Physics 20 - Lesson 7H
Rotational Kinematics

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1) /2 The odometer is calibrated to a 70 cm wheel. If 60 cm wheels were used the odometer would read the distance traveled for the 70 cm wheel $70\pi = 220$ cm for each revolution of the 60 cm wheel (actual distance = 188 cm). Therefore when the odometer reads 1.0 km traveled, only 0.86 km would have actually been traveled.

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2) /4

$\frac{\theta}{2\pi} = \frac{30}{360}$ ✓ $\quad \frac{\theta}{2\pi} = \frac{90}{360}$ $\quad \frac{\theta}{2\pi} = \frac{420}{360}$

$\theta = 0.524\,\text{rad}$ ✓ $\quad \theta = 1.57\,\text{rad}$ ✓ $\quad \theta = 7.33\,\text{rad}$ ✓

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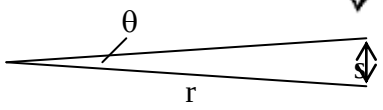
3) /4



✓

$\theta = \frac{s}{r}$ ✓

$s = \theta r = 1.8\times10^{-5}(380000\text{km})$ ✓

$s = 6.8\,\text{km}$ ✓

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4) /3

$n = \frac{\Delta d}{\text{circumference}}$ ✓

$n = \frac{2000\text{m}}{\pi(.68\text{m})}$ ✓

$n = 936\,\text{rev}$ ✓

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5) /5

$2000\,\text{rot/min} = 33.3\,\text{rot/s}$ ✓

a.

$\omega = \text{rot/s}\times 2\pi\,\text{rad/rot}$ ✓

$\omega = 33.3\times 2\pi\,\text{rad/s}$

$\omega = 209\,\text{rad/s}$ ✓

b.

$v = \omega r$ ✓

$v = 209\text{rad/s}(0.20\text{m})$

$v = 41.9\,\text{m/s}$ ✓

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6) /4

$\omega = 2\pi\frac{\text{rpm}}{60}$ $\quad \alpha = \frac{\omega_2 - \omega_1}{t}$ ✓

$\omega = 2\pi\frac{1200}{60}$ $\quad \alpha = \frac{0 - 125.66\text{rad/s}}{15\text{s}}$ ✓

$\omega_1 = 125.66\text{rad/s}$ ✓ $\quad \alpha = -8.4\,^{\text{rad}}/_{\text{s}^2}$ ✓

$\omega_2 = 0$

$t = 15\text{s}$

7) /3

$\omega = 2\pi\frac{\text{rpm}}{60}$ ✓

$\omega = 2\pi\frac{33}{60}$

$\omega_2 = 3.46\text{rad/s}$ ✓

$\omega_1 = 0$

$t = 2.8\text{s}$

$\alpha = \frac{\omega_2 - \omega_1}{t}$ ✓

$\alpha = \frac{3.46\text{rad/s} - 0}{2.8\text{s}}$ ✓

$\alpha = +1.2\ ^{\text{rad}}/_{\text{s}^2}$

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8) /4

	Orbit around sun	About its axis
	$\omega = \frac{2\pi}{t}$ ✓	$\omega = \frac{2\pi}{t}$ ✓
	$\omega = \frac{2\pi}{365\times24\times60\times60}$	$\omega = \frac{2\pi}{24\times60\times60}$
	$\omega = 1.99\times10^{-7}\ \text{rad/s}$ ✓	$\omega = 7.27\times10^{-5}\ \text{rad/s}$ ✓

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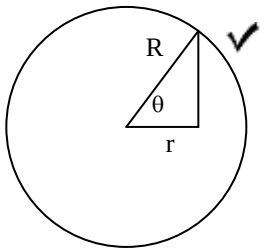
9) /6

$v_{equator} = \omega R$ ✓

$v_{equator} = 7.27\times10^{-5}\text{rad/s}(6.37\times10^{6}\text{m})$

$v_{equator} = 4.63\times10^{2}\ \text{m/s}$ ✓



✓

$v_{latitude} = \omega r\cos\theta$ ✓

$v_{latitude} = 7.27\times10^{-5}\text{rad/s}(6.37\times10^{6}\text{m})\cos 50$

$v_{latitude} = 2.98\times10^{2}\ \text{m/s}$ ✓

$r = R\cos\theta$ ✓

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10) /8

$\omega_1 = 2\pi\frac{4500}{60} = 471.2\,\text{rad/s}$ ✓

$\omega_2 = 2\pi\frac{1000}{60} = 104.7\,\text{rad/s}$ ✓

$t = 6.5\text{s}$

$\alpha = \frac{\omega_2 - \omega_1}{t}$ ✓

$\alpha = \frac{104.7\text{rad/s} - 471.2\text{rad/s}}{6.5\text{s}}$

$\alpha = -56.4\,^{\text{rad}}/_{\text{s}^2}$ ✓

$\theta = \frac{\omega_1 + \omega_2}{2}t$ ✓

$\theta = \frac{104.7\text{rad/s} + 471.2\text{rad/s}}{2}(6.5\text{s})$

$\theta = 1872\,\text{rad}$ ✓

$n = \frac{\theta}{2\pi} = \frac{1872\,\text{rad}}{2\pi}$ ✓

$n = 298\,\text{rev}$ ✓

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11) /4

$\omega_1 = 0$

$\omega_2 = 2\pi\frac{10000}{60} = 1047\,\text{rad/s}$ ✓

$\alpha = +120\,^{\text{rad}}/_{\text{s}^2}$

$\theta = ?$

$\omega_2^2 = \omega_1^2 + 2\alpha\theta$ ✓

$\theta = \frac{\omega_2^2 - \omega_1^2}{2\alpha}$

$\theta = \frac{(1047\,^{\text{rad}}/_{\text{s}})^2 - 0}{2(120\,^{\text{rad}}/_{\text{s}^2})}$ ✓

$\theta = 4.6\times10^3\,\text{rad}$ ✓

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12) /5

$\omega_2 = 2\pi\frac{33}{60} = 3.46\text{rad/s}$ ✓

$\omega_1 = 0$

$\theta = 1.5\times2\pi = 9.42\,\text{rad}$ ✓

$\alpha = ?$

$\omega_2^2 = \omega_1^2 + 2\alpha\theta$ ✓

$\alpha = \frac{\omega_2^2 - \omega_1^2}{2\theta}$

$\alpha = \frac{(3.46\,^{\text{rad}}/_{\text{s}})^2 - 0}{2(9.42\text{rad})}$ ✓

$\alpha = 0.63\,^{\text{rad}}/_{\text{s}^2}$ ✓

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13) /7

$\omega_1 = 2\pi\frac{80}{60} = 8.378\,\text{rad/s}$ ✓

$\omega_2 = 2\pi\frac{300}{60} = 31.4\,\text{rad/s}$ ✓

$t = 3.6\text{s}$

Find angular displacement

$\theta = \frac{\omega_1 + \omega_2}{2}t$ ✓

$\theta = \frac{8.378\text{rad/s} + 31.4\text{rad/s}}{2}(3.6\text{s})$ ✓

$\theta = 71.63\,\text{rad}$ ✓

Find s

$s = \theta r$ ✓

$s = (71.63)(0.20\text{m})$

$s = 14.3\,\text{m}$ ✓
