Your Name: _____

PHY203
Exam #1
Chapters 1,2,4
10/1/21

Solutions

1 _____ (out of 25)

2 _____ (out of 35)

3 _____ (out of 40)

Total _____

- Show your work
- Use correct SI units
- Use scientific notation
- All answers with 3 significant figures
- Use g = 9.81 m/s^2

Exam1F21

1. A ball is thrown straight down from a cliff of height 200 m, with an initial speed of 7.50 m/s at t=0. Take "up" as the positive x-direction and x=0 at ground level.

a. Find the velocity, acceleration, and position after the ball has traveled for 1.50 s (magnitudes and signs). **15**

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

$$v = -7.50 + gt = -7.50 - 9.81(1.50)$$

$$= -22.2\ m/s$$

$$x = 200 - 7.50(1.50) - \frac{1}{2}(9.81)(1.50)^2$$

$$= 178\ m$$

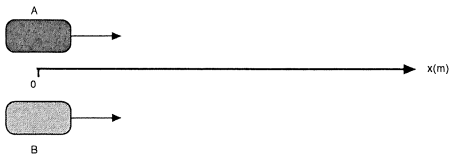
b. Find the time it takes the ball to hit the ground. **10**

$$0 = 200 - 7.50t - \frac{1}{2}gt^2$$

$$4.905t^2 + 7.50t - 200 = 0$$

$$t = \frac{-7.50 \pm \sqrt{7.50^2 + 4 \cdot 200 \cdot 4.905}}{9.81}$$

$$= 5.62\ s$$



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=4.50 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: **10**

$x_A =$ $16.0t$

b. Using the coordinate system depicted above, write an equation of motion (x vs. t) for train B: **15**

$x_B =$ $\frac{1}{2}(5.50)(t-4.50)^2$

c. Find the time at which the centers of the trains are side-by-side. **10**

$$16.0t = 2.75(t^2 - 9t + 20.25)$$

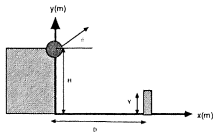
$$= 2.75t^2 - 24.75t + 55.7$$

$$2.75t^2 - 24.75t + 55.7 = 16.0t$$

$$2.75t^2 - 40.75t + 55.7 = 0$$

$$t = \frac{40.75 \pm \sqrt{40.75^2 - 4 \cdot 2.75 \cdot 55.7}}{5.50}$$

$= 1.57\text{s}$, 13.3s



3. A cannonball is shot from a cliff of height H = 115 m at a castle wall, as shown above. The castle wall is Y = 55.0 m high and a horizontal distance D = 205 m from the cannon. The initial vertical component of velocity of the ball is 35.0 m/s in magnitude. Take y = 0 at ground level. Assume the ball just grazes the top of the wall.

a. Find the initial velocity of the cannonball and write it in vector notation using the coordinate system above. **20**

$$y: \quad 55.0 = 115 + 35.0t - \frac{1}{2}gt^2$$

$$4.905t^2 - 35.0t - 60 = 0$$

$$t = \frac{35.0 \pm \sqrt{35.0^2 + 4.60.4.905}}{9.81}$$

$$= 8.56\,s$$

$$x: \quad 205 = v_{0x}(8.56), \quad v_{0x} = 23.9\ m/s$$

$$\vec{v}_0 = (23.9\hat{i} + 35.0\hat{j})\ m/s$$

b. Find velocity and acceleration of the cannonball at its highest point and write them in vector notation. **10**

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

$$\vec{v} = 23.9\hat{i}\ m/s$$

c. Find the velocity of the cannonball in vector notation just as it grazes the top of the wall. **10**

$$v_y = 35.0 - g(8.54)$$

$$= -49.0\ m/s$$

$$\vec{v} = (23.9\hat{i} - 49.0\hat{j})\ m/s$$

Exam1F21

1. A ball is thrown straight down from a cliff of height 250 m, with an initial speed of 9.50 m/s at t=0. Take "up" as the positive x-direction and x=0 at ground level.

a. Find the velocity, acceleration, and position after the ball has traveled for 2.50 s (magnitudes and signs). **15**

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

$$v = -9.50 - gt = -9.50 - 9.81(2.50)$$

$$= -34.0\ m/s$$

$$x = 250 - 9.50(2.50) - \frac{1}{2}g(2.50)^2$$

$$= 196\ m$$

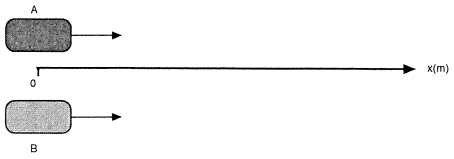
b. Find the time it takes the ball to hit the ground. **10**

$$0 = 250 - 9.50t - \frac{1}{2}gt^2$$

$$4.905t^2 + 9.50t - 250 = 0$$

$$t = \frac{-9.50 \pm \sqrt{9.50^2 + 4 \cdot 250 \cdot 4.905}}{9.81}$$

$$= 6.28\ s$$



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=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: **10**

$x_A =$ $18.0t$

b. Using the coordinate system depicted above, write an equation of motion (x vs. t) for train B: **15**

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

c. Find the time at which the centers of the trains are side-by-side. **10**

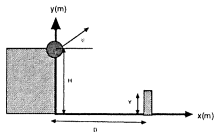
$$18.0t = 2.25(t^2 - 7t + 12.25)$$

$$= 2.25t^2 - 15.75t + 27.6$$

$$0 = 2.25t^2 - 33.75t + 27.6$$

$$t = \frac{33.75 \pm \sqrt{33.75^2 - 4 \cdot 2.25 \cdot 27.6}}{4.50}$$

$= 0.[illegible]\,s,\ 14.1\,s$



3. A cannonball is shot from a cliff of height H = 125 m at a castle wall, as shown above. The castle wall is Y = 55.0 m high and a horizontal distance D = 225 m from the cannon. The initial vertical component of velocity of the ball is 40.0 m/s in magnitude. Take y = 0 at ground level. Assume the ball just grazes the top of the wall.

a. Find the initial velocity of the cannonball and write it in vector notation using the coordinate system above. **20**

$$y: \quad 55.0 = 125 + 40.0t - \tfrac{1}{2}gt^2$$

$$4.905t^2 - 40t - 70 = 0$$

$$t = \frac{40 \pm \sqrt{40^2 + 4.70 \cdot 4.905}}{9.81}$$

$$= 9.64\ s$$

$$x: \quad 225 = v_{0x}(9.64), \quad v_{0x} = 23.4\ m/s$$

$$\vec{v}_0 = (23.4\hat{i} + 40.0\hat{j})\ m/s$$

b. Find velocity and acceleration of the cannonball at its highest point and write them in vector notation. **10**

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

$$\vec{v} = 23.4\hat{i}\ m/s$$

c. Find the velocity of the cannonball in vector notation just as it grazes the top of the wall. **10**

$$v_f = 40.0 - g(9.64) = -54.6\ m/s$$

$$\vec{v} = (23.4\hat{i} - 54.6\hat{j})\ m/s$$