

2425 Review problems for Chap. 11 – 16. Summer 2009

Name:

Section:

1. Change the angle of 150 degrees to radians.

$$(150)(\pi/180) = 5\pi/6 \text{ or } 2.63 \text{ rad.}$$

2. As a platter with diameter 0.350 m and mass 400 g is rotating with angular speed of 6.00 rad/s, you put a metal bar on it so they move with common angular speed of 4.00 rad/s. Ignore all the friction, please calculate the moment of inertia of the metal bar. If the bar's length is 0.300 m, can you tell me the mass of the bar?

$$(a) I_P \omega_i = (I_P + I_b) \omega_f \text{ this gives } I_b = I_P \left(\frac{\omega_i}{\omega_f} - 1 \right), \text{ so } I_b = 0.00306 \text{ kg m}^2$$

$$(b) I_b = \frac{mL^2}{12} \text{ so } m = \frac{12I_b}{L^2} = 0.408 \text{ kg}$$

3. A child exerts a tangential 40.0-N force on the rim of a merry-go-round with a radius of 2.40 m. Please calculate its torque. If the merry-go-round's moment of inertia is 800 kg m², what is its angular acceleration? What is its mass?

$$\tau = Fr \sin \theta = (40)(2.4) = 96.0 \text{ N m}$$

$$\alpha = \frac{\tau}{I} = \frac{96}{800} = 0.120 \frac{\text{rad}}{\text{s}}$$

$$I = \frac{mr^2}{2} \text{ so } m = \frac{2I}{r^2} = 248 \text{ kg}$$

4. (a) Calculate the potential energy of a 10.0-kg mass on the surface of the Earth and at an altitude of 700 km respectively; (b) calculate the speed needed to move this mass from surface of the Earth to the altitude of 700 km. (c) calculate the speed needed for this mass to circle around the Earth at this altitude.

$$(a) U_1 = -\frac{GmM}{R_E} = -6.24 \times 10^8 \text{ J}; U_2 = -\frac{GmM}{R_E + 700000} = -5.63 \times 10^8 \text{ J}$$

$$(b) \frac{mv^2}{2} + U_1 = U_2 \text{ so } v = \sqrt{\frac{2(U_2 - U_1)}{m}} = 3.50 \frac{\text{km}}{\text{s}}$$

$$(c) \frac{GmM}{r^2} = \frac{mv^2}{r} \text{ cancel } m, \text{ then } v = \sqrt{GM/r} = 7.50 \text{ km/s}$$

5. A 0.50-kg mass attached to a spring undergoes simple harmonic motion with a period of 1.50 s. (a) What is the force constant of the spring? (b) Suppose the amplitude is 0.50 m and initial phase angle is $\pi/4$ rad, write down the oscillation function on the oscillator. (c) Calculate its speed when the mass is at 0.25 m position.

$$(a) T = 2\pi \sqrt{\frac{m}{k}}, \text{ which yields } k = 8.77 \frac{N}{m}$$

$$(b) \omega = \frac{2\pi}{T} = 4.19 \frac{rad}{s} \text{ so } x(t) = 0.5 \cos\left(4.19t + \frac{\pi}{4}\right)$$

$$(c) \frac{1}{2}kA^2 = \frac{1}{2}kx^2 + \frac{1}{2}mv^2 \text{ this yields } v = 1.81 \text{ m/s}$$

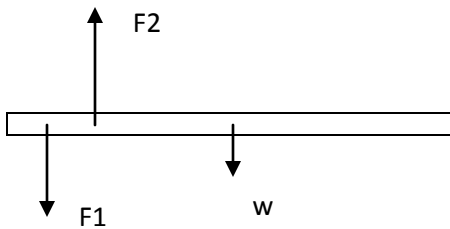
6. After landing on an unfamiliar planet, a space explorer constructs a simple pendulum of length 60.0 cm. The explorer finds that the pendulum completes 60.0 full swing cycles in a time of 120 s. (a) What is the acceleration of gravity on this planet? (b) If you want to change the period of the pendulum to 1.0 s on this planet, what should the pendulum's length be?

$$(a) T = 2.00 \text{ s}, \quad T = 2\pi \sqrt{\frac{L}{g}}, \text{ which yields } g = 5.92 \text{ m/s}^2$$

$$(b) \text{ still use the above equation, we can get } L = 15 \text{ cm}$$

7. Someone holds a horizontal meter stick of weight w with his thumb pushing down at the 10 cm line and his fingers pushing up at the 25 cm line. What are the applied forces of the thumb and of the fingers?

The free body diagram is as this.



$$\text{Choose } F_1 \text{ point as rotational axis: } F_2(15) = w(40) \text{ so } F_2 = 8w/3;$$

$$\text{Since } F_2 = F_1 + w, \text{ so } F_1 = 5w/3$$

8. The speed of sound in air at 20 °C is 344 m/s. (a) What is the wavelength of a sound wave with a frequency of 784 Hz, and (b) how many milliseconds does each vibration take?

$$(a) \lambda = v/f = 0.439 \text{ m},$$

$$(b) T = 1/f = 1.28 \text{ ms}$$

9. (a) Show that wave function can be written as

$$y(x,t) = A \cos \left[\frac{2\pi}{\lambda} x - vt \right]$$

(b) Use $y(x,t)$ to find an expression for the transverse velocity v_y of a particle in the string on which the wave travels.

(c) Find the maximum speed of a particle of the string. Under what circumstances is this equal to the propagation speed v ?

(a) start with $y(x,t) = A \cos(kx - \omega t)$; using $k = 2\pi/\lambda$ and $\omega = 2\pi/T$, and $\lambda/T = v$, we can get it easily.

(b) $v_y = \frac{\partial y}{\partial t} = \frac{2\pi Av}{\lambda} \sin \left[\frac{2\pi}{\lambda} (x - vt) \right]$

(c) $v_{y,max} = \frac{2\pi Av}{\lambda}$; if $v_y = v$, that means $\frac{2\pi Av}{\lambda} \sin \left[\frac{2\pi}{\lambda} (x - vt) \right] = v \xrightarrow{\text{yields}} \frac{2\pi A}{\lambda} \sin \left[\frac{2\pi}{\lambda} (x - vt) \right] = 1$

10. A baby's mouth is 30 cm from her father's ear and 1.50 m from her mother's ear. What is the difference between the sound intensity levels heard by the father and by the mother?

$$\beta_f - \beta_m = 10 \log \frac{I_f}{I_m} = 10 \log \frac{\frac{P}{4\pi r_f^2}}{\frac{P}{4\pi r_m^2}} = 10 \log \left(\frac{r_m}{r_f} \right)^2 = 20 \log \frac{1.5}{0.3} = 14 \text{ dB}$$

11. A car is travelling with speed of 10.0 m/s toward you. Its alarm is emitting sound waves of frequency 520 Hz. You are on a motorcycle, traveling directly away from the car. How fast must you be traveling if detect a frequency of 490 Hz?

At first, I need to tell you the direction of velocity of the car; otherwise, you can't determine the sign in Doppler Effect equation. So the first sentence is modified a little as seen now.

$$f' = \left(\frac{1 - \frac{u_o}{v}}{1 - \frac{u_s}{v}} \right) f = \frac{v - u_o}{v - u_s} f$$

That is: $u_o = v - \frac{(v - u_s)f'}{f} = 343 - (343 - 10) \left(\frac{490}{520} \right) = 29.2 \text{ m/s}$