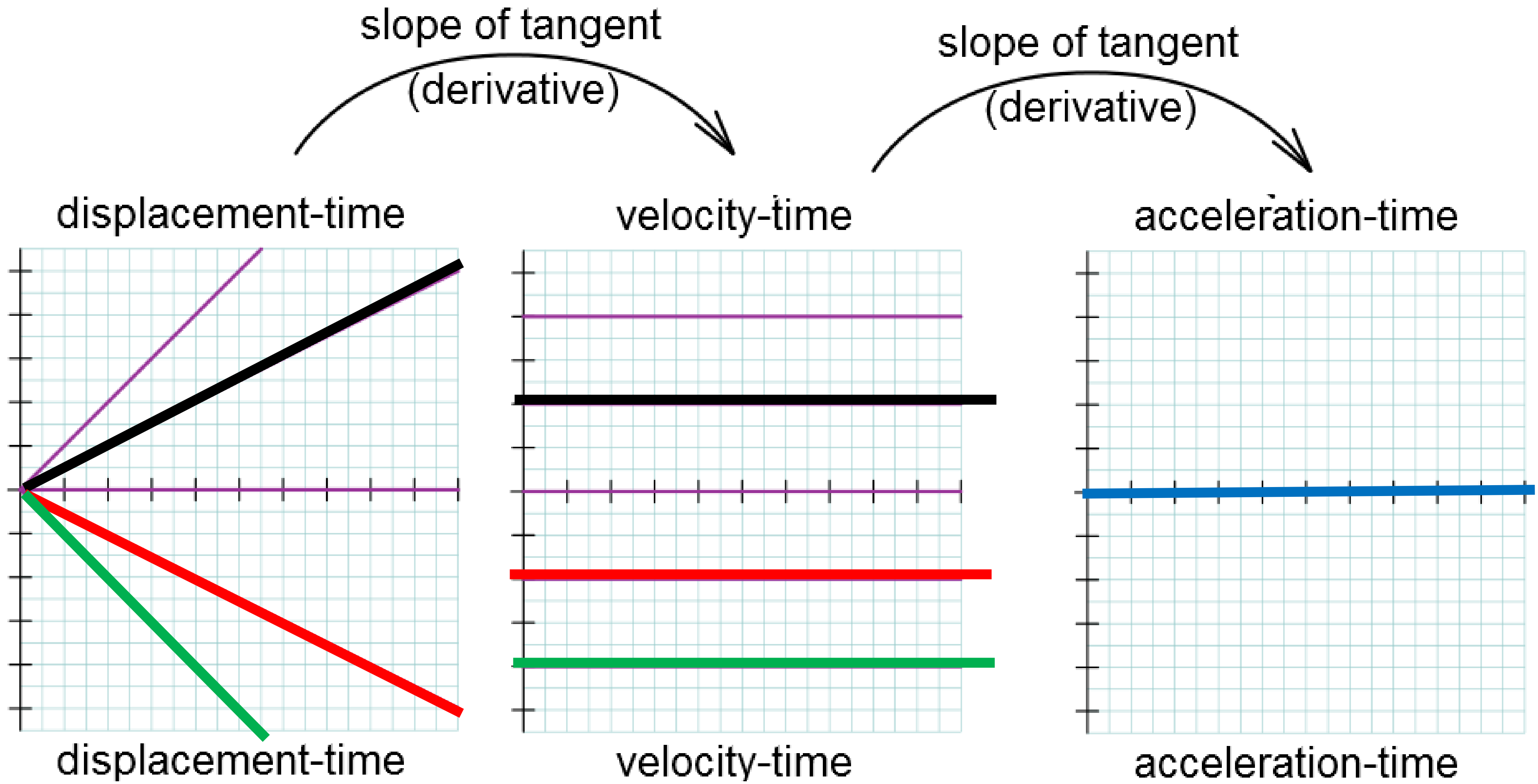
Practicing Problem Solving and Graphing & Answering Your Questions

Let's Draw Some Graphs!

Let's pick an origin and then draw the position, velocity and acceleration versus time graph for the following situation:

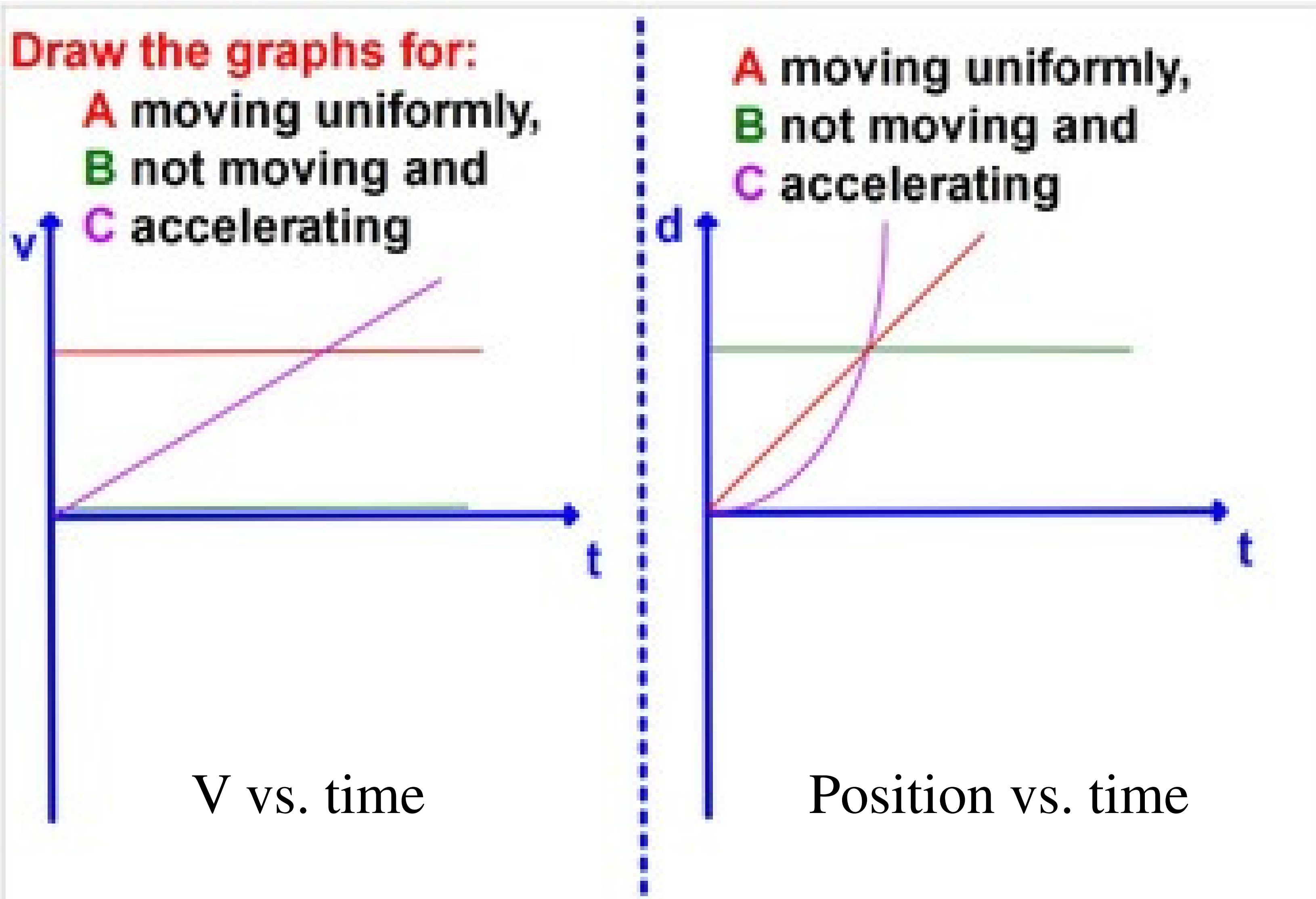
- Me standing still
- How would these change if I moved the origin?
- Me moving to left at constant speed (call right +)
- Me starting from rest and speeding up uniformly to the left
- A ball after left my hand going up and then falling down

Relating the Graphs



Integration (calculus) lets you find the area under a curve (which allows you to go backwards), which we won't be doing

Velocity and Position vs Time Graphs

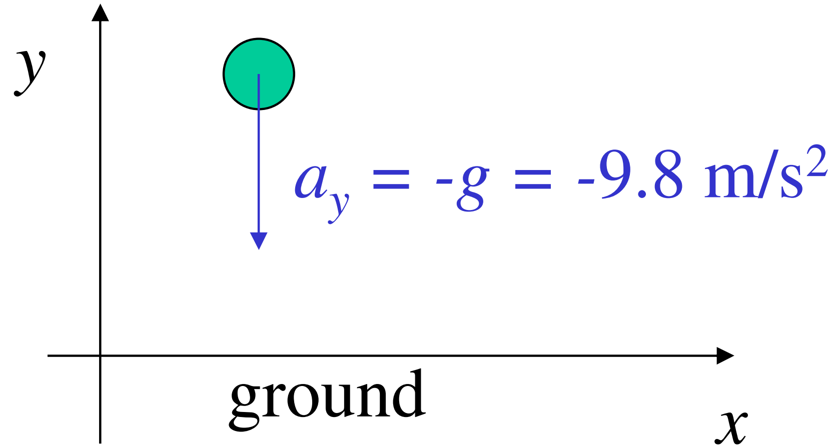


V vs. time

Position vs. time

Graphing Freely Falling Bodies

+y



Equation of a straight line

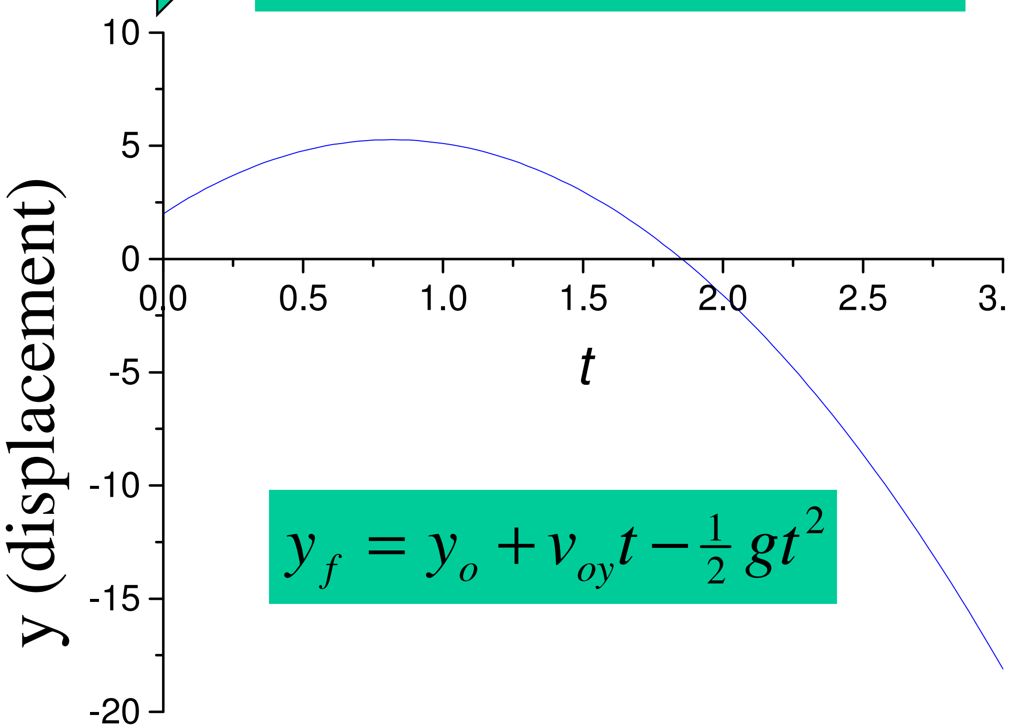
$$y = b + mx$$

b is y-intercept, m is slope

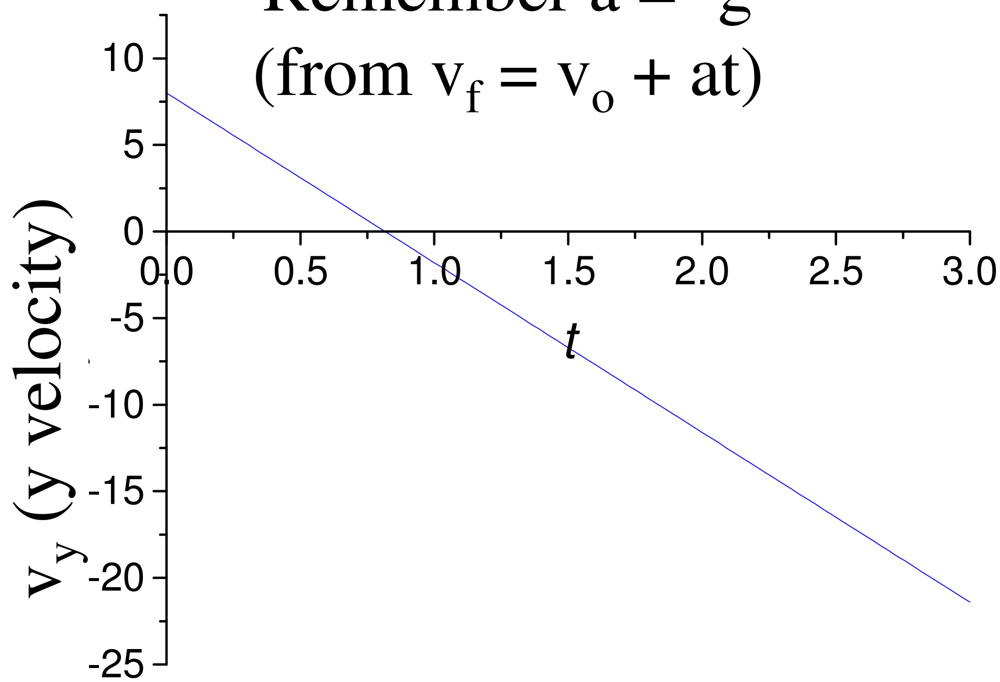
$$\Delta y = y_f - y_o = v_{oy}t - \tfrac{1}{2}gt^2$$

$$v_y = v_{oy} - gt$$

Remember a = -g
(from $v_f = v_o + at$)



$$y_f = y_o + v_{oy}t - \tfrac{1}{2}gt^2$$



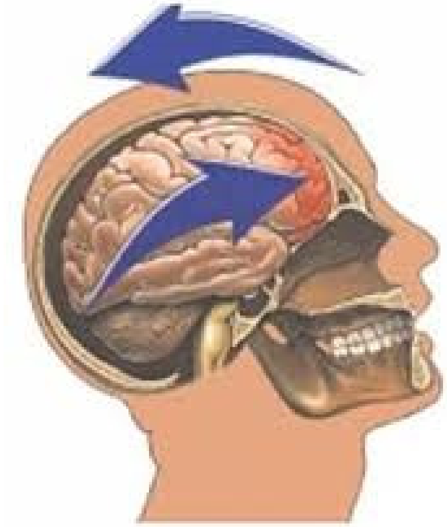
Injury from Falling and/or a Collision

- It's not the falling that hurts, but the stopping
- Skydiving at $a = \pm 9.8 \text{ m/s}^2$ is fine
- If we stop suddenly, magnitude is much more!
- How do treat a problem with 2 accelerations?

Concussions: The Gravity of It All

Pun intended ☺

I know, there's something wrong with my humor.



Traumatic brain injury results when the head undergoes a very large acceleration.

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC155415/

Generally, an acceleration less than 800 m/s^2 lasting for any length of time will not cause injury, whereas an acceleration greater than 1000 m/s^2 lasting for at least 0.001 seconds will cause injury.

So what do we need to know in order to get time and acceleration?

Challenging Application: Child Falling from Bed

Suppose a child falls off a bed that is 1.0 m above the floor. If the floor is hardwood, the child's head is brought to rest in ~ 2.0 mm (carpet ~ 1.0 cm, 5x more). Calculate the magnitude (and duration) of the acceleration for hardwood to determine the risk of injury.

Why is this a challenging problem?

Figuring Out Which Formula

(main formulas given on exam, see website)

$$\bar{v} \equiv \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t}$$

Eq. A

$$x = x_o + v_o t + \tfrac{1}{2} a t^2$$

Eq. B

$$v^2 = v_o^2 + 2a\Delta x$$

Eq. C

$$v = v_o + at$$

Eq. D

List your knowns and unknowns:

Sometimes easier to find which formula does not have the variable you are NOT considering

- Δx, v_o, v, a
- v_o, v, a, t
- Same strategy applies to multipart questions, you just do one part at a time. Sometimes need answer from a to answer b

A small bag is released from a helicopter that is descending steadily at 1.50 m/s.

(a) After 4.00 s, what is the speed of the bag?

(b) At 4 s, how far is it below where it was when it was dropped? Is this the same as how far is it below the helicopter at 4sec?

(c) What are your answers to parts (a) and (b) if the helicopter is instead rising steadily at 1.50 m/s? **Notice that a change of the sign of velocity affects the answer!**

If you drop an object in the absence of air resistance, it accelerates downward at 9.8 m/s^2. If instead you throw it downward, its downward acceleration after you stop touching it (but before it hits anything) is

A. less than 9.8 m/s^2.
B. 9.8 m/s^2.
C. more than 9.8 m/s^2.

Q12

Conceptual Problem

A person standing at the edge of a cliff throws one ball straight up and another ball straight down at the same initial speed. Neglecting air resistance, the ball to hit the ground below the cliff with the greater speed is the one initially thrown

$$v = v_o + at$$

$$\Delta x = v_o t + \tfrac{1}{2} a t^2$$

$$v^2 = v_o^2 + 2a\Delta x$$

A. upward.
B. downward.
C. neither—they both hit at the same speed.

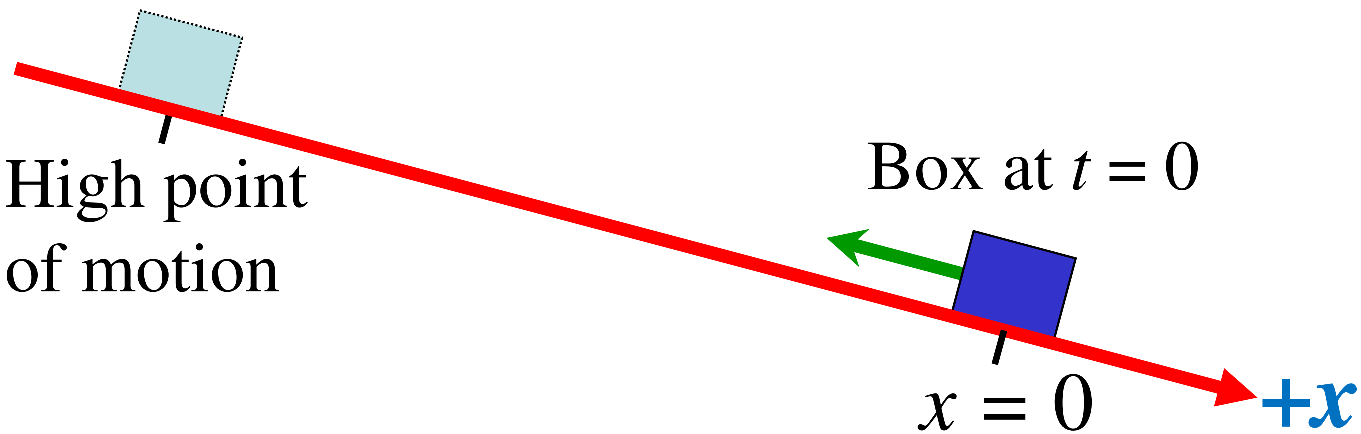
Q13

Talk to neighbors, this problem and next are tricky

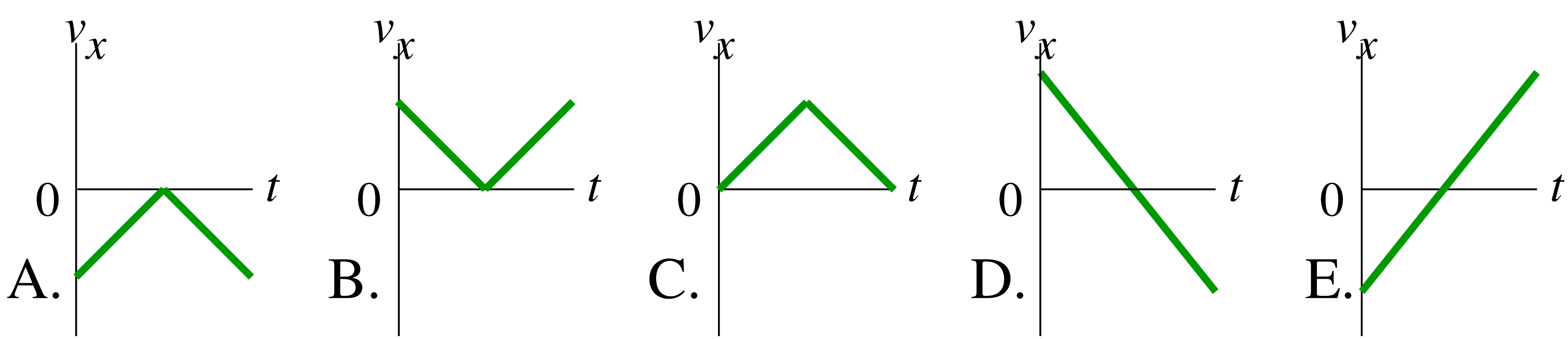
Q14

A box is on an inclined, frictionless track. The *positive x direction* points downhill. At $t = 0$ the box is at $x = 0$ and moving uphill.

After reaching the high point of its motion, it moves downhill and returns to $x = 0$.



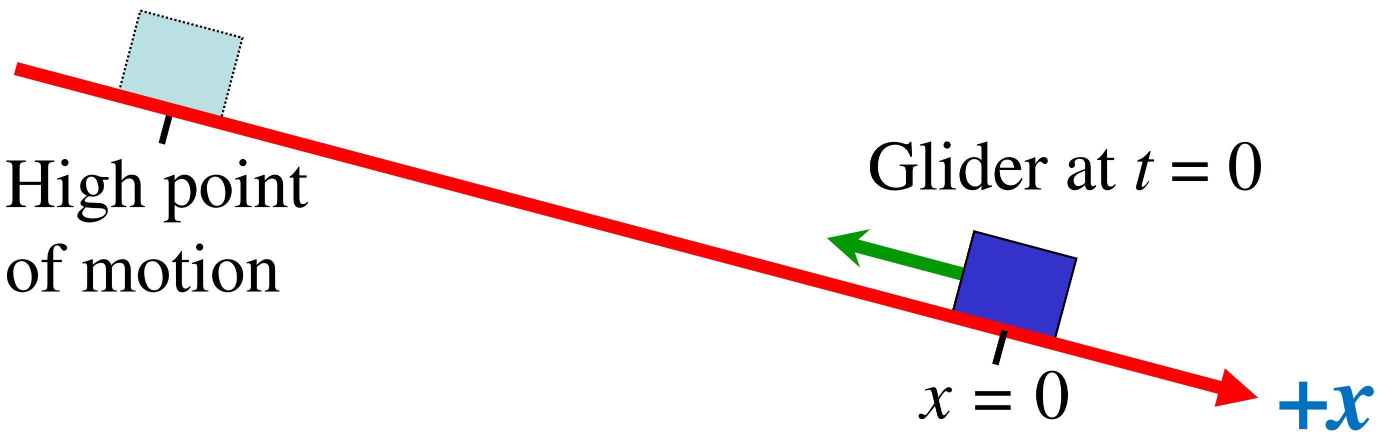
Which of the following graphs of velocity versus time best matches the motion of the box?



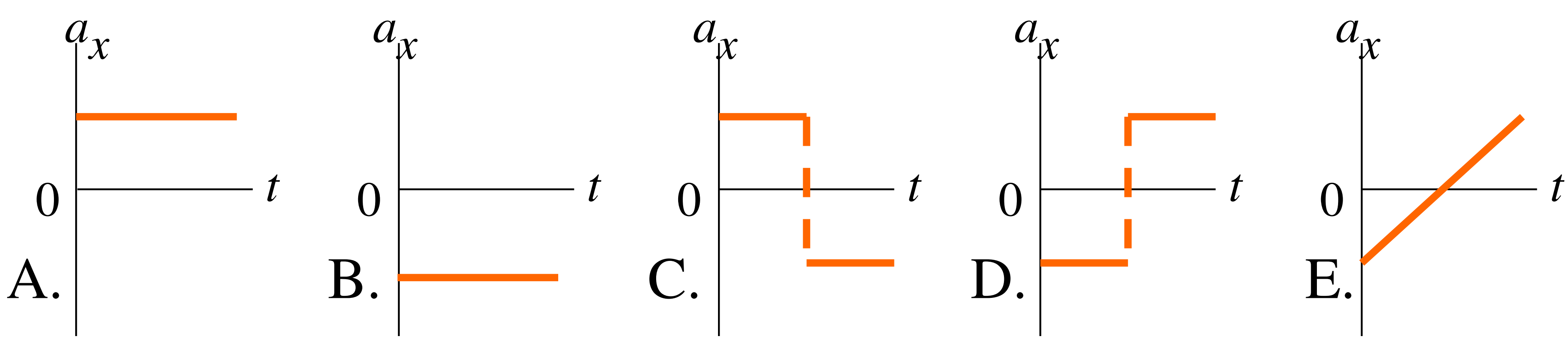
Q15

A box is on an inclined, frictionless track. The x-axis points downhill. At $t = 0$ the box is at $x = 0$ and moving uphill.

After reaching the high point of its motion, it moves downhill and returns to $x = 0$.



Which of the following a_x–t graphs (graphs of acceleration vs. time) best matches the motion of the box?



Clicker Answers

11=C, 12=B, 13=C, 14=E, 15=A