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General Physics I, Quiz 1
PHYS10400, Class year 99
09-30-2010

SN:_______________, Name:________________

Chapter 1-6, Serway; ABSOLUTELY NO CHEATING!
Please write the answers on the blank space or on the back of this paper to save resources.

1. Convert meters in the speed to miles:

$$(38.0\ \cancel{m}/\text{s})\left(\frac{1\ \text{mi}}{1\ 609\ \cancel{m}}\right) = 2.36\times10^{-2}\ \text{mi/s}$$

Convert seconds to hours:

$$(2.36\times10^{-2}\ \text{mi}/\cancel{s})\left(\frac{60\ \cancel{s}}{1\ \cancel{\text{min}}}\right)\left(\frac{60\ \cancel{\text{min}}}{1\ \text{h}}\right) = 85.0\ \text{mi/h}$$

The driver is indeed exceeding the speed limit and should slow down.

2.

Given $v_i = 12.0$ cm/s when $x_i = 3.00$ cm ($t = 0$), and at $t = 2.00$ s, $x_f = -5.00$ cm,

$$x_f - x_i = v_i t + \frac{1}{2}at^2:\ -5.00 - 3.00 = 12.0(2.00) + \frac{1}{2}a(2.00)^2$$

$$-8.00 = 24.0 + 2a \qquad a = -\frac{32.0}{2} = \boxed{-16.0\ \text{cm/s}^2}.$$

3.

(a) $R_x = \boxed{2.00}$, $R_y = \boxed{1.00}$, $R_z = \boxed{3.00}$

(b) $|\vec{\mathbf{R}}| = \sqrt{R_x^2 + R_y^2 + R_z^2} = \sqrt{4.00 + 1.00 + 9.00} = \sqrt{14.0} = \boxed{3.74}$

(c) $\cos\theta_x = \frac{R_x}{|\vec{\mathbf{R}}|} \Rightarrow \theta_x = \cos^{-1}\left(\frac{R_x}{|\vec{\mathbf{R}}|}\right) = \boxed{57.7^\circ \text{ from } +x}$

$$\cos\theta_y = \frac{R_y}{|\vec{\mathbf{R}}|} \Rightarrow \theta_y = \cos^{-1}\left(\frac{R_y}{|\vec{\mathbf{R}}|}\right) = \boxed{74.5^\circ \text{ from } +y}$$

$$\cos\theta_z = \frac{R_z}{|\vec{\mathbf{R}}|} \Rightarrow \theta_z = \cos^{-1}\left(\frac{R_z}{|\vec{\mathbf{R}}|}\right) = \boxed{36.7^\circ \text{ from } +z}$$

4.

Identify the student as the S' observer and the professor as the S observer. For the initial motion in S', we have

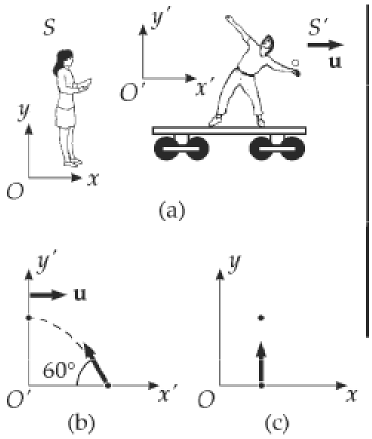
$$\frac{v'_y}{v'_x} = \tan 60.0° = \sqrt{3}$$

Let u represent the speed of S' relative to S. Then because there is no x-motion in S, we can write $v_x = v'_x + u = 0$ so that $v'_x = -u = -10.0$ m/s. Hence the ball is thrown backwards in S'. Then,

$$v'_y = v'_y = \sqrt{3}\left|v'_x\right| = 10.0\sqrt{3}\,\text{m/s}$$

Using $v_y^2 = 2gh$ we find

$$h = \frac{\left(10.0\sqrt{3}\,\text{m/s}\right)^2}{2\left(9.80\,\text{m/s}^2\right)} = \boxed{15.3\text{ m}}$$



ANS FIG. P4.43

The motion of the ball as seen by the student in S' is shown in diagram (b). The view of the professor in S is shown in diagram (c).

5.

Forces acting on $m_1 = 2.00$-kg block:

$$T - m_1 g = m_1 a \qquad (1)$$

Forces acting on $m_2 = 8.00$-kg block:

$$F_x - T = m_2 a \qquad (2)$$

(a) Eliminate T and solve for a:

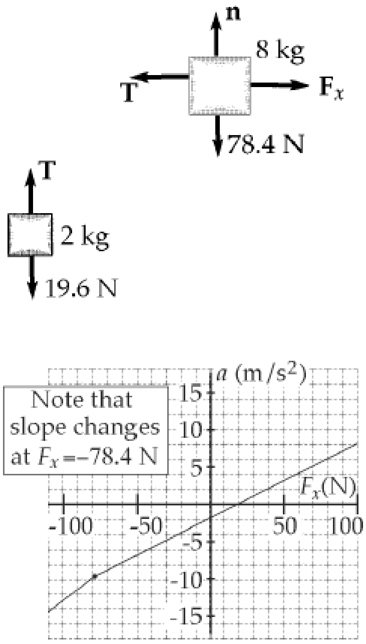
$$a = \frac{F_x - m_1 g}{m_1 + m_2}$$

$$\boxed{a > 0 \text{ for } F_x > m_1 g = 19.6\text{ N}}$$

(b) Eliminate a and solve for T:

$$T = \frac{m_1}{m_1 + m_2}\left(F_x + m_2 g\right)$$

$$\boxed{T = 0 \text{ for } F_x \le -m_2 g = -78.4\text{ N}}$$



ANS FIG. P5.33

Note that if $F_x < -m_2 g$, the cord is loose, so mass m_2 is in free fall and mass m_1 accelerates under the action of F_x only.

6.

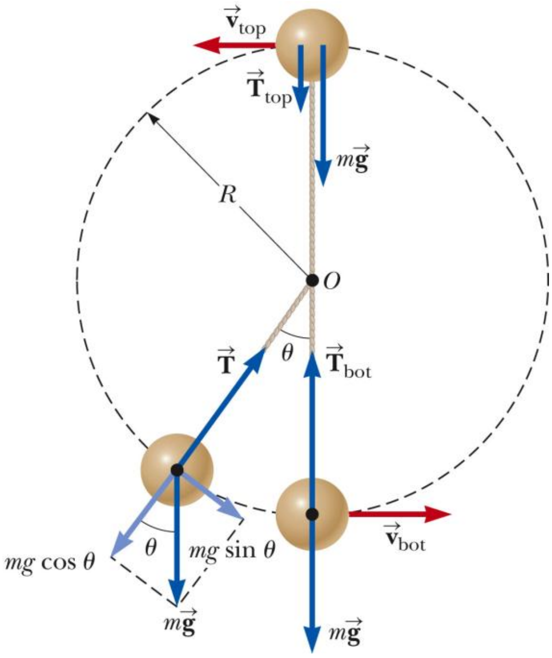


Figure 6.9 (Example 6.6) The forces acting on a sphere of mass *m* connected to a cord of length *R* and rotating in a vertical circle centered at *O*. Forces acting on the sphere are shown when the sphere is at the top and bottom of the circle and at an arbitrary location.

From the force diagram in Figure 6.9, we see that the only forces acting on the sphere are the gravitational force $\vec{\mathbf{F}}_g = m\vec{\mathbf{g}}$ exerted by the Earth and the force $\vec{\mathbf{T}}$ exerted by the cord. We resolve $\vec{\mathbf{F}}_g$ into a tangential component $mg\sin\theta$ and a radial component $mg\cos\theta$.

Apply Newton's second law to the sphere in the tangential direction:

$$\sum F_t = mg\sin\theta = ma_t$$

$$a_t = g\sin\theta$$

Apply Newton's second law to the forces acting on the sphere in the radial direction, noting that both $\vec{\mathbf{T}}$ and $\vec{\mathbf{a}}_r$ are directed toward *O*:

$$\sum F_r = T - mg\cos\theta = \frac{mv^2}{R}$$

$$T = mg\left(\frac{v^1}{Rg} + \cos\theta\right)$$

Let us evaluate this result at the top and bottom of the circular path (Fig. 6.9):

$$T_{\text{top}} = mg\left(\frac{v_{\text{top}}^2}{Rg} - 1\right) \qquad T_{\text{bot}} = mg\left(\frac{v_{\text{bot}}^2}{Rg} + 1\right)$$