Name Key Date Period

$a = \frac{v^2}{r}$ $F = ma$

Circular Motion Problems

1. "Daredevil Nick," the stunt motorcycle rider, is attempting to perform the 'Wall of Death' act. He needs to ensure a centripetal acceleration of 20 m/s², so as to not fall down. The wall of death is 15 m in diameter. How fast must Nick ride to complete the act successfully?

$a = 20\ m/s^2$
$r = 15/2 = 7.5m$
$v = ?$

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

$7.5 \times 20 = \frac{v^2}{7.5} \times 7.5$

$\sqrt{150} = \sqrt{v^2}$

$12.25\ m/s = v$

2. A 15 kg mass is swung in a circular path of radius 2.3 m by a centripetal force of 2000 N. What is the velocity of the whirling mass?

$m = 15kg$
$r = 2.3m$
$F = 2000\ N$
$v = ?$

$F = m\left(\frac{v^2}{r}\right)$

$\frac{2000}{15} = \frac{15\left(\frac{v^2}{2.3}\right)}{15}$

$2.3 \times 133.3 = \frac{v^2}{2.3} \times 2.3$

$\sqrt{306.67} = \sqrt{v^2}$

$17.51\ m/s = v$

3. A ball is tied to a 1.3 m string and whirled in a circular motion with a force of 220 N. If its speed is 6 m/s, (a) what is it centripetal acceleration?

$r = 1.3m$
$F = 220\ N$ (don't need this yet)
$v = 6\ m/s$

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

$a = \frac{6^2}{1.3}$

$a = \frac{36}{1.3}$

$a = 27.69\ m/s^2$

(b) What is the mass of the ball?

$F = ma$

$\frac{220}{27.69} = \frac{m(27.69)}{27.69}$

$7.95\ kg = m$

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4. A 0.40 kg mass is attached to a string 1.2 m long and swings in a horizontal circle. The mass goes around its path once each 0.31 second. (a) How fast is it moving?

$v = \frac{d}{t}$

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

$m = 0.40\ kg$

$r = 1.2\ m$

$t = 0.31\ s$

$v = ?$

$v = 2\pi r$

$v = 2\pi(1.2)$

$\boxed{v = 7.54\ m/s}$

(b) What is its centripetal acceleration?

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

$a = \frac{(7.54)^2}{1.2}$

$a = \frac{56.85}{1.2}$

$\boxed{a = 47.38\ m/s^2}$

5. The Earth (mass 5.98×10^{24} kg) orbits the sun at a distance of 1.50×10^{11} m and a speed of 29,865 m/s. (a) What is its centripetal acceleration?

$m = 5.98 \times 10^{24}\ kg$

$r = 1.5 \times 10^{11}\ m$

$v = 29,865\ m/s$

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

$a = \frac{(29,865)^2}{1.5 \times 10^{11}} = \boxed{0.0059\ m/s^2 \text{ or } 5.9 \times 10^{-3}\ m/s^2}$

(b) What is the centripetal force and what force provides it?

$m = 5.98 \times 10^{24}$

$a = 5.9 \times 10^{-3}$

$F = ma$

$F = (5.98 \times 10^{24})(5.9 \times 10^{-3})$

$\boxed{F = 3.53 \times 10^{22}\ N}$