Angular Kinematics

1a. $28° \times \frac{\pi}{180°} = 0.49$ rad.

b. $50° \times \frac{\pi}{180°} = 0.87$ rad

c. $145° \times \frac{\pi}{180°} = 2.53$ rad

d. $3 \text{ rev} \times \frac{2\pi}{1 \text{ rev}} = 6\pi$ rad.

f. $0.25 \frac{\text{rev}}{\text{s}} \cdot \frac{2\pi}{1 \text{ rev}} = \frac{1}{2}\pi \frac{\text{rad}}{\text{s}}$

e. $60 \text{ rev} \times \frac{2\pi}{1 \text{ rev}} = 120\pi$ rad.

g. $0.35 \frac{\text{rev}}{\text{s}^2} \times \frac{2\pi}{1 \text{ rev}} = 0.70\pi \text{ rad/s}^2$

2a. $\Delta x = r \Delta\theta$

$\theta = \frac{\Delta x}{r} = \frac{3 \text{ m}}{2 \text{ m}} = 1.5$ rad.

b. $r = \frac{\Delta x}{\theta} = \frac{8 \text{ in}}{4 \text{ rad}} = 2$ in.

c. $\Delta x = r\theta$

$= (4 \text{ ft})(25° \cdot \frac{\pi}{180°})$

$= \frac{5\pi}{9}$ ft ≈ 1.745 ft.

d. $r = \frac{\Delta x}{\theta} = \frac{30 \text{ in}}{260°} \cdot \frac{180°}{\pi} = 6.6$ in

3.

θ rev	θ (rad)	r (m)	Δx (m)
17	$34\pi \approx 106.8$	0.5	$17\pi \approx 53.4$
$1/\pi \approx 0.318$	2	0.25	0.5 m
$2/\pi \approx 0.636$	4	3	12
$5/\pi \approx 1.59$	10	4.5	45
8	$16\pi \approx 50.3$	0.398	20

ω (RPM)	ω (rad/s)	r (m)	v ($\frac{m}{s}$)
40	$\cdot \frac{2\pi}{60} = \frac{4}{3}\pi \approx 4.18$	2	$\frac{8}{3}\pi$
238.7	25	0.25	6.25
22.9	$12/5 = 2.4$	5	12
143.2	15	2.66	40
22	2.30	3.47	8

4. $7200 \text{ RPM} \times \frac{2\pi}{60} = 240\pi \frac{\text{rad}}{s} \approx 754 \frac{\text{rad}}{s}$.

$v = (0.0889 \text{ m})(240\pi \frac{\text{rad}}{s})$
$= 67.0 \frac{m}{s}$.

5. $v = r\omega$
$= r(\text{RPM} \times \frac{2\pi}{60})$
$= (0.085 \text{ m})(33.33 \text{ RPM} \times \frac{2\pi}{60})$
$= 0.297 \frac{m}{s}$.

6a. $15 \text{ RPM} \times 3 \text{ min} = 45 \text{ rev}$.

b. $15 \text{ RPM} \times \frac{10 \text{ s}}{60 \text{ s}} = 2.5 \text{ rev}$.

c. $1 \text{ rev} \times \frac{1 \text{ min}}{15 \text{ rev}} \times \frac{60 \text{ s}}{1 \text{ min}} = 4 \text{ s}$.

d. $v = (1.75 \text{ m})(15 \text{ RPM} \times \frac{2\pi}{60})$
$= \frac{7}{8}\pi$
$\approx 2.75 \frac{m}{s}$.

7a. $\frac{1 \text{ rev}}{24 \text{ hr}} \cdot \frac{1 \text{ hr}}{60 \text{ min}} = \frac{1}{1440} \text{ RPM} = 6.94 \cdot 10^{-4} \text{ RPM}$

b. $v = r\omega$
$= (6.378 \times 10^6 \text{ m})(6.94 \cdot 10^{-4} \text{ RPM} \times \frac{2\pi}{60})$
$= 463 \frac{m}{s}$.

8. $\omega = \frac{110 \frac{m}{s}}{0.184\ m} = 597 \frac{rad}{s} \times \frac{60\ s/min}{2\pi\ rad/rev} = 5709\ RPM.$

9. $\omega = \frac{343 \frac{m}{s}}{0.25\ m} = 1372 \frac{rad}{s} \times \frac{60}{2\pi} = 13,101\ RPM$

10a. ~~$\frac{1\ rev}{1\ hr} \cdot \frac{1\ hr}{3600\ s} \cdot \frac{2\pi\ rad}{1\ rev} =$~~

$\frac{1\ rev}{12\ hr} = \frac{2\pi}{12\ hr \cdot 3600\ s/hr} = 1.45 \cdot 10^{-4}\ rad/s \times \frac{60}{2\pi} = 0.00138\ RPM$

b. $\frac{1\ rev}{60\ min} = 0.016\ RPM \times \frac{2\pi}{60} = 1.74 \cdot 10^{-3} \frac{rad}{s}$

c. $1\ RPM = 0.105 \frac{rad}{s}.$

11a. ~~$v = (7.25 \cdot 10^{-6}$~~ $v = (0.05\ m)(1.45 \cdot 10^{-4}\ rad/s)$
$= 7.25 \cdot 10^{-6} \frac{m}{s}$

b. $v = (0.15\ m)(1.74 \cdot 10^{-3} \frac{rad}{s})$
$= 2.61 \cdot 10^{-4} \frac{m}{s}$

c. $v = (0.12\ m)(0.105 \frac{rad}{s})$
$= 0.0126 \frac{m}{s}$

12a. $5 \frac{rad}{s} \cdot 20_s = 100\ rad$

b. $\frac{100\ rad}{2\pi} = 15.9\ rev$

13a. $\omega = \frac{600\ rad}{10\ s} = 60 \frac{rad}{s}.$

14. $\frac{200\ rad}{60\ rad/s} = 3.3\ s.$

15a $\omega = 25\ RPM \times \frac{2\pi}{60} = 2.6 \frac{rad}{s}$

b. $2.6 \frac{rad}{s} \cdot 4_s = 10.5\ rad.$

16. $45\ RPM \times \frac{2\pi}{60} = 4.71\ rad$. They are equal.

17. $r_1\omega_1 = r_2\omega_2$

$\omega_2 = \frac{(0.35\ m)(6.5\ \frac{rad}{s})}{0.12\ m} = 18.9\ \frac{rad}{s}$

18. $\omega_f = \omega_i + at$

$a = \frac{\omega_f - \omega_i}{t} = \frac{-6\ rad/s}{30\ s} = \frac{-1}{6}\ \frac{rad}{s^2}$

19a. $\omega_f = 0 + (0.75\ rad/s^2)(60\ s)$

$= 45\ rad/s$

b. $\theta = \frac{1}{2}(0.75\ rad/s^2)(60\ s)^2$

$= 1350\ rad$

c. $v = (45\ rad/s)(7.3\ m)$

$= 328.5\ m/s$

20a. $\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$

$\alpha = \frac{\omega_f^2 - \omega_i^2}{2\Delta\theta}$

$= \frac{-20^2 + 8^2}{2 \cdot 500 \cdot \frac{2\pi}{1\ rev}} = -0.053\ \frac{rad}{s^2}$

★ answer key forgot to convert 500 rev to rad on 20.

b. $8\ rad/s = 20\ rad/s + (-0.053\ \frac{rad}{s^2}) \cdot t$

$t = 226\ s.$

21a. $200\ rad = \frac{1}{2}(2.5\ rad/s^2)(t^2)$

$t = 12.6\ s$

b. $\omega_f = (2.5\ rad/s^2)(12.6\ s)$

$= 31.5\ rad/s$

c. $v = (31.5\ rad/s)(0.05\ m)$

$= 1.6\ \frac{m}{s}$

22a $\Delta\theta = \frac{1}{2}(0.4\ \text{rad/s}^2)(9\ \text{s})^2$

$= 16.2\ \text{rad}.$

b. $\frac{16.2\ \text{rad}}{2\pi} = 2.57\ \text{rev}.$

23a $0 = 27\ \frac{\text{rad}}{\text{s}} - (0.15\ \frac{\text{rad}}{\text{s}^2})t$

$t = 180\ \text{s}$

b. $\theta = 27\ \frac{\text{rad}}{\text{s}} \cdot 180\ \text{s} - \frac{1}{2}(0.15\ \frac{\text{rad}}{\text{s}^2})(180\ \text{s})^2$

$= 2430\ \text{rad}$

$= 387\ \text{rev}.$