Physics 200 (Stapleton) Name: Answers

Practice Problems with Angular Acceleration, continued

6. (II) A bicycle with tires 68 cm in diameter travels 8.0 km. How many revolutions do the wheels make?

$\ell = r\theta$ $\ell = d_{linear} = 8{,}000\,m$ $r = 0.34\,m$

$\theta = (revolutions)(2\pi)$ $8{,}000\,m = 0.34\,m\,(revolutions)\,2\pi$

$revolutions = 3.74 \times 10^3$

7. (II) (*a*) A grinding wheel 0.35 m in diameter rotates at a constant 2500 rpm. Calculate its angular velocity in rad/s. (*b*) What are the linear speed and acceleration of a point on the edge of the grinding wheel?

a) $\theta = \omega t$ $2\pi\,rad\,(2500) = \omega\,(60s) \Rightarrow \omega = 262\,rad/s$

$2\pi\,rad$ ↑ (revolutions in 60 sec) ↑ 60 sec

$v = r\omega = 0.175\,m\,(262\,rad/s) = 46\,m/s$

★ See attached paper

16. (I) An automobile engine slows down from 4500 rpm to 1200 rpm in 2.5 s. Calculate (*a*) its angular acceleration, assumed constant, and (*b*) the total number of revolutions the engine makes in this time.

17. (I) Pilots can be tested for the stresses of flying highspeed jets in a whirling "human centrifuge," which takes 1.0 min to turn through 20 complete revolutions before reaching its final speed. (*a*) What was its angular acceleration (assumed constant), and (*b*) what was its final angular speed in rpm?

18. (II) A wheel 33 cm in diameter accelerates uniformly from 240 rpm to 360 rpm in 6.5 s. How far will a point on the edge of the wheel have traveled in this time?

19. (II) A cooling fan is turned off when it is running at 850 rev/min. It turns 1500 revolutions before it comes to a stop. (*a*) What was the fan's angular acceleration, assumed constant? (*b*) How long did it take the fan to come to a complete stop?

7. b) rpm is constant, so accel must be centripetal only.

$$a_{centrip} = \frac{v^2}{r} = \frac{(46\ m/s)^2}{0.175\ m} = 1.2\times10^4\ m/s^2$$

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16. a) $\alpha = \frac{\Delta\omega}{\Delta t} \leftarrow \omega_{Final} - \omega_{initial}$

$$\left(\frac{1\ rev.}{minute}\right)\left(\frac{2\pi\ rad}{rev.}\right)\left(\frac{1\ min}{60\ s}\right) = 0.1047\ rad/s = 1\ rpm$$

$$4500\ rpm\left(\frac{0.105\ rad/s}{rpm}\right) = 471\ rad/s$$

$$1200\ rpm\left(\frac{0.105\ rad/s}{rpm}\right) = 126\ rad/s$$

$$\Delta\omega = 126\ rad/s - 471\ rad/s = -345\ rad/s$$

$$\alpha = \frac{-345\ rad/s}{2.5\ s} = +138\ rad/s^2$$

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b) $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ 431 1175

$$\theta = (471\ rad/s)(2.5\ s) + \frac{1}{2}(-138\ rad/s^2)(2.5\ s)^2$$

$$\theta = 747\ rad$$

$$(747\ rad)\left(\frac{1\ rev.}{2\pi\ rad}\right) = 120\ revolutions$$

17. a) $\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

θ: $20(2\pi)$; ω_0: 0 ; t: $60\,s$

$40\pi = \frac{1}{2}\alpha (60\,s)^2$

$\alpha = 0.0700\ rad/s^2$

b) $\omega = \omega_0 t + \alpha t$

$\omega = 0.0700\ rad/s^2\,(60\,s)$

$\omega = 4.2\ rad/s = 40\ rpm$

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18. $\alpha = \frac{\Delta \omega}{\Delta t}$

$\alpha = \frac{37.7\ rad/s - 25.1\ rad/s}{6.5\,s}$

$\alpha = 1.94\ rad/s^2$

$240\ rpm\left(0.1047\frac{rad/s}{rpm}\right) = 25.1\ rad/s$

$360\ rpm\left(0.1047\frac{rad/s}{rpm}\right) = 37.7\ rad/s$

see # 16 solution

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$\theta = 25.1\ rad/s\,(6.5\,s) + \frac{1}{2}\left(1.94\ rad/s^2\right)(6.5\,s)^2$

$\theta = 204\ rad$

$\ell = r\theta = \left(\frac{0.165\ m}{rad}\right)(204\ rad) = 33.7\ m$

ℓ: dist

19. a) $\omega = 0 \text{ rad/s}$

$\omega_0 = 850 \text{ rpm}$ $\quad 850 \text{ rpm}\left(0.1047 \frac{\text{rad/s}}{\text{rpm}}\right) = 89.0 \text{ rad/s}$

$\omega_0 = 89.0 \text{ rad/s}$

$\omega^2 = \omega_0^2 + 2\alpha(\theta)$ $\quad 1{,}500 \text{ rev}\left(\frac{2\pi \text{ rad}}{\text{rev}}\right) = 9420 \text{ rad}$

$0 = (89.0 \text{ rad/s})^2 + 2\alpha(9420 \text{ rad})$

$-7{,}921 \frac{\text{rad}^2}{\text{s}^2} = 2\alpha(9420 \text{ rad})$

$-0.42 \text{ rad/s}^2 = \alpha$

b) $\omega = \omega_0 + \alpha t$

$0 = 89.0 \text{ rad/s} + (-0.42 \text{ rad/s}^2)\, t$

$-89.0 \text{ rad/s} = -0.42 \text{ rad/s}^2\,(t)$

$212 \text{ s} = t$