Assignment 3 Solutions

1. Acceleration of Earth around Sun

$$a = \frac{v^2}{R}$$

$$= \left(\frac{2\pi R}{T}\right)^2 \frac{1}{R}$$

$$= \frac{4\pi^2 R}{T^2}$$

$$= \frac{4\pi^2 \; 1.5\times10^{11}\ m}{\left(365.25\ days \times 24\ \frac{hr}{day} \times 3600\ \frac{sec}{hr}\right)^2}$$

$$= 5.9\times10^{-3}\ m/sec^2$$

2a) Acceleration at Earth's Equator

$$a = \frac{v^2}{R}$$

$$= \left(\frac{2\pi R}{T}\right)^2 \frac{1}{R}$$

$$= \frac{4\pi^2 \; 6.4\times10^{6}\ m}{\left(24\ hr \times 3600\ \frac{sec}{hr}\right)^2}$$

$$= 3.4\times10^{-2}\ m/sec^2$$

b) $$\frac{a}{g} = \frac{3.4\times10^{-2}}{9.8} = 3.45\times10^{-3}$$

c) For $a = g \Rightarrow$ $v^2 = Rg$

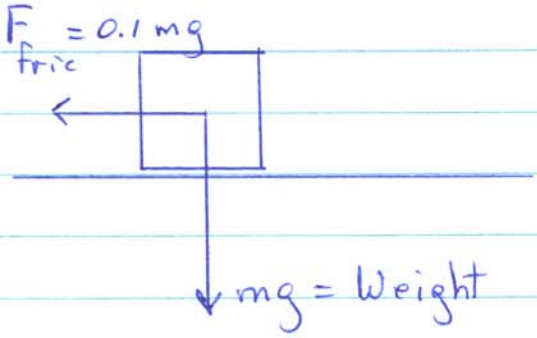
$$v = \left(6.4\times10^{6}\ m \times 9.8\ m/sec^2\right)^{1/2}$$

$$= 7920\ m/sec$$

i.e. Earth Period would be $v = 2\pi R/T$

or $$T = \frac{2\pi\times6.4\times10^{6}}{7920} = 5078\ sec = 1.4\ hr.$$

3



Newton's 2nd Law $\quad ma = -0.1\,mg.$

$$a = -0.1\,g. \qquad (1)$$

Acceleration $\quad a = \dfrac{0 - x}{4} = \dfrac{-x}{4} \qquad (2)$

$$(1) \& (2) \Rightarrow \quad \frac{-x}{4} = -0.1\,g$$

$$x = 0.4 \times 10$$

$$\therefore x = 4 \text{ meters}$$

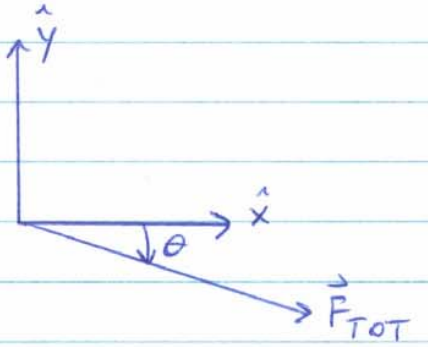
4. Centripetal force $F_c = \dfrac{mv^2}{R}$

$$= \frac{1.5 \times 10^3 \text{ kg} \times \left(100 \frac{\text{km}}{\text{hr}} \times 10^3 \frac{\text{m}}{\text{km}} \times \frac{1}{3600} \frac{\text{hr}}{\text{sec}}\right)^2}{75 \text{ m.}}$$

$$= 15{,}432 \text{ Nt.}$$

This force is about the same as the weight of the car! Ideally friction of the tires on the road keeps car from going off the turn. But in this case, the turn is likely too sharp for that to occur.

5 a)



$\vec{F}_1 = (5, 0)$

$\vec{F}_2 = 8(\cos 45^\circ, -\sin 45^\circ)$

$= (5.66, -5.66)$

$\vec{F}_{TOT} = \vec{F}_1 + \vec{F}_2$

$= (10.66, -5.66)$

b) $|\vec{F}_{TOT}| = \left[10.66^2 + (-5.66)^2\right]^{1/2} = 12.1$ Nt.

c) $\tan\theta = \dfrac{|F_{TOTY}|}{|F_{TOTX}|} = \dfrac{5.66}{10.66} = 0.53$

$\therefore \theta = 28^\circ$

d) Acceleration $\vec{a} = \dfrac{\vec{F}_{TOT}}{m}$

$= \frac{1}{2}(10.66, -5.66)$

$= (5.33, -2.83)$ m/sec^2