Answer Circular Motion

Mastery Problems A

1. In terms of π as requested:

$$\frac{\pi}{6};\ \frac{3\pi}{2};\ \frac{2\pi}{3};\ \frac{\pi}{4};\ \frac{4\pi}{3};\ \frac{5\pi}{6};\ \frac{\pi}{9};\ \frac{5\pi}{3};\ \frac{\pi}{8};\ \frac{4\pi}{9}$$

2. 135°; 150°; 18°; 270°; 330°; 60°; 240°; 15°; 22.5°; 80°

3. 0.61 rad, 1.4 rad, 0.93 rad, 1.2 rad, 0.77 rad.

4. 163.9°; 241.2°; 57.3°; 198.8°; 171.9°

Mastery Problems B

1.

T / s	f / Hz	ω / rad s^{-1}	Revs. per min. (rpm)
0.50	(a) 2.0	(b) $4\pi \approx 13$	(c) 120
(d) 2.1	(e) 0.48	3.0	(f) 29
(g) 0.016	(h) 63	(i) 400	3800
(j) 0.020	50	(k) 310	(l) 3000
2700	(m) 3.7×10^{-4}	(n) 2.3×10^{-3}	(o) 0.022

2.

- **a.** 10 rad s^{-1}
- **b.** 0.54 rad s^{-1}
- **c.** 3.49 rad s^{-1}
- **d.** 7.27×10^{-5} rad s^{-1}
- **e.** 0.105 rad s^{-1}
- **f.** 1.75×10^{-3} rad s^{-1}
- **g.** 1.45×10^{-4} rad s^{-1}

3. 1.9 revs/hour

4. 8.3 revs/hour

5. 30 rad s^{-1}

6. 56 rad s^{-1}

7.

- **a.** 1800 s
- **b.** 5.6×10^{-4} Hz
- **c.** 3.5×10^{-3} rad s^{-1}

Mastery Problems C

1.

- **a.** 1.2 m s^{-1}
- **b.** 13 rad s^{-1}
- **c.** 4.0 m

2. 8.4 m s^{-1}

3. 31 m s^{-1}

4.
   a. 120 m s^{-1}
   b. 4.8 revs/second
   c. 0.21 s

5. - Any second hand on any clock with have the same time period T = 1 min = 60 s
   - Therefore $\omega = 2\pi/T$ = 0.105 rad s^{-1}
   - However, the linear speed or tangential speed at the tip of the second hand depends on the length of the hand.
   - $v = \omega r$ implies that as length of hand increase so does tangential speed
   - this explains why second hands on larger clocks seem to move faster as one looks at the end of the hand to read off the time

6. 12.5 m

7.
   a. 0.63 m s^{-1}
   b. 16 cm
   c. The rope does not slip on the cylinder, the rope is inelastic, the rope is dimensionless

Mastery Problems D

1. 18 m s^{-2}
2. 6.0 m s^{-2}
3. 29 m s^{-2}, almost $3g$
4. 1.1 m s^{-2} , 2.2 m s^{-2}, 4.4 m s^{-2}
5. $\frac{48200}{g} \approx$ 4.9 km
6. 4.0 rad s^{-1}
7.
   a. 25 m s^{-1}
   b. 2300 m s^{-2}
8. 18 m s^{-1}

Mastery Problems E

1. 0.80 m
2. 3.8 N
3. 7.5 rad s^{-1}
4. 88 N
5. 0.69 s
6. Tension will quadruple.
7. 9.5m N, 7860 m s^{-1}, 1.21x10^{-3} rad s^{-1}, 1.44 hours
8. F_{vert} = 1100 N, $F_{hor} = mg$ = 440 N

Mastery Problems F

1. 37°

2. 6.8 rad s^{-1}

3. 1.1 s

4. $2.5T$

5. 6900 N, 8.6 m s^{-1}

6. 12 kN, 54 kN, $4.6g$

Mastery Problems G

1. $v_{\text{top}} = \sqrt{gl}$

2. 140 N

3. 19 N

4.

a. 18 m s^{-1} = 40 mph

b. $\frac{v^2}{r} + g = 5g + g = 6g$

5. $3mg\cos\theta + \frac{mu^2}{l} - 2mg$

Mixed Problems

1. 10 m s^{-1}, 10 m s^{-1}, zero, 6.4 m s^{-1} S, 9.1 m s^{-1} SE, 20 m s^{-1} W, 14 m s^{-1} SW

2. 88 N

3. See section 4.

4. @ $r = 300$ mm, $T = 2.5$ N $< T_{\text{MAX}} = 5.0$ N therefore it is possible

5. 6.7 N, 22 cm

6. $m(g - 0.4g\omega^2), \sqrt{5g/2}$

7.

8.

9. 0.99 rad s^{-1}

10. 2.0 m

11. 9.0 x10^{-2} J, 2.7 m s^{-1}, 1.8 m s^{-1}, 0.55 N

12. If they don't lean, the friction causes a clockwise moment (torque) that causes the cyclist to rotate clockwise. Leaning into the corner means the weight provides an anti-clockwise moment that opposes the clockwise moment of the friction. At the appropriate angle (which depends on the speed of the cyclist), these two moents are equal and opposite.

13. 940 m

14. $\sqrt{5gr}$, $\sqrt{4gr}$, $\sqrt{2gr}$, $\sqrt{5gr}$

15. $t_{AB} = \frac{\pi d}{2v}$, $\Delta p = 2mv$, $F = \frac{2mv^2}{d}$, $W = 0$ since F is ∟ to motion

16. 46 m s^{-1}, 9.4 m s^{-1}, 210 m (2sf)

17. $2mg$, a

18. $t = \frac{\pi r}{v}$, 4.4 s

19.

Extension Problems I

1. 0.74

2. 5.4 m s^{-2}

3. 78°

4. 2.8 m s^{-2}

5. 0.60 kg

6. 0.83

7. 42 N

8. 0.47 m s^{-2}

9. 36 m – not far off that stated in the highway code!

Extension Problems II

1.

2.

3. 10 m s^{-1}, 27°

4. 7.1 m s^{-1}