Thermal Energy

$E_h = m t c$ where "c" is specific heat capacity

$m =$ mass in kg

$t =$ temperature

$E_h =$ Heat energy in Joules

$J = kg \cdot C \cdot \boxed{\frac{J}{kg\,C}}$

Calculate the amount of energy in a 525 g cup of water @ temp of 15°C if the specific heat capacity of water is $4.18 \times 10^3 \frac{J}{kg\,C}$

$E_h = m t c$

$= (.525\,kg)(15°C)(4.18 \times 10^3 \frac{J}{kg\,C})$

$= \underline{\underline{3.3 \times 10^4\,J}}$

If I increased the temp to 75°C how much more energy is required

$\Delta E_h = m \Delta t c$

$= m(t_f - t_i)c$

This calculates how much more energy $= (.525\,kg)(60°C)(4.18 \times 10^3 \frac{J}{kg\,C})$

$E_{hf} = 1.32 \times 10^5\,J$

... 2 materials with different temperatures

Combining 2 materials with different temperatures

a cup of water with mass 475g and temp 15°C is added to 325g of hot water at a temperature of 80°C what is the combined temperature when they are mixed

$\Delta E_{CW} + \Delta E_{HW} = 0$

$m \Delta t c + m \Delta t c = 0$

$(.475kg)(t_f - 15°C)(4.18 \times 10^3 \frac{J}{kg C}) + (.325kg)(t_f - 80°C)(4.18 \times 10^3) = 0$

$.475kg(t_f - 15°C)\cancel{(4.18 \times 10^3 \frac{J}{kgC})} = -(.325kg)(t_f - 80°C)\cancel{(4.18 \times 10^3 \frac{J}{kgC})}$

$.475kg\,t_f - 7.125kgC - .325kg\,t_f + 26.0\,kgC$

$.475kg\,tf + .325kg\,tf = 26kgC + 7.125kgC$

$t_f \frac{(.475\cancel{kg} + .325kg)}{.475kg + .325kg} = \frac{33.125kg\,C}{.475kg + .325k}$

$t_f = 41.4°$

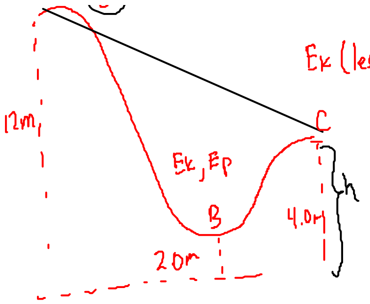
Pg 219-221 1-9 odd

#8 pg 227

A (Ek) Ep max

$\Delta E_p + \Delta E_k + \Delta E_T = 0$

0



$$E_{pf} - E_p + E_{kf} - E_{ki} = 0$$

$$\cancel{m}gh_f - \cancel{m}gh_i + \tfrac{1}{2}\cancel{m}v_f^2 - \tfrac{1}{2}mv_i^2 = 0$$

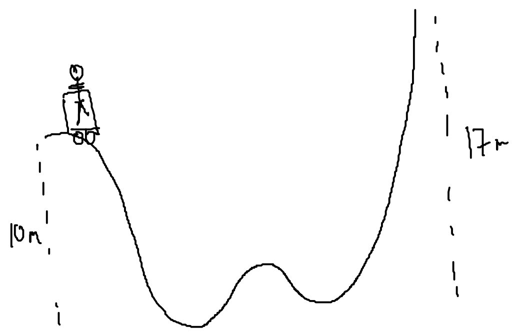
$$(9.8\tfrac{m}{s^2})(4m) - (9.8)(12) + \tfrac{1}{2}v_f^2 = 0$$

$$39.2\tfrac{m^2}{s^2} - 117.6\tfrac{m^2}{s^2} + \tfrac{1}{2}v_f^2 = 0$$

$$2\left(\tfrac{1}{2}v_f^2\right) = \left(78.4\tfrac{m^2}{s^2}\right)2$$

$$v=0 \quad V_f = \sqrt{154.8}$$

$$= 12.5\ m/s \doteq 13\tfrac{m}{s}$$



Determine what initial velocity is required to reach the top of the roller coaster assume frictionless

$$\Delta E_k + \Delta E_p = 0$$

$$E_{kf} - E_{ki} + E_{pf} - E_{pi} = 0$$

$$0 - \tfrac{1}{2}\cancel{m}v_i^2 + \cancel{m}gh_f - \cancel{m}gh_i = 0$$

$$v = \underline{11.7\ m/s}$$

if it is no longer frictionless, heat generated by the wheels is 75 J determine initial velocity. mass of the car is 150 kg

$$\Delta E_p + \Delta E_k + \Delta E_T = 0$$

$$mgh_f - mgh_i + \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2 + \underbrace{E_{Tf} - E_{Ti}}_{\Delta h} = 0$$

$$(150kg)(9.8)(17-10) + 0 - \tfrac{1}{2}(150)v_i^2 + 75 - 0$$

$v_i = 11.8 m/s$

last lesson we did on the white board

today we will cover power and efficiency

Def'n Power = the rate of doing work, Recall def^n of work is the amount of applied force × distance, this is a scalar, the unit is Joule "J"

Power = work per unit of time

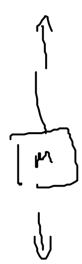
"P" = $\frac{\text{work}}{\text{time}} = \frac{F \cdot d}{\text{time}} = \frac{\text{Energy}}{\text{time}}$

uppercase

SI unit for power is Watts "W" upper case w

ex) an electric motor lifts an elevator that weighs $1.20 \times 10^4 N$ a distance of 9.00m in 15.0s, what is the power output of the motor?

A) $P = \frac{F \cdot d}{t} = \frac{1.20 \times 10^4 N \cdot 9.00 m}{15.0 s} = 7.20 \times 10^3 W$



Note 1 kW = 1000 watts

$\therefore$ 7.2 kW

ex) a box of mass 25 kg is lifted a distance of 20.0m by a rope by constant velocity i.e. This is done in 10.0s what is the power output of the person lifting this box

A = $P = \frac{F \cdot d}{t} = \frac{(25 kg)(9.8 \frac{m}{s^2}) \cdot (20.0 m)}{10.0 s} = 490 W$

Recall $P = F \cdot \boxed{\frac{d}{t}}$ or $P = F \cdot \bar{v}$ where $\bar{v}$ is average velocity

ex an electric motor lifts an elevator of weight 15000 N. If the power output of the motor is 4 kW, calculate the average speed of the elevator

A) $P = \frac{W}{t} = F \cdot \bar{v}$

$$\bar{v} = \frac{P}{F} = \frac{4000}{15000\text{N}} = .2\bar{6}\,\frac{m}{s}$$

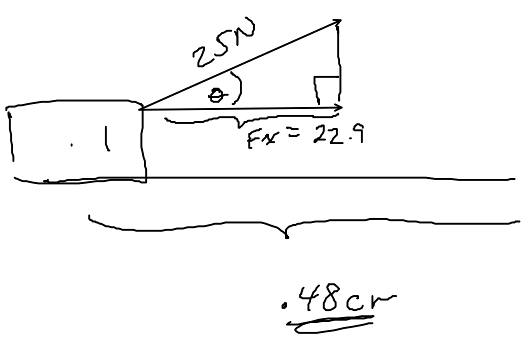
ex) An electric motor develops 65 kW of power as it lifts a loaded elevator 17.5 m in 35.0 s. How much force does the motor exert?

$$\bar{v} = \frac{17.5\text{m}}{35.0\text{s}} = .50\,\frac{m}{s}$$

$P = F \cdot \bar{v}$

$$F = \frac{P}{\bar{v}} = \frac{65000\text{ W}}{.50\text{m/s}} = 130000\text{N}$$

PS#234 #1, 2, 3, 5



11 J

$W = 11$ J

$11\text{J} = F_x \cdot .48$ m

$F_x = 22.9$ N

$$\theta = \cos^{-1}\left(\frac{22.1}{25}\right) = 24^\circ$$

Machines + efficiency

ex of simple machines
- wedges (inclines)
- levers (bottle openers) (bike pedals)
- wheels
- pulleys

when you use a bottleopener, what is actually happening?

you! are exerting a force on the lever (machine)
the lever will turn around and exert a force on the bottle cap

Some textbook will call the force you exert F_e or effort force, The force exerted by the machine is called resistance force F_r

Mechanical advantage of that machine is

$$M.A. = \frac{F_r}{F_e}$$

Many machines have a Mechanical advantage greater than 1

We can calculate MA of a machine based on our Idea of work

W_o = Work you get out

$W_o = W_i$ W_i = work you put in

In an Ideal machine (No such machine exists)

Using this information we can come up with

$F_r d_r = F_e d_e$ d_r - distance moved by the machine

$\frac{F_r}{F_e} = \frac{d_e}{d_r}$ d_e - distance moved by effort

Since $\boxed{\frac{F_r}{F_e} = MA \qquad \frac{d_e}{d_r} = IMA}$ (Ideal mechanical advantage)

$$\boxed{\text{efficiency} = \frac{W_o}{W_i} \times 100\% \quad \text{or} \quad \frac{\text{Power out}}{\text{Power in}} \times 100\%}$$

$$= \frac{F_r d_r}{F_e d_e} \times 100\%$$

or $= \dfrac{\frac{F_r}{F_e}}{\frac{d_e}{d_r}} \times 100\%$

or $\dfrac{MA}{IMA} \times 100\%$

an efficient machine is one that has a ratio close to 1

#4 pg 235

$$\text{Efficiency} = \frac{\text{Power out}}{\text{Power in}} = \frac{F \cdot \boxed{d/t}}{10{,}000\text{ W}} = \frac{mg\bar{v}}{10{,}000\text{W}}$$

$$= \frac{(8.5\times10^{2}\,\text{kg})(9.8\,\text{m/s}^2)(1\,\text{m/s})}{10{,}000\,\text{W}} \times 100\%$$

$= 83.3\%$ efficient

#6 pg 236

motor output 500 W

Power gained $= (20)(9.8)\left(\frac{5.00}{3}\right)$

$$\text{Efficiency} = \frac{\text{Power out}}{\text{Power in}}$$

$$= \frac{(20\,\text{kg})(9.8)(5/3)}{500\,\text{W}} \times 100\%$$

$= 56\%$

#7 pg 236

Power in $= 100 \times 1000\,\text{W}$

$= 1\times10^{5}\,\text{W}$

efficiency 82%

Power out $= .82 \times 1\times10^{5}\,\text{W}$

$$\text{Eff} = \frac{\text{Power out}}{\text{Power in}}$$

$m = 50\,\text{kg}$ g 9.8 $d = 8$

$$= 8.2\times10^4 W = F \cdot \frac{d}{t}$$

$$t = \frac{F \cdot d}{8.2\cdot10^4 W}$$

$$= \frac{mg\,d}{8.2\times10^4 W} = \frac{(50)(9.8)(8)}{8.2\cdot10^4 W}$$

$$=$$

$$t = .05\,s$$

Mechanical advantage

ex) A sledge hammer is used to drive a wedge into a log to split it. The wedge is driven 20cm into the log and the log is seperated 5.0cm a force of $1.9\times10^4 N$ is needed to split the log and the sledge hammer exerts a force of $9.8\times10^3 N$

find IMA of the wedge

$$IMA = \frac{d_e}{d_r} = \frac{20cm}{5cm} = 4.0$$

$$\text{find } MA = \frac{F_r}{F_e} = \frac{1.9\times10^4 N}{9.8\times10^3 N} = 1.9$$

efficiency? $\frac{MA}{IMA} = \frac{1.9}{4} \times 100\% = 48\%$

ex) A worker uses a pulley system to raise a 225N box 16.5m. A force of 129 N is exerted and the rope is ~~33.0m~~ pulled 33.0m

find MA = ?

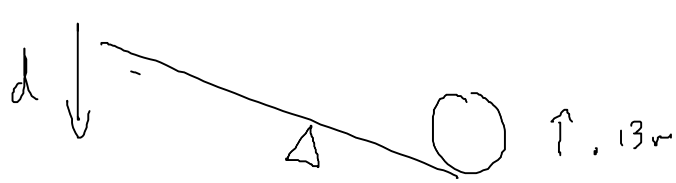
$$MA = \frac{F_R}{F_e} = \frac{225N}{129N} = 1.74$$

find efficiency?

$$IMA = \frac{d_e}{d_r} = \frac{33m}{16.5} = 2.0$$

$$\text{Efficiency} = \frac{MA}{IMA} \times 100 = 87\%$$

ex A boy exerts a force of 225N on a lever to raise a 1.25×10^3 N rock a distance of .13m If the efficiency of the lever is 88.7% how far did the boy move his end of the lever.



$$Eff = \frac{MA}{IMA}$$

$$\frac{.887}{1} = \boxed{\frac{\frac{F_R}{F_e}}{\frac{d_e}{d_r}}} = \frac{\frac{1.25\times10^3 N}{225}}{\frac{de}{.13}} = \frac{.887}{1}$$

$$.887 \cdot \frac{de}{.13}$$

$$\frac{1.25\times10^3 N}{225 N} = \left(\frac{.887}{.13}\right) \cdot de$$

$$\frac{.887}{.13} \cdot de$$

$$\frac{5.5}{6.82} = \frac{6.82}{6.82} \cdot de$$

$de = .81m$

H/O #17, 18, $\boxed{20}$, 22, 27, 29, 30, 31, 34,

w/B ~~pg~~ pg 239 # 1-6

HW pg 210 # 14-15 answers back

pg 215 #29-31 No answers