Quiz #7A

Clearly indicate (with a box) your answers to the following questions. SHOW ALL WORK.

1. A compact disc with a radius of 3.0 cm is spinning at a rate of 240 rev/min when the power to the player is shut down. Over the course of the next 4.0 seconds, the CD comes to a stop.

a) Through how many revolutions does the CD turn during this 4.0 second time interval?

b) What is the magnitude of the tangential acceleration of a point on the rim of the compact disc during this interval?

c) What is the magnitude of the radial acceleration of a point on the rim of the compact disc at the beginning of this interval?

d) What is the magnitude of the radial acceleration of a point on the rim of the compact disc at t = 2.0 seconds?

$\Delta\theta = ?$

$\omega_0 = 240 \frac{rev}{min} = 25.1\ rad/sec$

$\omega = 0$

$\alpha = ?$

$t = 4.0\ s$

a) $\Delta\theta = \frac{1}{2}(\omega + \omega_0)t$

$= \frac{1}{2}(0 + 25.1)(4)$

$= 50.2\ rad$

$= \boxed{8.0\ rev}$

b) $\omega = \omega_0 + \alpha t$

$0 = 25.1 + \alpha(4.0)$

$\alpha = -6.275\ rad/s^2$

$|a_{tan}| = r|\alpha| = \boxed{0.19\ m/s^2}$

c) $a_{rad} = r\omega^2$

$= (.03)(25.1)^2 = \boxed{19\ m/s^2}$

d) $\omega = 25.1 - (6.275)(2.0) = 12.55$

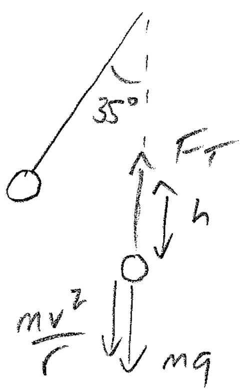
$a_{rad} = (.03)(12.55)^2 = \boxed{4.7\ m/s^2}$

2. A pendulum bob of mass 2.5 kg is attached to a 1.2 meter string and held at an angle of 35° with respect to the vertical. The bob is then released from rest.

a) What is the speed of the bob when it passes through its lowest point?

b) What is the tension in the string when the bob passes through its lowest point?

c) What is the tension in the string when the bob reaches its highest point again and comes to rest?



$h = L - L\cos 35°$

$= 1.2(1 - \cos 35°) = 0.217 \text{ m}$

a) $\Sigma W_F = W_T + W_c + W_{grav} = \Delta K$

$0 + 0 + mgh = \frac{1}{2}mv^2 - 0$

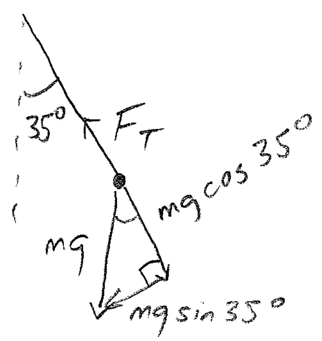
$v = \sqrt{2gh} = \boxed{2.1 \text{ m/s}}$

b) $\Sigma F_{rad} = -F_T + mg + \frac{mv^2}{r} = 0$

$F = mg + \frac{mv^2}{r} = 24.5 + 9.19$

$= \boxed{34 \text{ N}}$

c)



$\Sigma F_{rad} = mg\cos 35° - F_T = 0$

$\boxed{F_T = 20 \text{ N}}$

3. With what initial speed must a satellite be launched in order to reach a stable circular orbit at an altitude of 1200 km above the Earth's surface?

Also, what will be the period of this satellite, in hours?

$$r = 6.38 \times 10^6 + 1.2 \times 10^6$$

$$= 7.58 \times 10^6 \text{ m}$$

$$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{(6.67 \times 10^{-11})(5.98 \times 10^{24})}{7.58 \times 10^6}} = 7254 \text{ m/s}$$

$$K_i = \frac{1}{2} m v_0^2$$

$$K_f = \frac{1}{2} m v^2 = \frac{1}{2} m (7254)^2 = 2.63 \times 10^7 \, m$$

$$U_i = -\frac{GMm}{R_E} = -\frac{(6.67 \times 10^{-11})(5.98 \times 10^{24}) m}{6.38 \times 10^6}$$

$$= -6.25 \times 10^7 \, m$$

$$U_f = -\frac{GMm}{R_E + h} = -\frac{(6.67 \times 10^{-11})(5.98 \times 10^{24}) m}{7.58 \times 10^6}$$

$$= -5.26 \times 10^7 \, m$$

$$W_{grav} = \Delta K$$

$$-(U_f - U_i) = \frac{1}{2} m v^2 - \frac{1}{2} m v_0^2$$

$$5.26 \times 10^7 \, m - 6.25 \times 10^7 \, m = -\frac{1}{2} m v_0^2 + 2.63 \times 10^7 \, m$$

$$-9.9 \times 10^6 - 2.63 \times 10^7 = -\frac{1}{2} v_0^2$$

$$\boxed{v_0 = 8500 \text{ m/s}}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi (7.58 \times 10^6)}{7254} = 6566 \text{ sec}$$

$$= \boxed{1.8 \text{ hrs}}$$