Assignment 5 Solutions

1. 1 Joule = Newton meter

$= kg \frac{meter}{sec^2} \times meter$ (Recall $F = ma$)

$\therefore$ 1 Joule $= kg\ (m/sec)^2$

2a) i) Work $= F\ d$

$= mg \times d$

$= 250 kg \times 10\ m/sec^2 \times 2\ m.$

$= 5000\ J$

ii) Work = Work raising one meter up + Work sideways 3.5 m left (= 0) + Work one meter up

+ Work sideways 3.5 m right (= 0)

= same as work in i

$= 5000\ J$

b) Falling mass has gravitational potential energy converted into kinetic energy.

$mgh = \frac{m}{2} v^2$

$v = \sqrt{2gh}$

$= \sqrt{2 \times 10 \times 2}$

$= 6.3\ m/sec$

3a) Original K.E. $= \frac{m}{2} v^2$

$= \frac{20\,kg}{2} (50\,m/sec)^2$

$= 25{,}000\,J$

b) Speed after 2 sec $v = u - gt$

$= 50 - 10 \times 2$

$= 30\,m/sec$

K.E. after 2 sec $= \frac{m}{2} v^2$

$= \frac{20}{2} (30)^2$

$= 9000\,J$

c) Height of mass at 20kg $y = ut - \frac{g}{2} t^2$

$= 50 \times 2 - \frac{10}{2} 2^2$

$= 80\,m.$

Increase in P.E. during 2 sec $= mgy$

$= 20\,kg \times 10 \frac{m}{sec^2} \times 80\,m$

$= 16{,}000\,J$

= Decrease in K.E. in 2 sec.

4a) Initial P.E. $= mgh$

$= 5\,kg \times 10\,\frac{m}{sec^2} \times 100\,m$

$= 5000\,J$

Initial K.E. $= \frac{m}{2} v^2 = 0$

b) Final P.E. $= 0$ (Recall P.E. + K.E. = constant for falling object)

Final K.E. $= 5000\,J$

c) $\frac{m}{2} v^2 = 5000\,J$

$v = \sqrt{\frac{2 \times 5000}{5}}$

$= 44.7\ m/sec$

5. Energy falling H_2O in 1 day $= m\,g\,h$

$= 10^4\,\frac{m^3}{sec} \times \underbrace{10^3\,\frac{kg}{m^3}}_{\text{density}} \times \underbrace{24 \times 3600\,sec}_{\text{sec in 1 day}}$

$\times 10\,\frac{m}{sec^2} \times 20\,m.$

$= 1.73 \times 10^{14}\,J$