Your Name: _____

PHY203
Exam #1
Chapters 1-3
Fri., 9/27/19

Solutions

Your Name: _____

PHY203
Exam #1
Chapters 1-3
Fri., 9/27/19

1 _____ **(out of 25)**

2 _____ **(out of 35)**

3 _____ **(out of 40)**

Total _____

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

Exam1F19

1. A ball is thrown straight up from a cliff of height 250 m, with an initial speed of 52.5 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).

$v = 0$

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

b. Find the time it takes the ball to reach its highest point.

B $v = v_0 + at$

$0 = 52.5 + (-9.81)t$ 5

$t = 5.35\ s$

c. Find the velocity, acceleration (magnitude and sign), and the x position of the ball when it is 2.50 s from the highest point (2 sets of answers). (Assume it just clears the cliff on the way down.)

$t_1 = 5.35 - 2.50$

$= 2.85\ s$

$a_1 = -9.81\ m/s^2$

$v_1 = 52.5 - 9.81(2.85)$

$= 24.5\ m/s$

$x_1 = 250 + 52.5(2.85) - \frac{1}{2}g(2.85)^2$

$= 360\ m$

$t_2 = 5.35 + 2.50$

$= 7.85\ s$

$a_1 = -9.81\ m/s^2$ 4

$v_2 = 52.5 - 9.81(7.85)$

$= -24.5\ m/s$ 6

$x_2 = 250 + 52.5(7.85) - \frac{1}{2}g(7.85)^2$

$= 360\ m$ 6

2. Two trains are traveling to the right on parallel tracks. At a time of t=0 train A passes the x=0 point traveling in the +x direction with a constant speed of 19.0 m/s. At t=4.50 s train B which was at rest at x=-100 m starts traveling with a constant acceleration of 6.00 m/s^2 in the +x direction. The train accelerates for until t = 8.00 s then continues at a constant speed.

a. Write an equation of motion (x vs. t) for train A:

$x_A =$ $19.0t$ 5

b. Write equations of motion (x vs. t) for train B for t<8.00 s and t≥8.00s:

t<8.00 s $x_B =$ $-100 + \frac{1}{2}(6.00)(t-4.50)^2$

$= -100 + (3.00)(t-4.50)^2$ 10

t≥8.00 s $x_B =$

$x_B(8) = -100 + \frac{1}{2}(6.00)(3.50)^2 = -63.2\text{ m}$

$v_B(8) = 0 + 6.00(3.50) = 21.0\text{ m/s}$ 15

$\therefore x_B = -63.2 + 21.0(t-8)$

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

$19.0t = -63.2 + 21.0(t-8)$

$= -63.2 + 21t - 168$ 5

$2t = 231.2$

$t = 116\text{ s}$

3. A cannonball is launched from ground level with a speed of 65.0 m/s at angle of 35° with respect to the horizontal. Choose the x-axis as the horizontal direction (+x in the direction of travel); y-axis as vertical, +y is "up". Take x=y=0 at the starting point.

a. Find the velocity of the cannonball at its highest point in vector notation.

$v_{x0} = 65.0 \cos 35.0 = 53.2$ m/s

$\vec{v} = 53.2\hat{i}$ m/s

5

b. Find the acceleration of the cannonball at its highest point in vector notation.

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

5

c. Find the position of the cannonball at its highest point in vector notation.

$v_{y0} = 65.0 \sin 35.0 = 37.3$ m/s

ϵ: $0 = 37.3 - gt$, $t = 3.80$ s

$x = (53.2)(3.80) = 202$ m

$y = 0 + 37.3(3.80) - \frac{1}{2}g(3.80)^2$

$= 70.9$ m

$\vec{r} = (202\hat{i} + 70.9\hat{j})$ m

15

d. Find the position, velocity, and acceleration of the cannonball in vector notation after it has traveled a horizontal distance of 255 m.

ϵ: $255 = 53.2t$, $t = 4.79$ s

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

$v_y = 37.3 - g(4.79) = -9.69$ m/s

$\vec{v} = (53.2\hat{i} - 9.69\hat{j})$ m/s

$y = 0 + 37.3(4.79) - \frac{1}{2}g(4.79)^2$

$= 66.1$ m

$\vec{r} = (255\hat{i} + 66.1\hat{j})$ m

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Exam1F19 colt

1. A ball is thrown straight up from a cliff of height 175 m, with an initial speed of 57.5 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).

$v = 0$ 2

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

b. Find the time it takes the ball to reach its highest point.

B $v = v_0 + at$

$0 = 57.5 + (-9.81)t$ 5

$t = 5.86\ s$

c. Find the velocity, acceleration (magnitude and sign), and the x position of the ball when it is 2.25 s from the highest point (2 sets of answers). (Assume it just clears the cliff on the way down.)

$t_1 = 5.86 - 2.25 = 3.61\ s$ $t_2 = 5.86 + 2.25 = 8.11\ s$

$a_1 = -9.81\ m/s^2$ $a_2 = -9.81\ m/s^2$ 4

$v_1 = 57.5 - 9.81(3.61)$ $v_2 = 57.5 - (9.81)(8.11)$

$= 22.1\ m/s$ $= -22.1\ m/s$ 6

$x_1 = 175 + 57.5(3.61) - \frac{1}{2}g(3.61)^2$ $x_2 = 175 + 57.5(8.11) - \frac{1}{2}g(8.11)^2$

$= 319\ m$ $= 319\ m$ 6

2. Two trains are traveling to the right on parallel tracks. At a time of t=0 train A passes the x=0 point traveling in the +x direction with a constant speed of 17.0 m/s. At t=3.50 s train B which was at rest at x=-100 m starts traveling with a constant acceleration of 7.00 m/s^2 in the +x direction. The train accelerates until t = 7.50 s then continues at a constant speed.

a. Write an equation of motion (x vs. t) for train A:

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$x_A =$ $17.0t$

b. Write equations of motion (x vs. t) for train B for t<7.00 s and t≥7.00s:

5 5

t<7.50 s $x_B =$ $-100 + \frac{1}{2}(7.00)(t-3.50)^2$ 10

$= -100 + 3.50(t-3.50)^2$

t≥7.50 s $x_B =$

$x_B(7.50) = -100 + 3.50(4.00)^2 = -44.0\ m$

$v_B(7.50) = 0 + 7.00(4.00) = 28.0\ m/s$

$\therefore\ x_B = -44.0 + 28.0(t-7.50)$ 15

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

$17.0t = -44.0 + 28.0(t-7.50)$

$= -44.0 + 28.0t - 210$ 5

$11.0t = 254$

$t = 23.1\ s$

3. A cannonball is launched from ground level with a speed of 75.0 m/s at angle of 35° with respect to the horizontal. Choose the x-axis as the horizontal direction (+x in the direction of travel); y-axis as vertical, +y is "up". Take x=y=0 at the starting point.

a. Find the velocity of the cannonball at its highest point in vector notation.

$v_{x0} = 75.0 \cos 35.0 = 61.4 \text{ m/s}$

$\vec{v} = 61.4\,\hat{i} \text{ m/s}$

5

b. Find the acceleration of the cannonball at its highest point in vector notation.

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

5

c. Find the position of the cannonball at its highest point in vector notation.

$v_{y0} = 75.0 \sin 35.0 = 43.0 \text{ m/s}$

t: $0 = 43.0 - 9t$; $t = 4.39 \text{ s}$

$x = 61.4(4.39) = 269 \text{ m}$

$y = 0 + 43.0(4.39) - \frac{1}{2} g (4.39)^2$

$= 94.2 \text{ m}$

$\vec{r} = (269\,\hat{i} + 94.2\,\hat{j}) \text{ m}$

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d. Find the position, velocity, and acceleration of the cannonball in vector notation after it has traveled a horizontal distance of ~~205 m~~ 300 m.

t: $300 = 61.4t$; $t = 4.89 \text{ s}$

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

$v_y = 43.0 - g(4.89) = -4.93 \text{ m/s}$

$\vec{v} = (61.4\,\hat{i} - 4.93\,\hat{j}) \text{ m/s}$

$y = 0 + 43.0(4.89) - \frac{1}{2} g (4.89)^2$

$= 93.0$

$\vec{r} = (300\,\hat{i} + 93.0\,\hat{j}) \text{ m}$

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