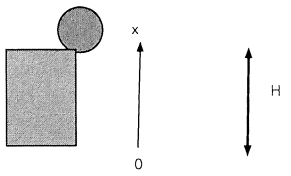
Your Name: _____

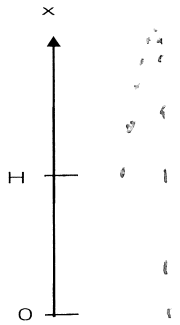
PHY203
Exam #1
Chapters 1-4
2/17/23

Solutions



12. A ball is thrown straight up from the top of a cliff of height, H, with an initial speed of 7.50 m/s. It takes 5.00 s for the ball to hit the ground. We want to find the height of the cliff. (Ignore air resistance.)

a. Produce a motion diagram of the ball: **5**



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

Parameter	Known Value
x_0	H
x_f	0
v_0	$7.50\ m/s$
v_f	
a	$-9.81\ m/s^2$
t	$5.00\ s$

c. Find the height of the cliff. **15**

$$0 = H + 7.50(5.00) - \frac{1}{2}g(5.00)^2$$

$$H = 4.905(5.00)^2 - 7.50(5.00)$$

$$= 85.1\ m$$

d. Find the velocity of the ball just before it hits the ground (magnitude and sign). **5**

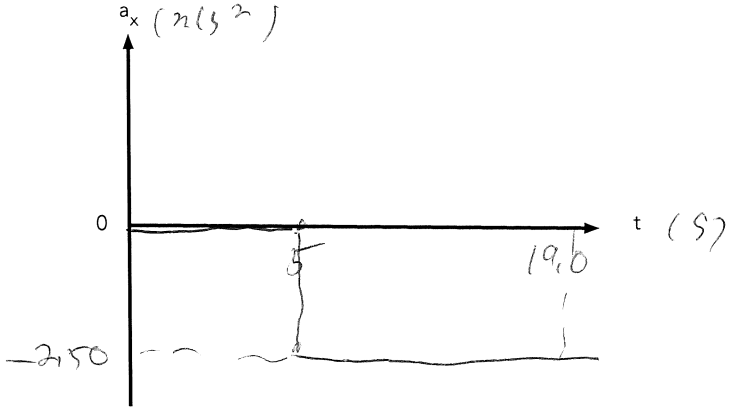
$$v = v_0 - at = 7.50 - g(5.00)$$

$$= -41.6\ m/s$$

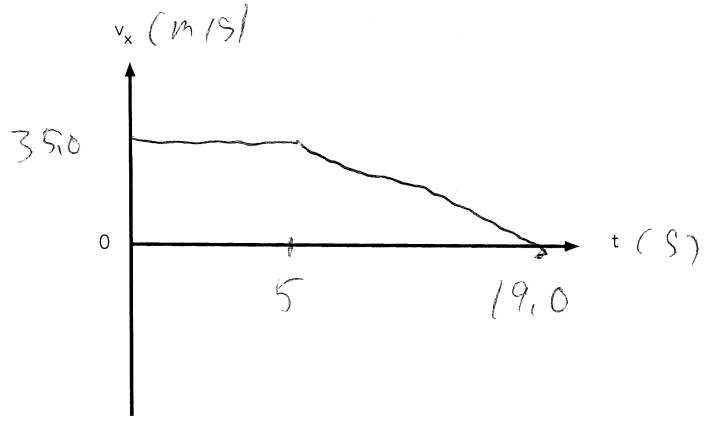
2. A puck is given a push along a horizontal, frictionless surface starting at x=0 at t=0 with an initial speed of 35.0 m/s. Traveling in the +x-direction after 5.00 s, the puck encounters air resistance which results in an acceleration acting in the -x-direction of magnitude 2.50 m/s^2.

Plot the following from t=0 until the puck stops moving, <u>including appropriate values and units on **both** axes</u>.

a. Acceleration vs. time. **10**



b. Velocity vs. time. **10**

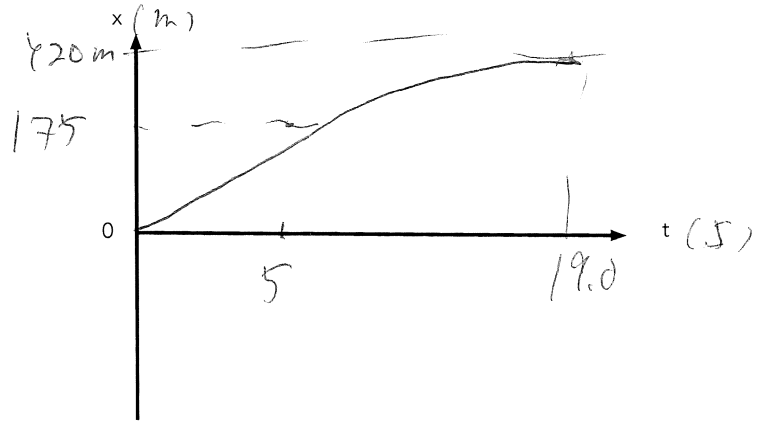


$0 = 350 - 2.50t$

$t = 14.0\text{ s}$

$+ 5.00 = 19.0$

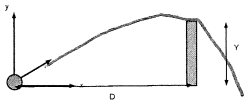
c. Position vs. time. **10**



$x_1 = 350(5.00) = 175\text{ m}$

$x_2 = 175 + 350(14) - \frac{1}{2}(250)(14)^2$

$= 420\text{ m}$



3. A cannonball is shot from ground level at a castle wall. 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 85.0 m/s in magnitude. Take y = 0 at ground level. Assume the ball just grazes the top of the wall <u>on the way down</u>.

a. Make a sketch of the trajectory of the ball from start until it grazes the wall. **5**

b. Fill out the tables of known values. (Take the "final" position as when the ball grazes the wall.) **5**

Parameter	Known Value
x_0	0
x_f	205 m
v_{x0}	
v_{xf}	
a_x	0
t	

Parameter	Known Value
y_0	0
y_f	55.0 m
v_{y0}	85.0 m/s
v_{yf}	
a_y	$-9.81\ m/s^2$
t	

c. Find the initial velocity of the cannonball and write it in vector notation using the coordinate system above. **15**

y: $55.0 = 0 + 85.0t - \frac{1}{2}gt^2$

$4.905t^2 - 85.0t + 55.0 = 0$

$t = \dfrac{85.0 \pm \sqrt{85.0^2 - 4(4.905)(55.0)}}{9.81} = 16.7\ s$

x: $205 = 0 + v_{0x}(16.7)$, $v_{0x} = 12.3\ m/s$

$\vec{v}_0 = (12.3\hat{i} + 85.0\hat{j})\ m/s$

d. Find the position, velocity, and acceleration of the cannonball in vector notation after it has been traveling for 11.5 s. **15**

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

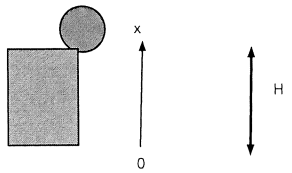
$v_y = 85.0 - g(11.5) = -27.8\ m/s$

$\vec{v} = (12.3\hat{i} - 27.8\hat{j})\ m/s$

$x = 12.3 \cdot 11.5 = 141\ m$

$y = 0 + 85.0(11.5) - \frac{1}{2}g(11.5)^2 = 329\ m$

$\vec{r} = (141\hat{i} + 329\hat{j})\ m$



1. A ball is thrown straight up from the top of a cliff of height, H, with an initial speed of 6.50 m/s. It takes 5.00 s for the ball to hit the ground. We want to find the height of the cliff. (Ignore air resistance.)

a. Produce a motion diagram of the ball: **5**

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

Parameter	Known Value
x_0	H
x_f	0
v_0	6.50 m/s
v_f	
a	$-9.81\ m/s^2$
t	5.00 s

c. Find the height of the cliff. **15**

$$\text{A: } \quad 0 = H + 6.50(5.00) - \frac{1}{2}g(5.00)^2$$

$$H = 90.1\ m$$

d. Find the velocity of the ball just before it hits the ground (magnitude and sign). **5**

$$V = V_0 + a t$$

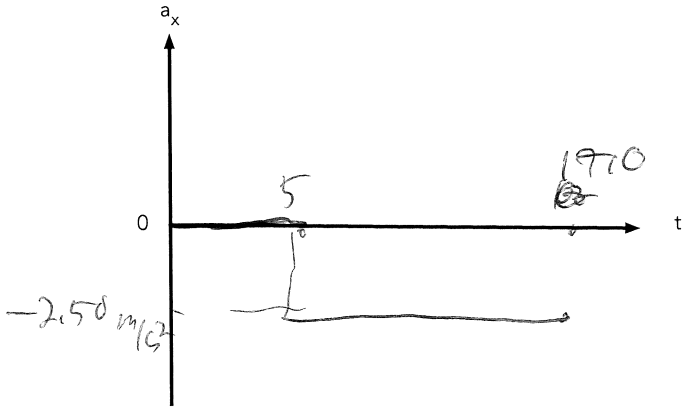
$$= 6.50 - g(5.00)$$

$$= -42.6\ m/s$$

2. A puck is given a push along a horizontal, frictionless surface starting at x=0 at t=0 with an initial speed of 30.0 m/s. Traveling in the +x-direction after 5.00 s, the puck encounters air resistance which results in an acceleration acting in the -x-direction of magnitude 2.50 m/s^2.

Plot the following from t=0 until the puck stops moving, <u>including appropriate values and units on **both** axes</u>.

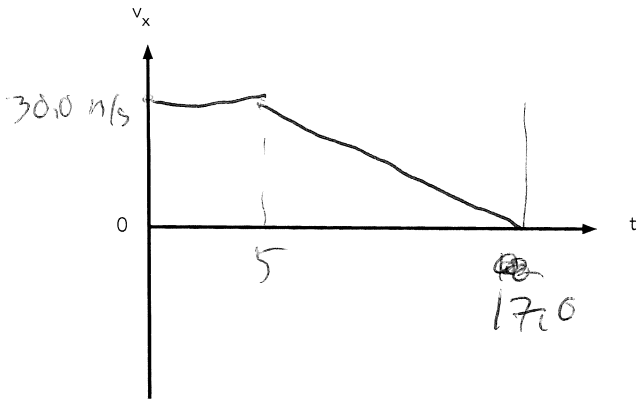
a. Acceleration vs. time. **10**



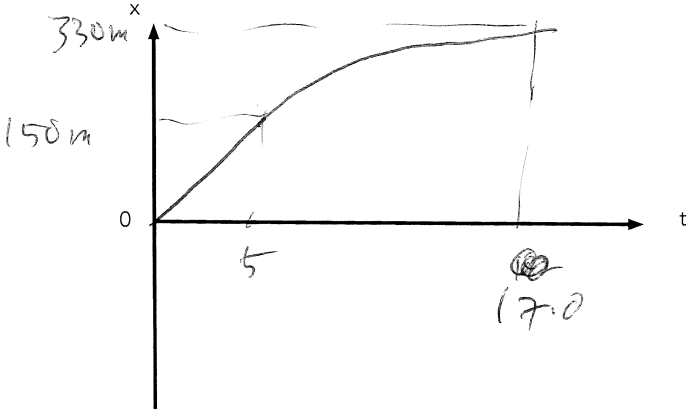
$0 = 30.0 - 2.50t$

$t = 12.0\ s$

b. Velocity vs. time. **10**



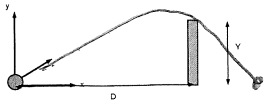
c. Position vs. time. **10**



$x_1 = 30.0 \cdot 5 = 150$

$x_2 = 150 + 30.0(12) - \frac{1}{2}(2.5)(12.0)^2$

$= 330\ m$



3. A cannonball is shot from ground level at a castle wall. 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 75.0 m/s in magnitude. Take y = 0 at ground level. Assume the ball just grazes the top of the wall <u>on the way down</u>.

a. Make a sketch of the trajectory of the ball from start until it grazes the wall. **5**

b. Fill out the tables of known values. (Take the "final" position as when the ball grazes the wall.) **5**

Parameter	Known Value
x_0	0
x_f	205 m
v_{x0}	
v_{xf}	
a_x	0
t	

Parameter	Known Value
y_0	0
y_f	55.0 m
v_{y0}	75.0 m/s
v_{yf}	
a_y	$-9.8 m/s^2$
t	

c. Find the initial velocity of the cannonball and write it in vector notation using the coordinate system above. **15**

y: $55 = 0 + 75t - \frac{1}{2} g t^2$

$4.905t^2 - 75t + 55 = 0$

$t = \frac{75 \pm \sqrt{75^2 - 4 \cdot 55 \cdot 4.905}}{9.81} = 14.5\ s$

x: $205 = v_{0x}(14.5)$; $v_{0x} \rightarrow 14.1\ m/s$

$\vec{v_0} = (14.1\hat{i} + 75.0\hat{j})\ m/s$

d. Find the position, velocity, and acceleration of the cannonball in vector notation after it has been traveling for 11.5 s. **15**

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

$v_f = 75.0 - g(11.5) = -37.8\ m/s$

$\vec{v} = (14.1\hat{i} - 37.8\hat{j})\ m/s$

$x = 14.1(11.5) = 164\ m$

$y = 0 + 75(11.5) - \frac{1}{2} g (11.5)^2 = 214\ m$

$\vec{r} = (164\hat{i} + 214\hat{j})\ m$