

Your Name: \_\_\_\_\_

**PHY203  
Exam #1  
Chapters 1-3  
Fri., 9/29/17**

*Solutions*

Exam1F17

1. A ball is thrown straight up from ground level with an initial speed of 25.5 m/s at  $t=0$ . Take "up" as the positive x-direction and  $x=0$  at ground level.

a. Find the velocity and acceleration at the highest point (magnitudes and signs).

$$v = 0 \quad 3$$

$$a = -9.81 \text{ m/s}^2 \quad 3$$

b. To find the distance the ball travels to reach its highest point, which kinematic equation works best, A, B, or C? Explain (briefly) why you chose this equation.

C  
we know  $v_i$  and  $v_f$   
and the acceleration, 4

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

$$0 = 25.5^2 - 2g \Delta x \quad 5$$

$$\Delta x = x = 33.1 \text{ m}$$

d. Find the 2 times at which the ball is at a position halfway to the highest point.

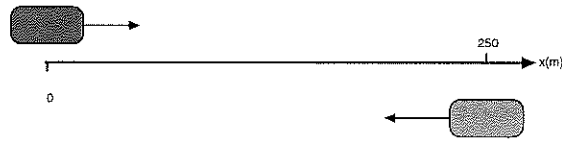
$$33.1 / 2 = 16.6 \text{ m}$$

eq. A:  $16.6 = 0 + 25.5t - \frac{1}{2}gt^2$

$$4.905t^2 - 25.5t + 16.6 = 0 \quad 10$$

$$t = \frac{25.5 \pm \sqrt{25.5^2 - 4 \cdot 4.905 \cdot 16.6}}{9.81}$$

$$= 0.763 \text{ s}, 4.43 \text{ s}$$



2. Two trains approach each other on parallel tracks. At a time of  $t=0$  the train on the left is at rest at  $x=0$  and begins to accelerate at  $2.50 \text{ m/s}^2$  to the right. At  $t=5 \text{ s}$  the train on the right is separated from the train on the left by  $250 \text{ m}$  and is traveling with a constant speed of  $15.0 \text{ m/s}$  and continues to travel at that speed to the left.

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

$$x_l = 0 + 0 + \frac{1}{2} (2.50)t^2 = 1.25t^2 \text{ m} \quad 10$$

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

$$x_r = 250 - 15.0(t-5) \quad 10$$

c. Find the 1st time at which the centers of the trains are separated by  $50.0 \text{ m}$ .

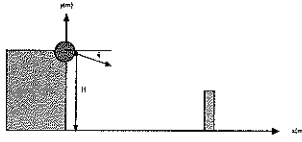
$$x_r - x_l = 50.0 \text{ m}$$

$$250 - 15.0(t-5) - 1.25t^2 = 50.0$$

$$1.25t^2 + 15.0t - 275 = 0$$

$$t = \frac{-15.0 \pm \sqrt{15.0^2 + 4 \cdot 1.25 \cdot 275}}{2 \cdot 1.25}$$

$$= 10.0 \text{ s}$$



3. A cannonball is shot from a cliff of height  $H = 675$  m at a castle wall. The initial velocity of the ball is  $v_0$  at an angle of  $\theta$  with respect to the horizontal direction. The castle wall is  $Y = 65.0$  m high and a horizontal distance of  $D = 175$  m from the base of the cliff. Assume the cannonball just grazes the top of the wall after a time of 5.50 s.

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

$$x: \quad 175 = 0 + v_{x0}(5.50) + 0 \quad 10$$

$$v_{x0} = 31.8 \text{ m/s}$$

$$y: \quad 65 = 675 + v_{y0}(5.50) - \frac{1}{2}g(5.50)^2 \quad 10$$

$$v_{y0} = -83.9 \text{ m/s}$$

$$\vec{v}_0 = (31.8 \hat{i} - 83.9 \hat{j}) \text{ m/s} \quad 5$$

b. Find the x position at which the cannonball lands.

$$y: \quad 0 = 675 + (-83.9)t - \frac{1}{2}gt^2$$

$$4.905t^2 + 83.9t - 675 = 0$$

$$t = \frac{-83.9 \pm \sqrt{83.9^2 + 4 \cdot 4.905 \cdot 675}}{9.81} \quad 15$$

$$= 5.97 \text{ s}$$

$$x: \quad X = 31.8(5.97) = 190 \text{ m}$$

Exam1F17 alt

1. A ball is thrown straight up from ground level with an initial speed of 35.5 m/s at  $t=0$ . Take "up" as the positive x-direction and  $x=0$  at ground level.

a. Find the velocity and acceleration at the highest point (magnitudes and signs).

$$v = 0 \quad 3$$

$$a = -9.81 \text{ m/s}^2 \quad 3$$

b. To find the distance the ball travels to reach its highest point, which kinematic equation works best, A, B, or C? Explain (briefly) why you chose this equation.

C

We know the initial and final velocity and acceleration. 4

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

$$0 = (35.5)^2 - 2g \Delta x \quad 5$$

$$\Delta x = x = 64.2 \text{ m}$$

d. Find the 2 times at which the ball is at a position halfway to the highest point.

$$64.2 / 2 = 32.1 \text{ m}$$

$$\text{eg. A: } 32.1 = 0 + 35.5t - \frac{1}{2}gt^2 \quad 10$$

$$4.905t^2 - 35.5t + 32.1 = 0$$

$$t = \frac{35.5 \pm \sqrt{35.5^2 - 4(4.905)(32.1)}}{9.81}$$

$$= 1.06 \text{ s}, 6.18 \text{ s}$$



2. Two trains approach each other on parallel tracks. At a time of  $t=0$  the train on the left is at rest at  $x=0$  and begins to accelerate at  $3.50 \text{ m/s}^2$  to the right. At  $t=5 \text{ s}$  the train on the right is separated from the train on the left by  $450 \text{ m}$  and is traveling with a constant speed of  $25.0 \text{ m/s}$  and continues to travel at that speed to the left.

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

$$x_l = 0 + 0 + \frac{1}{2} 3.50 t^2 = 1.75 t^2 \quad 10$$

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

$$x_r = 450 - 25.0(t - 5) \quad 10$$

c. Find the 1st time at which the centers of the trains are separated by  $50.0 \text{ m}$ .

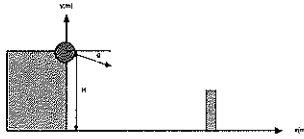
$$x_r - x_l = 50.0$$

$$450 - 25.0(t - 5) - 1.75t^2 = 50.0 \quad 15$$

$$1.75t^2 + 25.0t - 525 = 0$$

$$t = \frac{-25.0 \pm \sqrt{25.0^2 + 4 \cdot 1.75 \cdot 525}}{3.50}$$

$$= 11.6 \text{ s}$$



3. A cannonball is shot from a cliff of height  $H = 775$  m at a castle wall. The initial velocity of the ball is  $v_0$  at an angle of  $\theta$  with respect to the horizontal direction. The castle wall is  $Y = 95.0$  m high and a horizontal distance of  $D = 255$  m from the base of the cliff. Assume the cannonball just grazes the top of the wall after a time of 5.50 s.

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

$$x: 255 = v_{x0}(5.50) \quad 10$$

$$v_{x0} = 46.4 \text{ m/s}$$

$$y: 95.0 = 775 \text{ m} + v_{y0}(5.50) - \frac{1}{2}g(5.50)^2$$

$$v_{y0} = -96.7 \text{ m/s} \quad 10$$

$$\vec{v}_0 = (46.4\hat{i} - 96.7\hat{j}) \text{ m/s} \quad 5$$

b. Find the x position at which the cannonball lands.

$$y: 0 = 775 - 96.7t - \frac{1}{2}gt^2 \quad 15$$

$$4.905t^2 + 96.7t - 775 = 0$$

$$t = \frac{-96.7 \pm \sqrt{96.7^2 + 4 \cdot 4.905 \cdot 775}}{9.81}$$

$$= 6.11 \text{ s}$$

$$x: X = (46.4)(6.11) = 283 \text{ m}$$