

Your Name: _____

PHY203

Final Exam
12/18/09

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Part 1

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Solutions

For problems 1-4, consider a rocket being launched from rest straight up into the atmosphere of Planet XXX where the acceleration due to gravity is exactly 10m/s^2 . In the first stage, the rocket accelerates at 20m/s^2 for 15s. Then the motor cuts off and the rocket continues to travel upwards for a while.

1. Find the height of the rocket when the motor cuts off.

- | | | |
|-----------|---------------|---|
| a. | 75 m | $H_1 = 1/2(20 \text{ m/s}^2)15^2$
$= 2250\text{m}$ |
| b. | 150 m | |
| c. | 1125 m | |
| d. | 2250 m | |
| e. | 4500 m | |

2. Find the speed of the rocket when the motor cuts off.

- | | | |
|-----------|-------------------|---|
| a. | 150 m/s | $v = (20 \text{ m/s}^2)15\text{s}$
$= 300\text{m/s}$ |
| b. | 300 m/s | |
| c. | 2250 m/s | |
| d. | 4500 m/s | |
| e. | None of the above | |

3. Find the height of the rocket at which it stops traveling upwards and begins to descend.

- | | | |
|-----------|---------------|--|
| a. | 1125 m | $0 = (300 \text{ m/s})^2 + 2(-10 \text{ m/s}^2) (DH)$
$DH = 4500\text{m}$
$H_2 = 2250\text{m} + 4500\text{m} = 6750\text{m}$ |
| b. | 2250 m | |
| c. | 3375 m | |
| d. | 4500 m | |
| e. | 6750 m | |

4. Find the total time the rocket is in the air before it hits the ground.

- | | | |
|----|-----------|---|
| a. | 8.8 sec. | $0 = 2250 + 300 t_2 + 1/2(-10 \text{ m/s}^2) t_2^2$
$t_2 = 66.7\text{s}$ |
| b. | 23.8 sec. | |

- c. 66.2 sec. $t = 15s + 66.7s = 81.7s$
 d. **81.7 sec.**
 e. 148.5 sec.

For problems 5 and 6, on Planet XXX where the acceleration due to gravity is exactly 10m/s^2 , consider 2 balls that are dropped or thrown from a cliff. In both cases, find the time, t , at which the rocks are side-by-side.

5. Case 1: rock a is dropped from the cliff at $t=0$ sec.; rock b is dropped from the cliff at $t=5$ sec.

- a. 2.5 sec.
 b. 5.0 sec.
 c. 7.5 sec.
 d. 10.0 sec.
 e. **None of the above (never catches up)**

6. Case 2: 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.

- a. 2.0 sec. $x_1 = 1/2(10)(t)^2$; $x_2 = 40(t-2) + 1/2(10)(t-2)^2$
 b. **3.0 sec.** $x_1 = x_2$; $1/2(10)(t)^2 = 40(t-2) + 1/2(10)(t-2)^2$
 c. 4.0 sec. $t = 3.0s$
 d. 5.0 sec.
 e. 6.0 sec.

7. Let $\mathbf{B} = 3\mathbf{i} - 4\mathbf{j}$. Find the magnitude of the vector \mathbf{B} and the angle that vector \mathbf{B} makes with the positive x-axis (measured in a counterclockwise direction from the positive x-axis):

- a. 1, 307° $B = (3^2 + 4^2)^{1/2} = 5$
 b. 1, 323° $q = 360^\circ - \tan^{-1}(4/3) = 360^\circ - 53.1^\circ = 307^\circ$
 c. **5, 307°**
 d. 5, 323°
 e. None of the above

Problems 8-10

The figure below shows nine graphs of position, velocity, and acceleration for objects in linear motion.

Choose the letter in each case below that has all the graphs that clearly meet the following conditions:

8. Velocity is constant

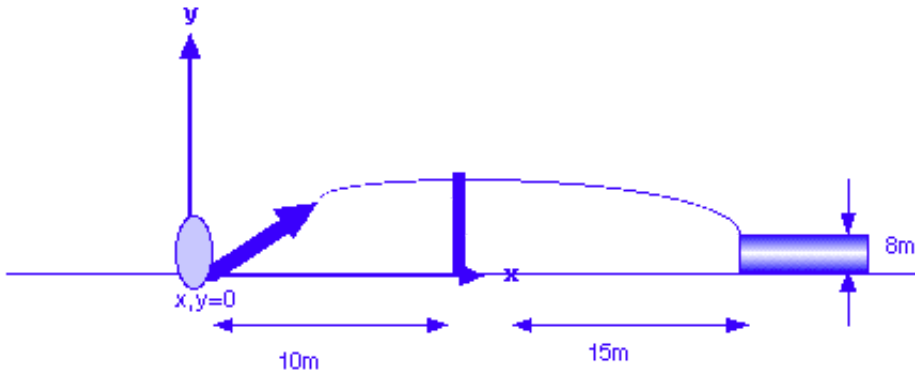
- a. a,f
 b. a,f,h
 c. **a,f,i**
 d. a,d,e,f
 e. a,f,h,i

9. Velocity has reversed its direction

- a. **c,d**
 b. c,i
 c. b,c,d
 d. c,d,i
 e. b,c,d,g

10. Acceleration is constant

- a. h,i
 b. a,f,h,i
 c. d,ef,h,i
 d. a,d,e,f,i
 e. **a,d,e,f,h,i**



11. A football is kicked from 10m from a goalpost such that it "just clears" the goalpost (i.e. is at its highest point as it clears the goalpost) and then lands in the 3rd row of the stands (at a height of 8m) 5.0 m behind the goalpost. The total time the ball is in the air is 1.5s. (Use $g=9.81\text{m/s}^2$)

a. Calculate the x-component of the initial velocity.

$$15\text{m} = (v_{0x})1.5\text{s}$$

$$v_{0x} = 10.0\text{ m/s}$$

b. Calculate the y-component of the initial velocity.

$$8\text{m} = 0 + v_{0y}(1.5\text{s}) + \frac{1}{2}(-9.81\text{ m/s}^2)(1.5\text{s})^2$$

$$v_{0y} = 12.7\text{ m/s}$$

c. Write the initial velocity vector, \mathbf{v}_0 , as a vector in proper vector notation, *using the coordinate system given above.*

$$\mathbf{v}_0 = (10.0\mathbf{i} + 12.7\mathbf{j})\text{m/s}$$

d. Calculate the height of the goalpost.

$$0 = (12.7\text{m/s})^2 + 2(-9.81\text{ m/s}^2)(H)$$

$$H = 8.22\text{ m}$$

e. Calculate the final velocity in the x-direction of the projectile just before it hits the stands and express it as a vector in proper vector notation, *using the coordinate system given above.*

$$10.0\mathbf{i}\text{ m/s}$$

f. Calculate the final velocity in the y-direction of the projectile just before it hits the stands *coordinate system given above using the coordinate system given above.*

$$v_y = 12.7\text{ m/s} + (-9.81\text{ m/s}^2)(1.5)$$

$$v_y = -2.0\mathbf{j}\text{ m/s}$$