Physics 10154 - Exam #2a

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. (40 pts) Two cars of equal mass collide at an intersection. Car A was originally moving due East with an unknown speed. Car B moves North prior to the collision at 45 miles/hour. The combined wreck slides away from the intersection at an angle of 35° North of East. What was the speed of car A prior to the collision?

x: $M v_{Ai,x} + M v_{Bi,x} = 2M v_{f,x}$

$M v_{Ai} + M(0) = 2M v_f \cos 35^\circ$

$v_{Ai} = 2 v_f \cos 35^\circ$

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y: $M v_{Ai,y} + M v_{Bi,y} = 2M v_{f,y}$

$M(0) + M(45) = 2M v_f \sin 35^\circ$

$45 = 2 v_f \sin 35^\circ$

So $v_f = 39.2$ mi/hr or 17.5 m/s

$v_{Ai} = 2(39.2)\cos 35^\circ$

$= 64$ mi/hr or 29 m/s

2. (30 pts) A 12 kg box on the rim of a circular platform with radius 4.5 meters. The box is initially at rest but then accelerates with the platform with a tangential acceleration of 0.85 m/s2. After 3.0 seconds have elapsed, find

a) How many revolutions the box has made.
b) The force of static friction acting on the box.

$\Delta s = ?$

$v_0 = 0$

$v = ?$

$a = 0.85\ m/s^2$

$t = 3.0\ s$

$v = v_0 + at$

$= 2.55\ m/s$

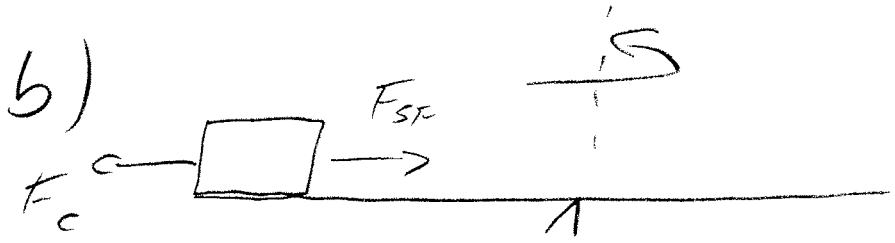
$\Delta s = v_0 t + \frac{1}{2} a t^2$

$= 3.825\ m$

a) $\Delta\theta = \frac{\Delta s}{r} = \frac{3.825}{4.5} = 0.85\ rad$

$= \boxed{0.14\ rev}$

b)



$\Sigma F_{rad} = F_c - F_{SF} = 0$

$F_{SF} = \frac{mv^2}{r} = \frac{(12)(2.55)^2}{4.5}$

$= \boxed{17\ N}$

3. (30 pts) A satellite is in orbit with a speed of 13,000 miles/hour.

a) What is the orbital period of the satellite?
b) What is the altitude of the satellite about Earth's surface?

$v = 13{,}000\ mi/hr = 5810\ m/s$

$v^2 = \frac{GM}{r} \qquad r = \frac{GM}{v^2}$

$= \frac{(6.676\times10^{-11})(5.98\times10^{24})}{5810^2}$

$= 1.18\times10^7\ m$

a) $T = \frac{2\pi r}{v} = \frac{2\pi(1.18\times10^7)}{5810} = 12800\ s$

or $\boxed{3.6\ hr}$

b) $h = r - R_E$

$= 1.18\times10^7 - 6.38\times10^6$

$= \boxed{5.42\times10^6\ m}$

or 3400 miles