat{k}$

$|\bar{C}| = 5.91$ m

ⓑ $\bar{D} = 2(3)i - \boxed{2(4)\hat{j}} + 2\underline{(4)}\hat{k} +$

$-2\hat{i} \boxed{-3\hat{j}} + 7\hat{k}$

$= 4\hat{i} - 11\hat{j} + 15\hat{k}$

$|\bar{D}| = 19$ m

37) $a\bar{A} = 6a\hat{i} - 8a\hat{j}$ | $b\bar{B} = -8b\hat{i} + 3b\hat{j}$

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

① $6a - 8b + 26 = 0$ ② $-8a + 3b + 19 = 0$

$a = -\frac{26+8b}{6}$ $\quad -8\left(\frac{-26+8b}{6}\right) + 3b + 19 = 0$

$\boxed{b = 7}$

③ $\boxed{a = 5}$

38)

$A_x = 0$

$A_y = 20$

$B_x = 28.28$

$B_y = 28.28$

$C_x = 21.21$

$C_y = -21.2$

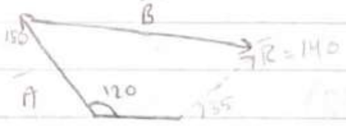
$R_x = 49.49$

$R_y = 27.07$

$|\bar{R}| = 56.4$

$\theta_R = 28.67°$

39)



$A_x = -75$ $\quad R_x = 114.6$

$A_y = 129.29$ $\quad R_y = 80.3$

$R_x = A_x + B_x$ $\quad R_y = A_y + B_y$

$114.6 = -75 + B_x$ $\quad 80.3 = 129.29 + B_y$

$B_x = 189.6$ $\quad B_y = -48.99$

$|\bar{B}| = 183.16$

$\theta_B = -14.48$

40)

$d_{3m} = d_{1m} + d_{2m}$

$= 104\hat{j} + 100\cos 23\,\hat{i} + 100\sin 23\,\hat{j}$

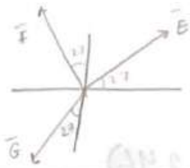
$= 92.05\hat{i} + 143.07\hat{j}$

$|\overline{d_{3m}}| = 170.12$ $\theta_{3m} = 57.24$

$d_{3f} = 84\hat{j} + 86\cos 28\,\hat{i} + 86\sin 28\,\hat{j}$

$= 75.9\hat{i} + 124.34\hat{j}$

$|d_{3f}| = 145.67$ $\theta_{3f} = 58.599$



41) ⓐ $E_x = 17\cos 27 = 15.1$

$E_y = 17\sin 27 = 7.7$

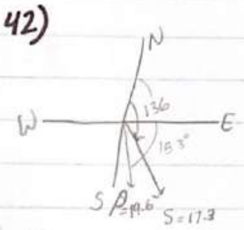
ⓑ $F_x = 17\cos(27+90) = -7.717$

$F_y = 17\sin(27+90) = 15.14$

ⓒ $G_x = 17\cos(63+180) = -7.71$

$G_y = 17\sin(63+180) = -15.14$

42)



$\theta_S = 136 - 90$
$= 46$

$\theta_P = 153 - 90$
$= -63$

$S_x = 17.3\cos(46) = 12.01$
$S_y = 17.3\sin(46) = -12.44$
$S_k = 0$

$P_x = 19.6\cos(-63) = 8.89$
$P_y = 19.6\sin(-63) = -17.46$
$P_k = 2.20$

ⓐ $\overline{D} = \overline{S} - \overline{P}$
$= 3.12\hat{i} + 5.02\hat{j} + 2.20\hat{K}$

ⓑ $|D| = 6.306$ km

43) ⓐ hurricanes displacement

$\Delta x = vt$
$= 41 \times 3$
$= 60$ North of west

44) in the book

45) $y_{\text{coordinate}} = 7.60 \times 10^3$

$x_{\text{coordinate}} = v_i t$

at t=30 $v_i = \frac{x}{t} = \frac{8.04 \times 10^3}{30} = 268$

position vector from you to plane at t=30 $= (268)\hat{i} + (7.60 \times 10^3)\hat{j}$

$t = 30 \rightarrow 8.04 \times 10^3$
$t = 45 \rightarrow x$

$x = \frac{8.04 \times 10^3}{30} \times 45 = 1.206 \times 10^4$

position vector from you to plane at t=45 $= (1.206 \times 10^4)\hat{i} + (7.60 \times 10^3)\hat{j}$

$|\overline{P}|_{\text{at } t=45} = 1.43 \times 10^4$ m

$\theta_{P \text{ at } t=45} = 32.2$

Ch-4

4/11/2020 — phys 1 - Sec 2 - L7

HW 1 - Q37 Ch3 pg 74

$\bar{A} = 6\hat{i} - 8\hat{j}$, $B = -8\hat{i} + 3\hat{j}$, $\bar{C} = 26\hat{i} + 19\hat{j}$,, $a\bar{A} + b\bar{B} + \bar{C} = 5\hat{i} - 8\hat{j}$

$6a\hat{i} - \boxed{8a\hat{j}} + 8b\hat{i} + \boxed{3b\hat{j}} + 26\hat{i} + \boxed{19\hat{j}} = 5i - 8\hat{j}$

① $6a - 8b + 26 = 5$, ② $-8a + 3b + 19 = -8$

$\boxed{a = -21 + 8b}$

$-8(-21 + 8b) + 3b + 19 = 8$

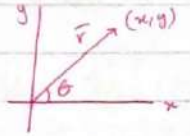
$b = 2.93$

③ $a = -21 + 8(2.93)$

$a = 2.44$

CH-4 motion in 2 dimension:-

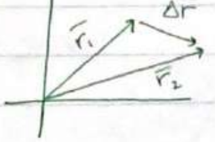
position vector $\bar{r}$:- $\bar{r} = x\hat{i} + y\hat{j}$ $|\bar{r}| = \sqrt{x^2 + y^2}$



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

Displacement vector $\bar{\Delta r}$:-

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



$$\bar{\Delta r} = \bar{r}_2 - \bar{r}_1 = \underbrace{(x_2 - x_1)}_{\Delta x}\hat{i} + \underbrace{(y_2 - y_1)}_{\Delta y}\hat{j}$$

average velocity

$$\bar{v} = \frac{\bar{\Delta r}}{\Delta t} = \frac{\Delta x\hat{i} + \Delta y\hat{j}}{\Delta t} = \underbrace{\left(\frac{\Delta x}{\Delta t}\right)}_{v_x}\hat{i} + \underbrace{\left(\frac{\Delta y}{\Delta t}\right)}_{v_y}\hat{j}$$

$\bar{v} = v_x\hat{i} + v_y\hat{j}$

Instantaneous velocity

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

average acceleration

$$\bar{a} = \frac{\Delta\bar{V}}{\Delta t} = \frac{\bar{V}_2 - \bar{V}_1}{\Delta t} = \frac{\Delta V_x}{\Delta t}\hat{i} + \frac{\Delta V_y}{\Delta t}\hat{j} = a_x\hat{i} + a_y\hat{j}$$

$$\left.\begin{array}{l} \bar{v}_2 = v_{2x}\hat{i} + v_{2y}\hat{j} \\ \bar{v}_1 = v_{1x}\hat{i} + v_{1y}\hat{j} \end{array}\right\} \Delta\bar{v} = \underbrace{(v_{2x} - v_{1x})}_{\Delta v_x}\hat{i} + \underbrace{(v_{2y} - v_{1y})}_{\Delta v_y}\hat{j}$$

instantaneous acceleration

$$\bar{a} = \frac{d\bar{v}}{dt} = \frac{d^2\bar{r}}{d^2t}$$

Equations of motion

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

$$\bar{\Delta} r = \bar{v}_i t + \tfrac{1}{2}\bar{a}t^2$$

$$\Delta r = \tfrac{1}{2}(\bar{v}_f + \bar{v}_i)t$$

$$v_f^2 = v_i^2 + \underbrace{2\bar{a}\,\Delta\bar{r}}_{\text{vector multiplication}} \Big\} \longrightarrow \text{تعطيني مقداراً لا اتجاهاً}$$

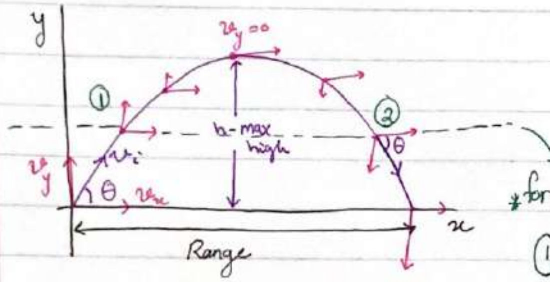
9/11/2020

phys - sec2 - L8

projectile motion :- is a good application on motion in 2D with no air effect & no friction effect.

- motion on x-axis with Zero acceleration $a_x = 0$
- motion on y-axis with gravity acceleration $a_y = g$

$\bar{a} = (0\hat{i} - 10\hat{j})\ m/s^2$



$v_f = v_i \cos\theta\ \hat{i} + v_i \sin\theta\ \hat{j}$

*for example :-

① $v_x = 10$ $v_y = 8$ $\theta = 38$

② $v_x = 10$ $v_y = -8$ $\theta = 360 - 38 = 322$

on x-axis

$$v_{xf} = \overset{v_i\cos\theta}{v_{xi}} + \cancel{\overset{a_x = 0}{a_x} t}^{\,0}$$

$$\boxed{v_{xf} = v_i \cos\theta} \quad ①$$

$$\Delta x = \overset{v_i\cos\theta}{v_{ix}} t + \cancel{\tfrac{1}{2} \overset{a_x = 0}{a_x} t^2}^{\,0}$$

$$\boxed{\Delta x = v_i \cos\theta\, t} \quad ②$$

on y-axis

$$v_{yf} = \overset{v_i\sin\theta}{v_{yi}} + \overset{g}{a_y} t$$

$$\boxed{v_{yf} = v_i \sin\theta + gt} \quad ③$$

at max hight it is = to zero

$$\Delta y = \overset{v_i\sin\theta}{v_{iy}} t + \tfrac{1}{2} \overset{g}{a_y} t^2$$

$$\boxed{\Delta y = v_i \sin\theta\, t + \tfrac{1}{2} g t^2}$$

- Equation that connects both x & y :-

$$y = x \tan\theta - \frac{g}{2 v_i^2 \cos^2\theta} x^2$$

- زمن الوصول لأقصى ارتفاع :-

$$t = \frac{v_i \sin\theta}{g} \quad ④$$

- الزمن الكلي :-

$$t = 2\left(\frac{v_i \sin\theta}{g}\right) \quad ⑤$$

- $\text{Rang}_{max} \rightarrow \Delta x_{max}$:-

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

$$= \frac{v_i^2 \sin 2\theta}{g} \quad ⑥$$

- max hight $\rightarrow \Delta y_{max}$:-

$$\Delta y = v_i \sin\theta\, t - \frac{1}{2} g t^2 \xrightarrow{\text{time to reach}} \text{max}$$

$$= v_i \sin\theta \cdot \frac{v_i \sin\theta}{g} - \frac{1}{2} g \left(\frac{v_i \sin\theta}{g}\right)^2$$

$$h = \frac{v_i^2 \sin^2\theta}{2g} \quad ⑦$$

11/11/2020 — phys 1 - sec 2 - L9

Solve problems #:- 13, 15, 16, 20, 23,

16/11/2020 — phys 1 - sec 2 - L10

باتجاه المماس وبيتغير مع الزاوية

- Circular motion :- الحركة الدائرية

بيكون عنه تسارع مركزي a_c
+ تسارع مماسي a_t

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

Changing the vector
- changing the magnitude. (speed)
- Changing the direction.

results from changing the (speed) magnitude of the velocity

gives linear (tangential) acceleration at

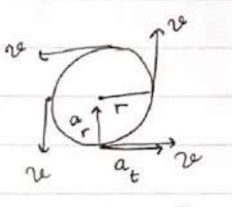
$$\boxed{\bar{a}_t = \frac{|\Delta \bar{v}|}{\Delta t}}$$

results in changing the centripetal acceleration even though the velocity is constant

التسارع المركزي ينتج عن تغير اتجاه السرعة

gives radial acceleration (centripetal) a_r or a_c

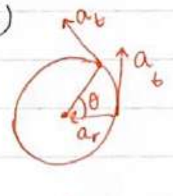
$$\boxed{\bar{a}_r = \frac{v^2}{r}}$$



- direction of at is always in the same dir. as the velocity (Tangent to direction)

- the direction of ar is always toward the center.

at ⊥ a_r always



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

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

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

If $a_t = 0$ (constant speed) velocity
uniform circular motion.

لأنني ما بغير بال magnitude تبعت ال velocity وبذلك لا ينشأ a_t

$a_t \neq 0$
non-uniform circular motion.

هنا التغير في المقدار والاتجاه

Solve problems #:- 36, 40, 41,

The book indicates that :- $a_r = -\frac{v^2}{r}$

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

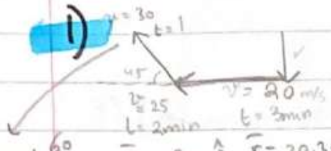
$a_t = \left|\frac{dv}{dt}\right|$

Solving problems

$x = vt$
$r = vt$

Section 1:-

1)



$r_3 = 30 \cdot 1 \cdot 60$
$= 1800$

$\bar{r}_2 = -3000\,\hat{i}$

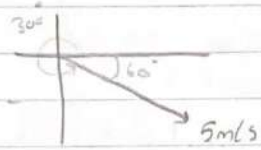
$\bar{r}_1 = 20 \cdot 3 \cdot 60$
$= -3600\,\hat{j}$

a) $\bar{R} = \bar{r}_1 + \bar{r}_2 + \bar{r}_3$
$= -3600\,\hat{j} + -3000\,\hat{i} + 1800\cos 45\,\hat{i} + 1800\sin 45\,\hat{j}$
$= (-4270\,\hat{i} + 3070\,\hat{j})\ m$

b) $\text{average speed} = \frac{\text{total dist}}{\text{total time}} = \frac{3600 + 3000 + 1800}{(3+2+1)_{\text{min}} \times 60} = 23.3$

c) $v_{avg} = \frac{|\Delta x|}{\Delta t} = \frac{-4270\,\hat{i} + 3070\,\hat{j}}{6 \times 60} = -11.8\,\hat{i} + 8.5\,\hat{j}$

2)



$v_x = 5\cos 300 = 2.5\ m/s$

3)

$r(t) = x(t)\,\hat{i} + y(t)\,\hat{j}$

a) $v_{avg} = \left[\left(\frac{\overset{at+b}{(1(4)+1) - (1(2)+1)}}{4-2}\right)\hat{i} + \left(\frac{\overset{ct^2+d}{0.125(4)^2+1 - 0.125(2)^2+1}}{4-2}\right)\hat{j}\right]$ $t_1 = 2$, $t_2 = 4$

$= 1\,\hat{i} + 0.750\,\hat{j}$

b) at $t = 2$

$v_x = \frac{dx}{dt} = a$
$v_y = \frac{dy}{dt} = 2ct$

$\bar{v} = a\,\hat{i} + 2ct\,\hat{j}$
$= 1\,\hat{i} + 0.25(2)\,\hat{j}$
$= 1\hat{i} + \frac{1}{2}\hat{j}$

$|\bar{v}| = \sqrt{1^2 + \frac{1}{2}^2} = 1.12$

4)

a) $v_x = -5 \cdot \cos \omega t \cdot \omega$

$v_y = -5 \cdot \sin \omega t \cdot \omega$

$\bar{v} = -5\cos\omega(0)\omega\,\hat{i} + 5\sin\omega(0)\cdot\omega\,\hat{j}$

$= -5\omega\,\hat{i} + 0\,\hat{j}$

b) $a_x = -5\omega \cdot -\sin\omega t\cdot\omega$

$a_y = 5\omega \cdot \cos\omega t\cdot\omega$

$\bar{a} = 5\omega^2 \sin\omega\overset{0}{t}\,\hat{i} + 5\omega^2\cos\omega\overset{0}{t}\,\hat{j}$

$= 0\,\hat{i} + 5\omega^2\,\hat{j}$

c) $r(t) = -5\sin\omega t\,\hat{i} + (4 - 5\cos\omega t)\,\hat{j}$

$v(t) = -5\cos\omega t\cdot\omega\,\hat{i} + 5\sin\omega t\cdot\omega\,\hat{j}$

$a(t) = 5\omega^2\sin\omega t\,\hat{i} + 5\omega^2\cos\omega t\,\hat{j}$

d) object moves in a circle with radius $= 5$ with center $= (0,4)$

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

b) $v(t) = (18)\,\hat{i} + (4 - 4.9(2)t)\,\hat{j}$

c) $a(t) = (0)\,\hat{i} + (-4.9(2))\,\hat{j}$

ⓓ $t = 3$

$r(3) = 54\,\hat{i} + -32.1\,\hat{j}$

$v(3) = 18\,\hat{i} + -25.4\,\hat{j}$

$a(3) = 0\,\hat{i} + -9.8\,\hat{j}$

Section 2:-

6) $\bar{a} = 0\,\hat{i} + 3\,\hat{j}$

$\bar{v} = 5\,\hat{i} + 0\,\hat{j}$

a) $\Delta \bar{r} = v_i t + \frac{1}{2}at^2$

$r_f - \overset{0}{r_i} = (5\hat{i} + 0\hat{j})t + \frac{1}{2}(0\hat{i} + 3\hat{j})t^2$

$r_f = 5t\,\hat{i} + \frac{3}{2}t^2\,\hat{j}$

b) $\bar{v} = v_i + at$

$= (5\,\hat{i} + 0\,\hat{j}) + (0\,\hat{i} + 3\,\hat{j})t$

$= 5\,\hat{i} + 3t\,\hat{j}$

c) $r_f = 5(2)\,\hat{i} + \frac{3}{2}(2)^2\,\hat{j}$

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

d) $\bar{v} = 5\,\hat{i} + 3(2)\,\hat{j}$

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

$\text{speed} = |\bar{v}| = \sqrt{5^2 + 6^2}$

$= \sqrt{61} = 7.81$

7) a) $\bar{v} = 0\hat{i} - 2(6)t\hat{j}$
$= 0\hat{i} - 12t\hat{j}$

b) $\bar{a} = 0\hat{i} - 12\hat{j}$

c) $\bar{r} = 3\hat{i} - 6t^2\hat{j}$
$= 3\hat{i} - 6(1)\hat{j}$
$= 3 - 6\hat{j}$

$\bar{v} = -12(1)\hat{j}$
$= -12\hat{j}$

8) —

9) a) $v_f = v_i + at$

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

$a = \dfrac{(20-4)\hat{i} + (-5-1)\hat{j}}{20} = \underset{a_x}{\left(\dfrac{4}{5}\right)}\hat{i} + \underset{a_y}{\left(\dfrac{-3}{10}\right)}\hat{j} \Rightarrow |a| = 0.85$

b) $\theta_a = -20.55$

$\theta_a = 360 - 20.55$
$= 339.45$

c) $\bar{\Delta r} = v_i t + \frac{1}{2}at^2$

$r_f - r_i = 4(25)\hat{i} + 25\hat{j} + \frac{1}{2}\left(\frac{20-4}{25}\right)(25)^2\hat{i} + \frac{1}{2}\left(\frac{-5-1}{25}\right)(25)^2\hat{j}$

$= (300\hat{i} - 50\hat{j}) + \underbrace{(10\hat{i} - 4\hat{j})}_{r_i}$

$= 310\hat{i} - 54\hat{j}$

حل الدليل غلط لأنه استخدم a اللي محسوبة على ان t واللي هو 20 ، ليس 25 كما طلب السؤال.

or

$r_f - r_i = \frac{1}{2}(v_i + v_f)t$

$r_f = \underbrace{\frac{1}{2}(25)(4)}_{\hat{i}} + \underbrace{\frac{1}{2}(25)(1)}_{\hat{j}} + \underbrace{\frac{1}{2}(25)(20)}_{\hat{i}}$

$+ \underbrace{\frac{1}{2}(25)(-5)}_{\hat{j}} + 10\hat{i} - 4\hat{j}$

$= 310\hat{i} - 54\hat{j}$

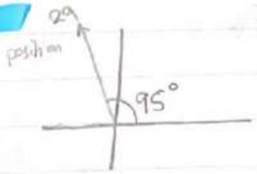
d) direction of motion ⇒ direction of $\bar{v}$.

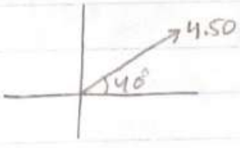
$v_f = v_i + at$
$= 4\hat{i} + 1\hat{j} + \frac{20-4}{25}(25)\hat{i} + \frac{-5-1}{25}(25)\hat{j}$
$= 20\hat{i} + -5\hat{j}$

$\theta = -14^\circ$

$\theta_{tot} = 360 - 14 = 346$

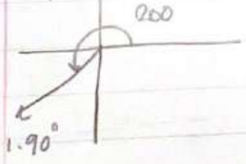
10)





$r_x = 29\cos 95$
$r_y = 29\sin 95$

$v_x = 4.50\cos 40$
$v_y = 4.50\sin 40$
$|v| = 4.5$



$a_x = 1.90\cos 200$
$a_y = 1.90\sin 200$
$|a| = 1.9$

a) $v_f = v_{i_x} + a_x t + v_{i_y} + a_y t \rightarrow = 3.45 - 1.79t\,\hat{i}$
$2.89 - 0.650\hat{j}$

b) $r_f = r_i + v_i t + \frac{1}{2}at^2 \rightarrow$
$= (-2.53 + 3.45t - 0.89t^2)\hat{i} + (21.9 + 2.89t - 0.35t^2)\hat{j}$

Section 3:-

11) $h_{max} = \boxed{12\ ft}$ $v_i = ?$

$\theta = 45°$ $\downarrow$ 3.66m

$h_{max} = \frac{v_i^2 \sin^2\theta}{2g} \longrightarrow 3.66 = \frac{v_i^2 \sin^2(45)}{2(+9.8)}$

$v_i = 11.9779 \approx 12$

12) $R = 15$

$v = 3$

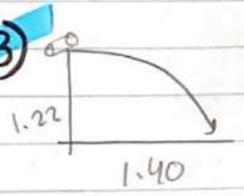
$a_g = g = ?$

$\theta = 45$

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

$g = \frac{v_i^2 \sin 2\theta}{R} = 0.6\ m/s^2$

13)



$v_{iy} = 0$

$v_f = ?$

$v_i = ?$

$\Delta y = -1.22$

$\Delta x = 1.40$

ⓐ

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

$1.40 = v_{ix} t$

2) $\Delta y = \cancel{v_{iy}} t + -4.9t^2$ $\overset{0}{}$

$-1.22 = -4.9t^2$

$t = 0.498$

3) $1.40 = v_{ix}(0.498)$

$v_{ix} = 2.811$

ⓑ $v_f = (2.8\hat{i} + 0\hat{j}) + (0\hat{i} + -9.8\hat{j})(0.498)$

$= 2.8\hat{i} + -4.88\hat{j}$ $\theta = -60.2°$

14)

$v_{ix} = \frac{d}{\sqrt{\frac{\cancel{-}2h}{\cancel{-}g}}}$

$= \frac{d}{\sqrt{\frac{2h}{g}}}$

$v_f = v_{ix} + a_y\left(\sqrt{\frac{\cancel{-}2h}{\cancel{-}g}}\right)$

$= v_{ix} + a_y\left(\sqrt{\frac{2h}{g}}\right)$

$t = \sqrt{\frac{2h}{g}}$

15) $R = 3h$ $\rightarrow \theta = ?$

$\frac{\cancel{v_i^2} 2\sin\theta\cos\theta}{\cancel{g}} = 3 \cdot \frac{\cancel{v_i^2} \sin^{\cancel{2}}\theta}{2\cancel{g}}$ ^{1} $\nearrow$

$\overset{2}{2}\cos\theta = 3\sin\theta$

$\frac{\sin\theta}{\cos\theta} = \frac{4}{3}$

$\tan\theta = 4/3 \longrightarrow$

$\theta = \tan^{-1}\left(\frac{4}{3}\right)$

$= 53.13$

حل النقطة
القذيفة وهي
طالعة وهي
نازلة

1) find t at max height

if > t=42
وهي طالعة

if < t=42
وهي نازلة

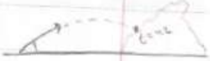
~~OR~~ $v_f = v_i + at$
$= 172\hat{i} + 246\hat{j} + (0\hat{i} + -9.8\hat{j}) \times 42$
$v_f = 172\hat{i} - 165\hat{j}$
(وهي نازلة)

$\bar{a} = 0\hat{i} + -9.8\hat{j}$

$\bar{v}_i = 300\cos 55 + 300\sin 55$
$= 172\hat{i} + 246\hat{j}$

$\Delta r = v_i t + \frac{1}{2} a t^2$
$= (172\hat{i} + 246\hat{j})(42) + \frac{1}{2}(0\hat{i} - 9.8\hat{j})(45)^2$
$= 7227\hat{i} + 1677.7\hat{j}$

16) $v_i = 300$
$\theta = 55°$
$t = 42$

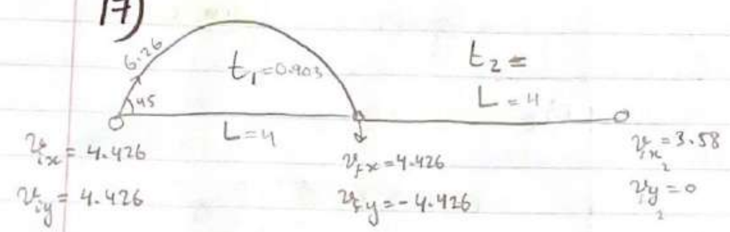


~~OR~~

$x_f = \cancel{x_i}^{0} + v_{ix} t + \frac{1}{2} \cancel{a_x}^{0} t^2$
$= 300\cos 55 \times 42$
$= 7227.06$

$y_f = \cancel{y_i}^{0} + v_{iy} t + \frac{1}{2} a_y t^2$
$= 300\sin 55 \times 42 + \frac{1}{2}(-9.1)(42)^2$
$= 1677.7$

17)



a) $v_{avg} = \frac{\Delta x \rightarrow 2L}{\boxed{\Delta t} \rightarrow t_1 + t_2}$

$v_{f(y)} = v_{iy} + at_1$ ← مش ال(x) بتاعة

$t_1 = \frac{-4.426 - 4.426}{-9.8} = 0.903$

$L = v_i \cos\theta\, t_1$
$= 6.26\cos 45 \times 0.903$
$= 3.997 \simeq 4\ m$

$t_2 = \frac{L}{v} = \frac{4}{3.58} = 1.12\ sec$

$v_{avg} = \frac{2(4)}{0.903 + 1.12} = 3.96\ m/s$

b) $100 \times \frac{\Delta t_1 + \Delta t_2}{\Delta t_2} = \frac{2.02 - 2.23}{2.23} \times 100 = -9.4\%$

reduces by 9.4

$= t_1 + t_2$
$= 0.903 + 1.12$
$= 2.02$
proposing manuover

$\frac{2L}{v} = \frac{2(4)}{3.58} = 2.23$
without proposing
distance = 2L

18)

R = h

a) $\frac{\cancel{v_i^2}\sin 2\theta}{\cancel{g}} = \frac{\cancel{v_i^2}\sin^2\theta}{2\cancel{g}}$ (R, h)

$\theta = 76°$

b) $R = \frac{v_i^2 \sin(2(76))}{g}$

$R_{max} = \frac{v_i^2 \sin(2(45))}{g} = \frac{v_i^2}{g}$

$R = R_{max} \cdot \sin(2(76))$

$R_{max} = \frac{R}{\sin(2(76))} = 2.13R$

19) $v_{i_b} = \frac{1}{2} v_{i_{b_2}}$

$\theta = \tan^{-1}\left(\frac{v_{yi}}{v_{xi}}\right) = \tan^{-1}\left(\frac{\sqrt{2gh}}{\sqrt{\frac{gh}{3}}}\right)$

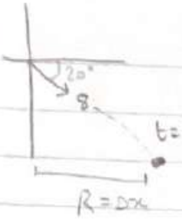
$= \tan^{-1}\sqrt{6} = 67.8$

$\bar{a} = 0\hat{i} - 9.8\hat{j}$

$\bar{v} = 8\cos 20\hat{i} - 8\sin 20\hat{j}$

$= 7.5\hat{i} - 2.73\hat{j}$

20)



a) $\Delta x = v_{i_x} t$

$= 7.5(3)$

$= 22.5$

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

$0 - y_i = -2.73(3) + \frac{1}{2}(-9.8)(3)^2$

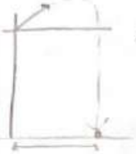
$y_i = 52.29$

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

$10 - 52.29 = -2.73t + \frac{1}{2}(-9.8)t^2$

$t = 2.67$ ~~$t = 3.2$~~

HW1



$\bar{a} = 0\hat{i} - 9.8\hat{j}$

$\bar{v} = 7.5\hat{i} + 2.73\hat{j}$

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

$= 7.5(3)$

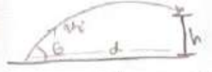
$= 22.5$

b) $y_i = \frac{+2.73(3) + \frac{1}{2}(-9.8)(3)^2}{-1}$

$= 35.91$

c) $10 - 35.91 = +2.73t + \frac{1}{2}(-9.8)t^2$

$t = 2.59$, $t = -$ ~~2.03~~



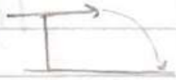
$d = v_i \cos\theta\, t$

$* t = \frac{d}{v_i \cos\theta}$

21) $* y_f = y_i + v_{iy} t + \frac{1}{2} a_y t^2$

$= d\tan\theta - \frac{g d^2}{2 v_i^2 \cos^2\theta}$

HW2



a) $\Delta x = v t$

$= 8(3)$

$= 24$

b) $y_i = \frac{8(3) + \frac{1}{2}(-9.8)(3)^2}{-1}$

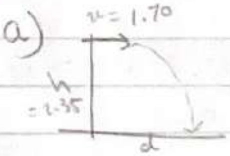
$= 20.1$

c) $10 - 20.1 = \overset{0}{v_{iy} t} + \frac{1}{2}(-9.8)t^2$

$t = 1.43$, $t =$ ~~-1.43~~

22)

a)



$d = v t$

$= 1.70(0.69)$

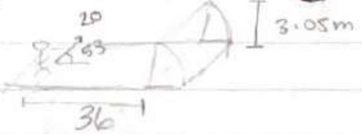
$= 1.173$

$y_f - y_i = \overset{0}{v_{iy} t} + \frac{1}{2} a_y t^2$

$0 - 2.35 = 0 + \frac{1}{2}(-9.8)t^2$

$t = 0.69$, $t =$ ~~-0.69~~

23)



a) $d = v_i \cos\theta\, t$

$t = \frac{d}{v_i \cos\theta}$

$y_f - \overset{0}{y_i} = v_{iy} t + \frac{1}{2} a_y t^2$

$= 3.939$

or use

$y_f = d\tan\theta - \frac{g d^2}{2 v_i^2 \cos^2\theta}$

b) $v_f = v_i + a t$

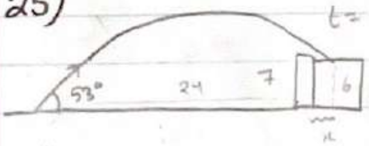
$= (20\cos 53\hat{i} + 20\sin 53\hat{j})$

$+ (0\hat{i} + -9.8\hat{j})(2.99)$

$= 12\hat{i} - 13.3\hat{j}$

[illegible]

25)



a) $d = v_i \cos\theta\, t$

$24 = v_i \cos(53)(2.20)$

$v_i = 18.126$ m/s

b) $y_f = 24\tan 53 - \frac{9.8(24)^2}{2(18.126)^2\cos^2(53)}$

$= 8.13$ m

$8.13 - 7 = 1.13$m

c) $\overset{6}{y_f} = x\tan\theta - \frac{g x^2}{2 v_i \cos^2\theta}$

$x = 26.78$

$x = 5.439$

$x = 26.78 - 24$

$= 2.78$m

26) $v_i = 11.2$

$\theta = 18.5$

$y_f = 0.360$

$y_i = 0.840$

$x_f = 10.62$

$x_i = 0$

ⓐ center of mass original position is :- $(x_i, y_i) = (0, 0.840)$

$\bar{r} = 0\hat{i} + 0.840\hat{j}$

ⓑ original velocity vector is :- $v = v_x\hat{i} + v_y\hat{j}$

$= 10.6\hat{i} + 3.55\hat{j}$

$|v| = 11.17 \quad \theta = 18.51°$

ⓒ $x_f = 10.6t$

$y_f = y_i + v_y t + \frac{1}{2}a_y t^2$

$0.360 = 0.840 + 3.55t + -4.9t^2$

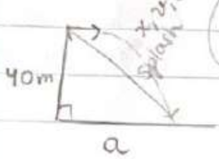
$t = 0.840$

$x_f = 10.6(0.840)$

$= 8.904$

$\approx 9m$

27)



$\boxed{\begin{aligned} v_{s} &= 343 \\ t &= 3 \end{aligned}}$

$v_{i_x} = ?$

$v_{iy} = 0$

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

$0 - 40 = \frac{1}{2}(-9.8)(t^2)$

$t = 2.85$ sec original flight

2) $t_{flight} = t_{splash} - t_{original\ flight}$

$= 3 - 2.85$

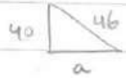
$= 0.14s$

3) $x_{splash} = v_{splash} \cdot t_{splash}$

$= 343 \cdot 3$

$= 49$

4)



$a = \sqrt{49^2 - 40^2}$

$= 28.3m$

5) $a = v_i t$

$28.3 = v \cdot 2.85$

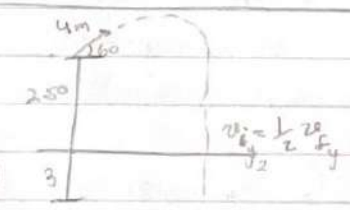
$v = 9.92 m/s$

31) $y_i = 2.50$

$\theta = 60$

$v_i = 4 m/s \lessgtr \begin{matrix} v_{ix} = 2 \\ v_{iy} = 3.4 \end{matrix}$

total time of flight $t = ?$



$v_{iy_2} = \frac{1}{2} v_{fy}$

1) $\cancel{y_{f_1}}^{0} - y_{i_1} = v_{iy} t + \frac{1}{2}a_y t^2$

$-2.50 = 3.4t + \frac{1}{2}(-9.8)t^2$

$t = 1.141$ sec

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

$= 3.4 + (-9.8)(1.141)$

$= -8.04$

3) $v_{iy_2} = \frac{1}{2} v_{fy_1}$

$= \frac{1}{2}(-8.04)$

$= -4.02$

4) $y_{f_2} - y_{i_2} = v_{iy_2} t + \frac{1}{2} a_y t^2$

$0 - 3 = -4.02t + \frac{1}{2}(-9.8)t^2$

$t = 0.473$

5) $t_{total\ time\ of\ flight} = 1.141 + 0.473$

$= 1.61$ sec

Section 4:-

33) $r = 1.06$

$m = 1\ kg$

$v = 20$

$a_c = ?$

$$a_c = \frac{v^2}{r} = \frac{20^2}{1.06} = 377\ m/s^2$$

36)

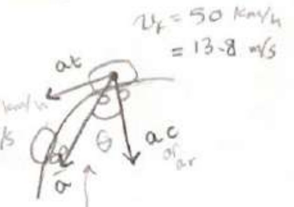
$r = 0.500$

$$v = 200 \frac{rev}{min} \times \frac{2\pi r\ rad}{1\ rev} \times \frac{1\ min}{60\ sec}$$

$$= 10.47\ rad/sec$$

$$a_c \text{ or } a_r = \frac{v^2}{r} = \frac{10.47^2}{0.500} = 219.3\ m/s^2$$

41)



$v_f = 50$ $t = 15$

$v_i = 90$ $r = 150$

$$|\bar{a}| = \sqrt{\underset{\frac{v^2}{r}}{a_c}^2 + \underset{\left|\frac{\Delta v}{\Delta t}\right|}{a_t}^2}$$

$$= \sqrt{\left(\frac{13.8^2}{150}\right)^2 + \left(\frac{13.8 - 25}{15}\right)^2}$$

$$= 1.472\ m/s^2$$

$$\theta = \tan^{-1}\left(\frac{|a_t|}{a_c}\right) = -30.46$$

38)

$v_1 = 8\ rev/sec = 30.15$

$r_1 = 0.600\ m$

$r_2 = 0.900$

$v_2 = 6\ rev/sec = 33.9$

ⓐ the second rate $v = 6\ rev/sec$ gives the greatest speed of a ball.

ⓑ $a_{c_1} = \frac{v^2}{r} = \frac{30.15^2}{0.600} = 1515.03\ m/s^2$

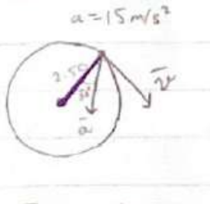
ⓒ $a_{c_2} = \frac{v^2}{r} = \frac{33.9^2}{0.900} = 1276.9\ m/s^2$

gives the higher acceleration

the greater the speed the greater the acceleration.

Section 5:-

40)



$-a_c$

ⓐ $a_c = \bar{a} \cos(30)$

$= 15 \cos(30)$

$= 12.99 \approx 13\ m/s^2$

ⓑ $a_c = \frac{v^2}{r}$

$v = \sqrt{a_c \times r}$

$= \sqrt{13 \times 2.50}$

$= 5.7\ m/s$

ⓒ $a^2 = a_t^2 + a_c^2$

$a_t = \sqrt{a^2 - a_c^2}$

$= \sqrt{15^2 - 13^2}$

$= 7.50\ m/s^2$

18/11/2020 phys 1 - Sec2 - L11

* Newton's Laws:-

- 1st law:- object at rest or moving with CONSTANT VELOCITY stays as it is, unless an external force acting on it.

Constant velocity → constant in magnitude, → Constant in direction] No change in velocity means acceleration is (0) $a=0$

So $\sum \bar{F}=0 \Rightarrow \bar{a}=0$

$a_x=0$, $a_y=0$, $a_z=0$ ⟷ [$\sum F_x=0$, $\sum F_y=0$, $\sum F_z=0$] ⟷ is a vector equation [object at rest / moving with constant velocity — equilibrium

- 2nd law:- when a constant force acts on a massive body it causes it to accelerate, & change it's velocity at a constant rate

$\sum F_x = ma_x$

$\sum F_y = ma_y$

$\sum F_z = ma_z$

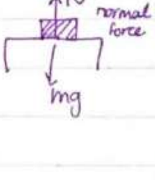
$$\left[\sum \bar{F} \neq 0 \Rightarrow \bar{a} \neq 0\right] \quad \sum \bar{F} \propto \bar{a} \Rightarrow \sum \bar{F} = \overset{\text{need a constant}}{\boxed{\text{constant}}} \cdot \bar{a}$$

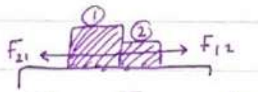
mass مقدار مايحويه الجسم من مادة

$$\bar{F} = m\bar{a} \Rightarrow N = Kg \cdot \frac{m}{s^2}$$

$$w = mg$$

- 3rd law:- Every action has a reaction equal in magnitude & opposite it in direction.





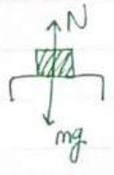
$\bar{F}_{12} = -\bar{F}_{21}$ مساويان في المقدار ومعاكسان في الاتجاه

$|\bar{F}_{12}| = |\bar{F}_{21}|$

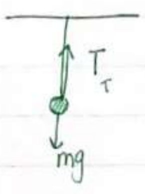
internal force $\bar{F}_{12} + \bar{F}_{21} = 0 \Rightarrow \sum \bar{F} = 0$

* Forces:-
  1- contact force
  2- Feild force → electric force, magnatic force, gravitational force
  3- Frictional force

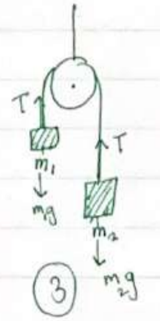
* Free body digram:-



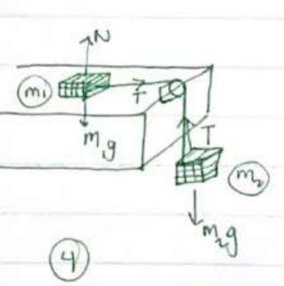
①



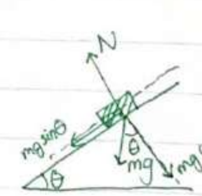
②



③



④



⑤

$$\sum_1 F_y = m a_y \Rightarrow \underbrace{N \overset{\text{opposite direction}}{\boxed{-}} mg\cos\theta}_{\sum_1 F_y} = 0 \quad \Big] \; N = mg\cos\theta$$

$$\sum_1 F_x = m a_x \Rightarrow \underbrace{mg\sin\theta}_{\sum_1 F_x} = m a_x$$

---

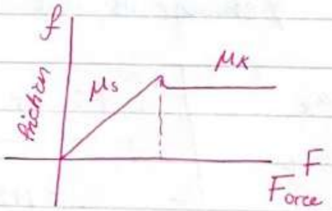
* <u>Frictional force</u> :- قوة الاحتكاك f is allways in opposite direction to the direction of the motion.

$$f \propto N \Rightarrow f = \underset{\mu}{\boxed{\text{Const}}} \cdot N \quad \Big] \; F = \underset{\text{coefficient of friction}}{\mu} N$$

---

* Static friction:- $f_s \Rightarrow F_s = \underset{\text{معامل الاحتكاك السكوني}}{\boxed{\mu_s}} \cdot N$

* Kinetic friction :- $f_K \Rightarrow F_K = \underset{\text{معامل الاحتكاك الحركي}}{\boxed{\mu_K}} N$



$\mu_s > \mu_K$

$1\ lb = 4.45\ N$

Section 1 to 6:- **Solving problems**

1) $120\ lb \xrightarrow{\times 4.45} 534\ N =$

ⓐ $\underset{\text{weight}}{F_g} = 534\ N$

ⓑ $m = \frac{F_g}{g} = \frac{534}{9.8} = 54.5\ kg$

2) $F_g = 900\ N \quad , g_J = 25.9$

$m_J = \frac{F_g}{g} = \frac{900}{9.8} = 91.8\ kg$

$F_g = m_J g_J = 25.9 \times 91.8$
$= 2377.62\ N$

3) $F = ma_x + ma_y$
$= 3 \times 2\hat{i} + 3 \times 5\hat{j}$

ⓐ $= 6\hat{i} + 15\hat{j}$

ⓑ $|F| = 16.155$

4) $\sum_1 F_x = T_1\cos(14) + -T_2\cos(14) = 0$

$\sum_1 F_y = -T_1\sin(14) + -T_2\sin(14) = -2T\sin(14$

$|\bar{F}| = \sqrt{(0)^2 + (-2T\sin(14))^2} = 8.709$

5) $F = m\textcircled{a} \longrightarrow \frac{\Delta v}{\Delta t} = \frac{(8\hat{i} + 10\hat{j}) - 3\hat{i}}{8-0} = \frac{+5\hat{i} + 10\hat{j}}{8} = +\frac{5}{8}\hat{i} + +\frac{10}{8}\hat{j}$

$F = 4 \times +\frac{5}{8}\hat{i} + 4 \times +\frac{10}{8}\hat{j}$
$= +\frac{5}{2}\hat{i} + 5\hat{j}$

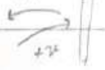
ⓐ $F = \frac{5}{2}\hat{i} + 5\hat{j}$ ⓑ $|\bar{F}| = 5.59016\ N$

6)

$\underset{\text{speed}}{\text{average}} = 6.70 \times 10^2$

$m = 4.68 \times 10^{-26}$

$t = 3 \times 10^{-13}$



ⓐ $a_{avg} = \frac{\Delta V}{\Delta t} = \frac{-6.7 \times 10^2 - 6.7 \times 10^2}{3 \times 10^{-3}} = -4.47 \times 10^{15}\ m/s^2$

ⓑ $F = ma = 4.68 \times 10^{-26}(-4.47 \times 10^{15})$
$= -2.09 \times 10^{-10}\ N$

7)

$F_{paris} = mg_{paris}$ $F_{cayenne} = mg_{cayenne}$

$\Delta F = mg_{cayenne} - mg_{paris}$

$= 90 \times 9.7808 - 90 \times 9.8095$

$= \ominus 2.583$

Lose weight

8) $F = m\text{\textcircled{a}} = 0$

because it is a
constant
speed

11) $m = 9.11 \times 10^{-31}$

$v_i = 3 \times 10^5$

$v_f = 7 \times 10^5$

$\Delta x = 5 \times 10^{-2}$

$\cancel{\frac{\Delta v}{\Delta t}}$?

$$F = ma \rightarrow v_f^2 - v_i^2 = 2a\Delta x \rightarrow a = \frac{v_f^2 - v_i^2}{2\Delta x}$$

$$= 9.11 \times 10^{-3} \left(\frac{(7 \times 10^5)^2 - (3 \times 10^5)^2}{2(5 \times 10^{-2})} \right)$$

$$= 3.6 \times 10^{-18}\ N$$

12) $m = 2.80$

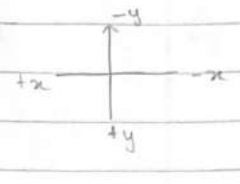
$v_i = 0$

$t_i = 0$

$t_f = 1.20$

$\Delta r = 4.20\hat{i} - 3.30\hat{j}$

$F_1 = mg$] gravitational force



$\cancel{\frac{\Delta v}{\Delta t}}$?

$$F_2 = ma \rightarrow \Delta r = v_i t + \tfrac{1}{2}at^2 \rightarrow a = 5.83\hat{i} + -4.58\hat{j}$$

$$= 16.32\hat{i} - 12.824\hat{j}$$

$$\sum F = F_1 + F_2 = 2.80 \times 9.8\hat{j} + 6.32\hat{i} - 12.824\hat{j}$$

$$= 6.32\hat{i} + 14.616\hat{j}$$

13) in the book **14)** in the book

15) $F_1 = -6\hat{i} - 4\hat{j}$, $m = 2\ kg$

$F_2 = -3\hat{i} + 7\hat{j}$, $(x, y) = (-2, 4)$

$t = 10$

ⓐ $\sum F = -9\hat{i} + 3\hat{j}$

$$\bar{a} = \frac{\sum F}{m} = \frac{-9}{2}\hat{i} + \frac{3}{2}\hat{j}$$

$$\bar{a} = \frac{v}{t} \Rightarrow v_f = at = \frac{-9}{2} \times 10\hat{i} + \frac{3}{2} \times 10\hat{j}$$

$$= -45\hat{i} + 15\hat{j}$$

ⓑ $\theta = \tan^{-1}\left(\frac{15}{-45}\right) + 180 = 161.56$

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

$$x_f = \tfrac{1}{2} \times -\tfrac{9}{2} \times 10^2$$

$$= -225$$

$y_f - \cancel{y_i}^0 = \cancel{v_{iy}}^0 t + \frac{1}{2} \bar{a}_y t^2$

$$y_f = 75$$

$$\Delta \bar{r} = -225\hat{i} + 75\hat{j}$$

ⓓ $\Delta r = r_f - r_i$

$$r_f = \Delta r + r_i$$

$$= -225\hat{i} + 75\hat{j} + -2\hat{i} + 4\hat{j}$$

$$= -227\hat{i} + 79\hat{j}$$

16) $F_{wind} = 390\hat{j} \uparrow$ $m = 270\ kg$

$F_{water} = 180\hat{i} \rightarrow$

$|\sum F| = 429.53\ N$

$\theta = 65.224$ North of east

$$\bar{a} = \frac{|\sum F|}{m} = 1.590\ m/s^2$$

17) in the book

18) $F = m_1 \times 3$

$F = m_2 \times 1$

ⓐ $\frac{m_1}{m_2} = \frac{\frac{F}{3}}{\frac{F}{1}} = \frac{\frac{1}{3}}{\frac{1}{1}} = \frac{\frac{1}{3}}{1} = \frac{1}{3}$

$\underline{\underline{\text{or}}}$

$3m_1 = 1m_2$

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

ⓑ

$M = m_1 + m_2$

$F = M_a$

$F = \left(\frac{F}{3} + F\right) \cdot a$

but:- $F = 3m_1 \rightarrow m_1 = \frac{F}{3}$

$F = 1m_2 \rightarrow m_2 = \frac{F}{1} = F$

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

$\frac{4}{3} a = 1 \longrightarrow a = \frac{3}{4} = 0.75\, m/s^2$

19) ⓐ $F_1 = 20\hat{i}$

$F_2 = 15\hat{j}$

$m = 5\, kg$

$\overline{a} = \frac{|\sum F|}{m} = \frac{\sqrt{20^2 + 15^2}}{5} = 5$

$\theta_a = 36.869$

ⓑ $F_1 = 20\hat{i}$

$F_2 = 15\cos 60\,\hat{i} + 15\sin 60\,\hat{j}$

$= \frac{15}{2}\hat{i} + \frac{15\sqrt{3}}{2}\hat{j}$

$|\overline{a}| = \frac{|\sum F|}{m} = \frac{5\sqrt{37}}{5} = 6.08\, m/s^2$

$\theta_2 = 25.3°$

20) in the book

21) in the book

22) $F_1 = -2\hat{i} + 2\hat{j}$

$F_2 = 5\hat{i} - 3\hat{j}$

$F_3 = -45\hat{j} + 0\hat{j}$

$\sum F = -42\hat{i} - 1\hat{j}$

$|\sum F| = 42.0119$

$|\overline{a}| = 3.75$

ⓐ $\theta_f = 181 \quad = \theta_a$

ⓑ $F = ma$

$42.01 = m(3.75)$

$m = 11.2\, kg$

ⓒ $v_f = \overset{0}{v_i} + at$

$= 37.5\, m/s$

ⓓ $v_f = \overset{0}{\cancel{v_i}} + \overset{\frac{F}{m}}{a}t$

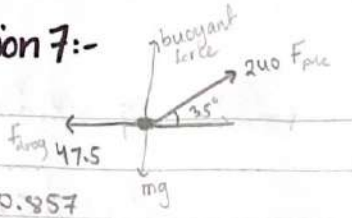
$= \frac{-42\hat{i} \times 10}{11.2} + \frac{-1 \times 10\hat{j}}{11.2}$

$= -37.5\hat{i} - 0.893\hat{j}$

24) in the book

Section 7:-

25)



$v_i = 0.857$

$m = 370$

ⓐ $\sum F_y = 0$

$\sum F_y = (F_{buoy} + F_{pole_y}) - mg = 0$

$F_{buoy} = mg - F_{pole\,y}$

$= 370 \times 9.8 - 240\sin 35$

$= 3488.34$

ⓑ

$v_f = v_i + at \longrightarrow \sum F_x = ma$

$= 0.857 + (0.4029) \times 0.450$

$= 1.038$ m/s

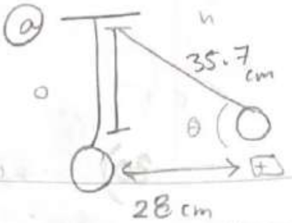
$a = \dfrac{\sum F_x}{m}$

$= \dfrac{240\cos 35 - 47.5}{370} = 0.4029$

26) $m = 65g$

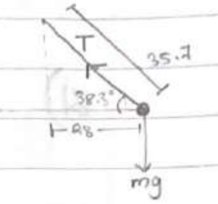
$= 65 \times 10^{-3}$ kg

ⓐ



ⓑ $\cos\theta = \dfrac{a}{h}$

$\theta = 38.3°$



or $\sum F_y = mg$ $\begin{cases} \sum F_y = 0 \\ T\sin\theta - mg = 0 \end{cases}$

$T\sin\theta = mg$

$T = \dfrac{mg}{\sin\theta} = \dfrac{65 \times 10^{-3} \, 9.8}{\sin 38.3} = 1.027$

ⓒ $\left.\begin{array}{l} \sum F_x = 0 \\ -T\cos\theta + F_{mag} = 0 \end{array}\right]$ or $\sum F_x = m\overset{=0}{a}$

$F_{mag} = +T\cos\theta$

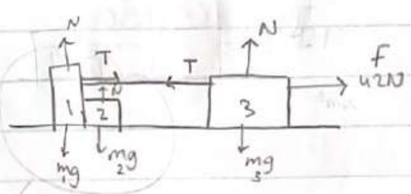
$= +1.027 \times \cos(38.3)$

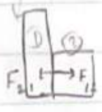
$= +0.806$

27) in the book

28) in the book

29)





$-T + F + ma = 0$

$\sum F = (F + ma) - T = 0$

$T = F + ma \longrightarrow$

ⓐ $F = \overset{m_1+m_2+m_3}{(M)}a$

$42 = (3+2+1)a$

$a = 7 m/s^2$

ⓑ $\left.\begin{array}{l} \sum F_x = 0 \\ F_3 + F_1 = 0 \end{array}\right] X$

or/so

$\sum F_x = ma_x$

$T - F = ma_x$

$T = ma_x + F$

$= -21 N$

to the left

ⓒ $F_{12} = -F_{21}$

Equal magnitude choose any one

* Choose m_2:-

$F_{12} = m_2 a$

$= 2 \times 7$

$= 14$

or Choose m_1:-

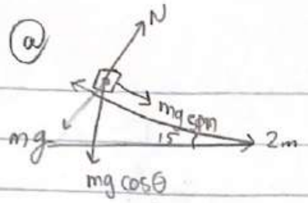
$F_{12} = T - F_{21}$

$= T - m_1 a$

$= 21 - 1 \times 7$

$= 14$

30) ⓐ



ⓑ $\sum F_x = ma_x$

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

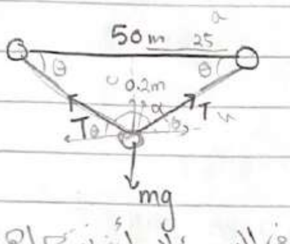
$a = 2.536$

ⓒ $v_f^2 - \cancel{v_i^2} = 2a\Delta x$

$v_f = \sqrt{2\times 2.536\times 2}$

$= 3.185$ m/s

31) ⓐ



ⓑ $\sum F_y = 2T\sin\theta - mg = 0$

$2T\sin\theta = mg$

مكتوب في السؤال أن نتجاهل الوزن $\longrightarrow$ $T = \dfrac{mg}{2\sin\theta} = \dfrac{mg}{2\sin(0.458)}$

$= 612.996$

$\tan\theta = \dfrac{0.2}{25}$

$= 0.458°$

32) $m = 3$ kg

$x = 5t^2 - 1$

$y = 3t^3 + 2$

$t = 2$

$\bar{r} = (5t^2-1)\hat{i} + (3t^3+2)\hat{j}$

$v = (10t)\hat{i} + (9t^2)\hat{j}$

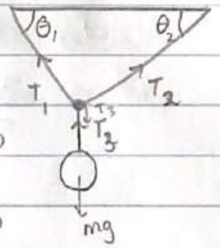
$a = 10\hat{i} + 18t\hat{j}$

$F_x = ma_x = 3\times 10 = 30$

$F_y = ma_y = 3\times 18(2) = 108$

$|F| = 112$

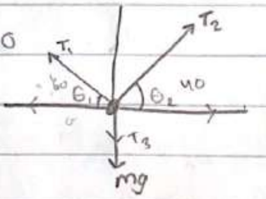
33)



$\sum F_x = 0$

$\sum F_y = 0$

زيادة [$\sum F_z = 0$



① $T_3 = \boxed{mg}$ = weight $T_3 = 325$

② $T_1\cos\theta_1 = T_2\cos\theta_2$

$T_1\cos\theta_1 - T_2\cos\theta_2 = 0$

$T_1\sin\theta_1 + T_2\sin\theta_2 = T_3$

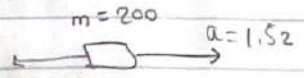
mode - 5 - 1 كأنهم

$T_1 = 252.80$

$T_2 = 165.0068$

34) in the book

35)



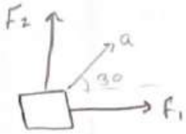
$F_1 + F_2 = 1.52\times 200$
$= 304$

$F_1 - F_2 = 0.518\times 200$
$= 103.6$

mode - 5 - 1

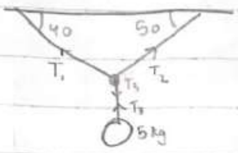
$F_1 = 203.8$

$F_2 = 100.2$



36)

ⓐ



① $T_3 = mg$
$= 49N$

mode-5-1

② $\sum_1 F_x = 0$

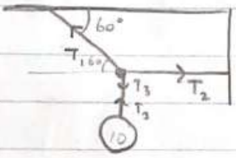
$T_1 \cos 40 - T_2 \cos 50 = 0$

③ $\sum_1 F_y = 0$

$T_1 \sin 40 + T_2 \sin 50 = \overset{T_3}{\textcircled{49}}$

$T_1 = 31.4$, $T_2 = 37.536$

ⓑ



① $T_3 = mg$
$= 98$

mode-5-1

② $\sum_1 F_x = 0$ $T_2 - T_1 \cos\theta = 0$

③ $\sum_1 F_y = 0$ $T_1 \sin\theta = \overset{T_3}{\textcircled{98}}$

$T_2 = 56.58$, $T_1 = 113.16$

37) $m = 1 kg$
$\bar{a} = 10$, $\theta = 60$ $\theta = 30$
$F_2 = 5N$, $F_1 = ?$

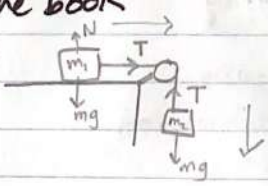
$\sum_1 F_x = m a_x$

$F_1 = m a_x$
$= 1 \times 10 \cos 30$
$= 8.66$

38)

39) in the book

40) ⓐ



$m_1 = 5$
$m_2 = 9$

or $mg - T = m_2 a_y$

ⓑ

choose m_1:-

$\sum_1 F_x = m_1 a_x$

$T = m_1 a_x$

$T - m_1 a_x = 0$

Choose m_2:-

$\sum_1 F_y = -m_2 a_y$

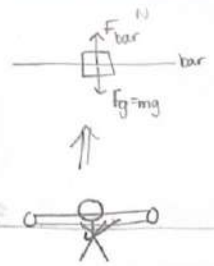
$T - m_2 g = -m_2 a_y$

$T + m_2 a_y = \textcircled{m_2 g}$ 88.2

$a = +6.3$
$T = 31.5$

T - 5a

$T - 5a = 0$
$T + 9a = 88.2$



41) $m = 64$

ⓐ $t=0$ $\quad \sum_1 F_y = ma_y$

$F_{bar} - mg = ma_y$

$F_{bar} = ma_y + mg$

$= 64(30_{x10^{-2}} + 9.8)$

$= 646.4$

ⓑ $t = 0.5$

$F_{bar} = ma_y + mg$

$= 64(30 \times 10^{-2} + 9.8)$

$= 646.4$

ⓒ $t = 1.1$ $\quad \sum_1 F_y = ma_y$

$F_{bar} - mg = \cancel{ma_y}^{0}$

$F_{bar} = mg = 627.2$

ⓓ $t = 1.6$

$\sum_1 F_y = ma_y$

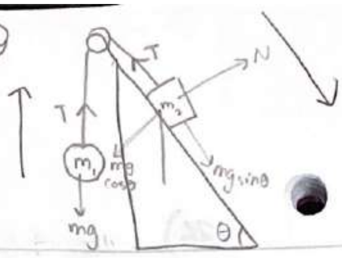
$F_{bar} - mg = ma_y$

$F_{bar} = 64(-60 \times 10^{-2} + 9.8)$

$= 588.8$

$m_1 = 2$
$m_2 = 6$
$\theta = 55$

ⓐ



42) ⓑ ⓒ $\sum_1 F_x = ma_x$

$m_2 g \sin\theta - T = m_2 a_x$

choose m_1 :- $\left[\begin{array}{l} \sum_1 F_y = ma_y \\ T - m_1 g = m_1 a_y \end{array} \right.$

$\left[\begin{array}{l} m_2 a_x + T = m_2 g \sin\theta \\ m_1 a_y - T = -m_1 g \end{array} \right]$ — mode-5-1

$a = 3.57 \, m/s^2$

$T = 26.7 \, N$

ⓓ $v_i = 0$
$v_f = ?$
$t = 2$

$v_f = v_i + at$

$= 0 + 3.57 \times 2$

$= 7.14 \, m/s$

44) in the book

45) in the book

46) in the book

43) $m = 3.5$

$a = 1.60 \uparrow$

ⓐ

mass 1 $\left[\begin{array}{l} \sum_1 F_{y_1} = ma_y \\ T_1 - (T_2 + mg) = ma_y \\ T_1 = ma_y + (T_2 + mg) \end{array} \right.$

$= 79.8$

mass 2 $\left[\begin{array}{l} \sum_1 F_{y_2} = ma_y \\ T_2 - mg = ma_y \end{array} \right.$

$T_2 = m(a_y + g)$

$= 3.50(1.60 + 9.8)$

$= 39.9$

ⓑ $T_1 = \overset{ma_y + mg}{\boxed{T_2}} + ma_y + mag.$

$T_1 = ma_y + mg + ma_y + mg$

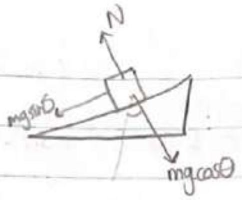
$T_1 = 2ma_y + 2mg$

$a_y = \dfrac{T_1 - 2mg}{2m} = 2.342 \, m/s^2$

47) $v_i = 5$

$\theta = 20$

$v_f = 0$



$\sum_i F_x = ma_x$

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

$a_x = g\sin\theta$

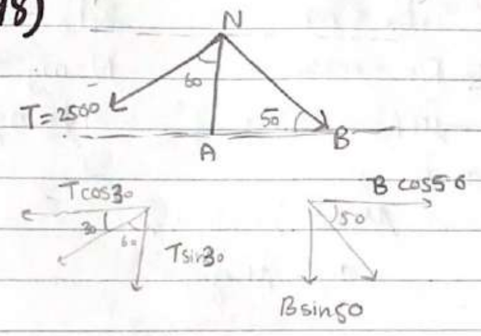
$= 9.8 \times \sin 20$

$= 3.35 \text{ m/s}^2$

$\overset{0}{v_f^2} - v_i^2 = 2a\Delta x$

$|\Delta x| = \frac{-v_i^2}{2a} = |-3.72| = 3.72$

48) Equilibrium:



$\sum_i F_x = 0$

$B\cos 50 - T\cos 30 = 0$

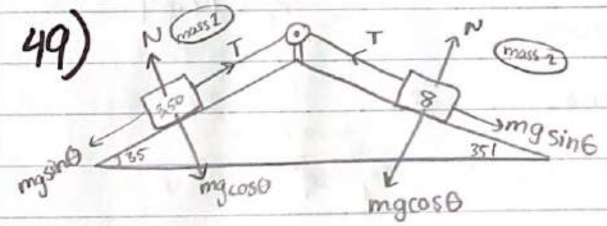
$B = 3368.24$

$\sum_i F_y = 0$

$A - (T\sin 30 + B\sin 50) = 0$

$A = 3830.22$

49)



ⓐ choose mass 1 :-

$\sum_i F_x = ma_x$

$T - m_1 g\sin\theta = ma_x$

$T - m_1 a_x = m_1 g\sin\theta$

choose mass 2 :-

$\sum_i F_x = ma_x$

$mg\sin\theta - T = m_2 a_x$ → or $T - mg\sin\theta = m_2 a_x$

$-T - ma_x = -m_2 g\sin\theta$

mode -5

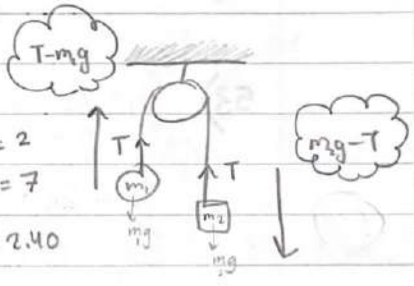
$T = 27.37 \text{ N}$

$a = 2.19 \text{ m/s}^2$

50) $m_1 = 2$

$m_2 = 7$

$v_i = 2.40$



$T = 29.2$

$a = 5.6$

$\sum_i F_y = m_1 a_y$

$T - m_1 g = m_1 a_y$

$T - m_1 a_y = m_1 g$

m_1

$\sum_i F_y = m_2 a_y$

$m_2 g - T = m_2 a_y$

$-T - m_2 a_y = -m_2 g$

m_2

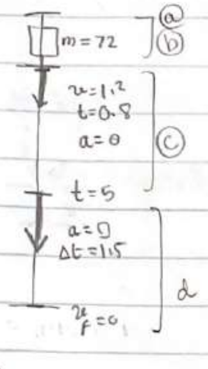
ⓐ $v_f^2 - v_i^2 = 2a\Delta y$

$y_f = -0.514$

ⓑ $v_f = v_i + at$

$= 7.68$ upward

51)



ⓐ $F_g = mg$
$= 72 \times 9.8$
$= 705.6\ N$

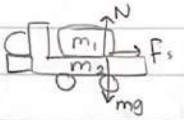
ⓑ $a = \frac{\Delta V}{\Delta t}$
$= \frac{1.2 - 0}{0.8}$
$= 1.5\ m/s^2$

ⓒ $F_{g_{ⓒ}} = F_g + ma$
$= 705.6 + 72 \times 1.5$
$= 813.6\ N$

ⓓ $F_{g_{ⓓ}} = F_g + ma$
$= 705.6 + 72 \times \frac{0 - 1.2}{1.5}$
$= 648\ N$

Section 8 :-

52) $m_1 = 10,000$
$m_2 = 20,000$
$v = 12$
$\mu_s = 0.500$



ⓐ choose m_1 :-
$\sum_1 F_x = m_1 a_x$
$-F_s = m_1 a_x$
$-\mu_s N = m_1 a_x$

Choose m_1 :-
$\sum_1 F_y = m_1 \overset{0}{\cancel{a_y}}$ b/c the motion is in x-axis
$N - mg = 0$
$N = mg$

$\underbrace{\qquad\qquad\qquad}$

$\mu_s(\cancel{m}g) = \cancel{m_1} a_x$
$a_x = -\mu_s g$

$\overset{0}{\cancel{v_f^2}} - v_i^2 = 2a\Delta x$
$|x_f - \overset{0}{\cancel{x_i}}| = |+14.69|$
$x_f = 14.69$

ⓑ $x_f = \frac{-v_i^2}{2\mu_s g}$

mass does not effect

53) $m = \frac{12}{1000} = 12 \times 10^{-3}$
$v = 260$
$x_f = 23 \times 10^{-2}$

$\sum_1 F_x = ma_x$
$F_s = m\boxed{a_x} \rightarrow$ $\overset{0}{\cancel{v_f^2}} - v_i^2 = 2a\Delta x$
$= ma_x$ $\quad a = -1.46 \times 10^5$
$= -1763.4\ N$

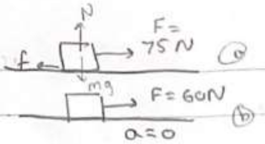
54) $v = 55\ mi/h$
$= 22.4\ m/s$
$\mu_s = 0.100$

ⓐ $\sum_1 F_x = ma_x$ $\quad \sum_1 F_y = \overset{0}{\cancel{ma_y}}$
$-F_s = ma_x$ $\quad N = mg$

$\underbrace{\qquad\qquad}$
$a = -\mu_s g$ $\rightarrow$ $x_f = \frac{\cancel{-}v^2}{\cancel{-}2\mu_s g} = 256m$

ⓑ $x_f = \frac{\cancel{-}v^2}{\cancel{-}2\mu_s g} = 42.7m$

55) $m = 25$



ⓐ $\sum F_x = m\cancel{a_x}^{0}$ $\sum F_y = 0$

$F - f = 0$ $N - mg = 0$

$N = mg$

$F - \mu_s N = 0$

$F - \mu_s (mg) = 0$

$F = \mu_s mg$

$\mu_s = \frac{F}{mg} = \frac{75}{25 \times 9.8} = 0.306$

58)

ⓐ $\sum F_x = ma$ $\sum F_y = \cancel{ma_y}^{0}$

$f_s = ma$ $N - mg = 0$

$N = mg$

$\mu_s N = ma$

$\mu_s \cancel{m} g = \cancel{m} a$

$\boxed{a = \mu_s g}$

$\Delta x = \cancel{v_i t}^{0} + \frac{1}{2} a t^2$

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

$\Delta x = \frac{1}{2} \mu_s g t^2$

$t = 4.43$

$\mu_s = ?$

$\Delta x = 0.25$ mile

$= 402.25$ m

$\mu_s = \frac{2\Delta x}{g t^2} = 4.18$

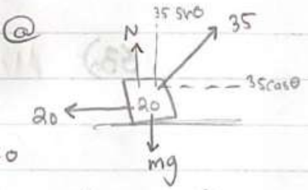
60) $m = 20$

$F = 35$

$F_k = 20$

constant speed → $a = 0$

ⓐ



ⓑ $\sum F_x = \cancel{ma_x}^{0}$ $\sum F_y = \cancel{ma_y}^{0}$

$35 \cos\theta - 20 = 0$ $N - mg + 35 \sin\theta = 0$

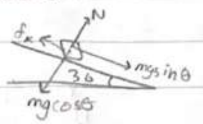
$\cos\theta = \frac{20}{35}$ ⓒ $N = mg - 35 \sin(55.15)$

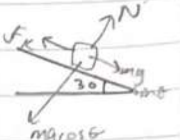
$\theta = 55.15^{\circ}$ $= 167.277$

ⓑ $\mu_k = \frac{F}{mg} = \frac{60}{25 \times 9.8} = 0.245$

56) in the book

57)





$mg \sin\theta_1 = \overset{\mu_k N}{f_k}$ $mg \sin\theta_2 = f_k$

$mg \cos\theta_1 = N$ $mg \cos\theta_2 = f_k$

$\cancel{mg} \sin\theta_1 = \mu_{k_1} \cancel{mg} \cos\theta_1$] or use θ_2 it is the same

$\mu_{k_1} = \frac{\sin\theta_1}{\cos\theta_1} = \tan\theta_1$

$\mu_{k_1} = 0.727$ $\mu_{k_2} = 0.577$

59) as usuall

$a = \mu_s g$

$\Delta x = \cancel{v_i t}^{0} + \frac{1}{2} a t^2$

$t = \sqrt{\frac{2\Delta x}{a_x}}$

ⓐ $\mu_s = 0.5$, $t = 1.11$ sec

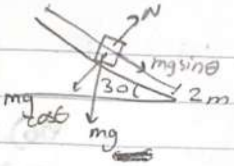
ⓑ $\mu_s = 0.8$, $t = 0.875$ s

61) $m = 3\,kg$

$v_i = 0$

$\theta = 30$

$t = 1.50$



ⓐ $\Delta x = \overset{0}{\cancel{v_i}}t + \frac{1}{2}at^2$

$a = 1.78\,m/s^2$

ⓒ $\sum_i F_x = ma_x$

$mg\sin\theta - \mu_k N = ma_x$

$mg\sin\theta - ma_x = \underset{f_k}{\boxed{\mu_k N}}$

$f = 9.36N$

$\sum_i F_y = m\overset{0}{\cancel{a_y}}$

$N - mg\cos\theta = 0$

$N = mg\cos\theta$

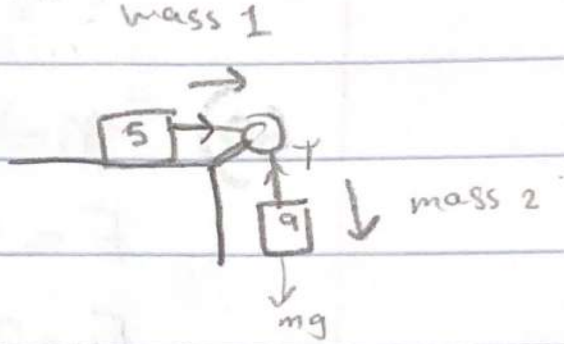
ⓑ $\mu_k = \frac{mg\sin\theta - ma_x}{\underset{N}{\boxed{mg\cos\theta}}}$

$= 0.3676$

ⓓ $v_f = v_i + at$

$= 2.67$

63) $\mu_k = 0.2$



mass 2:- $\sum F_y = ma_y$ $\quad \sum F_x = ma_x$

$m_2 g - T = m_2 a_y$ $\quad T - f = ma_x$

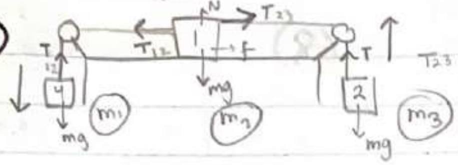
adding them

$$\begin{aligned} mg - \cancel{T} &= ma_y \\ \cancel{T} - f &= ma_x \quad + \\ \hline mg - f &= ma \\ a &= 5.60 \end{aligned}$$

$$\begin{aligned} m_2 g - T &= m_2 a_y \\ T &= m_2 g - m_2 a \\ &= 37.8 \end{aligned}$$

ⓐ

64)



$\mu = 0.350$

ⓑ $\sum_1 F_x = ma_x$ $\qquad \sum_1 F_y = ma_y$

m_1: $mg - T_{12} = ma_y$

m_3: $T_{23} - mg = m_3 a_y$

m_2: $n - m_2 g = \cancel{m a_y}^{0}$

$T_{12} - T_{23} - f = ma_x$

add them up →

$m_1 g - \cancel{T_{12}} = ma_y$ ✓

$\cancel{T_{23}} - m_3 g = ma_y$

$\cancel{T_{12}} - \cancel{T_{23}} - f = ma_x$

$m_1 g - m_3 g - f = a(m_1 + m_2 + m_3)$

4 $\quad \mu N$ $\quad$ 1 $\quad mg$

$a = 2.31$ m/s²

ⓒ $mg - T_{12} = ma_y$

$T_{12} = 30N$

$T_{23} - mg = ma_y$

$T_{23} = 24.2N$

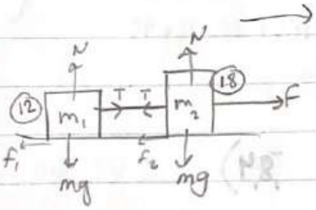
ⓓ $T_{12} = m_1 g - m_1 a$

decreases

$T_{23} = m_3 g + m_3 a$

increases

65) ⓐ



$f_1 = \mu N_1 = 11.8N$ $\quad$ (0.1, $m_1 g$)

$f_2 = \mu N_2 = 17.6N$ $\quad$ (0.1, $m_2 g$)

or

$F - f = Ma$

$F - \mu N = Ma$

$F - \mu Mg = Ma$

$a = 1.27$ m/s²

ⓑ $\sum_1 F_x = ma_x$ $\qquad \sum_1 F_y = \cancel{ma_y}^{0}$

$N - mg = 0$

$N = mg$

m_2: $F - T - f_2 = m_2 a_x$ $\quad$ (μN, mg)

m_1: $T - f_1 = m_1 a_x$

$T = m_1 a_x + f_1$

T [illegible]

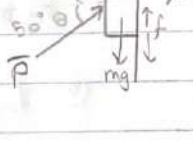
$F - m a_x + f_1 - f_2 = m a_x$

$a_x = \frac{F - f_1 - f_2}{m_1 + m_2} = 1.29$ m/s²

ⓒ $T - f_1 = max$

$T = 27.2$ N

66)



$\mu = 0.250$

ⓐ $\sum_1 F_x = \cancel{ma_x}^{0}$ $\quad$ لا يتحرك

$p\cos 50 - N = 0$

$N = p\cos 50$

$f_s = \mu N$ $\quad$ ($p\cos 50$)

$= 0.161P$

$\sum_1 F_y = \cancel{ma_y}^{0}$ $\quad$ لا يتحرك

نازل

$p\sin\theta - mg + f = 0$

$P_{min} = 31.7$

طالع

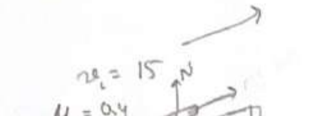
$p\sin\theta - mg - f = 0$

$p\sin\theta - mg - 0.161p = 0$

$P_{max} = 48.6N$

$31.7 < P < 48.6$

67)



$\sum_1 F_y = m\cancel{a_y}^{0}$

$N - mg\cos\theta = 0$

$N = mg\cos\theta$

$\sum_1 F_x = ma_x$

$f + mg\sin\theta = ma_x$

$a = \frac{mg\cos\theta \cdot \mu + mg\sin\theta}{m}$

$= 9.028 m/s^2$

$\cancel{v_f}^{0\,2} - v_i^2 = 2a_y(y_f - y_i)$

$y_f = \frac{-v_i^2}{2\boxed{a_y}_{g}} = 0.822$

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

$\boxed{v_f} = \sqrt{2a\Delta x + v_i^2}$

$= \sqrt{2 \times 9.028 \times 10 + 15^2}$

$= 6.67$

$y_{total} = \underset{h}{\boxed{10\sin 37}} + 0.822$

= 6.84 m

[illegible]
Trajectory

69)

$f = 0.100N$

$a = 3$

$\sum_1 f_x = ma_x$

$f = ma_x$

$a_x = 0.5$

$a = 0.5 - 3 = -2.5$

$\Delta x = \cancel{v_i t}^{0} + \frac{1}{2}at^2$

$0 - 30\times10^{-2} = \frac{1}{2}(-2.5)t^2$

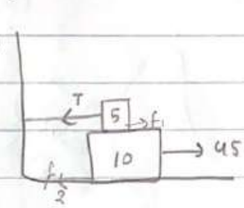
$t_{avg} = 0.490$

$\Delta x = \cancel{v_i t}^{0} + \frac{1}{2}(0.5)(0.490)^2$

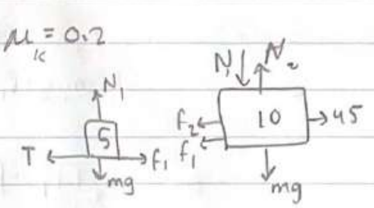
$= 0.06$ m

70)

ⓐ



$\mu_k = 0.2$



ⓑ

$\sum_1 f_y = 0$

$N_1 = mg$

$= 49N$

$\sum_1 F_x = \cancel{ma_x}^{0}$

$f_1 - T = 0$

mass: 5

$\boxed{f_1} = T$

μN_1

$T = 9.80 N$

mass 10 in $\sum_1 F_x$

$F - (f_1 + f_2) = ma$

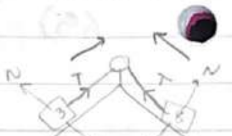
mass 10 in $\sum_1 F_y$

$N_2 - N_1 = mg$

$f_2 = \alpha\underset{mg+N_1}{\boxed{N_2}} = 29.4N$

71)

$a = 1.50$



ⓑ ⓐ

mass 3

$\sum_1 F_x = ma_x$

$T - m_1 g\sin\theta - f_k = m_1 a_x$

mass 8

$\sum_1 f_x =$

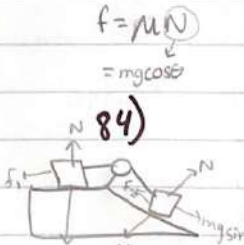
$\underbrace{m_2 g\sin\theta - T - f_k = m_2 a_x}_{\text{mode - 5 - 1}}$

$f = \mu\underset{= mg\cos\theta}{\boxed{N}}$

$f_k = 5.8026 \quad T = 27.16$

$\mu = \frac{f}{mg\cos\theta} = 0.09$

84)



$F = mg\sin\theta$

$= 29.4$

system will not move

ⓐ $f_{max} = f_1 + f_2$

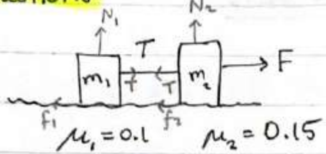
$= \mu N + \mu N$

$= \mu m_1 g + \mu m_2 g\cos\theta$

$= 38.9N$

Extra Questions:-

HW1:-



$F = 68$
$m_1 = 12$
$m_2 = 18$

② $f_1 = \mu_1 N_1 = 11.76$

$f_2 = \mu_2 N_2 = 26.46$

③ $\sum_1 F_x = ma_x$

mass 1 $\left[F - T - f_1 = m_1 a \right.$

mass 2 $\left[\begin{array}{l} T - f_2 = m_2 a \\ T = m_2 a + f_2 \end{array} \right.$

$F - m_2 a + f_2 - f_1 = m_1 a$

$a = 3.44 \, m/s^2$

① $\sum_1 F_y = m\cancel{a_y}$

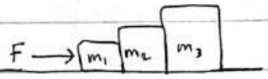
mass 1 $\left[\begin{array}{l} N_1 - m_1 g = 0 \\ N_1 = m_1 g \\ = 117.6 \end{array} \right.$

mass 2 $\left[\begin{array}{l} N_2 = m_2 g \\ = 176.4 \end{array} \right.$

$T - 26.46 = 18 \times 3.44$
$T = 88.38$

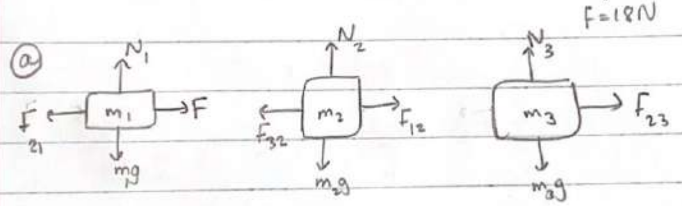
Q 83:-

Example 5.7:-



$m_1 = 2$
$m_2 = 3$
$m_3 = 4$
$F = 18N$

ⓐ



ⓑ acceleration:-

total $\left[\begin{array}{l} \sum_1 F_x = Ma_x \\ 18 = a(2+3+4) \\ a = 2 m/s^2 \end{array} \right.$

ⓒ

mass 1 $\left[\begin{array}{l} \sum_1 F = m_1 a_x \\ = 2 \times 2 \\ = 4 \end{array} \right.$

mass 2 $\left[\begin{array}{l} \sum_1 F = m_2 a_x \\ = 3 \times 2 \\ = 6 \end{array} \right.$

mass 3 $\left[\begin{array}{l} \sum_1 F_x = m_3 a_x \\ = 4 \times 2 \\ = 8 \end{array} \right.$

ⓓ

mass 1 $\left[\begin{array}{l} \sum_1 F_x = m_1 a \\ F - F_{21} = m_1 a_x \\ F_{21} = F - m_1 a_x \\ = 14 \, N \end{array} \right.$

mass 2 $\left[\begin{array}{l} \sum_1 F_x = m_2 a \\ \underset{f_{21}}{} = \boxed{F_{12}} - F_{32} = m_2 a \\ F_{32} = \underset{\text{or } F_{21}}{\boxed{F_{12}}} - m_2 a \\ = 8N \end{array} \right.$

mass 3 $\left[\begin{array}{l} F_{23} = F_{32} \\ = 8 \end{array} \right.$

or

$\sum_1 F = m_3 a$
$= 4 \times 2$
$= 8$

2/12/2020 — phys1 - sec2 - L15

Circular motion of Newton's law :-

Change velocity vector → direction تغير → a_c بيعطينا → $a_c = \frac{v^2}{r}$

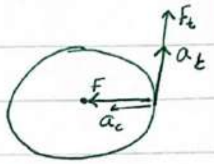
Change velocity vector → magnitude تغير → a_t بيعطينا → $a_t = \frac{\Delta |v|}{\Delta t}$

Change velocity vector → تغير كلاهما

$$\boxed{F_c = m a_c \quad a_c = \frac{v^2}{r}}$$

$$\boxed{a_t = \frac{\Delta |v|}{\Delta t} \quad \bar{F}_t = m \bar{a}_t}$$

تسارع مركزي → قوة مركزية



$a_c \perp a_t$

$F_c \perp F_t$

acceleration ≡ Change in velocity per unit of time

$$(\bar{a}_{tot} = a_r \hat{r} + a_t \hat{\theta}) \times m$$

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

$$\bar{F}_{tot} = F_r \hat{r} + F_t \hat{\theta}$$

$$|F_{tot}| = \sqrt{(F_r)^2 + (F_t)^2}$$

(constant speed) $a_t = 0$ $F_t = 0$] uniform circular motion.

$a_t \neq 0$ $F_t \neq 0$] Non-uniform circular motion.

Newtons law :-

+ Solve :- 6, 8, 14

linear motion [$\Sigma F_t = m a_t$

circular motion [$\Sigma F_c = m a_c = \frac{m v^2}{r}$

Ch-6

2/12/2020 — phys1 - sec2 - L15

Circular motion & Newton's law :-

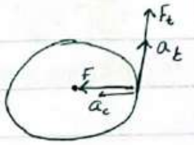
Change velocity vector →
- direction تغير → a_c بيعطينا → $a_c = \frac{v^2}{r}$
- magnitude تغير → a_t بيعطينا → $a_t = \frac{\Delta |v|}{\Delta t}$
- تغير كلاهما

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

$$\boxed{a_t = \frac{\Delta |v|}{\Delta t} \\ \bar{F}_t = m\bar{a}_t}$$

تسارع مركزي → قوة مركزية

acceleration ≡ Change in velocity per unit of time



$a_c \perp a_t$

$F_c \perp F_t$

$$(\bar{a}_{tot} = a_r \hat{r} + a_t \hat{\theta}) \times m$$

$$m\bar{a}_{tot} = ma_r \hat{r} + ma_t \hat{\theta}$$

$$\bar{F}_{tot} = F_r \hat{r} + F_t \hat{\theta}$$

$$|F_{tot}| = \sqrt{(F_r)^2 + (F_t)^2}$$

(constant speed) $a_t = 0$ $F_t = 0$] uniform circular motion.

$a_t \neq 0$ $F_t \neq 0$] Non-uniform circular motion.

Newtons law:-

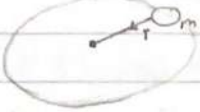
linear motion $\left[\sum_i F_t = ma_t \right.$

circular motion $\left[\sum_i F_c = ma_c = \frac{mv^2}{r} \right.$

+ Solve :- 6, 8, 14

Section 1:- **Solving problems**

1) $m = 3K$



$r = 0.800m$

$v = ?$

$245 = \frac{3 \times v^2}{0.8}$

hold a max load of 25

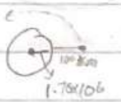
$T = a_c$

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

$v_{max} = 8.08$

$T = mg = 25 \times 9.8 = 245$

2)



ⓑ $v = \frac{2\pi r}{T}$

$1.65 \times 10^3 = \frac{2\pi \cdot (1.7 \times 10^6 + 100 \times 10^3)}{T}$

$T = 6.84 \times 10^3$ sec

ⓐ $\Sigma F_y = mg = a_c$

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

$\rightarrow v = \sqrt{rg}$

$= \sqrt{(1.7 \times 10^6 + 100 \times 10^3) \times 1.52}$

$= 1.65 \times 10^3 \, m/s$

3) $v = 2.2 \times 10^6$

$r = 0.529 \times 10^{-10}$

$m = 9.11 \times 10^{-31}$

ⓐ

$F = m \cdot a_c$

$F = \frac{mv^2}{r}$

$= 8.33 \times 10^8 N$

ⓑ $a_c = \frac{v^2}{r}$

$= 9.15 \times 10^{22}$

4) $v_{fast} = 18 \, m/s$

$F_{slow} = 130N$

$v_{slow} = 14$

$F = ma_c$

$F = m \cdot \frac{v^2}{r}$

$F_{fast} = \frac{m}{r} \cdot (18)^2$

$F_{slow} = \frac{m}{r} \cdot (14)^2$

$F \alpha v$

$\frac{F_{fast}}{F_{slow}} = \frac{18^2}{14^2}$

$F_{fast} = \frac{18^2}{14^2} \cdot F_{slow}$

$= \frac{18^2}{14^2} \cdot 130$

$= 215N$

5) $1u = 1.661 \times 10^{-27}$

$m = 2u$

$= 2 \times 1.66 \times 10^{-27}$

$v =$ 10% of $299 \times 10^6 = \frac{299 \times 10^{6\,5}}{10} = 2.99 \times 10^5$

$= 2.99 \times 10^7$

$= 2.99 \times 10^7$

$r = 0.480\text{m}$

$F = ma_c$

$= m \cdot \frac{v^2}{r}$

$= 6.22 \times 10^{-12}\text{N}$

6) arc length $= 235$

$t = 36\text{s}$

ⓐ $\bar{v} = \frac{x}{t} = \frac{235}{36} = 6.53\text{m/s}$

$v_x = -5.9$

$v_y = -2.79$

$\bar{a}_c = \frac{v_x^2}{r} + \frac{v_y^2}{r}$

$\frac{1}{4} \times 2\pi r = 235$

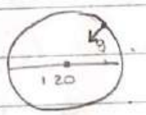
$r = 150\text{m}$

$= 0.23\hat{i} + 0.052\hat{j}$

7) $r = \frac{120}{2}$

$g = 3$

$f = ?$



$T = \frac{2\pi r}{v}$

$g = a_c$

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

$3 = \frac{v^2}{r}$

$v = \sqrt{3 \times \frac{120}{2}} = 13.4$

$T = \frac{2\pi r}{v}$

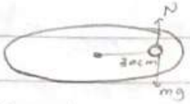
$= \frac{2\pi \times \frac{120}{2}}{13.4}$

$= 28$

$f = \frac{1\,\text{rev}}{28\,\text{s}} \longrightarrow = 2.14\,\text{rev/min}$

8)

9)



$v = 50$ cm/s

ⓐ Static friction

ⓑ $\sum F_y = \cancel{m a}^{0}$

$N = mg$

$\sum F_x = m a_c$

$f_s = m a_c$

$\mu_s N = m a_c$

$\mu_s \cancel{m} g = \cancel{m} a_c$

$\mu_s g = a_c$

$\mu_s = \frac{a_c}{g} = \frac{\frac{v^2}{r}}{g} = \frac{\frac{50^2}{30}}{9.8} = 8.50 \frac{1}{cm}$

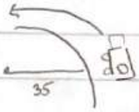
$= 8.50 \times 10^{-2}$

$= 0.0850$

$\frac{cm^2}{\cancel{s^2}} \cdot \frac{1}{cm} \cdot \frac{\cancel{s^2}}{cm^2}$

10) in the book

11)



$r = 35$

$\mu = 0.6$

$\sum F_y = m \cancel{a_y}^{0}$

$N = mg$

$\sum F_x = m a_c$

$\mu_s N = m a_c$

$\mu_s \cancel{m} g = \cancel{m} a_c$

$a_c = \mu_s g$

$= 0.6 \times 9.8$

$= 5.88$

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

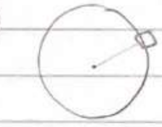
$5.88 = \frac{v^2}{35}$

$v = \sqrt{5.88 \times 35}$

$= 14.3$

Section 2:-

12)

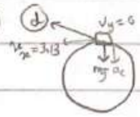


$r = 1m$

ⓐ $mg = F_g$, contact force acted by the water on the pail.

ⓑ contact force exerted by the pail,

ⓒ ⓓ



$\sum F = m a_c$

$\cancel{m} g = \cancel{m} a_c$

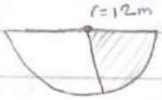
$a_c = g$

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

$v = \sqrt{rg}$

$= 3.13$

13)



$r = 12m$ $v = 4 m/s$

ⓐ $a_c = \frac{v^2}{r} = \frac{4^2}{12} = 1.33 \, m/s^2$

ⓑ $a_t = 1.20$

$\overline{a} = \sqrt{a_c^2 + a_t^2}$

$= \sqrt{1.33^2 + 1.20^2}$

$= 1.79$

$\theta_{\overline{a}} = 48°$

15) in the book:-

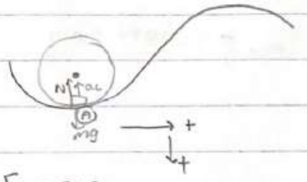
16) $m = 500\,kg$

$v_A = 20$

$r_1 = 10m$

$r_2 = 15m$

ⓐ



$\Sigma F_y = ma_c$

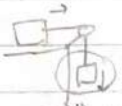
فوق → $N - mg = ma_c$

$N = ma_c + mg$

$= m(a_c + g)$

$= m\left(\frac{v^2}{r} + g\right)$

$= 2.4 \times 10^4 N$



تحت الطاولة $mg - N = ma$

فوق الطاولة $N - mg$

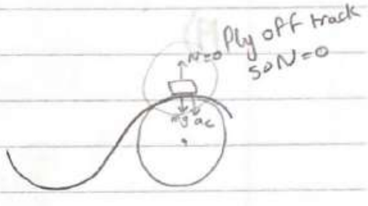
⇓

$mg - N = -ma_c$

أو

$N - mg = ma_c$

ⓑ



نازلة تحت يعني فوق ↪

$\Sigma F_y = ma_c$

$mg - N = ma_c$

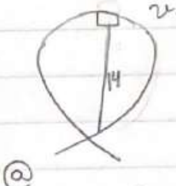
$a_c = \frac{mg - \cancel{N}^{0}}{m}$

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

$v = \sqrt{g \times r}$

$= 12.124\,m/s$

17)



$v = 13$

$a_c = 2g$

ⓐ

$a_c = 2g$

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

$r = \frac{v^2}{2g} = \frac{13^2}{2 \times 9.8} = 8.62$

ⓑ $m = M$

ΣF on the top :- F_g , $a_c^{=2g}$

ⓒ suppose $r = 20m$

$v = 13$

a_c at the top = ?

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

$= \frac{13^2}{20}$

$= 3.45$

[illegible]

ⓓ

$\Sigma F_y = -ma_c$

$-mg + N = -ma_c$

$\Rightarrow N + mg = ma_c$

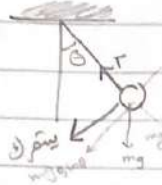
$N = ma_c - mg$

$= m(a_c - g)$

$= 500(3.45 - 9.8)$

$= -3175$

18)



$m=0.5$
$r=2m$
$\theta=20$
$v=8$

ⓐ

$\sum_i F = ma_c$

$T - mg\cos\theta = ma_c$

$T = ma_c + mg\cos\theta$

$= 20.604\ N$

ⓑ $\sum_i F_t = ma_t$

$\cancel{m}g\sin\theta = \cancel{m}a_t$

$a_t = g\sin\theta$

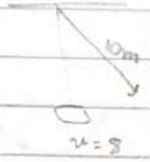
$= 3.35$

ⓒ $\bar{a} = \sqrt{a_c^2 + a_t^2}$

$= 32.174$

ⓓ acceleration regardless the direction of the swing.

19)



$m=85$

$T_{max} = 1000N = mg$

$T_{normal} = ?$

$\sum_i F_y = ma_c$

$T - mg = ma_c$

$T = ma_c + mg$

$= m(a_c + g) = 85(\frac{8^2}{10} + 9.8) = 1377 = 1.3\times10^3\ N$

he wil fall off

the vine will break

9/12/2020 phys - sec 2 - L16

* Work & Energy :-

* Vector product :-

1) Dot (scalar) product ⇒ Vector * Vector = scalar
2) Cross (vector) product ⇒ vector * vector = vector

* Dot product :-

1) let $\bar{A}$ & $\bar{B}$ to be 2 vectors $\bar{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$, $\bar{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$

Define the dot product $\bar{A}\cdot\bar{B}$:- ⇒ $\bar{A}\cdot\bar{B} = |\bar{A}||\bar{B}|\cos\theta$ ⇢ angle between $\bar{A}$ & $\bar{B}$

$$\bar{A}\cdot\bar{B} = \underbrace{\begin{bmatrix} A_xB_x\hat{i}\cdot\hat{i} + \cancel{A_xB_y\hat{i}\cdot\hat{j}} + \cancel{A_xB_z\hat{i}\cdot\hat{k}} \\ + \cancel{A_yB_x\hat{j}\cdot\hat{i}} + A_yB_y\hat{j}\cdot\hat{j} + \cancel{A_yB_z\hat{j}\cdot\hat{k}} \\ + \cancel{A_zB_x\hat{k}\hat{i}} + \cancel{A_zB_y\hat{k}\hat{j}} + A_zB_z\hat{k}\hat{k} \end{bmatrix} = A_xB_x + A_yB_y + A_zB_z}$$

$$\hat{i}\cdot\hat{i} = |\hat{i}||\hat{i}|\cos\theta$$
$$= 1\cdot 1\cdot\cos 0$$
$$= 1 \Rightarrow \hat{i}\cdot\hat{i} = 1 \ , \ \hat{j}\cdot\hat{j} = 1 \ , \ \hat{k}\cdot\hat{k} = 1$$

$$\bar{A}\cdot\bar{B} = |\bar{A}||\bar{B}|\cos\theta$$
$$= A_xB_x + A_yB_y + A_zB_z$$

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

EX:- let $\bar{A} = 3\hat{i} + 4\hat{j} - 2\hat{k}$, $\bar{B} = -6\hat{j} + 3\hat{j} + 4\hat{k}$

Find:-

a) dot product $\bar{A}\cdot\bar{B}$

b) the angle between $\bar{A}$ & $\bar{B}$

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

$$\bar{A}\cdot\bar{B} = A_x B_x \hat{i} + A_y B_y \hat{j} + A_z B_z \hat{k}$$

$$\bar{A}\cdot\bar{B} = (3\times -6) + (4\times 3) + (-2\times 4)$$

$$= -14$$

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

$$\theta = \cos^{-1}\left(\frac{A\cdot B}{|A||B|}\right)$$

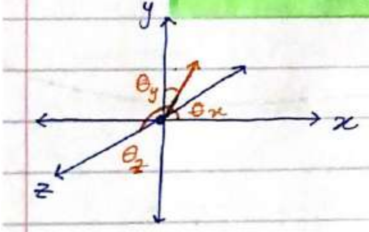
$$= \cos^{-1}\left(\frac{-14}{\sqrt{3^2+4^2+2^2}\cdot\sqrt{6^2+3^2+4^2}}\right)$$

$$= \cos^{-1}\left(\frac{-14}{27}\right) = 121°$$

$(\bar{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}) \times \hat{i}$ to find θ_x

$$|\bar{A}|\overset{1}{|\hat{i}|}\cos\theta_x = A_x$$

$$\theta_x = \cos^{-1}\left(\frac{A_x}{|\bar{A}|}\right), \quad \theta_y = \cos^{-1}\left(\frac{A_y}{|\bar{A}|}\right), \quad \theta_z = \cos^{-1}\left(\frac{A_z}{|\bar{A}|}\right)$$



Ex:- let $\bar{A} = 3\hat{i} + 6\hat{j} - 5\hat{k}$, Find:-

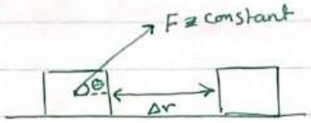
a) $\theta_x = \cos^{-1}\left(\frac{3}{\sqrt{70}}\right) = 69°$

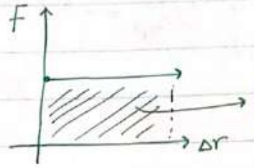
b) $\theta_y = \cos^{-1}\left(\frac{6}{\sqrt{70}}\right) = 44°$

c) $\theta_z = \cos^{-1}\left(\frac{-5}{\sqrt{70}}\right) = 127°$

14/12/2020 phys 1 - sec 2 - L18

* Workdone by Constant force :-





Work = area under the graph

* The work is defined as :- $W = F\Delta r \cdot \cos\theta$

$= (F\cos\theta)(\Delta r)$ القوة المسببة للحركة / الإزاحة] $\bar{F}$ vector, Δr vector

$= \bar{F} \cdot \bar{\Delta r}$

$= F\Delta r \cos\theta$

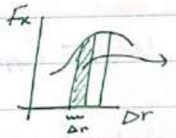
* Unite :- $W = N.m$

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

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

$W = (J)$ (Joul)

* Work done by varying force :-



$W_{total} = \sum_i W = \sum_i \bar{F} \cdot \bar{\Delta r}$

$$W = \int_{r_i}^{r_f} \bar{F} \cdot d\bar{r} \quad \left\{ \underbrace{= \lim_{\Delta r \to 0} \sum_i \bar{F} \cdot \bar{\Delta r}}_{\text{integration}} \right.$$

* Work & potential Energy :- الشغل وطاقة الوضع

* Spring force :- (Varying force)

$F_{app} \propto \Delta x$

$F_{app} = K\Delta x$ spring constant $[K] = N/m$

$F_{app} = K\Delta x$

$f_{spring} = -F_{app}$

$= -K\Delta x$

$F_s = -K\Delta x$ → spring / restoring

$$W_{app} = \int_{x_i}^{x_f} F_{app} \cdot dx = \int_{x_i}^{x_f} K\Delta x \, dx$$

$W_{app} = \Delta U_s$

$W_s = -\Delta U_s$

$W_{app} = \frac{1}{2}Kx_f^2 - \frac{1}{2}Kx_i^2$

$W_s = -\left(\frac{1}{2}Kx_f^2 - \frac{1}{2}Kx_i^2\right)$

elastic potential Energy :-

$U_s = \frac{1}{2}Kx^2$

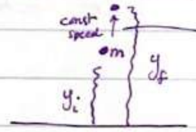
$U_S = \frac{1}{2} k x^2$

$$\left.\begin{aligned} W_{app} &= \Delta U_S \\ W_s &= -\Delta U_S \end{aligned}\right\} W_{app} = -W_s$$

(+) أخذ

(-) فقد

* Work done by gravitational force:-



$\bar{F}_{app} = mg\,\hat{j}$ للأعلى

$\bar{F}_{gra} = -mg\,\hat{j}$ للأسفل

Constant force

* rule:-

$W_{app} = \bar{F}_{app} \cdot \bar{\Delta y} = mg\hat{i} \cdot (y_f - y_i)\hat{j}$

$W_{app} = mgy_f - mgy_i$

$W_{gra} = -(mgy_f - mgy_i)$

$= -W_{app}$

* Define the gravitational potential energy :-

$$\left.\begin{aligned} U &= mgy \\ W_{app} &= \Delta U \\ W_g &= -\Delta U \end{aligned}\right\} W_{app} = -W_g$$

* Work & potential Energy theorem :-

if the only change is in height (position), the work done by the applied force = to the change in potential energy

$W_{app} = \underbrace{\Delta U}_{\text{potential energy}}$

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* Work & Kinetic Energy :-

$W = \int_{r_i}^{r_f} \bar{F} . d\bar{r} \Rightarrow$

$F = ma$

$= m . \frac{dv}{dt}$

$= m . \frac{dv}{dr} . \frac{dr}{dt}$

$W = \int m . \frac{dv}{dr} \underbrace{\left(\frac{dr}{dt}\right)}_{v} . dr \Leftarrow$

$= \int_{v_i}^{v_f} m v . dv$

if m is constant $\Leftarrow$

$= m \int_{v_i}^{v_f} v \, dv$

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

* Define the Kinetic Energy :-

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

$W = K_f - K_i$

$W_{app} = \Delta K$

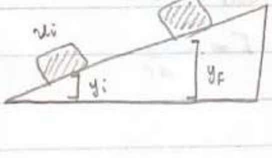
if the only change is in speed then the work done by the applied is equal to the change in the KE.

* In General :-

$W_{app} = \Delta U + \Delta KE$

Change in height $W_{app} = \Delta U$

Change in speed $W_{app} = \Delta KE$



* The mechanical Energy :-

$E = U + K$

$= mgy + \frac{1}{2} m v^2$

$W_{app} = \Delta E$

→ In any Conservative system the total Energy is constant (No Energy loss or gain)

$E = const \Rightarrow E = 0 \Rightarrow \Delta U = -\Delta KE$

- gravity.
- spring.
- electric, ...

* Conservative System :-

if applied or friction force = 0

mechanical Energy is conserved

$0 = \Delta E$

$E_f - E_i = \Delta E$

$E_f = E_i$

$\rightarrow U_f + K_f = U_i + K_i$

$U_f - U_i = K_i - K_f$

$\Delta U = -\Delta KE$

[illegible]

$m = 1\,kg$

	U	K	E	
	1000	0	1000	
70	ΔU	ΔK		ΔE=0
	700	300	1000	
100	ΔU	ΔK		ΔE=0
20	200	800	1000	
	ΔU	ΔK		ΔE=0
	0	1000	1000	

$W_{spring} = -\Delta U_s$

$W_{electrical} = -\Delta U$

$W_{gravity} = -\Delta U$

* for any Conservative force or system:-

- total energy is conserved $\Delta E = 0$ & $\Delta U = -\Delta KE$
- work depends on initial & final point not on the curve or track.

$$W = \int_{r_i}^{r_f} \bar{F} \cdot \bar{dr}$$

- work done on a closed track $= 0$

$$W = \oint \bar{F} \cdot \bar{dr} = 0$$

- the work done by conservative force = to the negative change of the potential energy

* $F = -\frac{du}{\boxed{dr}}$ → scalar

F ↓ vector → F_x F_y F_z

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

$dr = dx\hat{i} + dy\hat{j} + dz\hat{k}$

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

$$F_y = -\frac{dU}{dy}$$

$$F_z = -\frac{dU}{dz}$$

- for any conservative force, you can define a potential energy function:-

$$W_{con} = -\Delta U = -(U_f - \cancel{U_i}^{0}) = -U$$

$$d\left(\int \bar{F}_{con} \cdot dr\right) = (-U)d$$

$$F \cdot dr = -du$$

$$F = -\frac{du}{dr}$$

- Example:- let ($U = 2x^2y + 4yz$) to be potential Energy, find $\bar{F}$ at the point (1,1,1).

$F_z = -(4x + 0) = -(4(1)) = -4$

$F_y = -(2x^2 \cdot 1 + 4 \cdot 1 \cdot z) = -2(1)^2 \cdot 1 + 4 \cdot 1 \cdot 1 = -6$

$F_z = -(0 + 4 \cdot y \cdot (1)) = -(4(1)(1) = -4$

$F = -4\hat{i} - 6\hat{j} - 4\hat{k}$

* NOW:-

$W_{app} = \Delta E$

$W_{app} - (-W_{fric}) = \Delta E$

$W_{app} \mp W_{fric} = \Delta E$

→ $W_{app} - \boxed{f_r}d = \Delta E$ → $f_r = \mu N$

No app. force = No friction ⇒ $\Delta E = 0$

$W_{app} = \Delta E$

$W_{fr} = f_r d \cos\theta$

$\theta = 180$

$W_{fr} = -f_r d$

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$\Delta E = W_{app} - f_k d$ work done by friction

$\Delta E = w_{app} + W_{fr}$, $W_{fk} = f_k d \overset{(-1)}{\cancel{\cos\theta}}$

$\Delta E = \Delta K + \Delta U$

$$\left[\begin{array}{l} K = \frac{1}{2} m v^2 \\ U \begin{cases} U_g = mgy \\ U_s = \frac{1}{2} k x^2 \end{cases} \end{array} \right. \qquad \left[\begin{array}{l} W_g = -\Delta U_g \\ W_{ext} = \Delta K \end{array} \right.$$

$\Delta E = W_{app} - f_k d$

*POWER :- القدرة

power :- work (energy) done per unite of time.

$$\text{power} = \frac{\text{work}}{\text{time}} \Longrightarrow P = \frac{W}{t} \Longrightarrow [P] = J/s$$

$$\Downarrow [P] = \text{watt}$$

*Rules:-

$$P = \frac{w}{t} \longrightarrow \begin{array}{l} P_{avg} = \frac{\Delta W}{\Delta t} \\ P_{instant} = \frac{dw}{dt} \end{array}$$

Since:- $P = \frac{w}{t} = F \frac{\Delta r}{t} \bar{v} \Rightarrow P = \bar{F} \cdot \bar{V}$

$$[P] = N \cdot \frac{m}{s} = \frac{kg \cdot m}{s^2} \cdot \frac{m}{s} = kg \cdot \frac{m^2}{s^3} = \text{watt}$$

-problems:-

Section 2:-

1) ⓐ $W = Fd\cos\theta$

$= 35 \times 50 \times \cos(-25)$

$= 1.59 \times 10^3$ J

2) ⓐ $W = mgh$

$= 3.35 \times 10^{-5} \times 9.8 \times 100$

$= 3.28 \times 10^{-2}$ J

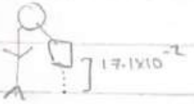
ⓑ it is falling in constant velocity forces are then equal.

$W_{\text{air resis.}} = -W$

$= -3.28 \times 10^{-2}$ J

3) $m = 281.5$

$d = 17.1 \times 10^{-2}$



ⓐ $W = F_g d\cos\theta$ or $W = F_{app} \cdot d$

$= (-mg) d\cos\theta$ $= mg\, d$

$= (-281.5 \times 9.8) \times 17.1 \times 10^{-2} \times \cos(180)$

$= 471.73$ J

ⓑ $F_{app} = mg$

$= 281.5 \times 9.8$

$= 2758.7$ N

4) $W = F_{app} d \times \text{times}$

$= (mg) d \times \text{times}$

$= (653.2 \times 9.8) \times \frac{4}{39.37} \times 24$

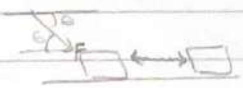
$= 15609.10$ J

5) $m = 2.50$

$d = 2.20$

$F_{app} = 16$

$\theta = -25$



ⓐ $W_{app} = F_{app} d\cos\theta$

$= 16 \times 2.20 \times \cos(-25)$

$= 31.9$ J

ⓑ $W = \overset{F_N}{\text{Ⓝ}}\, d\cos\theta$

$= N d \cos(90)$

$= 0$

ⓒ $W = F_g d\cos\theta$

$= (mg) d \cos(90)$

$= 0$

ⓓ $W = \Sigma F$

$= 31.9 + 0 + 0$

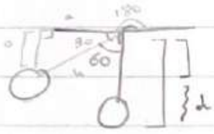
$= 31.9$

6) $m = 80$ kg

$L = 12$

$\theta = 30 + 180$

$= 210$



$W = F_g d\cos\theta$

$= (-mg) d\cos\theta$

$= (-80 \times 9.8) \cos(180) \times d$

$= 4704$ J

$d = 12 - (h\sin\theta)$

$= 12 - (12 \times \sin 30)$

$= 6$

Section 3:-

7) in the book

8) $A \cdot B = AB\cos\theta$

$= 5 \times 9 \times \cos(50)$

$= 28.925$

9) $\bar{C}\cdot(\bar{A}-\bar{B}) = C\cdot(3--1\,\hat{i} + 1-2\,\hat{j} + -1-5\,\hat{k})$

$= C\cdot(4\hat{i} + -1\hat{j} - 6\hat{k})$

$= (0\hat{i} + 2\hat{j} - 3\hat{k})\cdot(4\hat{i} - 1\hat{j} - 6\hat{k})$

$= 0 + -2 + 18$

$= 16$

10) $f \left[\begin{array}{l} \bar{A} = 32.8\ N \\ \theta_A = 118+90 = 208 \end{array}\right.$ $r \left[\begin{array}{l} \bar{B} = 17.3\ cm \\ \theta_B = 360-132 = 228 \end{array}\right.$

$F\cdot r = 32.8 \times 17.3\times10^{-2} \cos\boxed{\theta} \rightarrow \theta_B - \theta_A = \theta_{\substack{Between \\ f\ \&\ r}}$

$= 5.3321 J$

11) ⓐ $W = F\cdot r$

$= 6\times3 + -2\times1$

$= 16 J$

ⓑ $F\cdot r = |F||r|\cos\theta$

$\theta = \cos^{-1}\left(\frac{F\cdot r}{|F||r|}\right)$

$= 36.9°$

12) ⓐ $\theta = \cos^{-1}\left(\frac{A\cdot B}{|\bar{A}||\bar{B}|}\right)$

$= 11.3°$

ⓑ $\theta = 156°$

ⓒ $\theta = 82.3°$

13) $B = 5$, $\theta_B = 60$, $\bar{C} = |\bar{A}|$

$\theta_C = 25 + \theta_A$

$A\cdot B = 30$

$B\cdot C = 35$

$|\bar{A}| = \bar{C}$

$=$

$A\cdot B = BA\cos\theta$

$\boxed{5A\cos\theta = 30}$

$B\cdot C = BC\cos\theta$

$\boxed{5C\cos\theta = 35}$

Section 7.4 :-

14) ⓐ $W = \frac{1}{2}(8)(6)$

$= 24$

ⓑ $W = \frac{1}{2}(2)(-3)$

$= -3$

ⓒ $W = 24 + -3$

$= 21$

15) ⓐ $W = \frac{1}{2}(5)(3)$

$= 7.5$

ⓑ $W = 5\times3$

$= 15$

ⓒ $W = \frac{1}{2}(5)(3)$

$= 7.5$

ⓓ $W = 7.5 + 15 + 7.5$

$= 30$

16) $m = 4.70\times10^{-3}$

$a = 0.800\times9.8$

$x = 0.5\times10^{-2}$

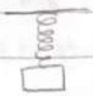
$k = ?$

$F = Kx$

$ma = Kx$

$K = \frac{ma}{x} = 7.37\ N/m$

17)



$m=4$

$\Delta x = 2.5\times10^{-2}$

ⓐ $m = 1.50kg$

$\Delta x = ?$

$m \propto \Delta x$

$\Delta x = \frac{1.50}{4} \times 2.5\times10^{-2}$

$= 9.375\times10^{-3}$

<u>or</u>

$F = K\Delta x$

$mg = K\Delta x$

$K = 1.57\times10^{3}$

ⓐ $\Delta x = \frac{mg}{K}$

ⓑ $w = \frac{1}{2}kx^2$

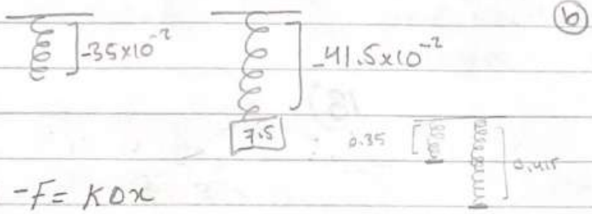
ⓑ $W_{app} = \Delta U_s$

$= \frac{1}{2}K\Delta x^2$

$= \frac{1}{2}(1.57\times10^{3})(4\times10^{-2})^2$

$= 1.25 J$

18)



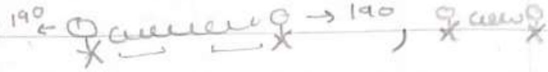
ⓐ $-F = K\Delta x$

$K = \frac{-F}{\Delta x}$

$= \frac{-7.5\times9.8}{-41.5\times10^{-2} - -35\times10^{-2}}$

$= 1130.76$

ⓑ



$F = K\Delta x$

$\frac{190+190}{1130.76} = \Delta x \rightarrow$ القيمه الي انثنت

$= 0.3360$

$\Delta x + x_{original} = 0.3360 + 35\times10^{-2}$

$= 0.68605$

<u>but</u>

$F = -190 + 190 = 0$

So we consider 1 force:-

$\frac{190}{1130.76} = \Delta x$

$\Delta x = 0.168$

$\Delta x + x_{orig.} = 0.168 + 35\times10^{-2}$

$= 0.51802$

19)

$\Delta x = 0.4$

$F = 230$

ⓐ $F = Kx$

$K = \frac{F}{x} = \frac{230}{0.4}$

$= 575$

ⓑ $W_{app} = U_s$

$= \frac{1}{2}K\Delta x^2$

$= \frac{1}{2}\times575\times(0.4)^2$

$= 46$

347

20) 

$K_1 = 1200$

$K_2 = 1800$

$m_2 = 1.50$

$F = K\Delta x$

ⓐ $\Delta x_{total} = \Delta x_1 + \Delta x_2$

$= \frac{F}{K_1} + \frac{F}{K_2}$

$= \frac{mg}{K} + \frac{mg}{K}$

$= 2.4 \cdot 10^{-2}\, m$

ⓑ نفترض انهم عبارة عن

spring واحد :-

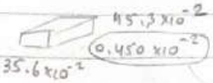
$F = Kx$

$K = \frac{F}{x} = \frac{mg}{x_{total}}$

$= 720\ N/m$

21) **in the book.**

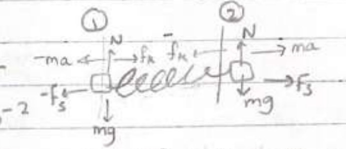
22) $K = \frac{F}{x} = \frac{N}{m} = \frac{Kg \cdot \frac{m}{s^2}}{m} = Kg/s^2$

23) 

$m = 580$

ⓑ $F = Kx$

$K = \frac{F}{x} = \frac{\frac{mg}{4}}{x} = \frac{\frac{580 \times 9.8}{4}}{0.456 \times 10^{-2}} = 316$

24) 

$K = 3.85$

$\Delta x = 8 \times 10^{-2}$

$m_1 = 0.250$

$m_2 = 0.5$

ⓐ $\mu_k = 0$

ⓑ $\mu_k = 0.1$

ⓒ $\mu_k = 0.462$

$F_y \left[\begin{array}{l} m_1 g = 2.45N = N \\ m_2 g = 4.90\ N = N \end{array} \right.$

نفس الشيء عند الكل في

حال انعدام μ_k

ⓐ $\sum F_x = m_1 a_x$

$\cancel{f_k}^{0} - F_s = -m_1 a_x$

$a_x = \frac{-K\Delta x}{-m_1}$

$= +1.232$ to the left

mass 1

$-\cancel{f_k}^{0} - F_s = m_2 a_x$

$a_x = \frac{F_s}{m_2} = \frac{K\Delta x}{m_2}$

$= 0.616$

to the right

mass 2

ⓑ $f_k - F_s = m_1 a_x$

$a_x = -\frac{(\mu_k N - K\Delta x)}{m_1}$

$= 0.252$

to the left

mass 1

$-f_k + F_s = m_2 a_x$

$a_x = \frac{-\mu_k N + K\Delta x}{m_2}$

$= -0.364$ to the right

mass 2

ⓒ $a_x = -\frac{(\mu_k N - K\Delta x)}{m_1}$

$= -3.2956$ to the left

mass 1

$a_x = \frac{-\mu_k N + K\Delta x}{m_2}$

$= 0.154$ to the right

mass 2

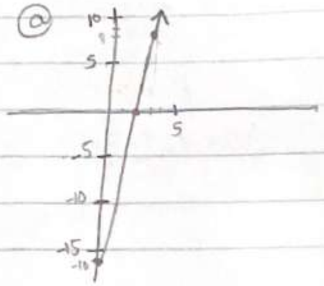
25) in the book.

26) $F = 8x - 16$

ⓑ $x = 0$ to $x = 3$

27) in the book.

ⓐ



$$W = \frac{1}{2}(-16)(2) + \frac{1}{2}(1)(8)$$
$$= -12\,J$$

28) $m = 100\,g$

$L = 0.6\,m$

$F = 15000 + 10000\,x - 25000\,x^2$

ⓐ $W = \int_0^{0.6} F$

$= 9 \times 10^3\,J$

ⓑ $W = \int_0^{1} F$

$= 11{,}666.6\,J$

ⓒ $\dfrac{11{,}666.6 - 9\times10^3}{9\times10^3} \times 100\% = \boxed{29.62\%}$ greater by.

29) $F = 4x\hat{i} + 3y\hat{j}$

$x = 0$, to, $x = 5$

$$W = \int_0^5 F \cdot dx = \int_0^5 4x\,\hat{i} + 0 = 50\,J$$

from Dr.:-

$(0,0)$ to $(5,4)$

$$W = \int_0^5 4x + \int_0^4 3y = 50 + 24$$
$$= 74$$

30) $a(5,-2)$, $b(25,8)$

$\boxed{m = 0.5}$

$u = 0.5x - 4.5$

$u = mx + b$

$-2 = 0.5(5) + b$

$\boxed{b = -4.5}$

ⓐ $\int_5^{25} (0.5x - 4.5) = 0.6\,J$

ⓑ $\int_{25}^{5} (0.5x - 4.5) = -0.6\,J$

ⓒ $\int_a^b v\,du = \int_{-2}^{8} \underset{\downarrow}{\textcircled{v}} = \int_{-2}^{8} 2u + 9 = 150\ N.cm \approx 1.5\ Nm$

$$m = \frac{25 - 5}{8 - -2} = 2$$

$b = x\text{int} = 9$

Section 5:-

31) $m = 3$

$v_i = 6\hat{i} - 2\hat{j}$, $\bar{v}_i = \sqrt{6^2+2^2} = 2\sqrt{10}$, $v_f = 8\hat{i} + 4\hat{j}$, $\bar{v}_f = \sqrt{8^2+4^2} = 4\sqrt{5}$

ⓐ $KE = \frac{1}{2} m v^2$

$= \frac{1}{2}(3)(2\sqrt{10})^2$

$= 60 J$

ⓑ $KE = \frac{1}{2} m v^2$

$= \frac{1}{2}(3)(4\sqrt{5})^2$

$= 120 J$

$\Delta KE = \frac{1}{2} m \Delta V^2$

$= \frac{1}{2}(3)\left((4\sqrt{5})^2 - (2\sqrt{10})^2\right)$

$= 60 J$

32) $m = 35$

$x = 12$

$W = 350$

ⓐ $W = F \Delta x$

$F = \frac{W}{\Delta x} = \frac{350}{12} = 29.2 N$

33) $m = 0.6$] Ⓐ

$v = 2$

$KE = 7.50$] Ⓑ

ⓐ $KE_{Ⓐ} = \frac{1}{2} m v^2$

$= \frac{1}{2} \times 0.6 \times 2^2$

$= 1.2 J$

ⓑ $KE = \frac{1}{2} m v^2$

$v = \sqrt{\frac{KE \times 2}{m}}$

$= \sqrt{\frac{7.50 \times 2}{0.6}}$

$= 5 m/s$

ⓒ $W = \Delta KE$

$= KE_b - KE_A$

$= 7.50 - 1.2$

$= 6.3 J$

34) $m = 4$

ⓐ $x = 0$ to $x = 5$

$W = \int F = \text{area of } F = \Delta KE$

$v = \sqrt{\frac{(\overset{\text{area}}{7.5})2}{4}} = 1.94 m/s$

ⓑ $x = 0$ to $x = 10$

$v = \sqrt{\frac{2(22.5)}{4}}$

$= 3.35 m/s$

ⓒ $x = 0$ to $x = 15$

$v = \sqrt{\frac{2(30)}{4}}$

$= 3.87 m/s$

35) $m = 2{,}100$

$h = 5$

$\Delta x = 12 \times 10^{-2}$

$F = ?$

$v_f = 0$

$v_i = 0$

$\sum_i^f W = \Delta KE$

$W_{grav} + W_{beam} = \frac{1}{2} m \cancel{v_{rest}}^{2\,\nearrow 0} - \frac{1}{2} m \cancel{v_{falls}}^{2\,\nearrow 0}$

$mg(\Delta x + h) + F \Delta x = 0 - 0$

$F = \frac{-mg(\Delta x + h)}{\Delta x} = 8.78 \times 10^5 N$

36) in the book

37) in the book

38) $m = 1.80\times10^{-3}$

$v_i = 575$

$\Delta x = 5.5\times10^{-2}$

$v_f = 0$

ⓐ $\vec{\Sigma} W = \Delta KE$

$F\Delta x = \frac{1}{2}mv_f^{2^{0}} - \frac{1}{2}mv_i^2$

$F = \frac{-\frac{1}{2}mv_i^2}{\Delta x} = -2.34\times10^4$ opposite the direction of motion

ⓑ $t = \frac{\Delta x}{\bar{v}_{avg}} = \frac{\Delta x}{\frac{v_f+v_i}{2}} = \frac{5.5\times10^{-2}}{\frac{0+575}{2}} = 1.91\times10^{-4}$

39) $m = 5.75$

$v_i = 5\hat{i} - 3\hat{j}$

$\bar{v}_i = \sqrt{5^2+3^2}$

$= \sqrt{34}$

$b = 2$

$\Delta x = (8.5, 5)$

ⓐ $KE = \frac{1}{2}mv^2$

$= \frac{1}{2}(5.75)(\sqrt{34})^2$

$= 97.75\ J$

ⓑ $F = m\textcircled{a}$

$8.5\hat{i} + 5\hat{j} = 5\hat{i} - 3\hat{j}t + \frac{1}{2}a\times t^2$

$a = -0.75\hat{i} + 5.5\hat{j}$

$F = ma$

$= -4.3\hat{i} + 28.8\hat{j}$

ⓒ $v = ?$

$v_f = v_i + at$

$= 5\hat{i} + 3\hat{j} + -0.75t\hat{i} + 5.5t\hat{j}$

$= 3.5\hat{i} + 8\hat{j}$

$\bar{v} = 8.6\ m/s$

$W = \Delta K$

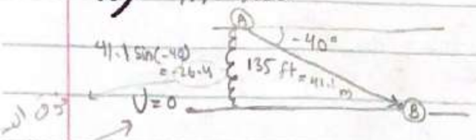
$F\cdot\Delta x = K_f - \overset{97.75}{\textcircled{K_i}}$

$(-4.3\hat{i} + 28.8\hat{j})\times(8.5\hat{i} + 5\hat{j}) = \frac{1}{2}(5.75)(v)^2 - 97.75$

$\bar{v}_f \cong 8.6\ m/s$

Section 6:-

40) $m = 1{,}000$



ⓐ $U_{Ⓑ} = 0$

$U_{Ⓐ} = mgh$

$= 1{,}000\times9.8\times(+26.4)$

$= 2.59\times10^5\ J$

$\Delta U = U_{Ⓑ} - U_{Ⓐ}$

$= 0 - 2.59\times10^5$

$= -2.59\times10^5\ J$

ⓑ $U_{Ⓐ} = 0$

$U_{Ⓑ} = mgh$

$= 1{,}000\times9.8\times(-26.4)$

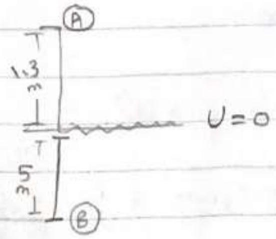
$= -2.59\times10^5\ J$

$\Delta U = U_B - U_A$

$= -2.59\times10^5 - 0$

$= -2.59\times10^5\ J$

41) $m = 0.20$



ⓐ $U_{Ⓐ} = mgh$

$= 0.2 \times 9.8 \times 1.3$

$= 2.5\,J$

ⓑ $U_{Ⓑ} = mgh$

$= 0.2 \times 9.8 \times -5$

$= -9.8\,J$

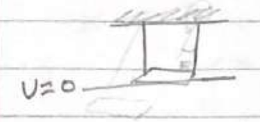
ⓒ
$\Delta U = U_{Ⓑ} - U_{Ⓐ}$

$= -9.8 - 2.5$

$= -12.3\,J$

42) $F = mg = 400\,N$

$L = 2m$



ⓐ $U_{\text{horizontal}} = \overset{F}{mg}h$

$= 400 \times 2$

$= 800$

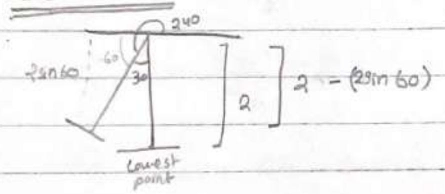
ⓑ $U_{30^\circ \text{ vertical}} = mgh$

$= 400 \times (2 - 2\sin 60)$

$= 107.17\,J$

ⓒ $U_{\text{Bottom}} = 0$

SIDE VIEW:-



Section 7:-

43) $m = 4$

$F_g = mg$

$= 4 \times 9.8$

$= 39.2\,N$ downward

ⓐ $W_{OAC} = W_{OA} + W_{AC}$

$= F\Delta r\cos\theta + F\Delta r\cos\theta$

$= \cancel{39.2 \times 5 \times \cos 90}^{\to 0} + 39.2 \times 5 \times \cos 180$

$= -196\,J$

ⓑ $W_{OBC} = W_{OB} + W_{BC}$

$= F\Delta r\cos\theta + F\Delta r\cos\theta$

$= 39.2 \times 5 \times \cos 180 + \cancel{39.2 \times 5 \times \cos 90}^{\to 0}$

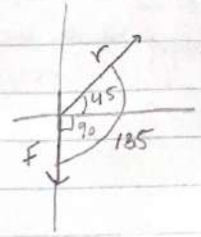
$= -196\,J$

ⓒ $W_{OC} = W_{OC}$

$= F\Delta r\cos\theta$

$= 39.2 \times \left(\sqrt{5^2+5^2}\right) \times \cos(135)$

$= -196\,J$



ⓓ F_g is conservative.

Section 8 :-

47) $U(r) = \frac{A}{r}$

$F = -\frac{dU}{dr} = \frac{A}{r^2}$

48) in the book

49) $U = 3x^3y - 7x$

$F_x = -\frac{dU}{dx} = -(9x^2y - 7) = 7 - 9x^2y$

$F_y = -\frac{dU}{dy} = -(3x^3 - 0) = -3x^3$

$F = F_x\hat{i} + F_y\hat{j}$

$= (7 - 9x^2y)\hat{i} + (-3x^3)\hat{j}$

50) $U = -\int F$

ⓐ $= U_f - \cancel{U_i}^{\,0}$

$= -\int_0^x (-Ax + Bx^2)\hat{i}$

$= -\left(\frac{-Ax^2}{2} + \frac{Bx^3}{3}\right)\Big|_0^x$

$= \frac{Ax^2}{2} - \frac{Bx^3}{3}$

ⓑ $U(2) = 2A - 2.67B$

$U(3) = 4.5A - 9B$

$\Delta U = U(3) - U(2)$

$= 2.5A - 6.33B$

ⓒ $\Delta K = -\Delta U = -2.5A + 6.33B$

51) $m = 5$

$F_x = 2x + 4$

ⓐ $W = \int_1^5 2x + 4$

$= 40J$

ⓑ $\Delta U = -W_{int}$

$= -40J$

ⓒ

KE = ? at $x = 5$

$v = 3$ at $x = 1$

$\Delta KE = W$

$\Delta KE = K_f - K_i$

$K_f = \Delta KE + K_i$

$= 40 + \frac{1}{2}mv^2$

$= 40 + \frac{1}{2} \times 5 \times 3^2$

$= 62.5J$

W_{ext} = work external

W_{int} = work internal

T_{mw} = mechanical waves

T_{mT} = matter transfer

T_{ET} = electrical Transmission

T_{ER} = electromagnetic radiation

problems:-

Section 1:-

1) ⓐ

$$\Delta E_{int} = \underset{\text{ﺣﺮﺍﺭﺓ}}{Q} + T_{ET} + T_{ER}$$

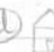
ⓑ

$$\Delta KE + \Delta U + \Delta E_{int} = W + Q + T_{mw} + T_{mT}$$

ⓒ

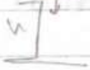
$$\Delta U = Q + T_{mT}$$

ⓓ



$$0 = Q + T_{mT} + T_{ET} + T_{ER}$$

2) ⓐ



System of ball & earth is isolated

$$\Delta K + \Delta U = 0$$

$$\left(\frac{1}{2}mv^2 - 0\right) + (0 - mgh) = 0$$

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

$$v = \sqrt{2gh}$$

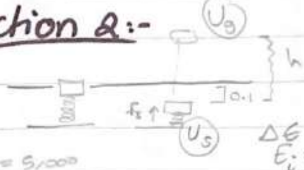
ⓑ System of the ball $\Delta K = W$

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

$$v = \sqrt{2gh}$$

Section 2:-

3)



$K = 5,000$

$m = 0.250$

$\Delta x = 0.100$

$v_0 = 0$

$h = ?$

$$\Delta E = 0$$

$$E_i = E_f$$

$$UE_s = UE_g$$

$$\frac{1}{2}kx^2 = mgh$$

$$h = \frac{kx^2}{2mg}$$

$$= 10.2\,m$$

4) $m = 20$

$v_0 = 1,000$

$\theta = 37$

$\theta = 90$

ⓐ $h_1 = \frac{v^2\sin^2\theta}{2g}$

$= 18478.6\,m$

$h_2 = \frac{v^2\sin^2\theta}{2g}$

$= 51020.4\,m$

ⓑ $\Delta E = K_i + \cancelto{0}{U_i}$

$= \frac{1}{2}mv^2$

$= 1\times10^7\,J$

5) $v_0 = 0$

$h = 3.50R$

ⓐ $\Delta E = 0$

$E_f = E_i$

$U_f + K_f = U_i + \cancelto{0}{K_i}$

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

$gh + \frac{1}{2}v^2 = gh$

$19.6R + \frac{1}{2}v^2 = 34.3R$

$v = \sqrt{2(14.7R)}$

$= \sqrt{29.4R}$

ⓑ $m = 5\times10^{-3}$

$-N - mg = -ma_c$

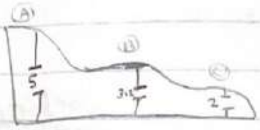
$N = +mg + m\frac{v^2}{R}$

$= m\left(+g + \frac{29.4R}{R}\right)$

$= m(+g + 29.4)$

$= 0.196\,N$

6) $m=5$



ⓐ $\Delta E=0$

$E_f = E_i$

$K_f + U_f = \cancel{K_i}^{0} + U_i$

$\frac{1}{2}mv^2 + mg\times 3.2 = mg\times 5$

$v = 5.939$ m/s

ⓑ $W = \Delta KE$

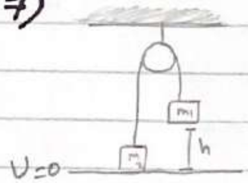
$= KE_f - \cancel{KE_i}^{0}$

$= \frac{1}{2}m\boxed{v^2} \rightarrow \frac{1}{2}mv^2 + mg\times 2 = mg\times 5$

$v = 7.66$

$= 147$ J

7)



$m_1 = 5$

$h = 4$

$m_2 = 3$

ⓐ $\Delta E = 0$

$E_f = E_i$

$E_i = E_f$

$U_{1i} + \cancel{U_{2i}}^{0} + \cancel{K_{1i}}^{0} + \cancel{K_{2i}}^{0} = \cancel{U_{1f}}^{0} + U_{2f} + K_{1f} + K_{2f}$

$U_{1i} = U_{2f} + K_{2f} + \boxed{K_{1f}}$ just as it hits the table ع تخبط بعد

$m_1gh = m_2gh + \frac{1}{2}m_2v^2 + \frac{1}{2}m_1v^2$

$v = 4.22$ m/s

ⓑ

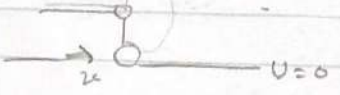
$h = \frac{v^2}{2g}$

$= 1$ m

$y_{max} = 4 + 1 = 5$

8) in the book

9) $L = 77\times10^{-2}$



$E_f = E_i$

$\cancel{K_f}^{0} + U_f = K_i + \cancel{U_i}^{0}$

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

$v = \sqrt{2g\boxed{h}} \rightarrow 2L$

$= 5.493$ m/s

11) in the book

Section 3:-

12) $v_0 = 2$, $\mu_k = 0.1$

$v_f = 0$

ع تتوقف ف هو اذا صفر

$-f_kd = E_f - E_i$

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

$-f_kd = -K_i$

$\Delta K = \Delta U$

$=$

$\mu_kNd = \frac{1}{2}mv^2$

$\mu_k\cancel{m}gd = \frac{1}{2}\cancel{m}v^2$

$d = 2.04$ m

14) $m=10$

$v_0 = 1.5$

$F=100$

$\theta = 20^\circ$

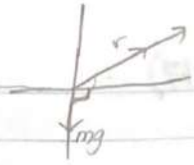
$\mu_k = 0.4$

$x = 5$

ⓐ $W_g = F \cdot \Delta r \cdot \cos\theta$

$= (10 \times 9.8) \times 5 \times \cos(90+20)$

$= -167.58\ J$



ⓑ

$\sum F_y = 0$

$N - mg\cos\theta = 0$

$N = mg\cos\theta$

$-f_k d = \Delta E_{int}$

$\Delta E_{int} = -\mu_k N d$

$= -\mu_k mg\cos\theta\, d$

$= -184.17\ J$

ⓒ $W_{EXT} = F d \cos\theta$

$= 100 \times 5 \times \cos(0)$

$= 500\ J$

ⓓ

$\Delta KE = W_g + W_{Ext} + -f_k d$

$= -167.58 + 500 + -184.17$

$= 148.25$

ⓔ $\Delta KE = 148.25$

$KE_f - KE_i = 148.25$

$\frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = 148.25$

$v_f = 5.648\ m/s$

15) $m=2$

$k = 500$

$\Delta x = 5 \times 10^{-2}$

$v_0 = 0$

$\mu_k = 0.350$

ⓐ $\Delta E = 0$

$E_f = E_i$

$E_i = E_f$

$U_{Spring} = KE_f$

$\frac{1}{2}kx^2 = \frac{1}{2}mv_f^2$

$v = 0.7905\ m/s$

ⓑ $\Delta E = -f_k d$

$E_f - E_i = -f_k d$

$KE_f - U_{spring} = -\mu_k N d$

$\frac{1}{2}mv^2 - \frac{1}{2}kx^2 = -\mu_k \cdot mg d$

$v = 0.531\ m/s$

16) $m=40$

$d=5$

$F_{app} = 130$

$\mu_k = 0.3$

ⓐ $W_{app} = F_{app} \Delta r$

$= 130 \times 5$

$= 650\ J$

ⓑ $\Delta E_{int} = -f_k d$

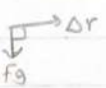
$= -\mu_k mg d$

$= -588\ J$

ⓓ $W_g = F_g \Delta r \cos\theta$

$= mg\Delta r \cancel{\cos 90}^{0}$

$= 0$



ⓒ $W_N = F_n \Delta r \cos\theta$

$= N \Delta r \cancel{\cos 90}^{0}$

$= 0$

ⓔ $\Delta KE = W_g + W_N + W_{app} + \Delta E_{int}$

$= 0 + 0 + 650 - 588 = 62\ J$

ⓕ $\Delta KE = 62$

$K_f - \cancel{K_i}^{0} = 62 \rightarrow \frac{1}{2}mv_f^2 = 62$

$v = 1.76\ m/s$

17) ⓐ

$r = 0.5$

$m = 0.4$

$v_0 = 8$

one rev. $v = 6$

$$\Delta E_{int} = -\Delta K$$
$$= -\left(\frac{1}{2}m(6)^2 - \frac{1}{2}m(8)^2\right)$$
$$= 5.6\ J$$

ⓑ

$$\Delta E_{int} = -\Delta K$$
$$f_k d = -\cancel{K_f}^{0} + K_i$$
$$\mu_k \cancel{m}g(2\pi r(n)) = \frac{1}{2}\cancel{m}v^2$$
$$\mu_k\ 2\pi r\ n = \frac{1}{2}v^2$$
$$n = 2.28$$ if supposed that $r = 1.5$ not 0.5 & $\mu_k = 0.152$

غلط بالسؤال

Section 4:-

18) $KE = 30$, $U = PE = 10$ t_i

$KE = 18$, $U = ?$ t_f

ⓐ

$$\Delta E = 0$$
$$E_f = E_i$$
$$U_f + K_f = U_i + K_i$$
$$U_f = U_i + K_i - K_f$$
$$= 10 + 30 - 18$$
$$= 22\ J$$

$$E_i = K_i + U_i$$
$$= 30 + 10$$
$$= 40\ J$$

ⓑ ?

ⓒ ?

19) $m = 47$

$v = 1.40$

$d = 2.60$

$h = 12.4$

$v_f = 6.20$

$F_f = 41\ N$

$$W_{ext} - f_k d = \Delta E$$
$$W_{ext} - f_k d = E_f - E_i$$
$$W_{ext} = K_f - (K_i + U_i) + f_k d$$
$$= \frac{1}{2}mv_f^2 - \left(\frac{1}{2}mv_i^2 + mgh\right) + f_k d$$
$$= 168\ J$$

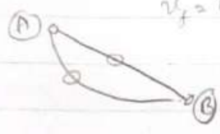
20)

$m = 25 \times 10^{-3}$

$d = 0.60$

$h = 0.2$

$f_s = 0.025$



ⓐ $\cancelto{0}{W_{ext}} - f_k d = \Delta E$

$E_f - E_i = -f_k d$

$K_f - (U_i) = -f_k d$

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

$v_f = 1.649$ m/s

21)

$m = 5.3 \times 10^{-3}$

$\Delta x = 5 \times 10^{-2}$

$K = 8$

$F_k = 0.0320$

$d = 15 \times 10^{-2}$

$v_0 = 0$

$v_f = ?$

ⓐ $\cancelto{0}{W_{ext}} - f_k d = \Delta E$

$E_f - E_i = -f_k d$

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

$\frac{1}{2} m v^2 - \frac{1}{2} K x^2 = -f_k d$

$v_f = 1.4$ m/s

ⓑ

$-f_K = Kx$

$x = \frac{-f_K}{K}$

$= -0.004$

$x_{max} = \Delta x + x$

$= 5 \times 10^{-2} + \bar{0}.004$

$= 0.046$m

ⓒ $(K_f + U_f) - (\cancelto{0}{K_i} + U_i) = -f_k d$

$\frac{1}{2} m v^2 + \frac{1}{2} k \underset{0.004}{\boxed{x}}^2 - \frac{1}{2} K \underset{0.05}{\boxed{x}}^2 = -f_k d$

$v = 1.79$ m/s

23)

$m_1 = 3$

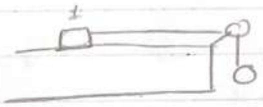
$\mu_K = 0.4$

$v_0 = 0$

$m_2 = 5$

$h = 1.5$

$\cancelto{0}{W_{ext}} - f_k d = \Delta E$



$E_f - E_i = -f_k d$

$(\cancelto{0}{U_{1f}} + U_{2f} + K_{1f} + K_{2f}) - (\cancelto{0}{U_{1i}} + \cancelto{0}{U_{2i}} + \cancelto{0}{K_{1i}} + \cancelto{0}{K_{2i}}) = -f_{k_1} d$

$m_2 g \overset{-1.5}{\boxed{h}} + \frac{1}{2} m_1 v^2 + \frac{1}{2} m_2 v^2 = -\mu_k m_1 g \boxed{d} = h$

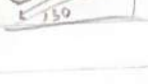
$v = 3.736$ m/s

23) $m = 5$

$v_0 = 8$

$d = 3$

$\theta = 30$



ⓐ $\Delta KE = KE_f - KE_i$

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

$= -160$J

ⓑ $\Delta U = U_f - U_i$

$= mg\boxed{h} - mg\cancelto{0}{h}$

$= 5 \times 9.8 \times 3 \sin 30$

$= 73.5$

ⓒ $\cancelto{0}{W_{ext}} - f_k d = \Delta E$

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

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

$f_k = 28.83$

ⓓ $\mu_k = \frac{28.83}{mg \cos\theta}$

$= 0.6193$

24) $m = 1.5$

$h = 1.2$

$K = 320$

$v_s = 0$

ⓐ $\Delta E = 0$

$E_f = E_i$

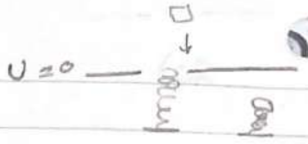
$E_i = E_f$

$\cancelto{0}{K_i} + U_i + \cancelto{0}{U_{si}} = \cancelto{0}{K_f} + U_f + U_{sf}$

$mgh = mg\underset{-x}{\boxed{h}} + \frac{1}{2}kx^2$

$\frac{1}{2}kx^2 + mgx - mgh = 0$

$x = 0.881139$



ⓑ $F_K = 0.7N$

$mgh - mg\overset{-x}{\boxed{h}} + \frac{1}{2}kx^2 = -F_k\overset{h+x}{\boxed{d}}$

$-\frac{1}{2}kx^2 + mgx + F_k(h+x) + mgh = 0$

$-\frac{1}{2}kx^2 + (mg + F_K)x + (mgh + F_kh) = 0$

$x = 0.391$

ⓒ ----

25) $m = 200\times10^{-3}$

$K = 1.40\times10^{3}$

$\Delta x = 10\times10^{-2}$

$\theta = 60^\circ$

ⓐ

$W_s + W_g = 0$

$\frac{1}{2}Kx_i^2 + mg\boxed{d}\sin 60 = 0$

$d = 4.12$

ⓑ $W_s + W_g - f_k d = 0$

$\mu_k = 0.4$

$\frac{1}{2}Kx_i^2 - mgd\sin\theta - F_k d = 0$

$d = 3.35$

27) in the book.

29) $F = 820$

$h = 12$

$t = 8$

$$\text{power} = \frac{\text{Work}}{\text{time}}$$

$$P = \frac{Fd}{t} = \frac{820 \times 12}{8} = 1230\,W$$

30) $m = 875 \times 10^{-3}$

$v = 0.620$

$t = 21 \times 10^{-3}$

$$P = \frac{W}{t} = \frac{\frac{1}{2}mv^2}{t}$$

$$= 8.008\,W$$

31) $175\,hp \times 746$ $\qquad 1hp = 746W$

$v = 29$

$$P = 175 \times 746$$

$$= 130550$$

$$P = F \times v$$

$$F = \frac{P}{v} = \frac{130550}{29} = 4501.7\,N$$

32) $h = 1.25 \times 10^3$

$m = 3.2 \times 10^7$

$P = 2.7 \times 10^3$

$$P = \frac{W}{t}$$

$$t = \frac{W}{P} = \frac{mgh}{P}$$

$$= 1.45 \times 10^8$$

33) - 37) in the book

38) $$P = \frac{\Sigma W}{t} = \frac{\frac{1}{2}mv^2 + mg\textcircled{h}}{t}$$

$m = 650$

$t = 3$

$v = 1.75$

$$= 5916.13\,W$$

$$x = \bar{v}t$$

$$= \left(\frac{0 + 1.75}{2}\right) \times 3$$

$$= 2.63$$