

Your Name: _____

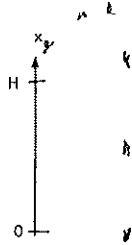
PHY203
Exam #1
Chapters 1-4
Fri., Sept. 26, 2025

Solutions

Exam 1926 Makeup F25

1. A ball is thrown straight up from a cliff of height 50.0 m with an initial speed of 27.5 m/s. Take $x=0$ at ground level.

a. Produce a motion diagram of the ball from cliff to ground level: 5



b. Fill out the table of known quantities for the ball: 5

Parameter	Known Value
x_0	50.0 m
x_f	0
v_0	27.5 m/s
v_f	
a	-9.81 m/s ²
t	

c. Find the position of the highest point. 10

$$0 = 27.5^2 - 2g \Delta x$$

$$\Delta x = \frac{27.5^2}{2g} = 38.5$$

$$x = 38.5 + 50 = 88.5 \text{ m}$$

d. Find the 2 times it takes for the ball to reach a position of 82.0 m. 10

$$A: 82 = 50 + 27.5t - \frac{1}{2}gt^2$$

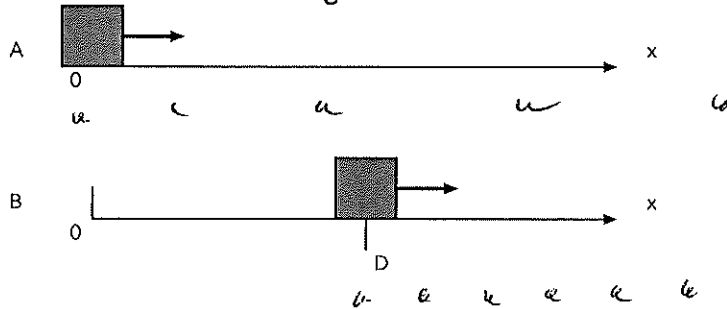
$$4.905t^2 - 27.5t + 32 = 0$$

$$t = \frac{27.5 \pm \sqrt{27.5^2 - 4(4.905)(32)}}{9.81}$$

$$= 1.65 \text{ s or } 3.96 \text{ s}$$

2. Two trains are traveling in the same direction on parallel tracks. At $t=0$, train A passes the $x=0$ point with a speed of 6.00 m/s and starts to accelerate with an acceleration of 3.00 m/s^2 . At $t=0$, train B passes the point $D = 150$ with a constant speed of 9.00 m/s . We want to find the time that the trains are side-by-side.

a. Produce motion diagrams of the trains from $t=0$ below each sketch: 5



b. Fill out the tables of known quantities for the two trains:

Train A:

Train B:

Parameter	Known Value	Parameter	Known Value
x_0	0	x_0	150 m
x_f		x_f	
v_0	6.00 m/s	v_0	9.00 m/s
v_f		v_f	9.00 m/s
a	3.00 m/s ²	a	0
t		t	

c. Write the equation for the position of train A as a function of time: 10

$$x_A = 6.00t + \frac{1}{2}(3.00)t^2 = 6.0t + 1.5t^2$$

d. Write the equation for the position of train B as a function of time: 10

$$x_B = 150 + 9.00t$$

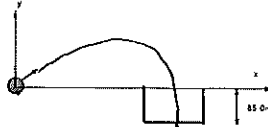
e. Find the time the trains are side-by-side. 5

$$6t + 1.5t^2 = 150 + 9t$$

$$1.5t^2 - 3t - 150 = 0$$

$$t = \frac{3 \pm \sqrt{3^2 + 4 \cdot 150 \cdot 1.5}}{2 \cdot 1.5}$$

$$= 11.0 \text{ s}$$



3. A cannonball is shot from ground level with an initial speed of 55.0 m/s at an angle of 40.0° with respect to the horizontal. Take $y=0$ at ground level. It eventually lands in a valley with a depth of 85.0 m.

a. Make a sketch of the trajectory of the ball from start until it hits the ground. **5**

b. Fill out the tables of known values. (Take the "final" position as the ball at its highest point.)

Parameter	Known Value
x_0	0
x_f	
v_{x0}	42.1 m/s
v_{xf}	42.1 m/s
a_x	0
t	

Parameter	Known Value
y_0	0
y_f	
v_{y0}	35.4 m/s
v_{yf}	0
a_y	-9.81 m/s^2
t	

$$55 \cos 40 = 42.1$$

$$55 \sin 40 = 35.4$$

c. Find the position, velocity, and acceleration of the cannonball at its highest point in vector notation using the coordinate system above. **20**

$$\vec{a} = -9.81 \text{ m/s}^2 \hat{j} ; \vec{v} = 42.1 \text{ m/s} \hat{i}$$

$$y: 0 = 35.4 - g t, t = 3.60 \text{ s}$$

$$x: x = 42.1 (3.60) = 152 \text{ m}$$

$$y: 0 = 35.4^2 - 2g \Delta y$$

$$\Delta y = 63.9$$

$$\vec{r} = (152 \hat{i} + 63.9 \hat{j}) \text{ m}$$

d. Find the velocity of the cannonball in vector notation just before it hits the ground (in the valley). **15**

$$y: v_y^2 = 35.4^2 - 2g (-85.0)$$

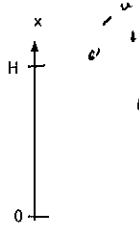
$$v_y = -54.0$$

$$\vec{v} = (42.1 \hat{i} - 54.0 \hat{j}) \text{ m/s}$$

PHY203Exam1F25alt

1. A ball is thrown straight up from a cliff of height 60.0 m with an initial speed of 17.5 m/s. Take $x=0$ at ground level.

a. Produce a motion diagram of the ball from cliff to ground level: 5



b. Fill out the table of known quantities for the ball: 5

Parameter	Known Value
x_0	60.0 m
x_f	0
v_0	17.5 m/s
v_f	
a	$\sim 9.81 \text{ m/s}^2$
t	

c. Find the position of the highest point. 10

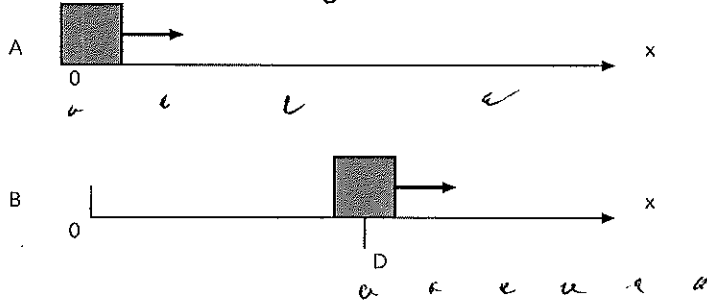
$$\begin{aligned}
 \text{c: } 0 &= (17.5)^2 - 2g \Delta y \\
 \Delta y &= (17.5)^2 / 2g = 15.6 \\
 15.6 + 60 &= 75.6 \text{ m}
 \end{aligned}$$

d. Find the 2 times it takes for the ball to reach a position of 70.0 m. 10

$$\begin{aligned}
 \text{A: } 70 &= 60 + 17.5t - \frac{1}{2}gt^2 \\
 4.905t^2 - 17.5t + 10 &= 0 \\
 t &= \frac{17.5 \pm \sqrt{17.5^2 - 4(4.905)(10)}}{9.81} \\
 &= \frac{17.5 \pm 10.5}{9.81} = 0.715 \text{ s}, 2.85 \text{ s}
 \end{aligned}$$

2. Two trains are traveling in the same direction on parallel tracks. At $t=0$, train A passes the $x=0$ point with a speed of 5.00 m/s and starts to accelerate with an acceleration of 2.50 m/s^2 . At $t=0$, train B passes the point $D = 150$ with a constant speed of 8.00 m/s . We want to find the time that the trains are side-by-side.

a. Produce motion diagrams of the trains from $t=0$ below each sketch: 5



b. Fill out the tables of known quantities for the two trains:

Train A:

Train B:

Parameter	Known Value	Parameter	Known Value
x_0	0	x_0	150 m
x_f		x_f	
v_0	5.00 m/s	v_0	8.00 m/s
v_f		v_f	8.00 m/s
a	2.50 m/s ²	a	0
t		t	

c. Write the equation for the position of train A as a function of time: 10

$$x_A = 0 + 5.00t + \frac{1}{2}(2.50)t^2 = 5t + 1.25t^2$$

d. Write the equation for the position of train B as a function of time: 10

$$x_B = 150 + 8.00t$$

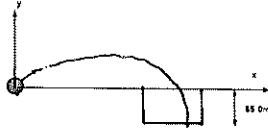
e. Find the time the trains are side-by-side. 5

$$5t + 1.25t^2 = 150 + 8t$$

$$1.25t^2 - 3t - 150 = 0$$

$$t = \frac{3 \pm \sqrt{3^2 + 4 \cdot 1.25 \cdot 150}}{2 \cdot 1.25}$$

$$= 17.2 \text{ s}$$



3. A cannonball is shot from ground level with an initial speed of 65.0 m/s at an angle of 40.0° with respect to the horizontal. Take $y=0$ at ground level. It eventually lands in a valley with a depth of 75.0 m.

a. Make a sketch of the trajectory of the ball from start until it hits the ground. 5

b. Fill out the tables of known values. (Take the "final" position as the ball at its highest point.)

Parameter	Known Value
x_0	0
x_f	
v_{x0}	49.8 m/s
v_{xf}	49.8 m/s
a_x	0
t	

Parameter	Known Value
y_0	0
y_f	
v_{y0}	41.8 m/s
v_{yf}	0
a_y	-9.81 m/s^2
t	

$$65 \cos 40^\circ = 49.8$$

$$65 \sin 40^\circ = 41.8$$

c. Find the position, velocity, and acceleration of the cannonball at its highest point in vector notation using the coordinate system above. 20

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

$$\vec{v} = 49.8 \hat{i} \text{ m/s}$$

$$y: B: 0 = 41.8 - g t, \quad t = 4.26 \text{ s}$$

$$x: A: x = 0 + 49.8(4.26) = 212 \text{ m}$$

$$y: C: 0 = 41.8^2 - 2g \Delta y$$

$$\Delta y = 89.1 \text{ m}$$

$$\vec{r} = (212 \hat{i} + 89.1 \hat{j}) \text{ m}$$

d. Find the velocity of the cannonball in vector notation just before it hits the ground (in the valley). 15

$$y: C: v_y^2 = 41.8^2 - 2g(-75 - 0)$$

$$= 41.8^2 + 2g(75)$$

$$v_y = 56.7 \text{ m/s}$$

$$\vec{v} = (49.8 \hat{i} + 56.7 \hat{j}) \text{ m/s}$$