2425, Answers for Review of chapters 1 – 5

1. Meter, kilogram, second.

2. Displacement, velocity, acceleration, force.

3. A.

4. 1 m^2 = 10000 cm^2 = 10^4 cm^2.

5. g, down.

6. Yes.

7. Average velocity.

8. Instantaneous acceleration.

9. B.

10. False. They have equal magnitudes but opposite direction.

11. True.

12. 0 degree.

13. b.

14. True.

15. True.

16. 0.

17. True.

18. False.

19. True. w = mg, g might change with location.

20. c.

Quantitative problems.

1. A car with initial velocity of 15.0 m/s moves with constant acceleration. At the end of 10.0 s, it is moving at a velocity of 55.0 m/s. Find the car's acceleration and its displacement during this 10.0s.

   Method 1:

$$a = \frac{v - v_0}{t} = \frac{55 - 15}{10} = 4.00\ m/s^2$$
$$\Delta x = v_{ave} t = \frac{v_0 + v}{2} t = \frac{15 + 55}{2}(10) = 350\ m$$

Method 2:

After getting a = 4.00 m/s^2, use

$$\Delta x = v_0 t + \frac{1}{2} a t^2 = (15)(10) + \frac{1}{2}(4)(10^2) = 350\ m$$

2. A tennis ball is released at rest from the top of a building in A&M University. It hits the ground after falling 2.50 s. Neglecting air resistance, what was the height from which the ball was dropped?

Using:

$$\Delta x = v_0 t + \frac{1}{2} a t^2 = \frac{1}{2}(9.81)(2.5^2) = 30.6\ m$$

3. A stone is thrown with an initial velocity of 35 m/s at an angle of 37^o above the horizontal. Find: (a) its horizontal and vertical displacement after 0.55 s; (b) its velocity after 0.55 s (both magnitude and direction). (c) its maximum height and range.

Choose coordinates: x axis to the right, y is up.

(a)

$$v_{0x} = v_0 cos\theta = 35 \cos(37°) = 28\ m/s$$
$$v_{0y} = v_0 sin\theta = 35 \sin(37°) = 21\ m/s$$

$$\Delta x = v_{0x} t = (28)(.55) = 15\ m$$

$$\Delta y = v_{0y} t + \tfrac{1}{2} a t^2 = (21)(0.55) - \tfrac{1}{2}(9.81)(.55^2) = 10\ m$$

(b) $v_x = v_{0x} = 28\ m/s$ (horizontal)

$v_y = v_{0y} - gt = 21 - (9.8)(.55) = 16\ m/s$ (up, because it is still positive)

(c) $v_y^2 = v_{0y}^2 + 2a\Delta y$; that is: $0 = 21^2 - (2)(9.8)h \xrightarrow{yields} h = 23\ m$

$$R = \frac{v_0^2 \sin(2\theta)}{g} = \frac{35^2 \sin(74°)}{9.8} = 120\ m$$

4. An astronaut applies a force of 500 N to an asteroid and it accelerates at 5.0 m/s^2 (far far away from the Earth and other planets). What is the asteroids mass?

$$m = \frac{F}{a} = \frac{500}{5} = 100\ kg$$

5. A 5.60 kg sled is pulled across a smooth ice surface (see figure below). The force acting on the sled is of magnitude 25.3 N and points in a direction 35.0° above the horizontal. If the sled starts at rest, how fast is it going after being pulled 2.50 s?

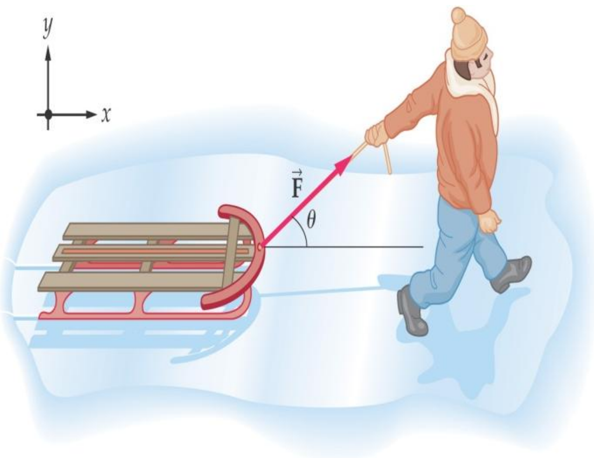


Figure for problem 5.

Choose coordinates: x axis is to the right; y up.

$$a_x = \frac{F_x}{m} = \frac{25.3\cos(35°)}{5.6} = 3.70\ m/s^2$$

$$v_x = v_0 + at = (3.7)(2.5) = 9.25\ m/s$$

Acceleration and velocity in y direction should be zero.

6. An instructor asks students to weigh a 6.0 kg salmon by hanging it from a fish scale attached to the ceiling of an elevator. What is the apparent weight of the salmon, if the elevator (a) is at rest, (b) moves with an upward acceleration of 35 m/s^2, or (c) moves with a downward acceleration of 58 m/s^2? Do you have any comments on your results?

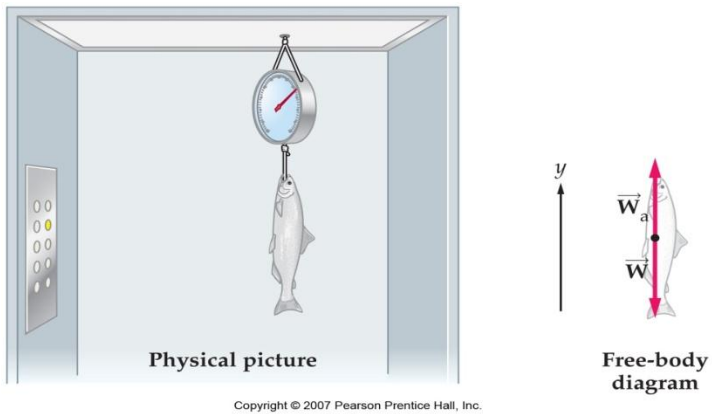


Figure for problem 6.

Choose y direction up, x direction is not important in this problem.

$$w_a - w = ma$$

(a) a = 0, $w_a = w = 59$ N
(b) a = 35 m/s^2, $w_a = w + ma = m(g+a) = 6\,(9.8+35) = 269$ N
(c) a = -58 m/s^2, $w_a = w + ma = m(g+a) = 6\,(9.8-58) = -289$ N
The fish needs the downward force to have this acceleration.

7. A truck tows a 500 kg car with a rope having a tensile strength of 350 N. If the driver wishes to attain a final speed of 20 m/s, what is the shortest interval of time to achieve this speed without breaking the rope?

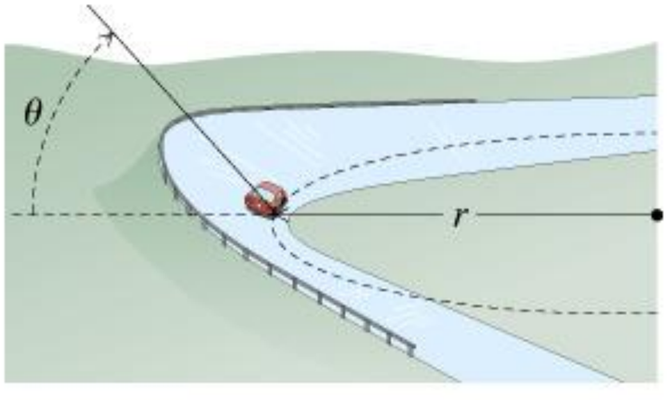
$$maximum\ acceleration:$$

$$a = \frac{F}{m} = \frac{350}{500} = 0.70\frac{m}{s^2}\quad (accleration\ greater\ than\ this\ value\ will\ break\ the\ rope);$$

$$The\ shortest\ time\ corresponds\ the\ maximum\ acceleration\ according\ to$$

$$t = \frac{v - v_0}{a} = \frac{20 - 0}{0.70} = 29\ s$$

8. A car of mass M= 1500 kg traveling at 55.0 km/h enters a banked turn covered with ice. The road is banked at an angle θ, and there is no friction between the road and the car's tires.



What is the radius r of the turn if θ = 20.0° (assuming the car continues in uniform circular motion around the turn)? In the case that θ = 0° (flat road), at least what the coefficient of static friction should be to avoid any sliding of the car?

Choose coordinates: x to the right and y up. After decomposing the normal force we get

$$In\ x\ direction: \quad n sin\theta = \frac{mv^2}{r} \quad (1)$$

$$In\ y\ direction: \quad n cos\theta = mg \quad (2)$$

Eq. (1)/Eq. (2) we get

$$tg\theta = \frac{v^2}{gr} \quad so \qquad r = \frac{v^2}{g tg\theta} = \frac{15.3^2}{(9.8)tg20°} = 65.4\ m$$

If the road is flat, then

$$\mu mg = \frac{mv^2}{r} \quad so \quad \mu = \frac{v^2}{gr} = 0.364$$