PROBLEM SET 3

CHAPTER 5: # 10, 26, 32, 40
CHAPTER 6: # 4

CHAPTER 5 #10 [4 marks]

$a_c = (6.25 \times 10^{3})g$
$r = 5.00\ \text{cm} = 5.00 \times 10^{-2}\ \text{m}$
$1/T = ?$

$$a_c = \frac{v^2}{r} \Rightarrow v = \sqrt{a_c r}$$

$$v = \frac{2\pi r}{T} \Rightarrow \frac{1}{T} = \frac{v}{2\pi r} = \frac{\sqrt{a_c r}}{2\pi r} = \frac{1}{2\pi} \cdot \sqrt{\frac{a_c}{r}}$$

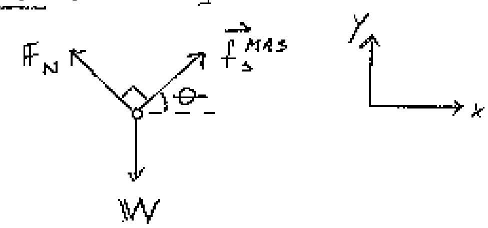
$$\frac{1}{T} = \frac{1}{2\pi}\left(\frac{6.25 \times 10^{3} \times 9.8}{5.00 \times 10^{-2}}\right)^{1/2} = 176\ \text{s}^{-1}$$

$$\frac{1}{T} = \left(\frac{60\ \text{s}}{1\ \text{min}}\right) 176\ \text{s}^{-1} = 1.06 \times 10^{4}\ \text{min}^{-1}$$

The sample is making 10600 revolutions per minute.

CHAPTER 5 # 26 [8 marks]

$r = 11.0\ m$
$\mu_s = 0.760$
$\theta = 36.0^\circ$
$T = ?$



The period is obtained from $v = \frac{2\pi r}{T} \Rightarrow T = \frac{2\pi r}{v}$

The speed is obtained from $a_c = \frac{v^2}{r} \Rightarrow v = \sqrt{a_c r}$

$\therefore\ T = \frac{2\pi r}{\sqrt{a_c r}} = 2\pi \sqrt{\frac{r}{a_c}}$

To obtain the acceleration we need to apply Newton's second law

$$x:\ -F_N \sin\theta + f_s^{MAX} \cos\theta = m a_c$$
$$-F_N \sin\theta + \mu_s F_N \cos\theta = m a_c$$
$$a_c = \frac{F_N}{m}(\mu_s \cos\theta - \sin\theta)$$

$$y:\ f_s^{MAX} \sin\theta + F_N \cos\theta - mg = 0$$
$$\mu_s F_N \sin\theta + F_N \cos\theta - mg$$
$$F_N = \frac{mg}{\mu_s \sin\theta + \cos\theta}$$

$$\therefore\ T = 2\pi \left[\frac{r}{g}\ \frac{\mu_s \sin\theta + \cos\theta}{\mu_s \cos\theta - \sin\theta}\right]^{1/2}$$

$$\boxed{T = 45.3\ s}$$

CHAPTER 5 # 32 [5 marks]

$r_E = 1.50 \times 10^{11}$ m
$r_V = 1.08 \times 10^{11}$ m
$T_E = 1$ yr
$T_V = ?$

mass of planet   mass of sun

$T = \dfrac{2\pi r}{v}$ and $F = m\dfrac{v^2}{r} = G\dfrac{m \cdot M_s}{r^2}$

$\therefore v = \left(\dfrac{G M_s}{r}\right)^{1/2}$

$\therefore T = \dfrac{2\pi r^{3/2}}{(G M_s)^{1/2}}$

Hence $\dfrac{T_V}{T_E} = \left(\dfrac{r_V}{r_E}\right)^{3/2}$

$T_V = \left(\dfrac{r_V}{r_E}\right)^{3/2} T_E$

$= \left(\dfrac{1.08}{1.50}\right)^{3/2} T_E$

$= 0.611\, T_E$

$T_V = 0.611 \times 365$ days/yr $\times 1$ yr

$\boxed{T_V = 223 \text{ days}}$

CHAPTER 5 #40 [4 marks]

$r = 0.950\ m$

horizontal circle : centripetal force provided by tension

$$T = m\frac{v^2}{r}$$

vertical circle : maximum tension when string is at lower point.

$$T_{MAX} - mg = m\frac{v^2}{r}$$

where T_{MAX} is 10.0% larger than T
$T_{MAX} = 1.10\,T$

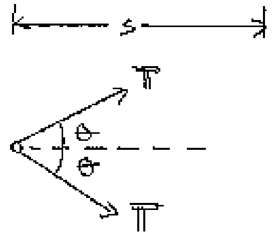
$$\therefore\ m\frac{v^2}{r} + mg = 1.10\, m\frac{v^2}{r}$$

$$0.10\frac{v^2}{r} = g$$

$$v = \left(\frac{r g}{0.10}\right)^{1/2} = \left(\frac{0.950 \times 9.80}{0.10}\right)^{1/2}$$

$$\boxed{v = 9.65\ m/s}$$

CHAPTER 6 #4 [3 marks]



$s = 2.00\ km = 2.00 \times 10^3\ m$

$T = 5.00 \times 10^3\ N$

$\theta = 20.0°$

work $W = 2(T \cos\theta)s$

$= 2 \times 5.00 \times 10^3 (\cos 20.0°) \times 2.00 \times 10^3$

$\boxed{W = 1.88 \times 10^7\ J}$