

# Unit 1 Test Review

## Physics Basics, Movement, and Vectors Chapters 1 - 3

**\* In studying for your test, make sure to study this review sheet along with your quizzes and homework assignments.**

**Multiple Choice Review:** On this portion of the test, you will not be allowed to use your calculator or AP formula sheet. (You may, however, use your AP table of information.) Approximate  $g=10\text{m/s}^2$  for simplicity of calculations. No partial credit will be given.

1. What is the magnitude of the velocity after 1.5 seconds of a ball thrown upward from a height of 5m at 40m/s?  
a. 15m/s      b. 20m/s      c. 25m/s      d. 30m/s      e. 35m/s
2. For an object that travels 20km north and then 15km south, what is the ratio of the distance traveled to the displacement?  
a. 0      b. 1/7      c. 1      d. 7      e. 35
3. Two vectors **A** and **B** both have magnitudes of 5 units. The magnitude of the vector sum of these two vectors...  
a. is 5 units.  
b. is 10 units.  
c. is 0 units.  
d. could be answer a or b, but not answer c.  
e. could be answer a, b, or c.
4. An object is thrown with a horizontal velocity of 20m/s from a cliff that is 125m above ground level. If air resistance is negligible, the time that it takes the object to fall to the ground from the cliff is most nearly...  
a. 3s      b. 5s      c. 6s      d. 12s      e. 25s
5. The rate of change of velocity is the definition of...  
a. displacement      c. instantaneous velocity  
b. average velocity      d. acceleration

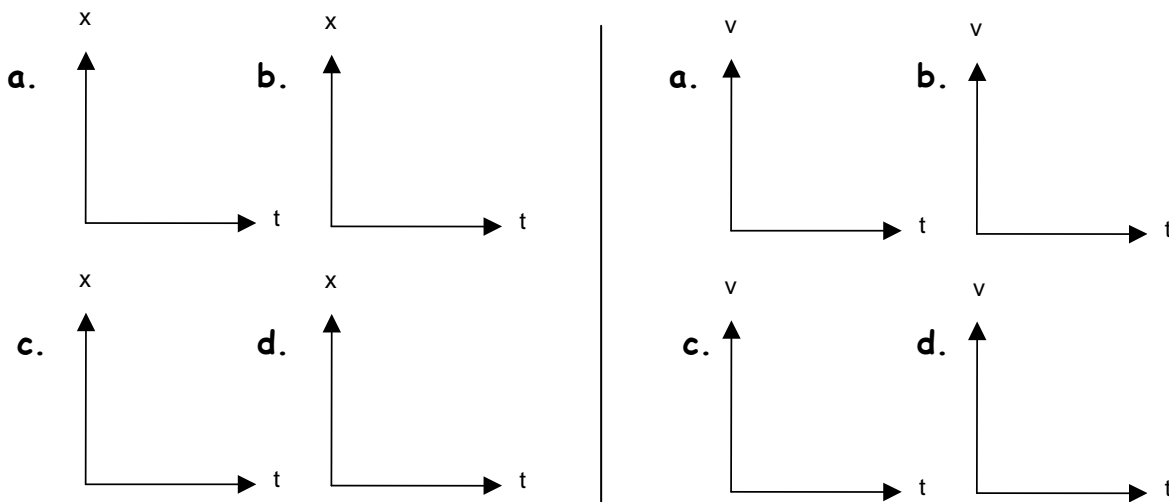
6. Three balls are projected from the edge of a cliff. Ball I is fired horizontally, ball II is fired at an angle of  $30^\circ$  above the horizontal with the same speed as ball I, and ball III is released from rest. Which one of the following is true?
- I and II hit at the same time, and III hits later.
  - I and II hit at the same time, and III hits earlier.
  - I and III hit at the same time, and II hits later.
  - I and III hit at the same time, and II hits earlier.
  - All three balls hit at the same time.
7. A rock is thrown horizontally off a building. The speed of the rock as it leaves the thrower's hand at the edge of the building is  $v_0$ . It takes an amount of time,  $t$ , to travel from the edge of the building to the ground. How far from the side of the building, measured horizontally, does the rock land?
- $v_0 t - \frac{g}{2} t^2$
  - $-\frac{g}{2} t^2$
  - $v_0 t$
  - $t \sqrt{g v_0^{14}}$
8. An object is thrown straight upward. Which of the following are the correct signs of the velocity and acceleration vectors at the moment the object is at its highest point?
- |    | <u>Velocity</u> | <u>Acceleration</u> |
|----|-----------------|---------------------|
| a. | +               | -                   |
| b. | +               | 0                   |
| c. | -               | 0                   |
| d. | 0               | -                   |
| e. | 0               | 0                   |
9. A spacecraft has one engine at its tail, which can propel it forward at 400m/s, as well as stabilizing engines on either side, each of which can propel the craft at 300m/s perpendicular to the direction of the tail engine's propulsion. If one of the side engines and the rear engine are simultaneously operating, at what angle will the craft travel relative to forward?
- $30^\circ$
  - $37^\circ$
  - $45^\circ$
  - $53^\circ$
  - $60^\circ$
10. At the highest point of its trajectory, a projectile fired at  $30^\circ$  above the horizontal from a starting height of 20m...
- is instantaneously at rest.
  - has traveled half the distance to its impact point.
  - has 0 acceleration.
  - has a horizontal velocity component equal to its initial value.
  - has more than one of the above properties.

**Problem Review:** On this portion of the test, you may use your calculator, AP formula sheet, and AP table of information. Partial credit will be given on these problems.

11. A rock is thrown straight downward at  $10\text{m/s}$  from a height of  $3.5\text{ m}$ . How long does it take the rock to reach the ground?

12. Sketch graphs of the following situations, first on position-time graphs and then on velocity-time graphs.

- |  |  |
|--|--|
| a. Slowing down at a constant rate.      | b. Speeding up at a constant rate.     |
| c. Sitting still at a positive position. | d. Moving at a constant pos. velocity. |



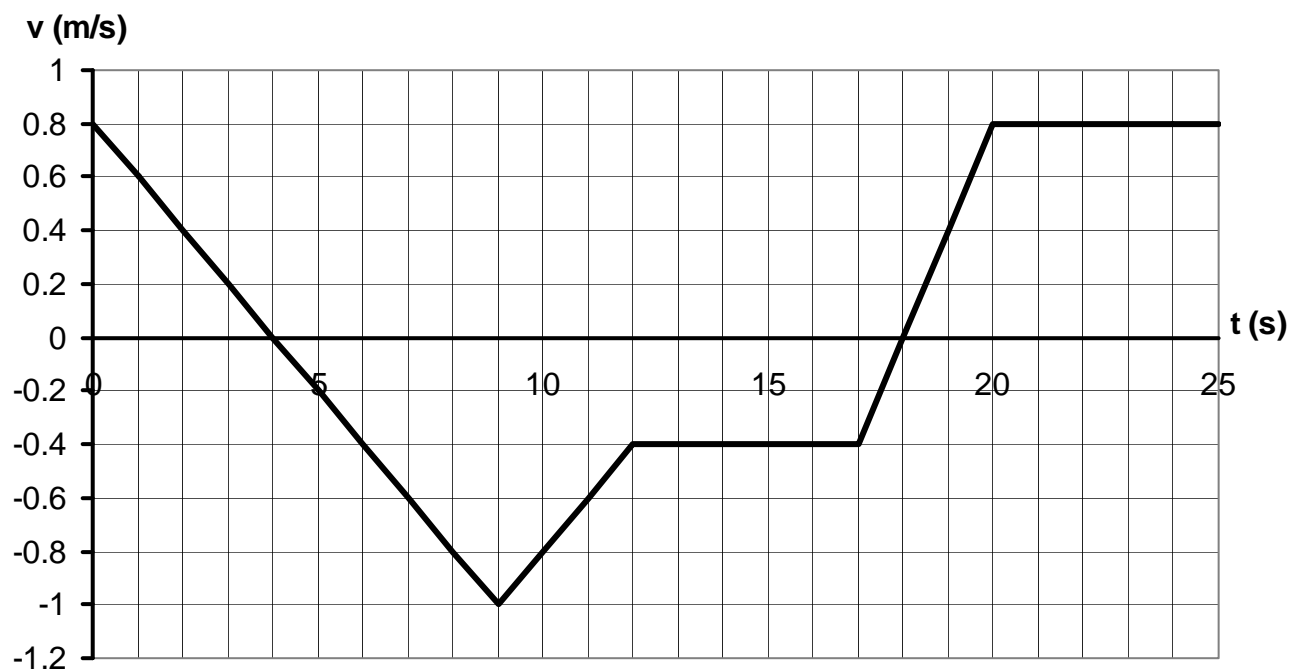
13. Two cars are in a race, with Car A driving at an average speed of  $70\text{mi/h}$  and Car B driving at an average speed of  $65\text{mi/h}$ . How long does the race take if it ends (when Car A crosses the finish-line) with Car A  $1/4$  mile in front of Car B?

14. A truck on a straight road starts from rest accelerating at  $3.0\text{m/s}^2$  until it reaches a speed of  $30.0\text{ m/s}$ . It then applies its brakes and comes to a stop in  $8.0\text{ s}$ . What total distance does the truck cover during the total period of motion described here?
15. The engine of a model rocket accelerates the rocket upward vertically. The rocket starts from rest and it accelerates upward at  $5\text{m/s}^2$  until its engines stop after  $4.1\text{ s}$ . What is the maximum height the rocket reaches?
16. A car takes a trip where there are two different displacements involved. The car first travels for  $2\text{h}$  at a velocity of  $60\text{ km/h}$  at  $70^\circ$  north of east. It then turns and travels for  $3.1\text{h}$  at a velocity of  $93\text{km/h}$  at  $20^\circ$  north of west. What is the car's resultant displacement?
17. A ball is thrown upward at an angle of  $25^\circ$  above the horizontal. It passes its maximum height, then strikes a wall  $30\text{m}$  away from its starting position at a height of  $10\text{m}$  above its starting height. What was the ball's initial velocity?

18. A stone is kicked horizontally from the edge of a cliff with an initial velocity of 30 m/s, and it lands on a flat, horizontal beach 70 m (measured horizontally) from the cliff wall. How far above the beach is the cliff? With what speed and angle of impact does the stone land?

19. Actual A.P. Physics B Free-Response Question (2000):

A 0.5kg cart moves on a straight horizontal track. The graph of velocity  $v$  versus time  $t$  for the cart is given below.

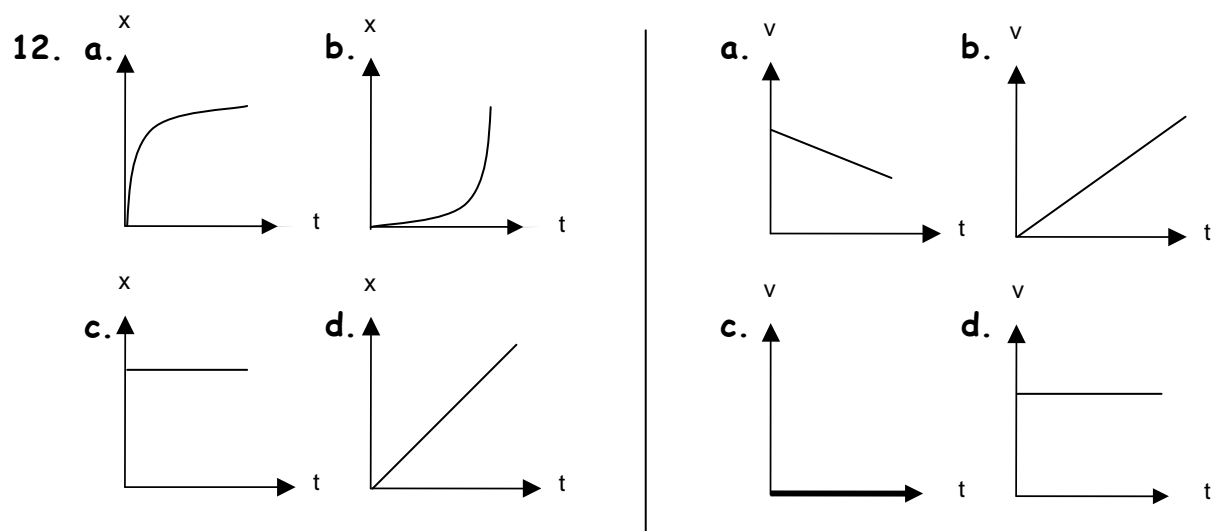


- a. Indicate every time  $t$  for which the cart is at rest.
- b. Indicate every time interval for which the speed (magnitude of velocity) of the cart is increasing.

- c. Determine the horizontal position  $x$  of the cart at  $t=9.0\text{s}$  if the cart is located at  $x=2.0\text{m}$  at  $t=0$ .
- d. Sketch an acceleration versus time graph for the motion of the cart from  $t=0$  to  $t=25\text{s}$ .
- e. From  $t=25\text{s}$  until the cart reaches the end of the track, the cart continues with constant horizontal velocity. The cart then leaves the end of the track and hits the floor, which is  $0.40\text{m}$  below the track. Neglecting air resistance, determine each of following:
- The time from when the cart leaves the track until it first hits the floor.
  - The horizontal distance from the end of the track to the point at which the cart first hits the floor.

## Unit 1 Test Review Answers:

1. C (It slows down by 10m/s every second, so in 1.5s it has slowed by 15 m/s.)
2. D (Distance = 35km and displacement = 5km, so  $35/5 = 7$ .)
3. E (Depending on the orientation of the two vectors, ABC are all possible.)
4. B (The approximation is  $x = 5t^2$ , so  $125 = 5t^2$  leads to  $t = 5$ s.)
5. D
6. C (Balls I and II both begin with  $v_y = 0$ m/s, so they both hit at same time.)
7. C (Horizontal velocity is not controlled by  $g$ , the acceleration due to gravity.)
8. D ( $v=0$  at highest point, acceleration is always  $-9.8$ m/s<sup>2</sup>.)
9. B (Just take  $\tan^{-1}(3/4)$  to find  $\theta$ . Notice that the green sheet has helpful geometry and trig info.)
10. D
11. Using  $x = v_0t + \frac{1}{2}at^2$  we have  $-3.5 = (-10)t - 4.9t^2$ .  
We use the quadratic formula to arrive at the answer  $t = 0.305$ s.



13.  $v_A = 70$  and  $v_B = 65$  and also,  $t_A = t_B$  and  $x_A = x_B + 0.25$   
 Since  $t_A = t_B$  then  $\frac{x_A}{70} = \frac{x_B}{65}$  and  $\frac{x_B + 0.25}{70} = \frac{x_B}{65}$   
 $x_B = 3.25$ mi so the race took time  $t_B = \frac{3.25}{65} = .05$ h or 3 minutes.

14. In part I we use  $v^2 = v_0^2 + 2ax$  to have  $30^2 = 0^2 + 2(3)x$  so  $x = 150$ m.  
 In part II we don't know acceleration, which we need for using any of our formulas. So we have to find accel. by using the definition of acceleration.  
 $a = \frac{0 - 30}{8} = -3.75$ m/s<sup>2</sup> Now use  $x = v_0t + \frac{1}{2}at^2 = 30(8) + \frac{1}{2}(-3.75)(8^2) = 120$ m  
 for part II of the trip. Lastly,  $x_{\text{total}} = 150 + 120 = 270$ m.

15. In the powered part of the rocket's flight, we use  $x = v_0t + \frac{1}{2}at^2$  to have  $x = 0 + \frac{1}{2}(5)(4.1^2) = 42.03\text{m}$  and  $v = v_0 + at = 0 + 5(4.1) = 20.5\text{m/s}$ .  
Once the engine stops, we use  $v^2 = v_0^2 + 2ax$  to have  $0^2 = 20.5^2 - 19.6x$ , which yields  $x = 21.44\text{m}$ . So, the max height of the rocket is  $42.03 + 21.44 = 63.47\text{m}$ .

16. Start by turning it into a displacement problem instead of a velocity problem. Then it becomes a '4-Step Addition' problem.

$$x_{\text{total}} = 288.3\cos 60 - 120\cos 70 = 103.11\text{km} \leftarrow$$

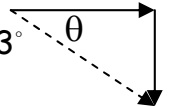
$$y_{\text{total}} = 120\sin 70 + 288.3\sin 60 = 362.44\text{km} \uparrow$$

$$R = \sqrt{x^2 + y^2} = 376.8\text{km} \quad @ \quad \theta = \tan^{-1}(y/x) = 74.12^\circ$$



17.  $x = v_x t$  gives  $30 = v_0 \cos 25t$   
Also,  $y = v_{y0}t + \frac{1}{2}at^2$  gives  $10 = v_0 \sin 25t - 4.9t^2$   
Now that's a system of equations w/two unknowns. Solve for  $v_0 = 36.7\text{m/s}$

18.  $x = v_{x0}t$  gives  $70 = 30t$  which makes  $t = 2.33\text{s}$   
so  $y = v_{y0}t - 4.9t^2 = 0 - 4.9(2.33^2) = -26.6\text{m}$ , the height of the cliff.  
Also, for velocity and angle of impact:  $v_y = v_{y0} - gt = -22.87$ , which is not the total final speed. Taking both velocity components into account yields the following:  $v = \sqrt{v_y^2 + v_x^2} = \sqrt{30^2 + 22.87^2} = 37.7\text{m/s} @ \theta = \tan^{-1} \frac{22.87}{30} = 37.3^\circ$



19. a. On a v/t graph, an object is stopped anytime  $v=0$ , or when the graph crosses the x-axis. This happens twice in this graph- at  $t=4\text{s}$  and  $t=18\text{s}$ .  
b. The speed is increasing anytime the signs of the vel and accel are the same sign. So this happens on the graph from  $t = 4$  to  $9\text{s}$  (when  $v$  and  $a$  are both negative), and from  $t = 18\text{s}$  to  $20\text{s}$  (when  $v$  and  $a$  are both positive).  
c. To use a kinematic to calculate position of the cart, we would first have to know the acceleration of the cart during the interval  $t = 0$  to  $9\text{s}$ .  
Acceleration is just slope =  $-0.2\text{m/s}^2$ .  
Then use  $v^2 = v_0^2 + 2ax$  which gives  $(-1)^2 = 0.8^2 + 2(-0.2)x$  and this gives  $x = -0.9\text{m}$ . It is lastly important to remember that the  $x$  in the above kinematic refers to a change in position, so we must calculate final position based on the cart's initial position being  $2.0\text{m}$ . So final position is  $2.0 - 0.9 = 1.1\text{m}$   
d. To come up with the correct graph, just calculate the cart's acceleration during each time interval by finding slope of each part of the first graph.  
e. i. In the vertical direction,  $y = v_{y0}t + \frac{1}{2}at^2$  so  $-0.4 = -4.9t^2$  so  $t = 0.286\text{s}$   
ii. In the horizontal direction,  $x = v_x t = (0.8)(0.286) = 0.229\text{m}$