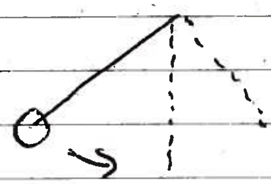
Energy Review solutions

1.) Mechanical energy is the energy available to do work. It is transferred [in physics class it is not transferred to heat.] Conservation of energy states that the total energy in the universe stays the same

e.g. 

pendulum swinging. Kinetic and potential energy are mechanical energy. It is transferred to heat by friction that is why the pendulum stops. The total energy stays the same [the energy becomes heat.]

2.) kinetic energy is the energy associated with moving objects. Any moving object will have kinetic energy.

$$\boxed{\Delta E_K = \tfrac{1}{2}mv_2^2 - \tfrac{1}{2}mv_1^2 = W_{ork}} \qquad \boxed{E_K = \tfrac{1}{2}mv^2}$$

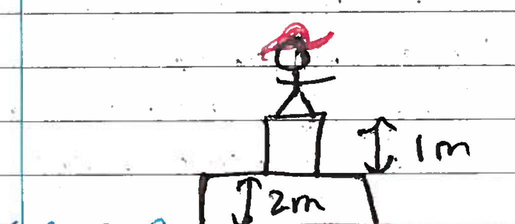
these are different!

3.) gravitational energy is the energy associated with lifting an object to a certain height. Since height measures are relative we need to set a reference line

$$\Delta E_g = mgh_2 - mgh_1 = Work$$

$$\boxed{E_g = mgh}$$

usually we choose $h_1 = 0$



the man's height relative to this line is 3m

ALWAYS from hot to cold

Heat transfer →

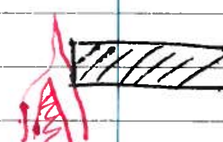
maccaroni

4.) Convection : warm fluid rises and colder air sinks

e.g. think of maccaroni in a pot of boiling water. It goes up and down

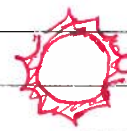
Conduction: when fast moving particles of a hot substance come in contact with slower moving particles of a cold substance.

e.g. metal put into a candle

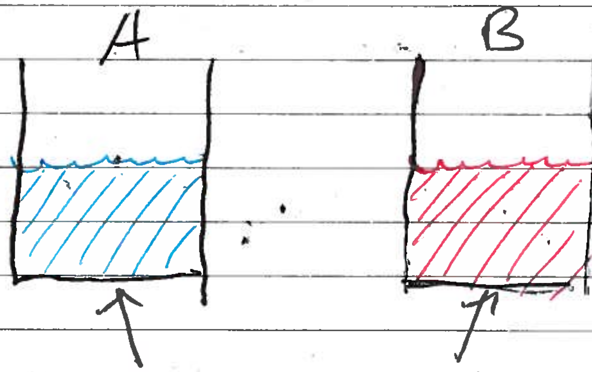


radiation: thermal energy that is transferred by electromagnetic radiation

e.g. the sun



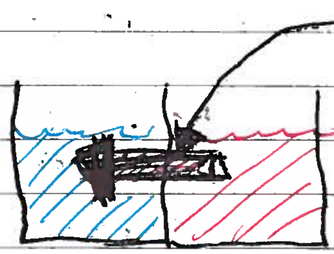
5.)



thermal energy
measure of kinetic and potential energy of a substance
[kind of like mech. energy.]

Glass A and B each have thermal energy.

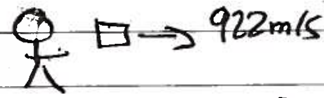
temperature:
a measure of the kinetic energy (only) of the thermal energy



Heat
the transfer of thermal energy from ~~B~~ a warmer to a colder body

Energy Review Solns

6.)



$m = 15.2\,g = 0.0152\,kg$

$v_1 = 0\,m/s$

G: $v_2 = 922\,m/s$

$\Delta d = 61\,cm = 0.61\,m$

a.) $a = ?$

$v_2^2 = v_1^2 + 2a\Delta d$

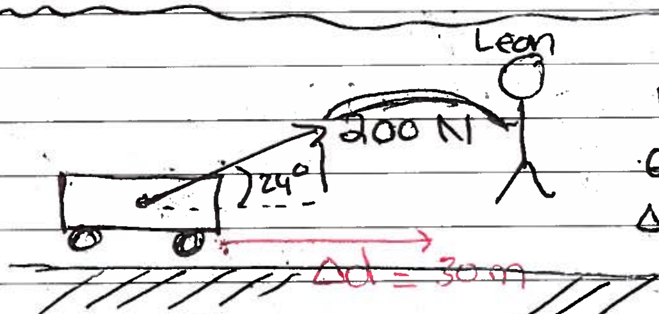
$2a\Delta d = v_2^2 - v_1^2$

$a = \dfrac{v_2^2 - \cancel{v_1^2}^{\,\to 0}}{2\Delta d} = \dfrac{(922)^2}{2(0.61)} = 6.97 \times 10^5\ m/s^2$

b.) $F_{net} = m \cdot a = (0.0152)(6.97\times10^5\,m/s^2) = 1.06\times10^4\ N$

c.) $W = F_{net} \cdot \Delta d = (1.06\times10^4)(0.61) = 6461\ J$

7.)



$F = 200\,N$

$\theta = 24°$

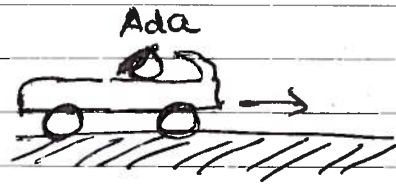
$\Delta d = 30\,m$

$W = F\cos\theta \cdot \Delta d$

$= (200)\cos 24\,(30)$

$= 5481\ J$

8.)



$m = 2100\ kg$
$v_1 = 0$
$a = 2.6\ m/s^2$
$\Delta t = 4s$

a.) $\Delta d = ?$

$$\Delta d = \cancel{v_1 \Delta t}^{0} + \frac{1}{2} a \Delta t^2 = \frac{1}{2}(2.6)(4)^2 = 20.8\ m$$

b.) $F_{net} = ?$

$$F_{net} = m \cdot a = (2100)(2.6) = 5460\ N$$

c.) $W = ?$

$$W = F \cdot \Delta d = (5460)(20.8) = 1.14 \times 10^5\ J$$

d.) $P = ?$

$$P = \frac{W}{\Delta t} = \frac{1.14 \times 10^5}{4} = 2.84 \times 10^4\ W$$

e.) $v_2^{\,2} = \cancel{v_1^{\,2}}^{0} + 2ad$ $\qquad v_2 = 10.4\ m/s$

$v_2^{\,2} = 2(2.6)(20.8)$

OR $W = \Delta E_k = \boxed{\frac{1}{2} m v_2^{\,2} - \frac{1}{2} m v_1^{\,2} = W}$

Solve this for v_2 [alternate]

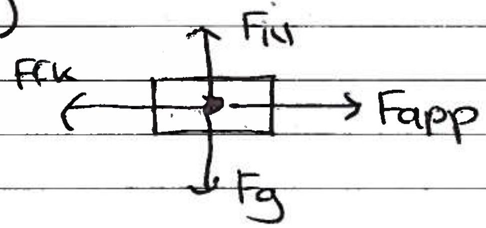
f.) you could do $\frac{1}{2} m v_2^{\,2} - \frac{1}{2} m v_1^{\,2} = \Delta E_k$

but $W = \Delta E_k$ so the answer will be

$1.14 \times 10^5\ J$

Energy Solutions

9.)



$m = 11\,kg$ $\quad F_{fk} = 86\,N$

$\Delta d = 22\,m$

a.) for constant velocity $\vec{a} = 0$

$\Rightarrow F_{net} = 0$ [from newton's 2nd Law]

$\Rightarrow F_{fk} = F_{app}$ so $F_{app} = 86\,N$

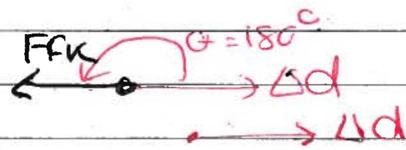
b.) $W = F_{app} \cdot \Delta d$

$= (86)(22) = 1892\,J$

c.) $W = F_{fk} \cos\theta \, \Delta d$ [F_{fk} and Δd are in opposite directions]

$W = 86 \cos 180 (22)$

$= -1892\,J$

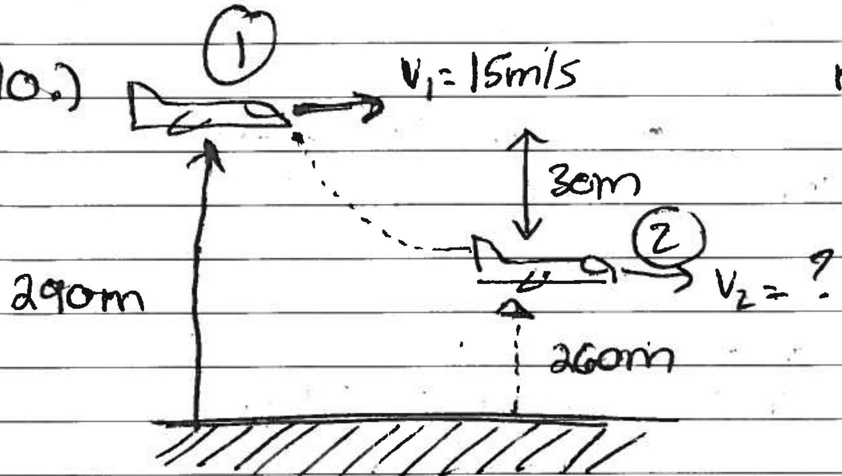


d.) $E_{in} = 2180\,J$ $\qquad$ $E_{out} = 1892\,J$

he put in this much energy $\qquad$ he got this much work done

$$Eff = \frac{E_{out}}{E_{in}} \times 100\% = \frac{1892}{2180} \times 100\% = 86.8\%$$

10.)



$m = 1200 kg$

$h_1 = 290 m$
$h_2 = 260 m$

a.) $E_{tot}^{(1)} = \frac{1}{2} m v_1^2 + mgh_1$

$= \frac{1}{2}(1200)(15)^2 + (1200)(9.8)(290)$

$= 3.54 \times 10^6 \text{ J}$

b.) $E_{tot}^{(2)} = E_{tot}^{(1)}$

$mgh_2 + E_k^{(2)} = E_{tot}^{(1)}$

$E_k^{(2)} = E_{tot}^{(1)} - mgh_2 = 3.54 \times 10^6 - (1200)(9.8)(260)$
$= 4.88 \times 10^5 \text{ J}$

c.) $E_k^{(2)} = \frac{1}{2} m v_2^2$

$v_2^2 = \frac{2 E_k^{(2)}}{m} = \frac{2(4.88 \times 10^5)}{1200} = 813$

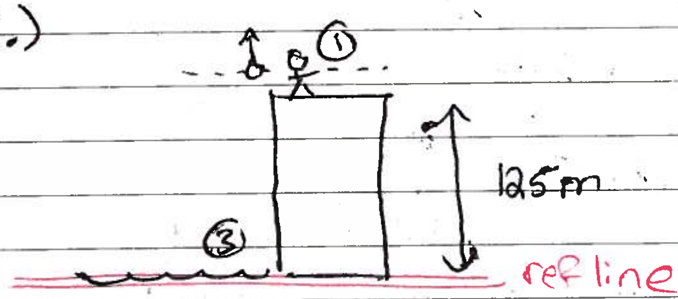
$v_2 = \sqrt{813} = 28.5 \text{ m/s}$

Energy review

0 ②

① wesker
② max height of rock
③ just before water

1.)



$v_1 = 20 m/s$ $\quad$ $V_2 = 0$ m/s [~~taking~~ highest pt] $\quad$ $V_3 = ?$

$h_1 = 126 m$ $\quad$ $h_2 = ?$ $\quad$ $h_3 = 0$

a.) $E_{tot}^{①} = E_{tot}^{②}$

$$\cancel{m}gh_1 + \tfrac{1}{2}\cancel{m}v_1^2 = \cancel{m}gh_2 + \cancel{\tfrac{1}{2}mV_2^2}$$

$$(9.8)(125) + 0.5(20)^2 = (9.8)(h_2)$$

$h_2 = 146$ m

b.) you could re-calculate everything

$h_2 = 145m$ $\quad$ $h_1 = 125 m$

$V_2 = 0 m/s$ $\quad$ $V_2 = ?$

but think for a second. V_2 should be 20 m/s!
[down though]

c.) $V_3 = ?$ $\quad$ $V_2 = 0 m/s$

$h_3 = 0 m$ $\quad$ $h_2 = 145m$

$E_{tot}^{②} = E_{tot}^{③}$

$$\cancel{\tfrac{1}{2}mV_2^2} + \cancel{m}gh_2 = \tfrac{1}{2}\cancel{m}V_3^2 + \cancel{mgh_3}$$

$$(9.8)(145) = \tfrac{1}{2}(V_3)^2$$

$V_3^2 = 2850$ $\quad$ $V_3 = 53.4 m/s$

$h_1 = 4m$ $h_2 = 3m$ $h_3 = 0m$ $V_4 = 6m/s$
$v_1 = 3m/s$ $v_2 = ?$ $v_3 = ?$ $h_4 = ?$ $m = 50k$

$$\boxed{E_m = E_k + E_g}$$

① $E_g = mgh = (50)(9.8)(4) = 1960\,J$

$E_k = \frac{1}{2}mV^2 = \frac{1}{2}(50)(3)^2 = 225\,J$

$E_m = 225 + 1960\,J = 2185\,J$

*** this is the same for 1,2,3,4

$V = 3m/s$ [given]

2.) $E_m = 2185\,J$

$E_g = (50)(9.8)(3) = 1470\,J$

$E_k = E_m - E_g = 2185 - 1470\,J = 715\,J$

$\frac{1}{2}mv^2 = 715\,J$

$V = \sqrt{\frac{2(715)}{50}} = \sqrt{28.6} = 5.35\,m/s$

3.) $E_m = 2185\,J$

$E_g = 0$ [$h=0$]

$E_k = E_m - E_g = 2185\,J$

$\frac{1}{2}mv^2 = 2185$

$v = \sqrt{\frac{2185(2)}{50}} = \sqrt{87.4} = 9.35\,m/s$

4.) $E_m = 2185\,J$ $V = 6\,m/s$

$E_k = \frac{1}{2}(50)(6)^2 = 900\,J$

$E_g = E_m - E_k = 1285\,J$

$E_g = 1285 = mgh \Rightarrow h = \frac{1285}{(50)(9.8)} = 2.62\,m$