Name: Solutions

Homework Week # 5

Uniform Circular Motion
Due Tue 9/24/19

Reading

C&J Physics: **Ch. 5: 1-3**

OS Coll Phys: **Ch. 6: 1-3**

Problems

Problem 1. **5.2.1**

Problem 2. **5.3.2**

Problem 3. **5.2.4**

Problem 4. **5.2.5**

Problem 5. **5.2.11**

Problem 6. **5.3.16**

*** Practice 1D & 2D Kinematics, and Forces. Remember that sig figs, units, scalar, and vector properties are used for everything for the rest of the semester.**

Prob. 1 5.1

UCM for $r = 2.6\,km$. 1 revolution in 360 s. Find a_c

$$v = \frac{2\pi r}{T} \qquad a_c = \frac{v^2}{r}$$

$$a_c = \frac{4\pi^2 r^2}{r T^2} = \frac{4\pi^2 r}{T^2}$$

$$a_c = \frac{4\pi^2 (2.6\,km)}{(360\,s)^2} = \boxed{7.9 \times 10^{-4} \frac{km}{s^2}}$$

$$\boxed{a_c = 0.79 \frac{m}{s^2}}$$

Prob. 2 5.2

Find a_c for 3 diff. sets of r and v

$$a_c = \frac{v^2}{r}$$

(i) $r = 0.50\,m$, $v = 12\,\frac{m}{s}$

$$a_c = \frac{12^2}{0.50}\,\frac{m}{s^2} = 288\,\frac{m}{s^2}$$

(ii) $r = \infty\,m$, $v = 35\,\frac{m}{s}$

$$a_c = \frac{35^2}{\infty}\,\frac{m}{s^2} = 0\,\frac{m}{s^2}$$

(iii) $r = 1.8\,m$, $v = 2.3\,\frac{m}{s}$

$$a_c = \frac{(2.3)^2}{1.8}\,\frac{m}{s^2} = 2.94\,\frac{m}{s^2}$$

Prob. 3 5.4

If a_c same for two diff. boats w/ diff. r's, find ratio of v's

$$a_c = \frac{v^2}{r}$$

$r_A = 120\,m$

$r_B = 240\,m$

Find $\frac{v_A}{v_B}$

$$a_c = \frac{v_A^2}{r_A} = \frac{v_B^2}{r_B}$$

$$\frac{v_A^2}{v_B^2} = \frac{r_A}{r_B}$$

$$\frac{v_A}{v_B} = \sqrt{\frac{r_A}{r_B}} = \sqrt{\frac{120\,m}{240\,m}} = \sqrt{\frac{1}{2}}$$

$$\boxed{\frac{v_A}{v_B} = \frac{\sqrt{2}}{2} = 0.707}$$

Prob 4 5.5

If UCM, how much time does it take to complete a full circle of radius = 2850m with a speed of 110 m/s.

If $v = 110 \frac{m}{s}$, $r = 2850m$, find T

$$v = \frac{2\pi r}{T}$$

$$vT = 2\pi r$$

$$T = \frac{2\pi r}{v}$$

$$T = \frac{2\pi (2850m)}{(110 \frac{m}{s})} = \boxed{163\ s}$$

Prob. 5 5.11

If $a_c = (6.25 \times 10^3)g$, what is ω in rev/min for $r = 5.00\,cm$

$$a_c = \frac{v^2}{r} = r\omega^2$$

$$\omega^2 = \frac{a_c}{r} \qquad r = 0.0500\,m = 5.00 \times 10^{-2}\,m$$

$$\omega = \sqrt{\frac{a_c}{r}}$$

$$\omega = \sqrt{\frac{(6.25 \times 10^3)(10.0\,m/s^2)}{(5.00 \times 10^{-2}\,m)}}$$

$$\omega = 1.12 \times 10^3 \ \frac{rad}{s}$$

$2\pi\,rad = 1\ rev$; $60\,s = 1\,min$

$$\omega = \frac{1.12 \times 10^3\ \cancel{rad}}{1\ \cancel{s}} \cdot \frac{1\ rev}{2\pi\ \cancel{rad}} \cdot \frac{60\ \cancel{s}}{1\ min}$$

$$\omega = \frac{30(1.12)}{\pi} \times 10^3 \ \frac{rev}{min} = \boxed{10.7 \ \frac{rev}{min}}$$

Prob. 6 5.16

Find mass of skater experiencing a 460 N centripetal force when turning a 31 m radius sector at a constant speed of 14 $\frac{m}{s}$.

$$\vec{F}_c = m\vec{a}_c \qquad a_c = \frac{v^2}{r}$$

$$F_c = ma_c = \frac{m v^2}{r}$$

$$m = \frac{r F_c}{v^2} = \frac{(31\,m)(460\,N)}{\left(14 \frac{m}{s}\right)^2}$$

$$m = 73 \ \frac{m \cdot N \cdot s^2}{m^2}$$

$$\boxed{m = 73\ kg}$$

$$\frac{N \cdot s^2}{m} = \frac{kg \cdot \cancel{m}}{\cancel{s^2}} \cdot \frac{\cancel{s^2}}{\cancel{m}} = kg$$