Physics 10154 - Exam #3d

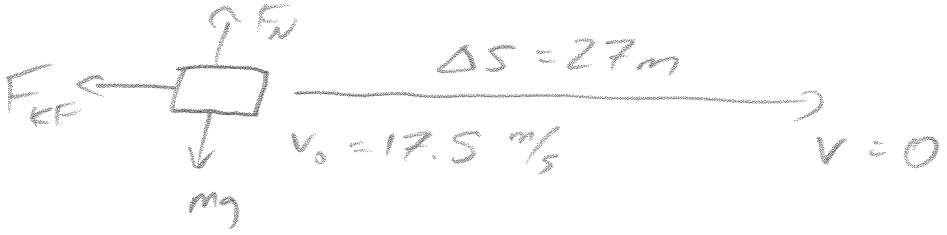
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (35 pts) Mass A is initially moving with a speed of 35 m/s prior to an elastic collision with mass B, initially at rest, which is three times more massive than mass A. After the collision, mass B slides 27 meters before coming to rest. What is the coefficient of kinetic friction between the block and the surface?

$$v_{2f} = \frac{2m_1}{m_1+m_2} v_{1i} + \dots (0)$$

$$= \frac{2m}{m+3m}(35)$$

$$= \frac{2}{4}(35) = 17.5$$



$$\Sigma W_F = W_{KF} + W_N + W_{grav} = \frac{1}{2}mv^2 - \frac{1}{2}mv_0^2$$

$$\mu_K F_N \Delta s \cos 180^\circ + 0 + 0 = 0 - \frac{1}{2}mv_0^2$$

$$-\mu_K mg\Delta s = -\frac{1}{2}mv_0^2$$

$$\mu_K = \frac{v_0^2}{2g\Delta s} = 0.58$$

2. (30 pts) A 750 kg satellite orbits the Earth with a period of 2.7 hours.

a) What is the altitude of the satellite above the Earth's surface?

b) What is the magnitude of the centrifugal force acting on the satellite due to its circular motion?

a) $T = 2.7\ hrs = 9720\ s$

$$r^3 = \frac{GMT^2}{4\pi^2} = \frac{(6.67\times10^{-11})(5.98\times10^{24})(9720)^2}{4\pi^2}$$

$$r^3 = 9.55\times10^{20}$$

$$r = 9.85\times10^{6}\ m$$

$$h = r - R_E = 9.85\times10^6 - 6.38\times10^6$$

$$\boxed{h = 3.5\times10^6\ m}$$

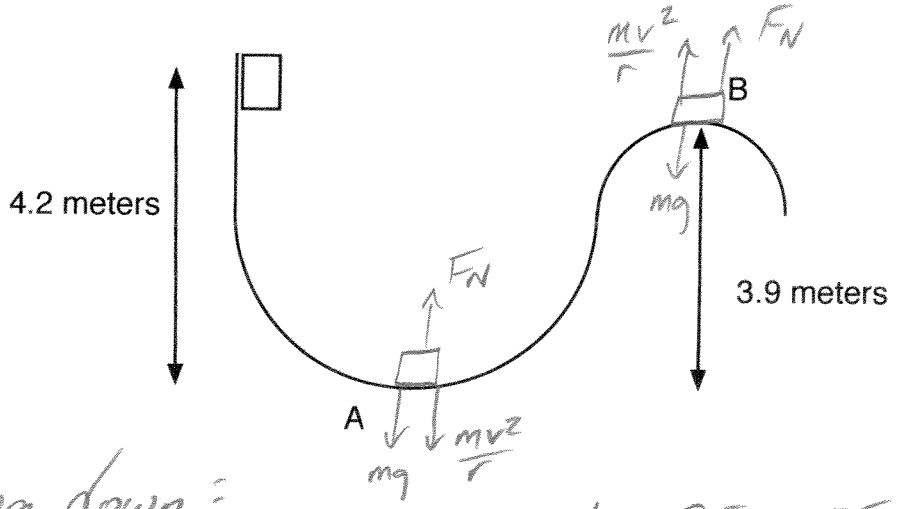
b) $$\omega = \frac{1\ rev}{2.7\ hrs}\cdot\frac{2\pi\ rad}{rev}\cdot\frac{1\ hr}{3600\ s} = .000646\ rad/s$$

$$F_{cent} = mr\omega^2$$

$$= (750)(9.85\times10^6)(.00646)^2$$

$$= \boxed{3100\ N}$$

3. (35 pts) A 2.0 kg block slides along a frictionless track as shown below, starting from rest. When the block is sliding through point A, at the bottom of the bigger curve,, the radius of curvature of the track is 2.6 meters. When the block is sliding through point B, at the top of the smaller curve, the radius of curvature of the track is 1.3 meters. Find the normal force acting on the block at point A and point B.



Sliding down:

$W_{grav} = \Delta K$

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

$v = \sqrt{2g(4.2)} = 9.07\ m/s$

At A: $\Sigma F_{rad} = F_N + \frac{mv^2}{r} + mg = 0$

$F_N = mg + \frac{mv^2}{r}$

$= 19.6 + 63.2$

$= \boxed{83\ N}$

At B: $W_{grav} = \Delta K$

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

$v = \sqrt{2(g)(0.3)} = 2.42\ m/s$

B: $\Sigma F_{rad} = F_N + \frac{mv^2}{r} - mg = 0$

$F_N = mg - \frac{mv^2}{r}$

$= 19.6 - 9.01$

$= 10.6\ N$ or $\boxed{11\ N}$