THE COPPERBELT UNIVERSITY
SCHOOL OF MATHEMATICS AND NATURAL SCIENCES
DEPARTMENT OF PHYSICS

PH 110 INTRODUCTORY PHYSICS

TUTORIAL SHEET 5_2023: WORK, POWER AND ENERGY

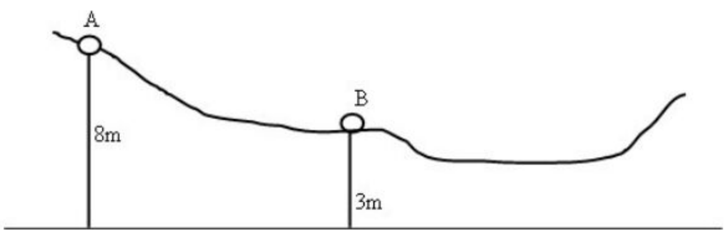
1. A car is moving at a speed of 20 m/s on a level ground when its brakes are applied. If it skids for 32.0 m before stopping what is the coefficient of kinetic friction between its tires and the road?

2. A force $\mathbf{F} = (6\mathbf{i} - 2\mathbf{j} + 5\mathbf{k})N$ acts on a particle that undergoes displacement $\mathbf{s} = (3\mathbf{i} + \mathbf{j} + 4\mathbf{k})\ m$. Find (a) the work done by the force on the particle and (b) the angle between $\mathbf{F}$ and $\mathbf{s}$.

3. A 15-kg block is dragged over a rough, horizontal surface by a constant force of 70 N acting at an angle of 20° above the horizontal. The block is displaced 5 m, and the coefficient of kinetic friction is 0.3. Find the work done by (a) the 70-N force, (b) the force of friction, (c) the normal force, and (d) the force of gravity. (e) What is the net work done on the block?

4. A 2 kg block starts to slide up a 20° incline with an initial speed of 200cm/s. It stops after sliding 37 cm and slides back down. Assuming the friction force impeding its motion to be constant, (a) how large is the friction force, and (b) what is the block's speed as it reaches the bottom?

5. A roller coaster car of mass 400 kg starts from rest at point A and passes the point B with a speed of 3 m/s. If the distance from A to B along the tracks is 20 m, how large is the average friction force retarding the motion of the car.



6. A crate of mass 10 kg is pulled up a rough incline with an initial speed of 2 m/s. The pulling force is 150 N parallel to the incline, which makes an angle of 20° with the horizontal. The coefficient of kinetic friction is 0.500 and the crate is pulled 6.00 m.
   (i) How much work is done by gravity?
   (ii) How much energy is lost due to friction?
   (iii) How much work is done by the 150 N force?
   (iv) What is the change in kinetic energy of the crate?
   (v) What is the speed of the crate after being pulled 6.00 m?

7. An elevator cab of mass 500 kg is descending with a speed of 4 m/s when its supporting cable begins to slip, allowing it to fall with a constant acceleration $a = \frac{g}{5}$. Where g, is the acceleration due to gravity.

(a) During the fall through a distance d of 10 m, what is the work W_g done on the cab by the gravitational force F_g.

(b) During the 10 m fall, what is the work W_T done on the cab by the upward tension T due to the elevator's cable?

(c) What is the net work W_{net} done on the cab during the fall?

(d) What is the cab's kinetic energy at the end of the 10m fall?

8. A bullet weighing 50 grams is fired with a velocity 400 m/s. It passes through a window pane 2 mm thick and its velocity is reduced to 200 m/s. Using work-energy theorem, calculate the force applied on the bullet by the window pane.

9. An engine pumps 2 tons of water in one minute to an average height of 10 m. Calculate the power of the engine if 30% of the energy is wasted in the process.

10. A 750 kg car has a maximum power of 30 kw and moves against a resistance to motion of 800 N. Find the maximum speed of the car:

i. on the level road.

ii. up an incline of $\arcsin\frac{1}{10}$ to the horizontal.

iii. down the same incline.

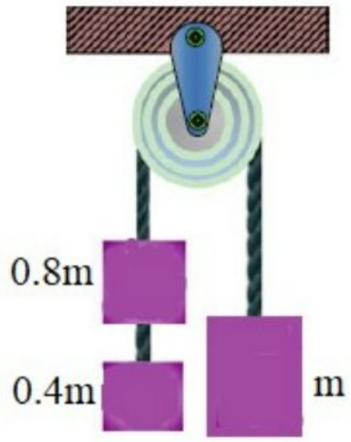
11. A pump on the ground floor of a building can pump up water to fill a tank of volume 30cm^3 in 30 minutes, if the tank is 40m above ground and efficiency of the pump is 40%. How much electric power is consumed by the pump?

12. A train of mass 200 tons moves with constant speed of 72km/h up an inclined hill when the engine is working at 800kw. Find the resistance to the motion of the motion of the train. (Use $\sin\theta = \frac{1}{50}$)

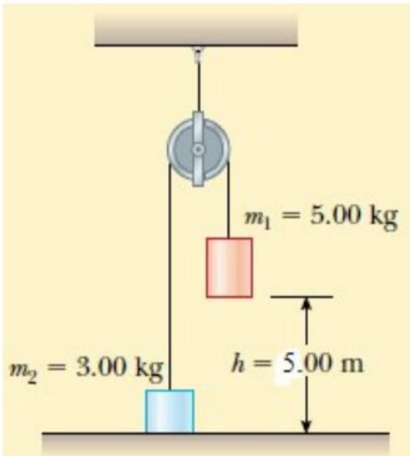
13. A sled of mass m is given a kick on a frozen pond, giving it an initial speed $v_0 = 2\ m/s$. The coefficient of kinetic friction between the sled and ice is 0.1. Use the work-energy theorem to find the distance the sled moves before coming to rest.

14. A 1500-kg car accelerates uniformly from rest to a speed of 10 m/s in 3 s. Find (a) the work done on the car in this time, (b) the average power delivered by the engine in the first 3 s, and (c) the instantaneous power delivered by the engine at $t = 2\ s$.

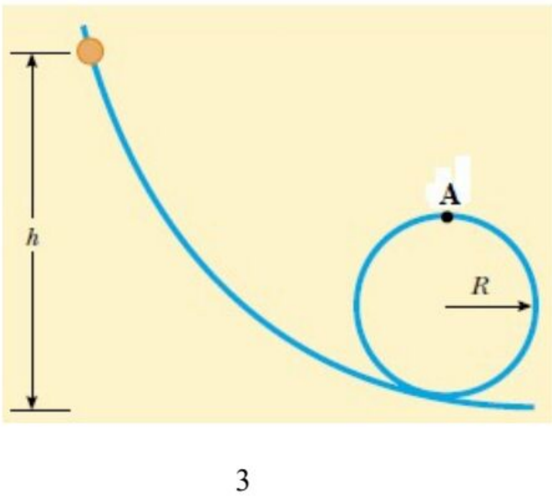
15. Three masses are connected as shown in the figure below over a frictionless pulley and the system is released from rest. After the object with mass m has risen a height of 81 cm, the object of mass 0.5m falls off from the system. What would be the speed of the mass m as it returns to its original position? Ignore air resistance.



16. Two bodies are connected by a string that passes over a pulley, as shown in the below. The lighter body is resting on the floor and the other is held in place a distance of 5.0 m from the floor. The heavier body is then released. Calculate the speeds of the two bodies as the heavy mass is about to hit the floor.



17. A bead slides without friction around a loop-the-hoop. The bead is released from a height h = 3.50R. (a) what is its speed at point A?(b) How large is the normal force on it if its mass is 5.00 g.



By Steven Kayelu
+260 964 626 286

PHYSICS

Tutorial sheet five solutions.

SKayelu

Work energy and power.

1. $V_0 = 20 m/s$ $V_f = 0 m/s$ (comes to rest)
s(displacement) = 32.0m.
Since friction is a non conservative force, we use the extended work energy theorem.

$$Wd_{nc} = \frac{1}{2}m(v^2 - V_0^2) + mg(h_2 - h_1)$$

Since the surface is flat, $h_2 = h_1$
∴ There is no potential energy.

$$Wd_{nc} = \frac{1}{2}m(v^2 - V_0^2)$$

$$-f \times d = \frac{1}{2}m(v^2 - V_0^2)$$ (−f because friction opposes the motion of the body).

$$-U_k \cancel{m} g \times d = \frac{1}{2}\cancel{m}(v^2 - V_0^2)$$

$$U_k = \frac{v^2 - V_0^2}{-2gd}$$

$$U_k = \frac{0^2 - 20^2}{-2(9.8)(32)}$$

$$U_k = 0.6$$

∴ The coefficient of friction is

$$U_k = 0.6$$

2. $F = (6i - 2j + 5k)\ N$

$S = (3i + j + 4k)\ m$

(a) Word done by force (F)

$Wd = F \cdot S$ (dot product) $\rightarrow$ Scalar.

$Wd = (6i - 2j + 5k)N \times (3i + j + 4k)m$

$= (18 - 2 + 20)\ Nm$

$= 36\ Nm$ OR 36 Joules

(b) Angle between F and S

$|F| = \sqrt{6^2 + (-2)^2 + 5^2}$

$= \sqrt{65}$

$Wd = |F||S| \cos\theta$

$|S| = \sqrt{3^2 + 4^2 + 1^2}$

$= \sqrt{26}$

$\theta = \cos^{-1}\left(\frac{Wd}{|F| \cdot |S|}\right)$

$\theta = \cos^{-1}\left(\frac{36}{\sqrt{65} \times \sqrt{26}}\right)$

$\theta = \cos^{-1}(36/\sqrt{1690})$

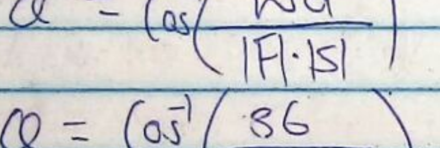
$\theta = 28.9^\circ$

$\therefore$ The angle between F and S is

$\theta = 28.9^\circ$

3. Mass = 15kg Force = 70N at 20° above horizontal.

Given $\mu_k = 0.3$



displacement = 5m

(a) Work done by 70N Force.

$Wd = F\cos\theta \times S$

$= 70\cos 20 \times 5$

$= 328.9$ Joules

(b) The force of friction. (work done by)

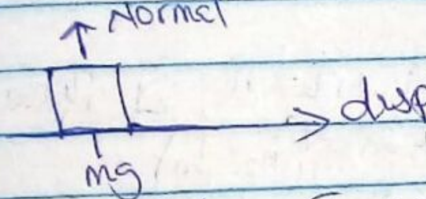
$Wd = -f \times d$ friction opposes motion, hence

$Wd = -U_K mg \times d$ Negative.

$= -0.3(9.8) \times 15 \times 5$

$= -220.5$ Joules

(c) The Normal force.   Normal is perpendicular to the displacement hence $\theta = 90°$



$\therefore Wd = F \times d$

$= N \cos\theta \times d$

$= N \cos 90 \times 5$

$= 0$ Joules

(d) The force of gravity.   mg is also perpendicular to the displacement but acts downwards, hence, $\theta = 270°$

$Wd = f \times d$

$- mg \times d$

$= mg \cos\theta \times d$

$= mg \cos 270 \times 5$

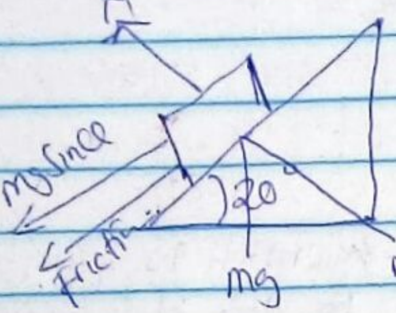
$Wd = 0$ Joules

(e) Net work done. $(\sum(Wd))$ Sum up all the works dones in the. x direction and y.

i.e $Wd_{net} = 328.9 + (-220.5) + 0 + 0$

$= 108.4$ Joules

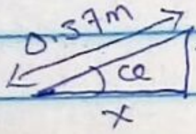
4. Mass = 2kg, $\theta = 20^\circ$, $V_0 = 2m/s$
Length of Incline = 0.37m, ~~at~~ friction - costant.
at the top, $V = 0m/s$



Friction is a non-conservative force, hence,

(a) using the extended work energy theorem-

$$Wd_{nc} = \frac{1}{2}m(v^2 - V_0^2) + mg(h_2 - h_1)$$



$y = 0.37 \sin 20$
$y = 0.13m$

$\therefore h_1 = 0m$ (bottom) and $h_2 = 0.13m$ (top).

Since $wd = f \times d$

$\therefore -fd = \frac{1}{2}m(v^2 - V_0^2) + mg(h_2 - h_1)$

friction is opposing motion (-ve).

$$f = \frac{m(v^2 - V_0^2) + 2mg(h_2 - h_1)}{-2d}$$

$$f = \frac{2(-2^2 + 0^2) + 2(2)(9.8)(0.13 - 0)}{-2(0.37)}$$ displacement = 0.37m

~~$f = -17.70N$~~

$$f = \frac{-8 + 5.09}{-0.74}$$

$f = +3.93 = 4N$

(b) Speed at bottom when coming back (downwards).

$V_0 = 0m/s$ (top) $V = ?$ h_1 (top) $= 0.13m$

h_2 (bottom) $= 0m$

4(b) Speed at bottom when coming downwards

V_0 (top) = 0 m/s V (bottom) = ? h_1 (top) = 0.13 m

h_2 (bottom) = 0 m

using the ~~work energy~~ extendend work energy theorem,

$$Wd = \frac{1}{2}m(v^2 - V_0^2) + mg(h_2 - h_1)$$

Since $V_0 = 0$ m/s and $h_2 = 0$ m

$$\therefore Wd = \frac{1}{2}mv^2 - mgh_1$$

$$F \times d = \frac{1}{2}mv^2 - mgh_1$$

F - friction, d = displacement.

making v subject of formular.

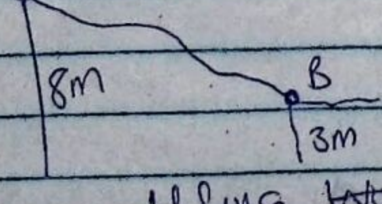
$$Fd + mgh_1 = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2(Fd + mgh_1)}{m}}$$

$$v = \sqrt{\frac{\cancel{2}(4 \times 0.37 + 2 \times 9.8 \times 0.13)}{\cancel{2}}}$$

$$v = 2 \text{ m/s}$$

5.



Mass of roller = ~~8~~400 kg

V_0 = 0 m/s V = 3 m/s at B.

distance = 20 m.

(a) how large is friction force.

Using ~~work~~ extended work energy theorem,

h_A = 8 m h_B = 3 m

$$Wd = \frac{1}{2}m(v^2 - V_0^2) + mg(h_B - h_A)$$

$$-f \times d = \frac{1}{2}m(v^2 - V_0^2) + mg(h_B - h_A)$$

$$F = \frac{m(v^2 - V_0^2) + 2mg(h_B - h_A)}{-2d}$$

4(b) Speed at bottom when coming downwards

V_0 (top) = 0 m/s V (bottom) = ? h_1 (top) = 0.13 m

h_2 (bottom) = 0 m

using the ~~work energy~~ extendend work energy theorem,

$$Wd = \frac{1}{2}m(v^2 - V_0^2) + mg(h_2 - h_1)$$

Since $V_0 = 0$ m/s and $h_2 = 0$ m

$$\therefore Wd = \frac{1}{2}mv^2 - mgh_1$$

$$F \times d = \frac{1}{2}mv^2 - mgh_1$$

F – friction, d = displacement.

making v subject of formular.

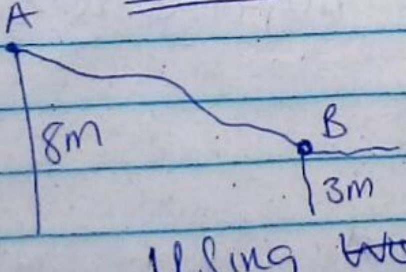
$$Fd + mgh_1 = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2(Fd + mgh_1)}{m}}$$

$$v = \sqrt{\frac{\cancel{2}(4 \times 0.37 + 2 \times 9.8 \times 0.13)}{\cancel{2}}}$$

$$\underline{\underline{v = 2 \text{ m/s}}}$$

5.



Mass of roller = 8400kg

$V_0 = 0$ m/s $V = 3$ m/s at B.

distance = 20m.

(a) how large is friction force

Using ~~work~~ extended work energy theorem, $h_A = 8$m $h_B = 3$m

$$Wd = \frac{1}{2}m(v^2 - V_0^2) + mg(h_B - h_A)$$

$$-f \times d = \frac{1}{2}m(v^2 - V_0^2) + mg(h_B - h_A)$$

$$f = \frac{m(v^2 - V_0^2) + 2mg(h_B - h_A)}{-2d}$$

Continuation.

5. $F = \frac{m(v^2 - v_0^2) + 2mg(h_B - h_A)}{-2d}$

$F = \frac{400(3^2 - 0^2) + 2(400)(9.8)(3-8)}{-2(20)}$

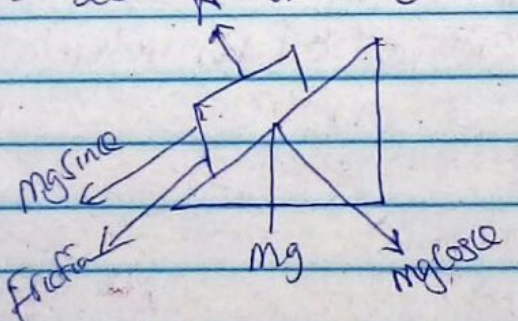
$F = \frac{3600 - 39200}{-40}$

$F = \underline{\underline{890N}}$

∴ The average friction is $\underline{\underline{890N}}$

6. mass = 10kg $V_0 = 2m/s$ Force = 150N
$\theta = 20°$ $U_k = 0.5$ displacement = 6m.

ΣF_Y : $N = mg\cos\theta$
$F_{ric} = U_k N = U_k mg\cos\theta$



(a) Work done by gravity.
$Wd = F \times d$
Force must always be in the direction of displacement, hence ~~mg cosθ~~ mg sinθ
$Wd = -mg\sin\theta \times d$
$= -10 \times 9.8 \sin 20 \times 6$
$= -201.1$ Joules

(b) Work ~~lost~~ due to friction (word done by friction).
$Wd = F \times d$ friction is negative.
$= -U_k mg\cos\theta \times d$
$= -0.5 \times 10 \times 9.8 \cos 20 \times 6$
$= -276.3$ Joules.

(c) Work done by 150N force

$Wd = F \times d$

$= 150 \times 6$

$= 900$ Joules

(d) ΔKE of the Crate

Using work energy theorem.

$Wd_{net} = \Delta KE$

So, we just find the ~~net~~ work done. which is summation of all works done respective of their signs.

$\Delta KE =$ Total work done

$\Delta KE = 900 + (-201.1) + (-276.3)$

$\Delta KE = 422.6$ Joules.

$\therefore$ The change in kinetic energy is

$= 422.6$ Joules

(e) Speed of crate at 6m.

Using the work energy theorem.

$W_{net} = \Delta KE$

$W_{net} = \frac{1}{2} m(v^2 - v_0^2)$ $v_0 = 2m/s$, $v = ?$

$W_{net} = 422.6J$

$2W_{net} = \cancel{\frac{1}{2}} mv^2 - mv_0^2$

$2W_{net} + mv_0^2 = mv^2$

$v = \sqrt{\frac{2W_{net} + mv_0^2}{m}}$ making v subject of the formula.

$v = \sqrt{\frac{(2 \times 422.6) + (10 \times 2^2)}{10}}$

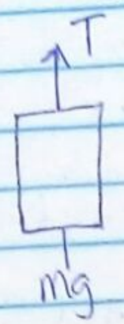
$v = \cancel{29.75 m/s}$ $9.4 m/s$

$\therefore$ The speed of the crate at 6m is

$v = 9.4 m/s$

7. Mass = 500kg $V_0 = 4m/s$

$a = g/5 \ m/s$



(a) distance = 10m (work by Gravity)

$wd = F \times d$

$= mg \times d$

$= 500 \times 9.8 \times 10$

$= 49000$ Joules | 49 KJ

(b) work done by tension

$\Sigma Fy: -T + mg = Ma$

$T = mg - Ma$

$T = m(g-a)$

$T = 500\left(9.8 - \frac{9.8}{5}\right)$

$T = 3920$

$wd = -F \times d$ T opposes the downward motion

$= -3920 \times 10$

$= -39200$ J OR 39.2 KJ

(c) Net work

$W_{net} = 49000 + (-39200)$

$= 9800$ Joules or 9.8 KJ

(d) Kinetic energy at end of 10m fall.

using work energy theorem.

$W_{net} = KE_f - KE_i$ $KE_i = \frac{1}{2} m V_0^2$

$KE_f = W_{net} + KE_i$

$KE_f = 9800 + \frac{1}{2} \times 500 \times (4)^2$

$= 13800$ Joulles

8. Mass = 0.05 Kg V_0 = 400 m/s
d = 0.002 m V = 200 m/s
using work energy theorem.

$$W_{net} = \frac{1}{2}m(V^2 - V_0^2)$$ The force is opposing the motion

$$-F \times d = \frac{1}{2}(mV^2 - mV_0^2)$$

$$f = \frac{m(v^2 - V_0^2)}{-2d}$$

$$f = \frac{0.05(200^2 - 400^2)}{-2(0.002)}$$

$$\underline{\underline{f = 1{,}500{,}000\ N}}$$

9. mass = 2000 Kg time = 60 seconds
distance (h) = 10 m.
power of engine? 30% of energy is wasted
here 30% is the efficiency.

$$\eta = \frac{\text{power out}}{\text{power In}} \times 100\%$$

$$\text{power output} = \frac{mgh}{t} = \frac{\text{Energy out}}{\text{time}}$$

$$\text{power output} = \frac{2000 \times 9.8 \times 10}{60}$$

$$= 3266.66\ W$$

power Input = power of engine.

$$\cancel{\text{power In} = \frac{\eta}{100\%} \times \left(\frac{1}{\text{power out}}\right)}$$

$$\text{power In} = \frac{100\% \times \text{power out}}{\eta}$$

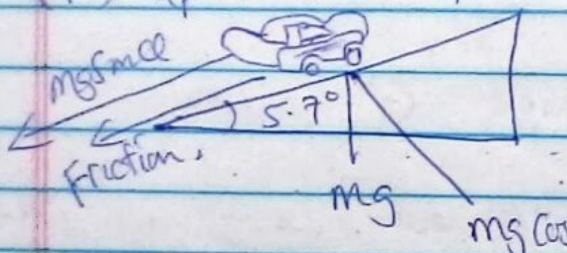
$$= \frac{100\% \times 3266.66\ W}{30\%}$$

$$\text{power of engine} = \underline{\underline{10{,}888.9\ W}}$$

10 Mass = 750kg power = 30KW
friction = 800N $\Sigma Fx = 800N$
(i) speed of car on level ground.
$P = F \times V$ 30KW = 30 000W

$300\cancel{00} = 8\cancel{00}V$
$V = \frac{300}{8}$
$V = 37.5 m/s$

(ii) up Incline of arcsine $\frac{1}{10}$ to horizontal.



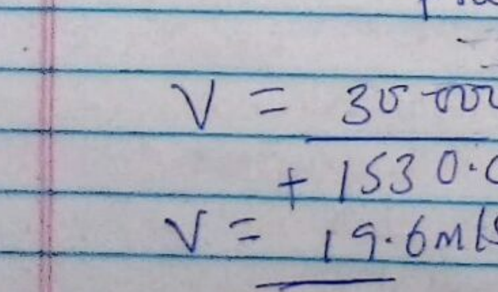
arcsine $\frac{1}{10} = \sin^{-1}\left(\frac{1}{10}\right)$
$\alpha = 5.7°$

$\Sigma Fx = + mg\sin\alpha + Friction$
Friction = 800N
power = Fnet × V

$V = \frac{power}{Fnet} = \frac{30\,000}{+(750 \times 9.8 \sin 5.7 + 800)}$

$V = \frac{30\,000}{+1530.00}$
$V = 19.6 m/s$

(iii) down the same Incline.



here friction is going up.
$\Sigma Fx = mg\sin\alpha - F$
$\therefore V = \frac{P}{mg\sin\alpha - F}$

$$V = \frac{30\,000}{750 \times 9.8 \sin 5.7 - 800}$$

$V = -428.6\ m/s$

The velocity downwards is

$V = -428.6\ m/s$

Note!
Negative shows the change in direction from upwards to downwards.

11. Volume $= 30\ cm^3 \times \left(\frac{1\ m^3}{1000000\ cm^3}\right) = \underline{3 \times 10^{-5}\ m^3}$

Time $= 30$ minutes $\times \left(\frac{60\ s}{1\ min}\right) = \underline{\underline{1800\ s}}$

height $= 40\ m$

efficiency(δ) $= 40\%$

How much electric power is consumed by the pump (power Input).

$$\delta = \frac{IN}{OUT} \times 100\%$$

$$\frac{\delta}{100\%} \times out = Input.$$

$$\text{Power In} = \frac{6.5 \times 10^{-3} \times 40\%}{100\%}$$

$$= \frac{6.5 \times 10^{-3} \times 4}{10}$$

Power in $= \underline{\underline{2.6 \times 10^{-3}\ W}}$

$\therefore$ $2.6 \times 10^{-3}\ W$ is consumed by the pump

power output

$$P = \frac{mgh}{t}$$

Converting from Volume to mass

$1\ m^3 \rightarrow 1000\ kg$

$\therefore 3 \times 10^{-5}\ m^3 \times \left(\frac{1000\ kg}{1\ m^3}\right)$

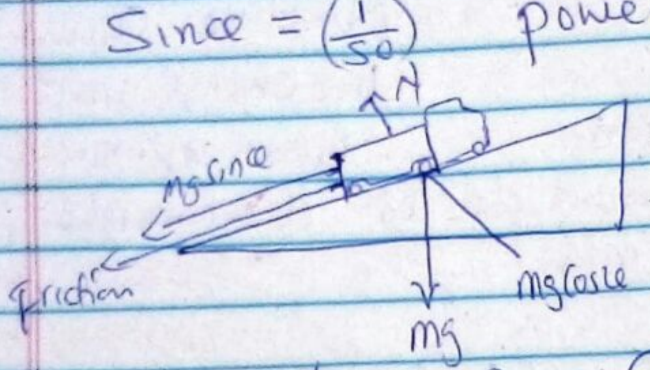
Mass $= 0.03\ kg$

$\therefore$ power out $= \frac{0.03 \times 9.8 \times 40}{1800}$

$$= \frac{0.03 \times 9.8 \times 40}{1800}$$

$= 6.5 \times 10^{-3}\ W$

12. mass 200 000 kg $V = 20 m/s$
Since $= \left(\frac{1}{50}\right)$ power $=$ 800 KW $= 800000 W$



Find restance force (friction).

$\Sigma F_x =$ mg Since + Friction.

power $= F \times V$.
power $= ($mg since + Fric$) V$

$\frac{\text{power}}{V} =$ mg Since + Fric

fric $= \frac{\text{power}}{V} -$ mg Since

fric $= \frac{800\,000}{20} - 200\,000 \times \frac{1}{50} \times 9.8$

$= 40000 - 4000 \times 9.8$
$= 800 N$.

$\therefore$ The resistance force $= 800 N$

13. $V_0 = 2m/s$ $\quad \mu_k = 0.1$ $\quad V = 0m/s$

Using the work energy theorem.

$$wd = \frac{1}{2} m(V^2 - V_0^2)$$

since $V = 0m/s$

$$wd = -\frac{1}{2} mV_0^2$$

$$-F \times d = -\frac{1}{2} mV_0^2$$

$$d = \frac{-mV_0^2}{-2f}$$

$f = \mu_k mg$

$$d = \frac{-\cancel{m}V_0^2}{\mu_k \cancel{m} g}$$

$$= \frac{+V_0^2}{+\mu_k g} = \frac{+(2)^2}{+0.1(9.8)}$$

$$\therefore d = \frac{4}{0.98}$$

$$d = 4.08\ m$$

$\therefore$ The distance moved is 4.08m

14. Mass = 1500kg $\quad V_0 = 0m/s$ $\quad V = 10m/s$ $\quad t = 3s$

Find (a) work done on car in this time.

(a) Work done = ΔKE using work energy theorem

$$wd = \frac{1}{2} mV^2 \quad \text{Since } V_0 = 0m/s$$

$$wd = \frac{1}{2} \times 1500 \times 10^2$$

$$wd = 75\,000 \text{ Joules.}$$

(b) Average power delivered in first three seconds

$$\text{power} = \frac{\text{Workdone in given time (3 sec)}}{\text{time}}$$

$$= \frac{75000}{3} = 25000\ W$$

(c) Instateneous power at $t = 2$ seconds.

$$a = \frac{V - V_0}{t} \quad a = \frac{10 - 0}{3} = 3.3m/s$$

Velocity at 2 seconds $\quad V = V_0 + at$

$$V = 3.3 \times 2 = 6.67m/s$$

Continuction

14 power = F x Velocity

~~Wd = F x d~~

$v^2 = v_0^2 + 2ad$

$d = \frac{v^2 - v_0^2}{2a} = \frac{6.67^2 - 0^2}{2(3.33)}$

$d = 6.68m$

Continuation

14 power = F x Velocity

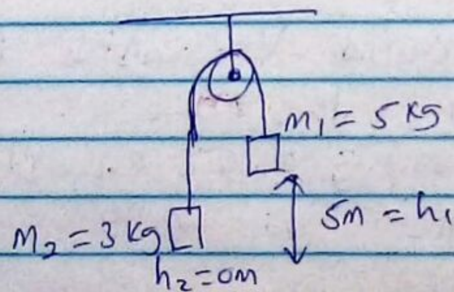
where $F = m \times a$

and Velocity at 2 sec $= 6.67 m/s$

power $= (1500 \times 3.33) \times 6.67$

$= 33,266.7 W$

15



Speed of two bodies.

Using the law of Conservation of energy.

$\cancel{\left(\frac{1}{2} m_1 V_1^2 + \frac{1}{2} m_2 V_2^2\right)} + m_1 g h_1 + \cancel{m_2 g h_2} = \left(\frac{1}{2} m_1 V_1'^2 + \frac{1}{2} m_2 V_2'^2\right) + \left(\cancel{m_1 g h_1'} + m_2 g h_2'\right)$

Since $h_2 = 0$, and $h_1' = 0m$

and $V_1' = V_2'$ and $V_1 = 0$ and $V_2 = 0$ (at rest)

hence $m_1 g h_1 = \frac{1}{2}(m_1 + m_2)V^2 + m_2 g h_2'$

$2(m_1 g h_1 - m_2 g h_2') = (m_1 + m_2)V^2$

$V = \sqrt{\frac{2(m_1 g h_1 - m_2 g h_2')}{m_1 + m_2}}$

16. Continuation

$$V = \sqrt{\frac{2(m_1 g h_1 - m_2 g h_2')}{m_1 + m_2}}$$

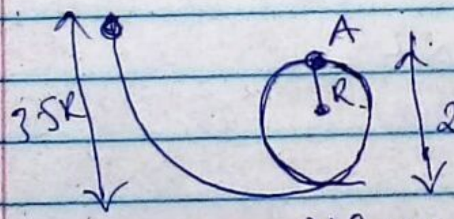
$$V = \sqrt{\frac{2(5\times9.8\times5 - 3\times9.8\times5)}{3+5}}$$

$$V = \sqrt{\frac{\cancel{2}\times5\times9.8(5-3)}{\cancel{8}\,\cancel{4}\,2}}$$

$$V = \sqrt{\frac{5\times9.8}{2}}$$

$$V = 4.95\,m/s$$

17



$V_0 = 0\,m/s$, $V_A = ?$

$h_A = \cancel{3.5R}\ 2R$, $h_{top} = 3.5R$

(a) using the law of conservation of energy.

$$\frac{1}{2}\cancel{m V_0^2} + mgh = \frac{1}{2}mv^2 + mgh$$

$V_0 = 0$

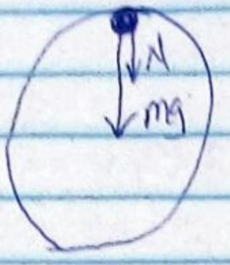
$$mgh_T = \frac{1}{2}mv^2 + mgh_A$$

$$2\cancel{m}g(h_T - h_A) = \cancel{m}v^2$$

$$v = \sqrt{2g(3.5R - 2R)}$$

$$V = \sqrt{3gr}\ m/s$$

(b) Normal force $\quad$ mass = 5 g



$\Sigma F_y = N + mg$

$F_c = N + mg$

Since $V = \sqrt{3gR}$

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

$V^2 = 3gR$

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

$N = m\left(\frac{v^2}{r} - g\right)$

$N = 0.005\left(\frac{3gR}{R} - g\right)$

$N = 0.005 \times g(3 - 1)$

$N = 0.005 \times 9.8 \times 2$

$N = 0.098 N$

$\therefore$ The Normal is $0.098 N$