NAME: KEY

Test 1: *1 D Motion*

(2013)

Equations and constants:

$\bar{v} = \frac{\Delta x}{\Delta t}$ $\bar{v} = \frac{(v_i + v_f)}{2}$ $v = \frac{dx}{dt}$ $\bar{a} = \frac{\Delta v}{\Delta t}$ $a = \frac{dv}{dt}$

$x = \frac{1}{2}at^2 + v_i t + x_i$ $v = at + v_i$ $v_f^2 = v_i^2 + 2a\Delta x$ $|g| = 10\ m/s^2$

Multiple Choice: *Choose the letter of the best answer. 3 points each.*

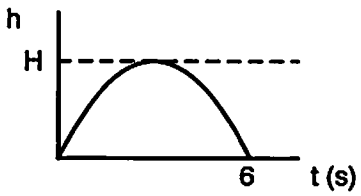
Unless otherwise noted, ignore the effects of air resistance.

1. D The acceleration as a function of time for an object is given by $a = 3t^2 + 5$. Which of the following could be the velocity as a function of time for the object?
   a. 6t. b. $6t^3 + 5t$. c. $3t^3 + 5t + 6$. d. $t^3 + 5t + 7$. e. None of those.

2. A The position as a function of time (in SI units) is given by $x = t^3 - 6t + 9$. What is the velocity of the object at t = 2 seconds? $v = 3t^2 - 6$
   a. 6 m/s. b. –4 m/s. c. 5 m/s. d. –2 m/s. e. 0 m/s.

3. C What must be true if you have a constant acceleration?
   a. You are always speeding up.
   b. You are always going forwards.
   c. Your velocity changes the same amount each second.
   d. You would have to be falling.

Questions 4 and yy refer to the following:
The 5 of a ball tossed in the air as a function of time is shown to the right.

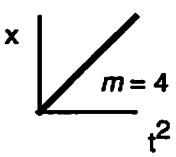


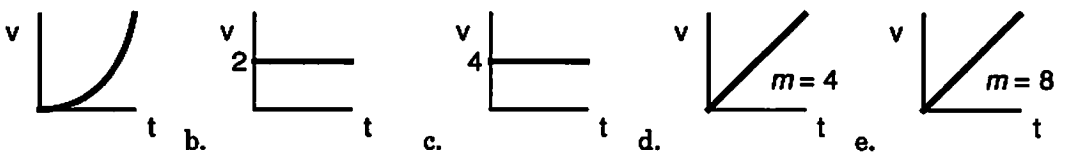
4. B What was the initial velocity of the ball?
   a. 60 m/s. b. 30 m/s. c. 10 m/s.
   d. 0 m/s. e. Need to know H to figure it out.

5. A At the maximum height of the ball, what is true about the acceleration of the ball?
   a. It is constant at 10 m/s^2 down.
   b. It is constant at 10 m/s^2, but changing from up to down.
   c. It is concave down.
   d. What?! It's zero because the ball is at its maximum height.

6. A Bob travels 100 meters to the left in 25 seconds. Then he travels 100 meters to the right in 50 seconds. What was his average velocity for both motions?
   a. 0 m/s. b. 2.67 m/s. c. 3 m/s. d. 6 m/s.

7. E The position vs time^2 for an object is shown in the diagram. The slope of the line is 4 (in standard SI units.). What is the best velocity vs time graph for the object?





8. C All of the following are units of acceleration EXCEPT
   a. km/h/s. b. m/s^2. c. m/s. d. m/s/s. e. mph/s.

a ✓

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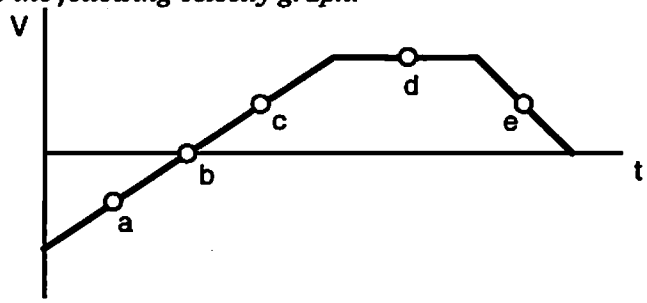
Questions 9 to 12 refer to the following velocity graph:



9. A E At which point(s) is the object slowing down?

10. D At which point(s) does the object have a constant speed?

11. B At which point(s) is the object at rest?

12. A B C At which point(s) does the object have a positive acceleration?

13. A Somehow, a hammer and a feather are dropped simultaneously from the same height on the airless moon. Which object hits the ground first?
   a. Really? They hit at the same time.
   b. The hammer hits first because it is heavier.
   c. The hammer hits first because the feather actually floats away.
   d. The feather hits first because it is weird on the moon.
   e. Either, depending on how NASA wants to fake things.

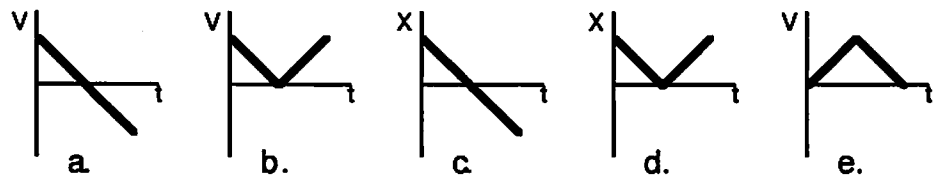
Questions 14 and 15 refer to the following:
You toss a pencil in the air with an initial velocity of 15 m/s and you catch it at the same height from which you tossed it.

14. A How long was the pencil in the air?
   a. 3 s. b. 1.5 s. c. 0.75 s. d. 1.7 s. e. Can't tell.

15. C How fast was the pencil going as you caught it?
   a. 30 m/s. b. 20 m/s. c. 15 m/s. d. 10 m/s. e. 5 m/s.

16. D A car is accelerating to the left. That means that the car
   a. is speeding up. b. is slowing down. c. has a constant speed.
   d. can't tell which is the correct answer.

17. A You are bored and tossing a ball up in the air, always catching it at the height from which you threw it. Which of the following graphs could describe the motion of the ball while in the air?



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Problem Solving: *Show all work.*
Unless otherwise noted, ignore the effects of air resistance.

18. **An apple is thrown straight up in the air with an initial speed of 32 m/s. Two seconds later, another apple is thrown up with an identical speed. What is the velocity of the second apple when it collides with the first?**

Apple 1 after 2 sec: $v = at + v_i \rightarrow v = -10(2) + 32 = \underline{12\ m/s}$

$h = \frac{1}{2}(-10)(2)^2 + 32(2) = -20 + 64 = \underline{44\ m}$

So Now

$h_1 = -5t^2 + 12t + 44$

$h_2 = -5t^2 + 32t$

$h_1 = h_2 \rightarrow 12t + 44 = 32t$

$20t = 44$

$t = 2.2\ s$

So $v_2 = -10t + 32$

$= -10(2.2) + 32$

$= -22 + 32$

$v_2 = 10\ m/s$

19. **On an strange distant planet, someone throws a ball up in the air with an initial speed of 24 m/s. After 3.5 seconds, the ball is coming down and has a speed of 8 m/s. How high is the ball at that time? (Assume the initial height of the ball was zero.)**

$v_i = 24\ m/s$

$v_f = -8\ m/s$

$t = 3.5\ s$

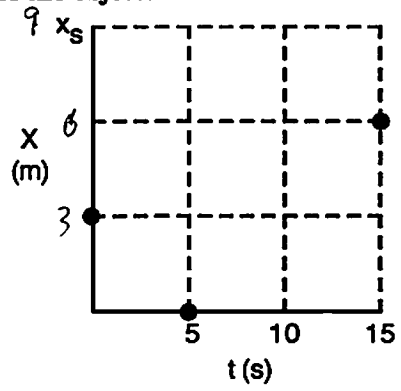
$a = \frac{v_f - v_i}{t} = \frac{-8 - 24}{3.5} = \frac{-32}{3.5} = \underline{-9.14\ m/s^2}$

$h = \frac{1}{2}(-9.14)(3.5)^2 + (24)(3.5) = -56 + 84$

$h = 28\ m$

oops!

20. **Some of the positions as a function of time for an object is given by the graph shown. The vertical scale on the graph is set by $x_s = 9$ meters. What was the (assumed constant) acceleration of the object?**



$x_i = 3$

x	t
0	5
6	15

~~$x = \frac{1}{2}at^2 + v_i t + x_i$~~

$0 = \frac{1}{2}a(5)^2 + v_i(5) + 3$

$6 = \frac{1}{2}a(15)^2 + v_i(15) + 3$

$0 = 25a + 10v_i + 6$

$12 = 225a + 30v_i + 6$

$-0 = 75a + 30v_i + 18$

$12 = 150a + 0v_i - 12$

$\therefore 24 = 150a$

$a = 0.16\ m/s^2$

$\frac{24}{150} = \frac{150a}{150}$

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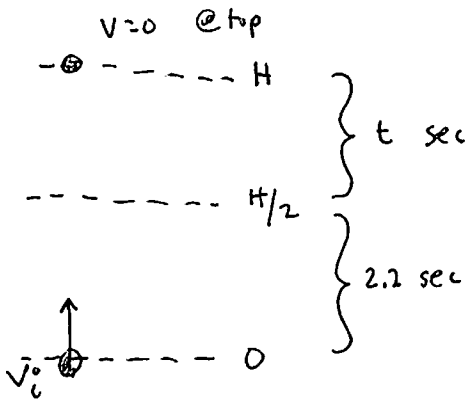
21. An object is thrown straight up with some initial velocity. After 2.2 seconds, it has reached half its maximum height. What was the initial velocity?



Since $t_{up} = t_{down}$ ...

Drop the object:

$d = \frac{1}{2}at^2 \qquad (v_i = 0)$

$\frac{H}{2} = \frac{1}{2}(10)t^2$

$H = \frac{1}{2}(10)(t+2.2)^2$

or just $0 = v_i^2 + 2(-10)H$, $v_i^2 = v_i^2 + 2(-10)(H/2)$, $v_f = -10(2.2) + v_i$, $v_f = -10(7.2) + v_i$

So $\frac{1}{2}(10)(t+2.2)^2 = 10t^2$

$t^2 + 4.4t + 4.84 = 2t^2$

$t^2 - 4.4t - 4.84 = 0$

So $t = \dfrac{4.4 \pm \sqrt{4.4^2 - 4(1)(-4.84)}}{2(1)}$

$t = \dfrac{4.4 \pm 6.22}{2} = 5.31$ sec

(+ root)

So After drop $v = at$

$v = (10)(5.31)$

$v = 53.1$ m/s

So $5.31 + 2.2 = 7.51$ sec

So $v = at$

$= (10)(7.51)$

$= 75.1$ m/s

(or 12.9)

(same height, so speed same.)

Slick way:

since $D \propto t^2$ for constant acceleration, to fall 2D will need $\sqrt{2}t$

$\left[\frac{D}{t^2} = \frac{2D}{x^2} \Rightarrow x = \sqrt{2}t\right]$

So $\sqrt{2}t = t + 2.2$

$t = \dfrac{2.2}{\sqrt{2}-1}$

$t = 5.31$ s

So $v_f = 10(5.31) = 53.1$ (as ↑)

So ↓

-2 wrong root.