Practice Problems for Exam - solutions.

#1 At the top of the loop

$$F_g = F_{centripetal}$$

$$\cancel{m}g = \frac{\cancel{m}v^2}{r}$$

$$v = \sqrt{gr}$$

$$= \sqrt{9.8(5.0)}$$

$$= 7.0 m/s$$

By Conservation of Energy

$$E_{earth} = E_{top\ of\ loop}$$

$$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2 + \cancel{m}g(2r)$$

$$9.8h = \frac{1}{2}(7.0)^2 + 9.8(2(5))$$

$$h = 12.5 m$$

2) $F_{net} = \frac{mv^2}{r}$

$$\frac{GM\cancel{m}}{r^{\cancel{2}}} = \frac{\cancel{m}v^2}{\cancel{r}}$$

$$v = \sqrt{\frac{GM}{r}}$$

$$\sqrt{\frac{GM}{r}} = \frac{2\pi r}{T} \quad \left(\text{since } v = \frac{d}{t}\right)$$

$$T = \frac{2\pi r}{\sqrt{\frac{GM}{r}}}$$

$$= \frac{2\pi(2.0\times10^{11})}{\sqrt{\frac{6.67\times10^{-11}(1.99\times10^{30})}{2.0\times10^{11}}}}$$

$$T = 4.9\times10^{7} s$$

$\boxed{OR}$

$$C_{sun} = \frac{r^3}{T^2}$$

$$= \frac{(1.49\times10^{11})^3}{(3.16\times10^{7})^2}$$

$$= 3.313\times10^{18} m^3/s^2$$

for unknown planet

$$C_{sun} = \frac{r^3}{T^2}$$

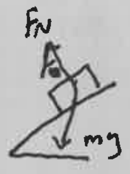
$$3.313\times10^{18} = \frac{(2.0\times10^{11})^3}{T^2}$$

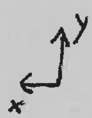
$$T = 4.9\times10^{7} s$$

#3)
$$p = p'$$
$$m_1 v_1 + m_2 v_2 = m_{12}' v_{12}'$$
$$24(3.1) + 24(-4.1) = 48v'$$
$$v' = -1.0\,m/s\,(\rightarrow) = 1.0\,m/s\,(\leftarrow)$$

#4)
$$F_m = F_{centripetal}$$
$$qvB\sin\theta = \frac{mv^2}{r}$$
$$B = \frac{mv}{qr}$$
$$= \frac{1.67\times10^{-27}(2.2\times10^{6})}{1.6\times10^{-19}(0.18)}$$
$$= 0.13\,T$$

#5)





$$\Sigma F_y = 0$$
$$F_N\cos\theta - mg = 0$$
$$F_N = \frac{mg}{\cos\theta} \quad ①$$
$$\Sigma F_x = \frac{mv^2}{r}$$
$$F_N\sin\theta = \frac{mv^2}{r} \quad ②$$

① into ②
$$\frac{\cancel{m}g}{\cos\theta}\sin\theta = \frac{\cancel{m}v^2}{r}$$
$$g\tan\theta = \frac{v^2}{r}$$
$$v = \sqrt{gr\tan\theta}$$
$$= \sqrt{9.8(88)\tan 17}$$
$$= 16.2\,m/s$$

#6)

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$= 2\pi\sqrt{\frac{0.55}{150}}$$

$$= 0.38\,s$$

$$f = \frac{1}{T}$$

$$= \frac{1}{0.38}$$

$$= 2.63\,Hz$$

#7)

$$2t + \underbrace{\tfrac{1}{2}\lambda_{film}}_{\text{phase shift}} = \tfrac{1}{2}\lambda_{film},\ \tfrac{3}{2}\lambda_{film},\ \tfrac{5}{2}\lambda_{film}$$

$$2t = \lambda_{film},\ 2\lambda_{film}$$

$$t = \frac{\lambda_{film}}{2},\ \lambda_{film}$$

$$= \frac{\lambda}{2n},\ \frac{\lambda}{n}$$

$$= \frac{645}{2n},\ \frac{645}{1.33}$$

$$= 242\,nm,\ 485\,nm$$

#8)

$$Work = q\Delta V$$

$$KE_{final} = q\Delta V$$

$$\tfrac{1}{2}mv^2 = q\Delta V$$

$$\Delta V = \frac{mv^2}{2q} \quad ①$$

From de Broglie

$$\lambda = \frac{h}{mv}$$

$$v = \frac{h}{m\lambda} \quad ②$$

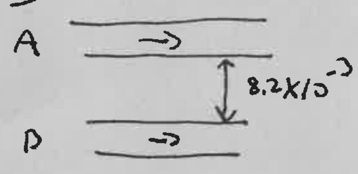
sub ② into ①

$$\Delta V = \frac{m\left(\frac{h}{m\lambda}\right)^2}{2q} = \frac{h^2}{2qm\lambda^2}$$

$$= \frac{(6.63\times10^{-34})^2}{2(1.6\times10^{-19})(9.11\times10^{-31})(1.0\times10^{-11})}$$

$$\Delta V = \underline{\underline{1.5\times10^{4}\,V}}$$

#9)



$F_{A/B\ \text{magnetic}} = F_{B\ \text{gravitational}}$

$$ILB = mg$$

$$IL\left(\frac{\mu_0 I}{2\pi r}\right) = mg$$

$$I^2 = \frac{2\pi r m g}{L \mu_0}$$

$$I^2 = \frac{2\pi(8.2\times10^{-3})(0.073)(9.8)}{0.85(4\pi\times10^{-7})}$$

$$I = 1.9\times10^{2}\,A$$

#10) Let $\lambda_1 = 645\,nm$, λ_2 unknown

3rd order ~~[illegible]~~ dark fringe $\quad \sin\theta_1 = (3-\frac{1}{2})\frac{\lambda_1}{d_1}$ ①

4th order bright fringe $\quad \sin\theta_2 = \frac{4\lambda_2}{d_2}$ ②

① = ② $\quad \frac{(3-\frac{1}{2})\lambda_1}{d_1} = \frac{4\lambda_2}{d_2}$

$d_1 = d_2$

$2.5(645) = 4\lambda_2$

$\lambda_2 = 403\,nm$

11) $KE_{electron} = hf_{photon} - W$

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - W$$

At $\lambda = 196nm$, a minimum amount of energy is used to eject electron $\therefore KE_{electron} = 0$

$$W = \frac{hc}{196 \times 10^{-9}} = 1.01 \times 10^{-18} J$$

At $141nm = \lambda$

$$\frac{1}{2}mv^2 = \frac{hc}{141 \times 10^{-9}} - (1.01 \times 10^{-18})$$

$$v^2 = \frac{2}{9.11 \times 10^{-31}} \left[\frac{6.63 \times 10^{-34}(3.0 \times 10^{8})}{141 \times 10^{-9}} - 1.01 \times 10^{-18} \right]$$

$$v = 9.38 \times 10^5 m/s$$