HW #2
SP211 Vanhoy

Due Tues 8 Sept

Ten Book problems

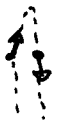
Serway Ch 3 Problems: 31, 49, 57

Ch 4 Problems: 11, 16a only, 17, 18, 25, 26, 31

Seven multiple choice

1. The acceleration of a car is zero when it is:
   a) turning left at constant speed.
   b) traveling up a long straight incline at constant speed.
   c) topping the crest of a hill.
   d) bottoming out at the lowest point of a valley.
   e) speeding up as it descends a long straight decline.

2. A person standing at the edge of a cliff throws one ball straight up and another ball straight down at the same initial speed. Neglecting air resistance, the ball to hit the ground below the cliff with the greater speed is the one initially thrown
   a) upward
   b) downward
   c) neither of the above



3. You are throwing a ball straight up in the air. At the highest point, the ball's
   a) velocity and acceleration are zero.
   b) velocity is nonzero but its acceleration is zero
   c) acceleration is nonzero, but its velocity is zero
   d) velocity and acceleretion are both nonzero

4. A package is dropped from a plane flying at constant velocity parallel to the ground. The package will:
   a) fall behind the plane
   b) remain directly below the plane until hitting the ground
   c) move ahead of the plane
   d) it depends on the speed of the plane

provided neglect air resistance

5. An object moves at constant speed once aroud a circle. Which of the following statements is true?

a) it displacement and acceleration are both zero.
b) its average speed is zero
c) its displacement is nonzero and its acceleration is zero
d) its displacement is zero.

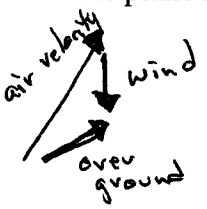
6. Which of the following statements is true for a particle in uniform circular motion?

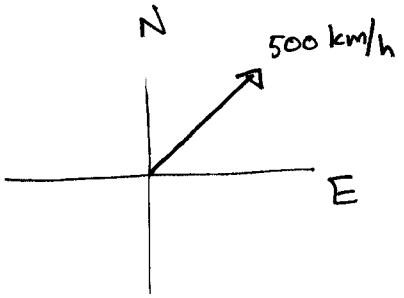
a) its velocity and acceleration vectors are always parallel
b) its velocity and acceleration vectors are always perpendicular
c) its acceleration vector is constant.
d) its velocity vector is constant.

} both change directions

7. A plane flies northeast with respect to the ground at 500 km/h. A wind is blowing with speed 100 km/h due south. The airspeed of the plane is

a) 500 km/h
b) 525 km/h
c) 575 km/h
d) 600 km/h
e) 625 km/h





$$\vec{V}_{\text{over ground}} = \vec{V}_{\substack{\text{plane}\\ \text{in}\\ \text{air}}} + \vec{V}_{\text{wind}}$$

$$(500\cos 45^\circ \hat{i} + 500\sin 45^\circ \hat{j}) = \vec{V}_{\substack{\text{plane}\\ \text{in}\\ \text{air}}} + (0\hat{i} - 100\hat{j})$$

$$(353.6\hat{i} + 356.6\hat{j}) = \vec{V}_{\substack{\text{plane}\\ \text{in}\\ \text{air}}} + (0\hat{i} - 100\hat{j})$$

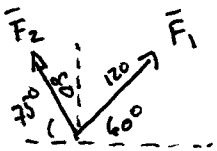
$$\vec{V}_{\substack{\text{plane}\\ \text{in}\\ \text{air}}} = 353.6\hat{i} + 456.6\hat{j}$$

the air speed is the magnitude

$$\sqrt{(353.6)^2 + (456.6)^2} = 578 \text{ km/h}$$

Ch3.31

a)



$$\vec{F}_{TOT} = \vec{F}_1 + \vec{F}_2$$

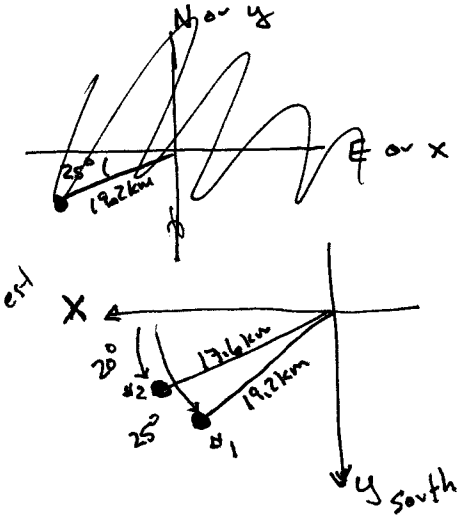
$$F_{TOT,x} = 120\cos 60^\circ - 80\cos 75^\circ$$
$$= 60 - 20.7$$
$$= 59.3 \text{ Newtons}$$

$$F_{TOT,y} = 120\sin 60^\circ + 80\sin 75^\circ$$
$$= 103.9 + 77.3$$
$$= 181.2 \text{ Newtons}$$

b) What third force could be added to cancel the above two?

$$\vec{F}_3 = -59.3\,\hat{i} - 181.2\,\hat{j} \text{ Newtons}$$

Ch 3.49



Use km units

Components for #1 $\vec{r}_1$

$x_1 = 19.2\cos 25^\circ$ $\quad y_1 = 19.2\sin 25^\circ$ $\quad z = 0.800$

$= 17.40$ $\quad = 8.11$ $\quad = 0.800$

Components for #2 $\vec{r}_2$

$x_2 = 17.6\cos 20^\circ$ $\quad y_2 = 17.6\sin 20^\circ$ $\quad z = 1.1$ km

$= 15.97$ $\quad = 6.02$ $\quad = 1.1$

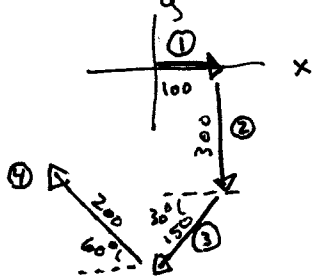
The separation vector is $\Delta\vec{r} = \vec{r}_2 - \vec{r}_1$

$\Delta x = -1.43$ $\quad \Delta y = -2.09$ $\quad \Delta z = 0.3$

The magnitude of the separation vector is

$$|\Delta\vec{r}| = \Delta r = \sqrt{(\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2}$$
$$= 2.55 \text{ km}$$

Ch3.57 Write each segment as a vector and add



$$\vec{r}_1 = 100\,\hat{i} + 0\,\hat{j}$$

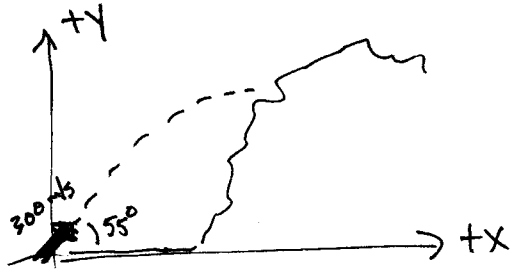
$$\vec{r}_2 = 0\,\hat{i} - 300\,\hat{j}$$

$$\vec{r}_3 = -150\cos 30^\circ\,\hat{i} - 150\sin 30^\circ\,\hat{j}$$
$$= -129.90\,\hat{i} - 75.0\,\hat{j}$$

$$\vec{r}_4 = -200\cos 60\,\hat{i} + 200\sin 60^\circ\,\hat{j}$$
$$= -100\,\hat{i} + 173.2\,\hat{j}$$

$$\vec{r}_{Tot} = -129.9\,\hat{i} - 201.8\,\hat{j}$$

Ch4.11



$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$

$x_0 = 0$

$v_{0x} = 300\cos 55^\circ = 172.1$

$a_x = 0$

$x(t) = 172.1\,t$

$y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

$y_0 = 0$

$v_{0y} = 300\sin 55^\circ = 245.7$

$a_y = -9.8\ m/s^2$

$y(t) = 245.7\,t + \frac{1}{2}(-9.8)t^2$

Location of projectile at $t = 42$ sec

$x = 172.1(42)$

~~$= 7442$ m~~

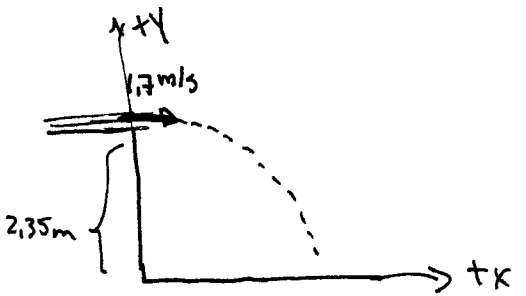
$= 7228$ m

$y = 245.7(42) + \frac{1}{2}(-9.8)(42)^2$

$10319.4 \qquad -8644.1$

$= 1676$ m

Ch4.16a



$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$

$x_0 = 0$

$v_{0x} = 1.7$

$a_x = 0$

$x(t) = 1.7\,t$

$y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

$y_0 = 2.35$

$v_{0y} = 0$

$a_y = -9.8$

$y(t) = 2.35 + \frac{1}{2}(-9.8)t^2$

Where does the water hit the ground?

$y(t) = 0 = 2.35 + \frac{1}{2}(-9.8)t^2$

$t = 0.693$ sec

$x = 1.7(0.693)$

$= 1.18$ m

This would give a walkway only about 4 feet wide.

I wonder how far away from the wall a 6 ft tall person could walk and not get wet? 6 ft ≈ 1.80 m

$y = 1.80 = 2.35 + \frac{1}{2}(-9.8)t^2$

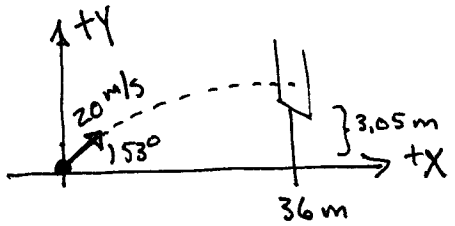
$t = 0.335$ sec

$x = 1.7(0.335)$

$= 0.57$ m ≈ 22"

So a walkway would probably be OK as long people stayed within 2ft of the wall.

Ch 4.17



$x(t) = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$ $\quad$ $y(t) = y_0 + v_{0y}t + \frac{1}{2}a_y t^2$

$x_0 = 0$ $\quad$ $y_0 = 0$

$v_{0x} = 20\cos 53^\circ = 12.0\ m/s$ $\quad$ $v_{0y} = 20\sin 53^\circ = 16.0\ m/s$

$a_x = 0$ $\quad$ $a_y = -9.8\ m/s^2$

$x(t) = 12t$ $\quad$ $y(t) = 16t + \frac{1}{2}(-9.8)t^2$

What is the ball's position when at goal ($x = 36$ m)?

$36 = 12t$

$t = 3$

$y = 16(3) + \frac{1}{2}(-9.8)(3)^2$

$= 3.9$ m

So the ball clears the cross bar by ~0.85 m

Is the ball rising or falling? To figure this out, find the position of max height.

The max height occurs when $v_y = 0$

$v_y(t) = v_{0y} + a_y t$

$0 = 16 - 9.8t$

$t = 1.63$ sec.

$x(t) = 12(1.63)$

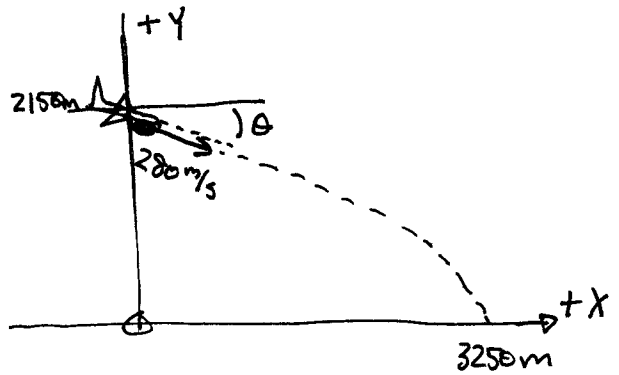
$= 19.6$ m

$y(t) = 16(1.63) + \frac{1}{2}(-9.8)(1.63)^2$

$= 17.6$ m

So the ball is falling as it goes though the goal

Ch 4. 18



$x(t) = x_0 + v_{ox}t + \frac{1}{2}a_x t^2$ $\quad$ $y(t) = y_0 + v_{oy}t + \frac{1}{2}a_y t^2$

$x_0 = 0$ $\quad$ $y_0 = 2150\ m$

$v_{ox} = 280\cos\theta = ?$ $\quad$ $v_{oy} = -280\sin\theta = ?$

$a_x = 0$ $\quad$ $a_y = -9.8\ m/s^2$

$x(t) = v_{ox}t$ $\quad$ $y(t) = 2150 + v_{oy}t + \frac{1}{2}(-9.8)t^2$

The bomb hits ground at $x = 3250$ $\quad$ $y = 0$

$3250 = v_{ox}t$ $\quad$ $0 = 2150 + v_{oy}t - 4.9t^2$

OK, there are really only 2 unknowns here, θ & t, but how do I get them out?

Try solving the horiz eqn for t, because it might make the least mess

$\frac{3250}{v_{ox}} = t$ $\quad\rightsquigarrow\quad$ $0 = 2150 + v_{oy}\frac{3250}{v_{ox}} - 4.9\left(\frac{3250}{v_{ox}}\right)^2$

$= 2150 - \tan\theta\ 3250 - 4.9\left(\frac{3250}{280\cos\theta}\right)^2$

$= 2150 - \tan\theta\ 3250 - 660.2\left(\frac{1}{\cos\theta}\right)^2$

OK, give up & do this numerically ---

$\theta = 22.89°$

Ch4.25

1 kg Radius = 1.06 m

$v = 20\ m/s$

$a_{\text{centripetal radial}} = \frac{v^2}{R} = \frac{(20)^2}{1.06}$

$= 377\ m/s^2$

$\vec{a}$ directed inward if constant speed

Ch4.26

$R = 9.45\ m$

$a_{radial} = \frac{v^2}{R}$

$v = R\omega$

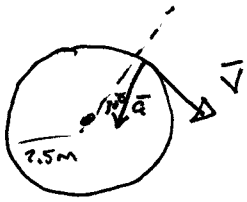
$= \omega^2 R$

$3(9.8\ m/s^2) = \omega^2\ 9.45$

$\omega = 1.76\ rad/sec$

$\omega = 0.28\ rev/sec$ (2π rad $\Leftrightarrow$ 1 rev)

Ch4.31



$|\vec{a}| = 15\ m/s^2$

$R = 2.5\ m$

a) radial comp of accel: from picture

$15\cos 30^\circ$

$13\ m/s^2$ (inward)

b) tangential speed

$a_{rad} = \frac{v^2}{R}$

$13 = \frac{v^2}{2.5}$

$v = 5.70\ m/s$

c) tangential comp of accel: from picture

$15\sin 30^\circ$

$7.5\ m/s^2$