Physics 10154 - Exam #7B

Each problem is worth 50 points. 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. A car on a circular track of radius 230 meters starts from rest and accelerates uniformly over 7.0 seconds to a final speed of 120 miles/hour.

a) How many laps (revolutions) does the car complete during the 7.0 second time interval?

b) 4.0 seconds after the car begins its motion, what is the magnitude of the tangential, radial and total accelerations?

$\Delta x =$

$v_0 = 0$

$v = 120\ ^{mi}/_{hr} = 53.6\ ^{m}/_{s}$

$a = ?$

$t = 7.0\ s$

$\Delta x = \frac{1}{2}(v + v_0)t$

$= \frac{1}{2}(53.6 + 0)(7)$

$= 188\ m$

$\Delta\theta = \frac{\Delta x}{r} = \frac{188}{230} = \boxed{0.82\ rad} = \boxed{0.13\ rev}$

b) At $t = 4$ sec, $v = \frac{4}{7}(53.6) = 30.6\ ^{m}/_{s}$

$a = \frac{v - v_0}{t} = \frac{53.6 - 0}{7} = 7.66\ ^{m}/_{s^2}$

$\boxed{a_{tan} = 7.7\ ^{m}/_{s^2}}$

$a_{rad} = \frac{v^2}{r} = \frac{30.6^2}{230} = \boxed{4.1\ ^{m}/_{s^2}}$

$a_{tot} = \sqrt{7.7^2 + 4.1^2} = \boxed{8.7\ ^{m}/_{s^2}}$

2. With what speed must you launch a rocket so that it will have an orbital period around Earth of 8.0 hours once it successfully achieves orbit? The constants you will need for this problem should all be on your formula sheet.

$$T = 8.0 \text{ hrs} = 28800 \text{ sec}$$

$$r^3 = \frac{GM}{4\pi^2} T^2 = \frac{(6.67\times10^{-11})(5.98\times10^{24})(28800)^2}{4\pi^2}$$

$$= 8.38\times10^{21}$$

$$r = 2.03\times10^{7}$$

$$V = \sqrt{\frac{GM}{r}} = \sqrt{\frac{(6.67\times10^{-11})(5.98\times10^{24})}{2.03\times10^{7}}} = 4430 \text{ m/s}$$

$$U_i - U_f = K_f - K_i$$

$$-\frac{(6.67\times10^{-11})(5.98\times10^{24})\cancel{m}}{6.38\times10^{6}} - \left(-\frac{(6.67\times10^{-11})(5.98\times10^{24})\cancel{m}}{2.03\times10^{7}}\right)$$

$$= \frac{1}{2}\cancel{m}(4430)^2 - \frac{1}{2}\cancel{m}v_0^2$$

$$-6.25\times10^{7} + 1.96\times10^{7} = 9.81\times10^{6} - \frac{1}{2}v_0^2$$

$$-5.27\times10^{7} = -\frac{1}{2}v_0^2$$

$$v_0 = \boxed{1.0\times10^{4} \text{ m/s}}$$