

PHY203
Exam #1
Chapters 1-3
Fri., 2/19/10

Solutions

For problems 1-4, on Planet XXX, the acceleration due to gravity is exactly 10m/s^2 . Rocks are dropped from the top of a cliff at a height of 500m.

1. Case 1: a rock of mass 1.5kg is dropped. Find the time, t , at which the rock hits the bottom of the cliff.

- a. 5.0 sec. $500\text{m} = 1/2(10)(t)^2$
- b. 7.1 sec. $t = 10.0\text{s}$
- c. 10.0 sec.**
- d. 100 sec.
- e. None of the above

2. Case 2: a rock of mass 3.0kg is dropped from the top of the same cliff as above. Find the time, t , at which the rock hits the bottom of the cliff.

- a. 5.0 sec. same as previous problem
- b. 7.1 sec.
- c. 10.0 sec.**
- d. 100 sec.
- e. None of the above

3. Case 3: the 1.5kg rock is thrown straight down with an initial speed of 40 m/s. Find the time, t , at which the rock hits the bottom of the cliff.

- a. 0.45 sec. $500 = 40(t) + 1/2(10)(t)^2$
- b. 6.8 sec.** Solve quadratic equation
- c. 13.5 sec. $t = 6.8\text{s}$
- d. 14.8 sec.
- e. 29.5 sec.

4. Case 4: identical rocks of mass 1.5kg: rock a is dropped from the cliff at $t=0$ sec.; rock b is thrown straight down at $t=2$ sec. with an initial speed of 40 m/s. Find the time, t , at which the rocks are side-by-side.

- a. 1.0 sec. $x_1 = 1/2(10)(t)^2$; $x_2 = 40(t-2) + 1/2(10)(t-2)^2$
- b. 2.0 sec. $x_1 = x_2$; $1/2(10)(t)^2 = 40(t-2) + 1/2(10)(t-2)^2$
- c. 3.0 sec.** $t = 3.0\text{s}$
- d. 4.0 sec.
- e. 5.0 sec.

5. The speed of sound in air is 343m/s. Find the speed in miles per hour of a supersonic plane flying at 10 times the speed of sound.

- a. 0.59 mph $343\text{m/s} \times 10 = 3430\text{m/s} = 3.43\text{km/s}$
- b. 128 mph $(3.43\text{km/s})(.6215\text{mi/km})(3600\text{s/hr})$
- c. 331 mph $=7670$ mph
- d. 7670 mph**

e. 19,900 mph.

For problems 6 and 7, an object is moving along the x axis. At $t=6.0$ s, the object is at $x=4.0$ m and its velocity is $+4.5$ m/s. At $t=10$ s, the object is at 11.0 m and its velocity is -1.5 m/s.

6. Find the average velocity of the object during the time interval 6-10 s.

- a. 0.45 m/s avg. vel= $(11\text{m} - 4\text{m})/(4\text{s})=1.75\text{m/s}$
 b. 0.75 m/s
 c. 1.5 m/s
d. 1.75 m/s
 e. 3.75 m/s.

7. Find the average acceleration of the object during the time interval 6-10 s.

- a. -1.5 m/s^2 avg. acc= $(-1.5\text{m/s} - 4.5\text{m/s})/(4\text{s})= -1.5 \text{ m/s}^2$
 b. -0.75 m/s^2
 c. 0.75 m/s^2
 d. 1.5 m/s^2
 e. None of the above

8. Determine the x and y components of a 30m/s velocity vector which makes an angle of 30° counterclockwise from the positive x axis.

- a. $v_x= 15\text{m/s}$, $v_y= -26\text{m/s}$ $v_x= 30\text{m/s}\cos(30^\circ)=26\text{m/s}$
 b. $v_x= 26\text{m/s}$, $v_y= -15\text{m/s}$ $v_y= 30\text{m/s}\sin(30^\circ)=15\text{m/s}$
 c. $v_x= +15\text{m/s}$, $v_y= +26\text{m/s}$
d. $v_x= 26\text{m/s}$, $v_y= +15\text{m/s}$
 e. None of the above

9. Determine the x and y components of a 30m/s velocity vector which makes an angle of 60° clockwise from the negative x axis.

- a. $v_x= -26\text{m/s}$, $v_y= -15\text{m/s}$ $v_x= -30\text{m/s}\cos(60^\circ)=-15\text{m/s}$
 b. $v_x= -26\text{m/s}$, $v_y= +15\text{m/s}$ $v_y= 30\text{m/s}\sin(60^\circ)=+26\text{m/s}$
 c. $v_x= +15\text{m/s}$, $v_y= -26\text{m/s}$
d. $v_x= -15\text{m/s}$, $v_y= +26\text{m/s}$
 e. $v_x= +26\text{m/s}$, $v_y= -15\text{m/s}$

10. Let $\mathbf{A} = -4\mathbf{i} + 6\mathbf{j}$, $\mathbf{B} = 3\mathbf{i} - 10\mathbf{j}$, $\mathbf{C} = -3\mathbf{A} + 3\mathbf{B}$

Write the vector, \mathbf{C} , in vector notation:

- a. $-3\mathbf{i} - 48\mathbf{j}$ $\mathbf{C} = -3(-4\mathbf{i} + 6\mathbf{j})+3(3\mathbf{i} - 10\mathbf{j}) = 21\mathbf{i} - 48\mathbf{j}$
 b. $-3\mathbf{i} - 12\mathbf{j}$
c. $21\mathbf{i} - 48\mathbf{j}$
 d. $21\mathbf{i} - 12\mathbf{j}$
 e. None of the above

11. A missile is shot from a cliff with height $H = 500$ m and initial speed of 50 m/s and an angle $\theta = 65^\circ$, as shown below. Use $g = 9.81 \text{ m/s}^2$. **Show your work.**



a. Write the initial velocity vector, \mathbf{v}_i , in vector notation, using the coordinate system above.

$$\mathbf{v}_0 = 50 \text{ m/s}(\cos 65^\circ \mathbf{i} + \sin 65^\circ \mathbf{j}) \\ = 21.1 \text{ m/s } \mathbf{i} + 45.3 \text{ m/s } \mathbf{j}$$

b. Calculate the time in sec. that it will take for the missile to reach its highest point.

$$0 = (45.3 \text{ m/s}) - (9.81 \text{ m/s}^2)(t) \\ t = 4.6 \text{ s}$$

c. Calculate the time in sec. that it will take for the missile to hit the ground.

$$0 = 500 \text{ m} + 45.3 \text{ m/s } t + \frac{1}{2}(-9.81 \text{ m/s}^2)t^2 \\ \text{solve quadratic eq.} \\ t = 15.7 \text{ s}$$

d. Calculate the x position at which the missile will hit the ground.

$$x = (21.1 \text{ m/s})(15.7 \text{ s}) = 332 \text{ m}$$

e. Write the final velocity vector (just as striking the ground), \mathbf{v}_f , in vector notation, using the coordinate system above.

$$v_{fy} = (45.3 \text{ m/s}) - (9.81 \text{ m/s}^2)(15.7 \text{ s}) = -108.7 \text{ m/s} \\ \mathbf{v}_f = 21.1 \text{ m/s } \mathbf{i} - 108.7 \text{ m/s } \mathbf{j}$$

11. A missile is shot from a cliff with height $H = 400 \text{ m}$ and initial speed of 50 m/s and an angle $\theta = 55^\circ$, as shown below. Use $g = 9.81 \text{ m/s}^2$. **Show your work.**



a. Write the initial velocity vector, \mathbf{v}_i , in vector notation, using the coordinate

system above.

$$\mathbf{v}_0 = 50 \text{ m/s}(\cos 55^\circ \mathbf{i} + \sin 55^\circ \mathbf{j})$$

$$= 28.7 \text{ m/s } \mathbf{i} + 41 \text{ m/s } \mathbf{j}$$

b. Calculate the time in sec. that it will take for the missile to reach its highest point.

$$0 = (41 \text{ m/s}) - (9.81 \text{ m/s}^2)(t)$$

$$t = 4.2 \text{ s}$$

c. Calculate the time in sec. that it will take for the missile to hit the ground.

$$0 = 400 \text{ m} + 41 \text{ m/s } t + \frac{1}{2}(-9.81 \text{ m/s}^2)t^2$$

solve quadratic eq.

$$t = 14.1 \text{ s}$$

d. Calculate the x position at which the missile will hit the ground.

$$x = (28.7 \text{ m/s})(14.1 \text{ s}) = 405.6 \text{ m}$$

e. Write the final velocity vector (just as striking the ground), \mathbf{v}_f , in vector notation, using the coordinate system above.

$$v_{fy} = (41 \text{ m/s}) - (9.81 \text{ m/s}^2)(14.1 \text{ s}) = -97.3 \text{ m/s}$$

$$\mathbf{v}_f = 28.7 \text{ m/s } \mathbf{i} - 97.3 \text{ m/s } \mathbf{j}$$