Your Name: _____

PHY203
Exam #1
Chapters 1-3
Fri., 2/15/19

Solutions

1. A rocket is launched straight up from rest at ground level with an initial acceleration of 45.0 m/s^2. Take "up" as the positive x-direction and x=0 at ground level. The rocket accelerates for 25.0 s, then the motor cuts off

a. Find the velocity and acceleration of the rocket just after the motor cuts off (magnitudes and signs).

$a = -9.81\ m/s^2$ 3

$v = v_0 + at$

$= 0 + (45.0)(25.0) = 1.12 \times 10^3\ \frac{m}{s}$ 6

b. Find the velocity and acceleration of the rocket at its highest point (magnitudes and signs).

$a = -9.81\ m/s^2$ 3

$v = 0$ 3

c. Find the position of the rocket at its highest point.

$x_1 = \frac{1}{2} a t^2 = \frac{1}{2}(45.0)(25)^2$

$= 1.41 \times 10^4\ m$

$v^2 = v_0^2 + 2a\Delta x$ 15

$\Delta x = \frac{0 - (1.12 \times 10^3)^2}{-2g}$

$= 6.39 \times 10^4\ m$

$+ \ 1.41 \times 10^4\ m$

$7.80 \times 10^4\ m$

2. Two trains are traveling to the right on parallel tracks. At a time of t=0 train A passes the x=0 point with a constant speed of 16.0 m/s. At t=3.50 s train B which was at rest at x=0 starts traveling with a constant acceleration of 4.50 m/s^2.

a. Using the coordinate system depicted above, write an equation of motion (x vs. t) for train A:

$x_A =$ $16.0t$ 5

b. Using the coordinate system depicted above, write an equation of motion (x vs. t) for train B:

$x_B =$ $\frac{1}{2}(4.50)(t-3.50)^2 = 2.25(t-3.50)^2$ 10

c. Find the time at which the centers of the trains are side-by-side.

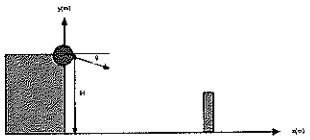
$16.0 = 2.25(t^2 - 7t + 12.25)$

$= 2.25t^2 - 15.75t + 27.56$

$0 = 2.25t^2 - 31.75t + 27.56$ 15

$t = \frac{31.75 \pm \sqrt{31.75^2 - 4 \cdot 2.25 \cdot 27.56}}{2 \cdot 2.25}$

$= 13.2\text{ s}, 0.9\text{ s}$



3. A cannonball is shot from a cliff of height H at a castle wall. The initial velocity of the ball is v_o at an angle of $\theta = -37.5^o$ with respect to the horizontal direction. The castle wall is Y = 65.0 m high and a horizontal distance of D from the base of the cliff. The initial vertical component of velocity of the cannonball is 55.0 m/s. The cannonball takes 12.5 s to reach the top of the castle wall, which it just grazes before traveling further.

a. Find the initial velocity of the cannonball and write it in vector notation using the coordinate system above.

In magnitude.

$$\tan 37.5 = \frac{55.0}{v_{0x}}, \quad v_{0x} = 71.7 \frac{m}{s} \qquad /10$$

$$\vec{v}_0 = (71.7\hat{i} - 55.0\hat{j})\ m/s$$

b. Find the height of the cliff.

$$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$$

$$65.0 = H - (55.0)(12.5) - \frac{1}{2}g(12.5)^2 \qquad /10$$

$$H = 1.52 \times 10^3\ m$$

c. Find the distance D of the wall from the cliff.

$$x = x_0 + v_{x0}t + 0 \qquad 5$$

$$D = 0 + (71.7)(12.5)$$

$$= 896\ m$$

d. Find the velocity and acceleration of the cannonball in vector notation just before it hits the ground.

$$\vec{a} = -9.81\hat{j}\ \frac{m}{s^2} \qquad 5$$

v_y:

$$v_y^2 = v_{y0}^2 + 2a_y \Delta y$$

$$v_y^2 = (55.0)^2 + 2(-g)(-1.52\times10^3) \qquad /10$$

$$= -181\ m/s$$

$$\vec{v} = (71.7\hat{i} - 181\hat{j})\ m/s$$

1. A rocket is launched straight up from rest at ground level with an initial acceleration of 55.0 m/s^2. Take "up" as the positive x-direction and x=0 at ground level. The rocket accelerates for 28.0 s, then the motor cuts off

a. Find the velocity and acceleration of the rocket just after the motor cuts off (magnitudes and signs).

$a = -9.81\ m/s^2$ 3

$v = v_0 + at = 0 + (55.0)(28.0)$

$= 1.54 \times 10^3\ m/s$ 6

b. Find the velocity and acceleration of the rocket at its highest point (magnitudes and signs).

$a = -9.81\ m/s^2$ 3

$v = 0$ 3

c. Find the position of the rocket at its highest point.

$x_1 = \frac{1}{2} a t^2 = \frac{1}{2} (55.0)(28.0)^2$

$= 2.16 \times 10^4\ m$

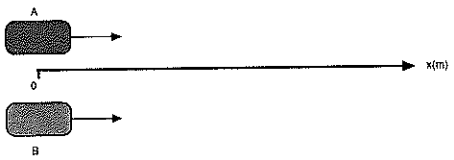
x_2: $v^2 = v_0^2 + 2a\Delta x$ 15

$0 = (1.54 \times 10^3)^2 + 2g\Delta x$

$\Delta x = 1.21 \times 10^5$

$+ 2.16 \times 10^4$

$1.42 \times 10^5\ m$



2. Two trains are traveling to the right on parallel tracks. At a time of t=0 train A passes the x=0 point with a constant speed of 18.0 m/s. At t=2.50 s train B which was at rest at x=0 starts traveling with a constant acceleration of 5.50 m/s^2.

a. Using the coordinate system depicted above, write an equation of motion (x vs. t) for train A:

$x_A =$ $18.0t$ 5

b. Using the coordinate system depicted above, write an equation of motion (x vs. t) for train B:

$x_B =$ $\frac{1}{2}(5.50)(t-2.50)^2 = 2.75(t-2.50)^2$ 10

c. Find the time at which the centers of the trains are side-by-side.

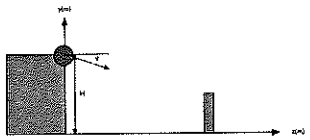
$18.0t = 2.75(t^2 - 5t + 6.25)$

$= 2.75t^2 - 13.75t + 17.2$

$0 = 2.75t^2 - 31.75t + 17.2$ 15

$t = \frac{31.75 \pm \sqrt{31.75^2 - 4 \cdot 2.75 \cdot 17.2}}{2 \cdot 2.75}$

$= 11.0\text{ s}, 0.5\cancel{23}\text{ s}$



3. A cannonball is shot from a cliff of height H at a castle wall. The initial velocity of the ball is v_o at an angle of $\theta = -37.5^o$ with respect to the horizontal direction. The castle wall is Y = 85.0 m high and a horizontal distance of D from the base of the cliff. The initial vertical component of velocity of the cannonball is 45.0 m/s. The cannonball takes 10.5 s to reach the top of the castle wall, which it just grazes before traveling further.

a. Find the initial velocity of the cannonball and write it in vector notation using the coordinate system above.

in magnitude

$$\tan 37.5^\circ = \frac{45.0}{v_{x0}}, \quad v_{x0} = 58.6 \frac{m}{s} \qquad 10$$

$$\vec{v_0} = (58.6\hat{i} - 45.0\hat{j})\ m/s$$

b. Find the height of the cliff.

$$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$$

$$85.0 = H - (45.0)(10.5) - \frac{1}{2}g(10.5)^2 \qquad 10$$

$$H = 1.10 \times 10^3\ m$$

c. Find the distance D of the wall from the cliff.

$$x = x_0 + v_{x0}t + 0 \qquad 5$$

$$D = 0 + (58.6)(10.5)$$

$$= 615\ m$$

d. Find the velocity and acceleration of the cannonball in vector notation just before it hits the ground.

$$\vec{a} = -9.81\hat{j}\ m/s^2 \qquad 5$$

$$v_y^2 = v_{y0}^2 + 2a_y \Delta y$$

$$v_y^2 = (45.0)^2 + (2)(-g)(-1.10 \times 10^3) \qquad 10$$

$$v_y = -153\ m/s$$

$$v_f = (58.6\hat{i} - 153\hat{j})\ m/s$$