

# AP Physics B Test Review for Units 1 - 4

One-Dimensional Motion, Vectors, Falling Bodies, Projectiles

Name \_\_\_\_\_

## Test Objectives and Study Hints

### Multiple Choice

Covers all topics, but stresses projectile motion concepts.

Be prepared to make or interpret graphs of objects in ANY of the motions we have studied, including falling objects and projectile motion.

Be prepared for questions testing your understanding of the independence of horizontal and vertical motion; review *concepts* behind class demos such as the simultaneous velocities apparatus, ballistic car, monkey and hunter.

#### TO PREPARE:

Read all of your notes carefully.

Review the readings and worksheets on motion graphs and projectile motion.

Study the multiple choice questions on the “measurement and motion” and “vectors/falling bodies” quizzes. Be sure you know the *concept* each questions deals with.

Do the accompanying concepts check and concept review questions.

*RELEVANT TEXT: Chapters 1-3*

### Problems

Be prepared for problems involving projectile motion, falling bodies, and a combination of both. For example, some falling body problems can become simple projectile motion problems testing your understanding of the independence of horizontal and vertical motion.

*EXAMPLE: Review Problem #9*

Be prepared for a multiple-step vector problem. For example, you could be given two acceleration vectors along with a time and asked to calculate the final velocity of an object that started from rest. You would add the accelerations with vector math and then use  $v_f = v_i + at$ .

*EXAMPLE: Review Problem #10*

Be prepared for a multiple-step ground-based problem. For example, sometimes the answer to one "part" of a problem becomes a given in the second "part" — you may be given information that will not directly lead to the answer, but can be used to generate another given that leads to the answer. Or, you may need to split a problem into two parts because the acceleration varies.

*EXAMPLE: Review Problem #12*

#### TO PREPARE:

Rework the problems on the “measurement and motion” and “vectors/falling bodies” quizzes. Rework several different types of projectile motion problem - there are about five variants.

*Up over level ground; dropped from height; shot angled downward from height; shot upward and land on cliff or land in valley.*

Do the accompanying review problems.

## Practice Problems

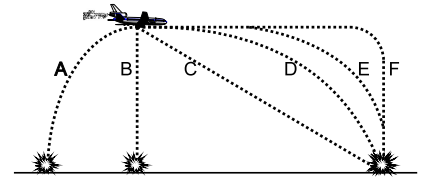
(answers are in italics at the right margin; some of these old questions were written with 2 significant figures - the test will be written with 3 sig figs throughout)

- Phyllis Physics set a course of  $25.0^\circ$  East of South in her airplane and a speed of  $100$  m/s. A storm during the flight created a strong wind of  $75.0$  m/s aimed  $65.0^\circ$  N of E. What was the resultant velocity of her plane?  
*77.4 m/s at  $17.0^\circ$  S of E*
- An angry Physics student wishes to drop an egg onto the head of poor Mr. M. He stations himself in a building window  $19.6$  m above the head of the approaching instructor. Determine how many seconds before the teacher is directly under him that he will have to drop the egg in order to get the desired splat.  
*2.00 s*
- If a stone thrown from a bridge strikes the water  $10.0$  m below after  $1.70$  s, what was the stone's initial velocity?  
*2.45 m/s upward*
- A shell leaves the muzzle of a howitzer at an angle of  $45^\circ$  above the horizontal and travels  $7,500$  m over level ground before hitting an enemy bunker. What was the maximum height of the shell?  
*1900 m*
- A skier leaves the line at  $5.00$  m/sec downhill and accelerates uniformly at  $1.50$  m/s<sup>2</sup> in the same direction. How fast will the skier be moving after having gone  $500$  m?  
*39.1 m/s*
- Spaced-out Sue is speeding at a constant  $3.500 \times 10^4$  km/h in her space coupe when she passes a galactic cop at rest by the side of the Milky Way. The instant Sue passes him, the cop accelerates after her at a constant rate. If it takes him  $3.000 \times 10^5$  km to catch up with her, how much was he accelerating?  
*8,167 km/h<sup>2</sup>*
- A ball is thrown from the top of one building toward a tall building  $50.0$  meters away. The initial velocity of the ball is  $15.0$  m/s at  $40.0^\circ$  above the horizontal. How far above or below its original level will the ball strike the opposite wall?  
*50.8 m below*
- An object travelling at  $5.0$  m/s speeds up by  $3.0$  m/s each second over a time period of  $8.0$  seconds. What was the object's average speed?  
*17 m/s*
- A bullet is fired horizontally from a height of  $78.4$  m and hits the ground  $1500$  m away.
  - With what velocity does the bullet leave the gun?  
*375 m/s in the direction it was fired*
  - At what angle did it strike the ground?  
*5.97° below the horizontal*
- Fluffy can swim with a speed of  $0.10$  m/s in still water. One day Fluffy attempted to swim west across a part of the Caney that was flowing from north to south with a speed of  $0.35$  m/s. What was Fluffy's displacement after swimming for  $25$  seconds?  
*9.1 m at  $74^\circ$  S of W*
- A hose lying on the ground shoots a stream of water upward at an angle of  $40^\circ$  to the horizontal. The speed of the water is  $20$  m/s as it leaves the hose. How high up will it strike a wall which is  $8.0$  m away?  
*5.4 m*
- NASA uses a tall research tower in Cleveland, Ohio to study falling bodies and low-gravity conditions. Items are placed in a "drag shield" so that they will not encounter air resistance - the shield is slowed by the air, but the items inside are allowed to move downward freely within it. An airbag at the bottom of the tower can rapidly decelerate a package at  $245$  m/s<sup>2</sup> over a distance of  $0.964$  m until it stops. Given this information, how far does a package drop before striking the bag?  
*24.1 m*

**Concept Check** (see reverse for answer analysis)

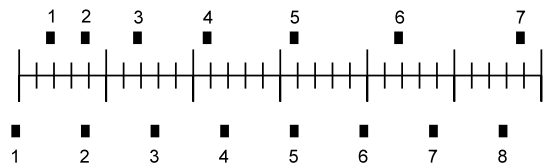
13. Two metal balls are the same size, but one weighs twice as much as the other. The balls are dropped from the top of a two story building at the same instant of time. The time it takes the balls to reach the ground below will be...
- about half as long for the heavier ball.
  - about half as long for the lighter ball.
  - about the same time for both balls.
  - considerably less for the heavier ball, but not necessarily half as long.
  - considerably less for the lighter ball, but not necessarily half as long.

14. A bowling ball accidentally falls out of the cargo bay of an airliner as it flies along in a horizontal direction (to the right as shown in the diagram). As seen from the ground, which path would the bowling ball most closely follow after leaving the airplane?



15. Two steel balls, one of which weighs twice as much as the other, roll off a horizontal table with the same speeds. In this situation...
- both balls hit the floor at approximately the same horizontal distance from the base of the table.
  - the lighter ball travels twice the horizontal distance from the table base than does the heavier ball.
  - the heavier ball travels twice the horizontal distance from the table base than does the lighter ball.
  - the lighter ball travels quite a bit farther from the table base than the heavier, but not necessarily twice as far.
  - the heavier ball travels quite a bit farther from the table base than the lighter, but not necessarily twice as far.

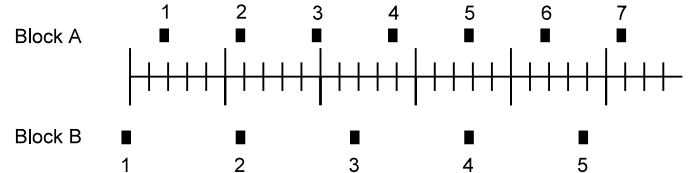
16. The position of two blocks at successive 0.20 second time intervals are represented by the numbered squares in the diagram at right. The blocks are moving toward the right.



Do the blocks ever have the same speed?

- No.
- Yes, at instant 2.
- Yes, at instant 5.
- Yes, at instant 2 and 5.
- Yes, at some time during interval 3 to 4.

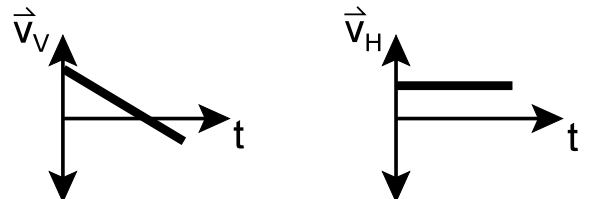
17. The position of two blocks at successive time intervals are represented by the numbered squares in the diagram at right. The blocks are moving toward the right.



The acceleration of block A is...

- larger than that of block B.
- greater than zero and equal to that of block B.
- less than that of block B.
- zero, as is that of block B.

18. The motion of an object after it is released until it is caught is graphed as shown at right. Which situation corresponds to the graphs? (Assume air resistance is negligible.)



- An object thrown straight upward which is caught below its starting point.
- An object thrown straight downward which bounces and is caught below its starting point.
- An object thrown upward at some angle to the horizon which is caught below its starting point.
- An object thrown upward at some angle to the horizon which is caught above its starting point.
- An object thrown downward at some angle to the horizon which bounces and is caught below its starting point.

**Concept Check Analysis:**

13. The correct answer is **C**. All objects fall with the same acceleration rate (same rate of velocity change) in the absence of air resistance. Even with air resistance, objects of the same size and shape can be presumed to encounter about the same drag.

Possible Misconceptions for Wrong Answers

- A:** Mistaken belief that heavier objects fall faster than lighter ones.  
**B or E:** Possible mis-reading of question or answers.  
**D:** Mistaken belief that heavier objects fall faster than lighter ones, or misinterpretation of the effect of air resistance.

14. The correct answer is **D**. A projectile will follow a parabolic path, and is immediately acted upon by gravity upon release.

Possible Misconceptions for Wrong Answers

- A or B:** Mistaken belief that mass makes things stop, or failure to realize that a projectile has same initial velocity as the projector.  
**C:** Failure to realize that the vertical velocity of a projectile in free-fall will change.  
**E or F:** Failure to realize that a projectile is affected by gravity immediately upon release, or mistaken belief that a projected object receives some sort of "impetus" that slowly disappears.

15. The correct answer is **A**. The horizontal velocity of a projectile is constant (its changing vertical motion will not directly affect its horizontal motion) and all objects fall with the same acceleration rate in the absence of air resistance. Even with air resistance, objects of the same size and shape can be presumed to encounter about the same drag.

Possible Misconceptions for Wrong Answers

- B:** Mistaken belief that heavier objects fall faster than lighter ones, or that lighter projectiles are not affected as quickly by gravity.  
**C** Mistaken belief that heavier projectiles retain their horizontal motion better than lighter ones. Possible mis-reading of question and answers.  
**D:** Mistaken belief that heavier objects fall faster than lighter ones, or that lighter projectiles are not affected as quickly by gravity. Also possible that the effect of air resistance was misinterpreted.  
**E:** Mistaken belief that heavier projectiles retain their horizontal motion better than lighter ones. Possible mis-reading of question and answers, or that the effect of air resistance was misinterpreted.

16. The correct answer is **E**. The bottom block retains a constant speed of 4 ticks per 0.2 s time interval. The top block is accelerating, as shown by an increase in speed (an increase in the "ticks" or distance traveled during each time interval). The top block traveled 4 ticks during the 3 to 4 time interval, so its average speed during that interval was the same as the the steady speed of the bottom block. Thus, it was moving at that speed sometime during the 3 to 4 interval.

Possible Misconceptions for Wrong Answers

- A:** Failure to properly distinguish between velocity and acceleration, or failure to note that distance/time indicates average speed.  
**B or C or D:** Failure to properly distinguish between displacement and velocity. The block's position alone does not indicate its speed. Its speed is found by examining the **change** in position over a time interval.

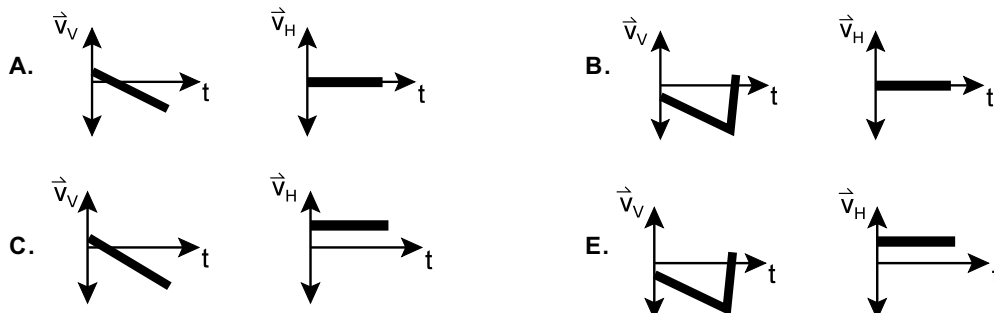
17. The correct answer is **D**. Both blocks are showing a steady change in distance over time, or a steady speed. (Block A has a speed of 4 ticks per time interval; block B has a speed of 6 ticks per time interval.) An object with a constant velocity is not accelerating.

Possible Misconceptions for Wrong Answers

- A:** Failure to note that distance/time indicates average speed.  
**B or C:** Failure to properly distinguish between velocity and acceleration, or failure to note that distance/time indicates average speed.

18. The correct answer is **D**. The object is a projectile in free-fall because it has a steady horizontal velocity and a changing vertical velocity. Its initial vertical velocity is positive, so it was projected upward. Its final vertical velocity is negative, so it ended its motion while moving downward. Its final downward speed is smaller than its initial upward speed, so it was caught before it had reached its original level (at which point it would have regained its original speed).

Graphs Corresponding to the Wrong Answers

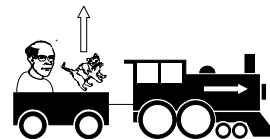


## Additional Concept Review Questions (answers on reverse)

Write the letter corresponding to the best answer in the blank at the left of each question. Assume no air resistance.

- \_\_\_\_\_ 19. When an object that was thrown upward reaches its highest point, which statement is true?
- A. The acceleration switches from positive to negative.
  - B. The acceleration is zero.
  - C. The total displacement is zero.
  - D. The velocity is zero.

- \_\_\_\_\_ 20. While riding at a constant speed on the train at the Kiddie Park, Mr. M playfully tossed Fluffy straight upward. During the time Fluffy was in the air, the train moved forward one meter. Fluffy landed...
- A. in Mr. M's loving arms.
  - B. one meter in front of Mr. M.
  - C. one meter behind Mr. M.
  - D. several meters behind Mr. M.

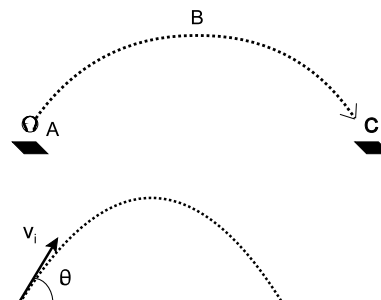


- \_\_\_\_\_ 21. An object is observed and a graph of its distance versus time is constructed. The graph has a slope of +5.00 when the distance is measured in meters and the time is measured in seconds. The object was...
- A. moving at a constant speed of 5.00 m/s.
  - B. motionless.
  - C. decelerating.
  - D. accelerating at 5.00 m/s<sup>2</sup>.

- \_\_\_\_\_ 22. Three forces simultaneously act on an object. The first is a 5 newton force acting due east, the second is a 3 newton force acting due west, and the third is a 4 newton force acting due east. What is the resultant force?
- A. 12 newtons east    B. 6 newtons east    C. 4 newtons east    D. 2 newtons west

### Questions 23 - 26 refer to the following situation:

A girl stood at first base on a level playing field and tossed a softball at an angle of 35° above the horizontal. It was caught by another player over home base at the same height above the ground as it was originally thrown.



- \_\_\_\_\_ 23. At which point along its trajectory was the softball travelling the **slowest**?
- A. Just after it was released.
  - B. When it reached its maximum height.
  - C. Just before it was caught.
  - D. Both A and C are correct if there is no air resistance.

- \_\_\_\_\_ 24. If the girl threw another softball with the same initial speed, but at 55° above the horizontal, . . .
- A. it would have risen to a lower height than before.
  - B. it would have risen to the same height as before.
  - C. it would have risen to a greater height than before.

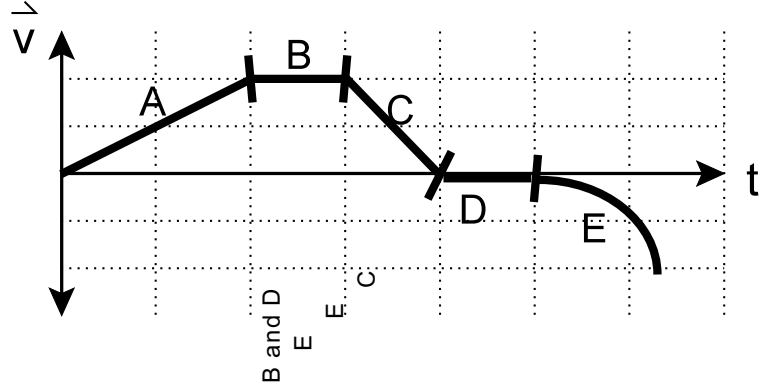
- \_\_\_\_\_ 25. What angle of release would make the softball travel as far as possible?
- A. 15°    B. 30°    C. 45°    D. 65°

- \_\_\_\_\_ 26. What was the softball's **horizontal** acceleration during its flight?
- A. 0 m/s<sup>2</sup>    B. 2.45 m/s<sup>2</sup>    C. 4.90 m/s<sup>2</sup>    D. 9.80 m/s<sup>2</sup>

Questions 27 through 31 refer to the lettered sections of the velocity vs. time graph, which is for an object moving in straight-line horizontal motion.

(A section can be the answer to more than one question, but each question has only one answer.)

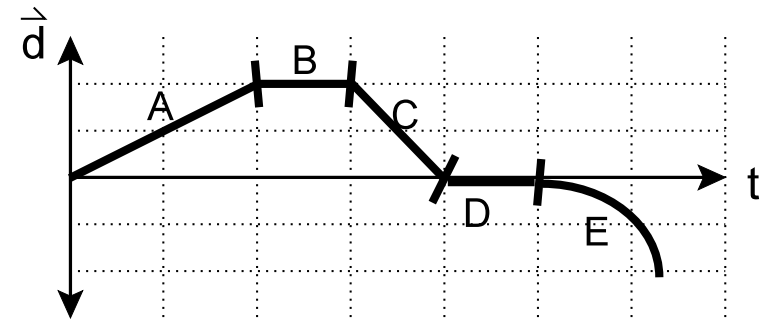
- \_\_\_\_\_ 27. During which section was the object accelerating forward?
- \_\_\_\_\_ 28. During which section did the object actually move backward?
- \_\_\_\_\_ 29. During which section was the object at rest?
- \_\_\_\_\_ 30. During which section was the object's acceleration always changing?
- \_\_\_\_\_ 31. During which section was the object moving at a constant speed?



Questions 32 through 35 refer to the lettered sections of the displacement vs. time graph, which is also for an object moving in straight-line horizontal motion.

(A section can be the answer to more than one question. Except as noted, each question has only one answer.)

- \_\_\_\_\_ 32. During which section(s) was the object at rest?
- \_\_\_\_\_ 33. During which section was the object always changing speed?
- \_\_\_\_\_ 34. During which section did the object move behind its starting point?
- \_\_\_\_\_ 35. During which section was the object moving backward at a constant speed?



ANSWERS	
19.	
20.	
21.	
22.	
23.	
24.	
25.	
26.	
27.	A
28.	C
29.	D
30.	B
31.	B
32.	B
33.	A, C, E
34.	C, D, E
35.	D