Mechanics & Relativity

Dr Lily Asquith (Lily)

28-30 September 2021 (Week 1)

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Kinematics

This week's topics:

1.1 Displacement, Velocity & Acceleration

1.2 Equations of motion (SUVAT)

1.3 Reading graphs

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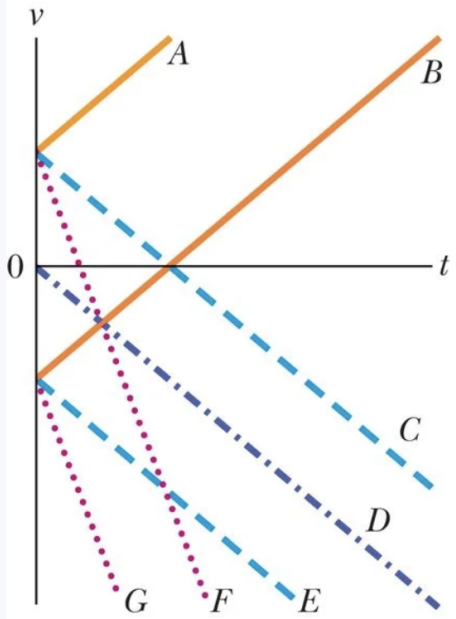
Quiz 1.2 suvat

TBD

Poll Everywhere Checkpoint

You are standing on a bridge with two eggs. You drop one, and you throw the other directly downwards.



Use your phone to go to: pollev.com/ilovephysics

(a) Which line best describes the motion of the dropped egg?

(b) Which line best describes the motion of the thrown egg?

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Integrating acceleration over time

We know that $a = \frac{dv}{dt}$

$$\begin{aligned}\int_{t_0}^{t} a dt &= \int_{t_0}^{t} \frac{dv}{dt} dt \\ &= \int_{t_0}^{t} dv \\ &= v_t - v_{t0}\end{aligned}$$

$$\int_{t_0}^{t} a dt = v_t - v_{t0} \quad \textbf{1.1}$$

The integral of the acceleration over time gives the change in velocity

Integrating velocity over time

Similarly $v = \frac{ds}{dt}$

$$\begin{aligned}\int_{t_0}^{t} v dt &= \int_{t_0}^{t} \frac{ds}{dt} dt \\ &= \int_{t_0}^{t} ds \\ &= s_t - s_{t0}\end{aligned}$$

$$\int_{t_0}^{t} v dt = s_t - s_{t0} \quad \textbf{1.2}$$

The integral of the velocity over time gives the change in position

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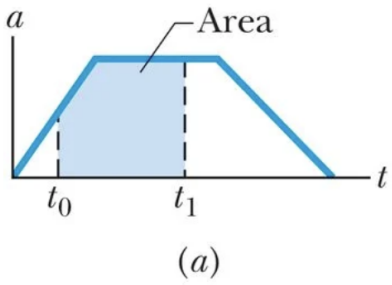
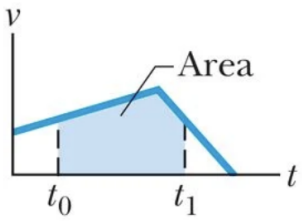
The area under a curve



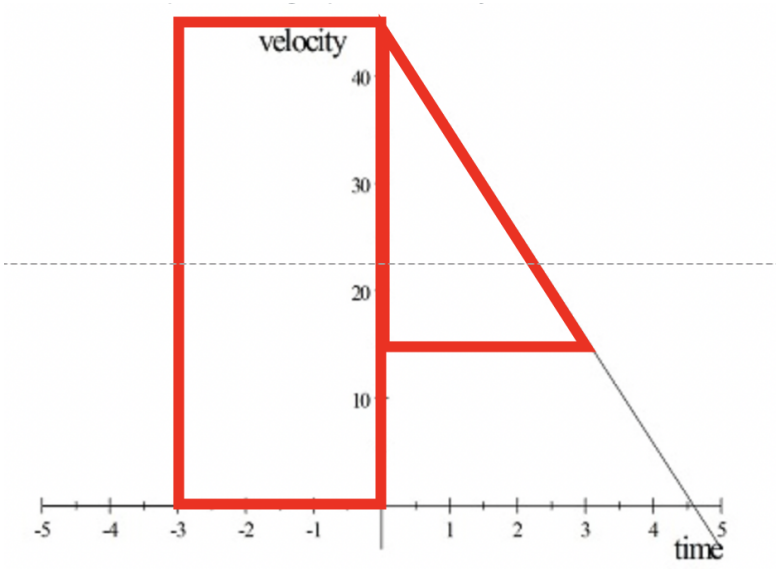
(a)

This area gives the change in velocity.



(b)

This area gives the change in position.



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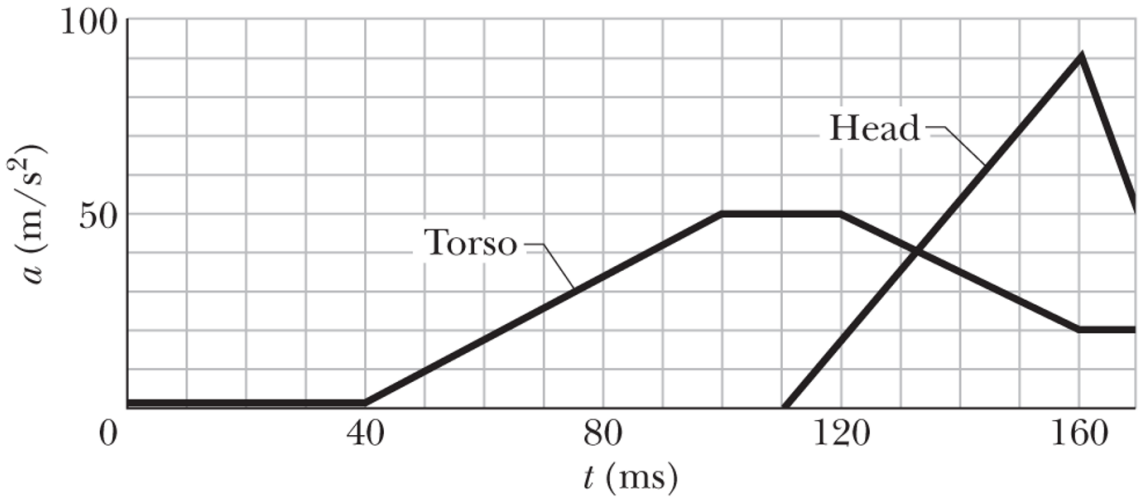
A example: whiplash curve



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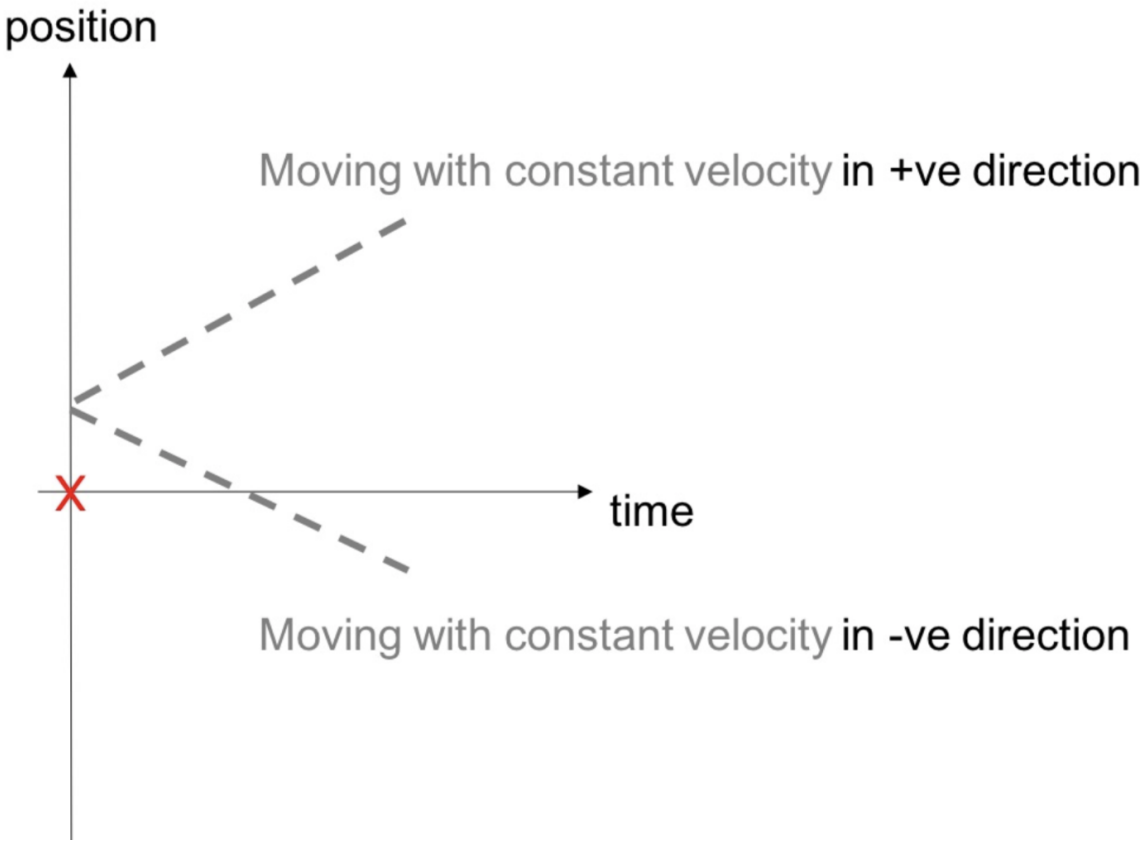
Tackling confusion with directions



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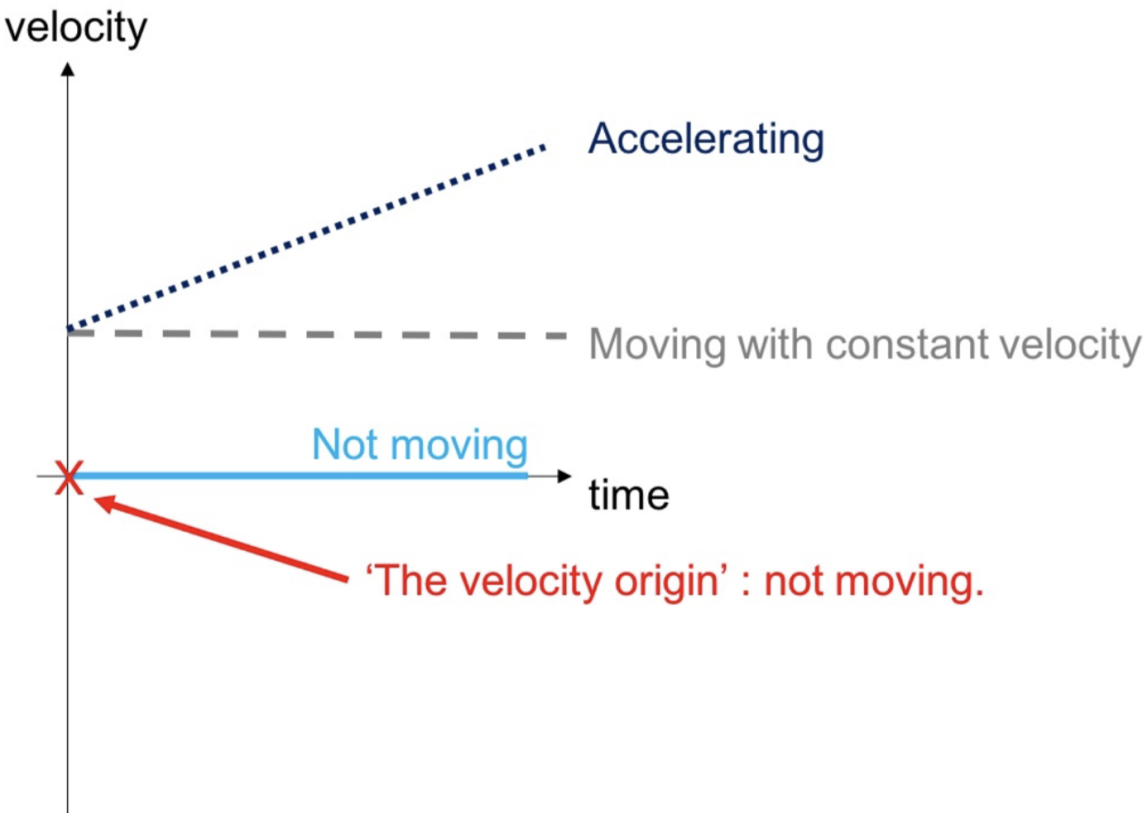
Zero velocity is constant velocity



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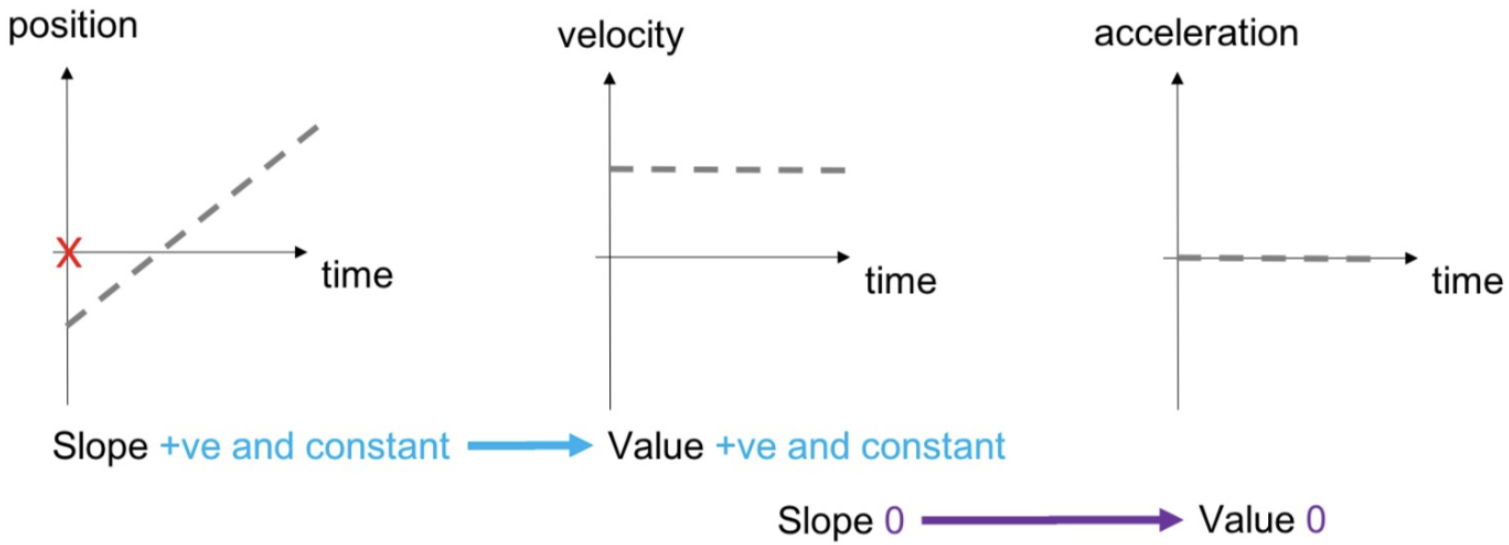
Matching slopes to values

Example: *A fire engine passes me (x) at 50 mph*



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A bouncing ball

How would we draw the motion of a ball being dropped from height, reaching ground, and bouncing back up again?

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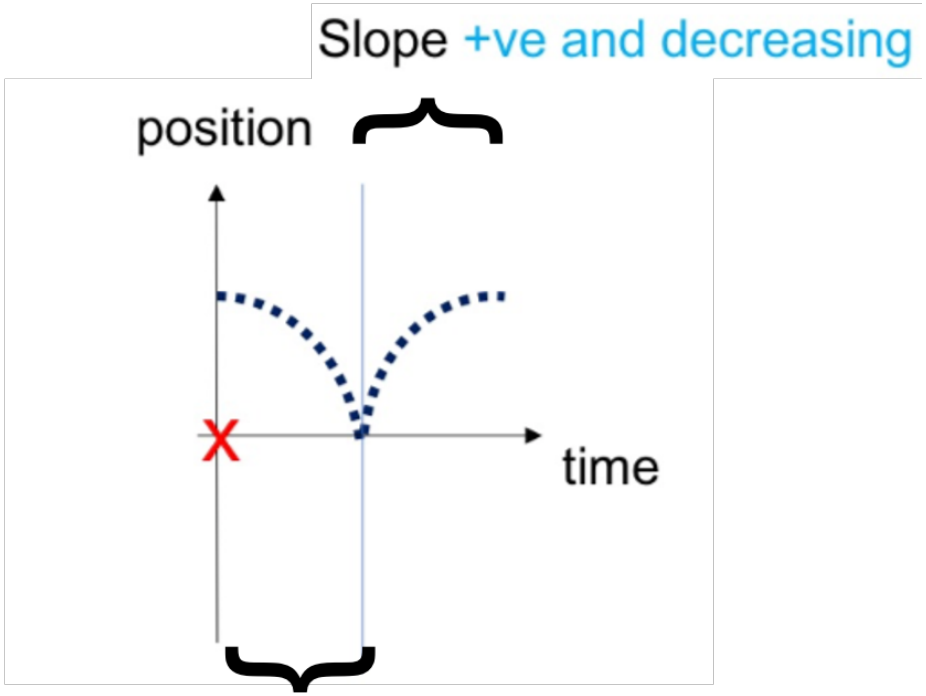
Divide & Conquer



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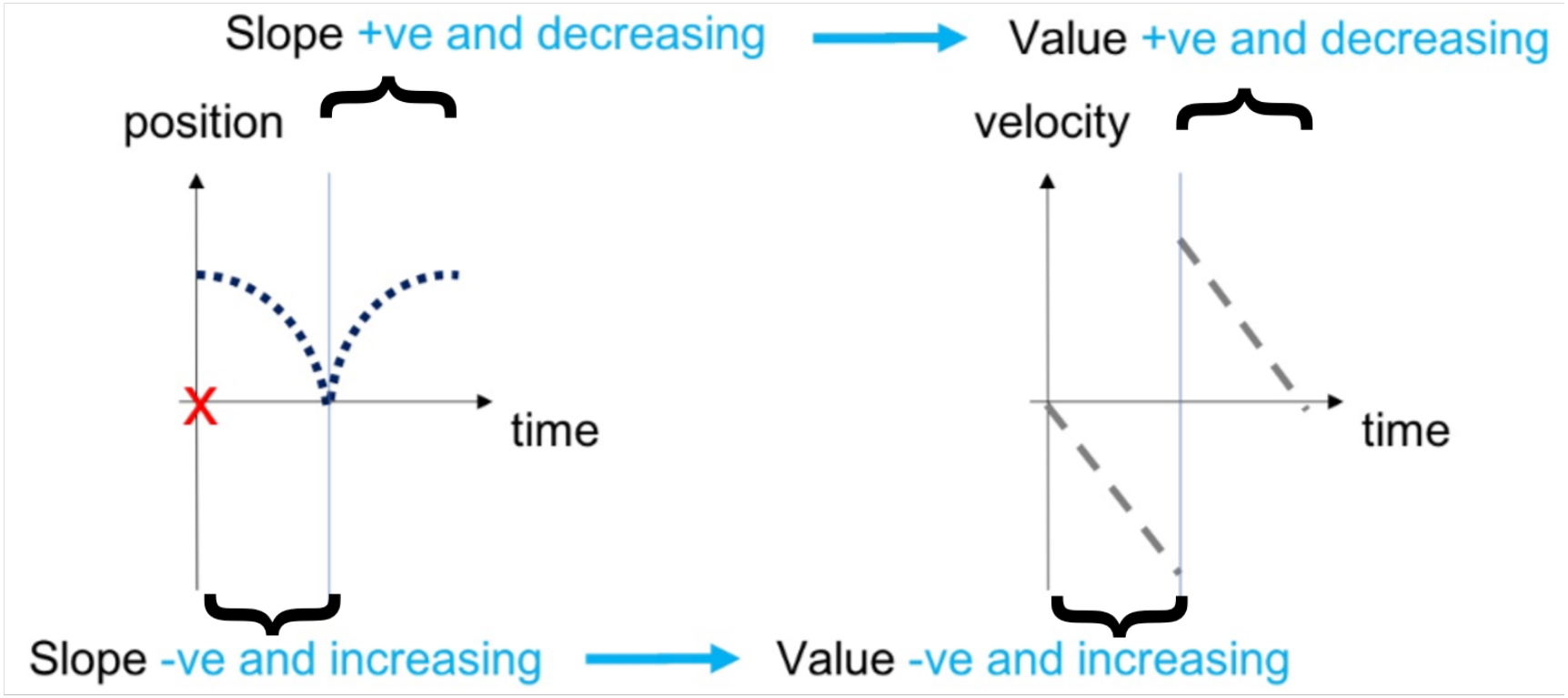
Divide & Conquer



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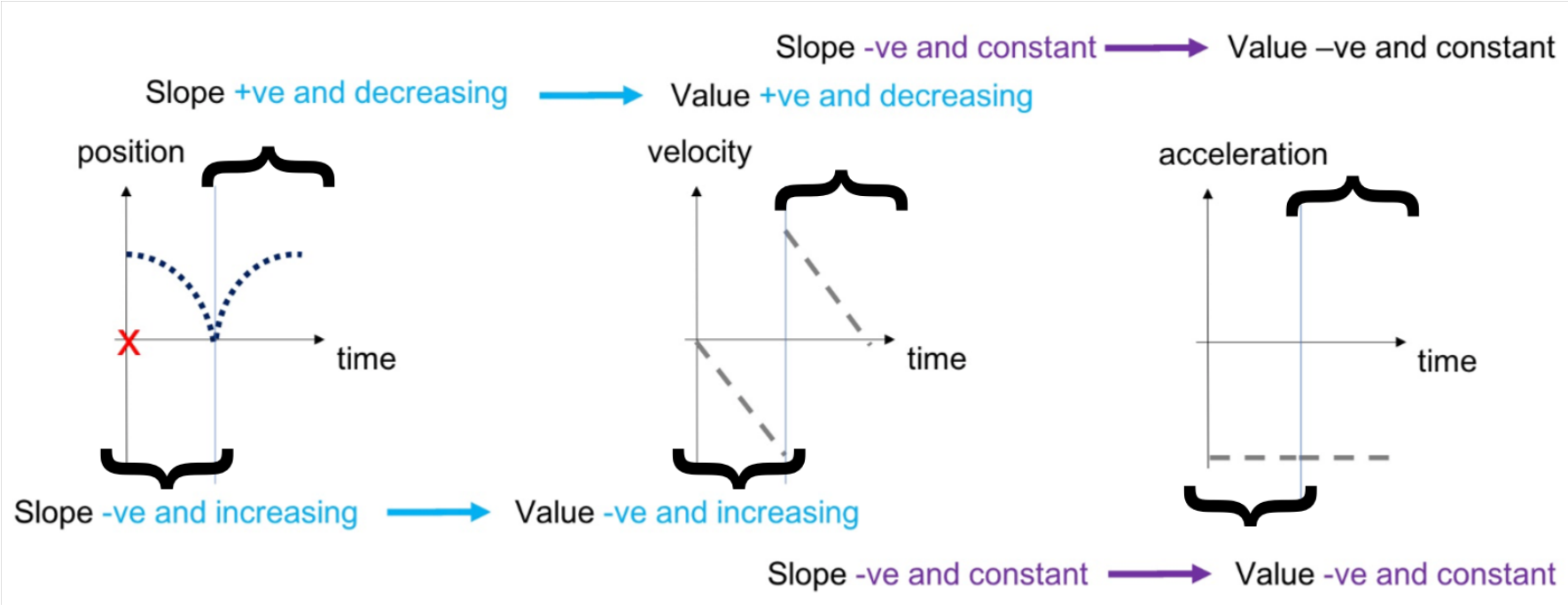
Divide & Conquer



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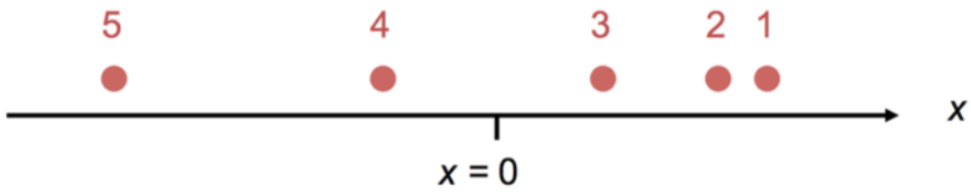
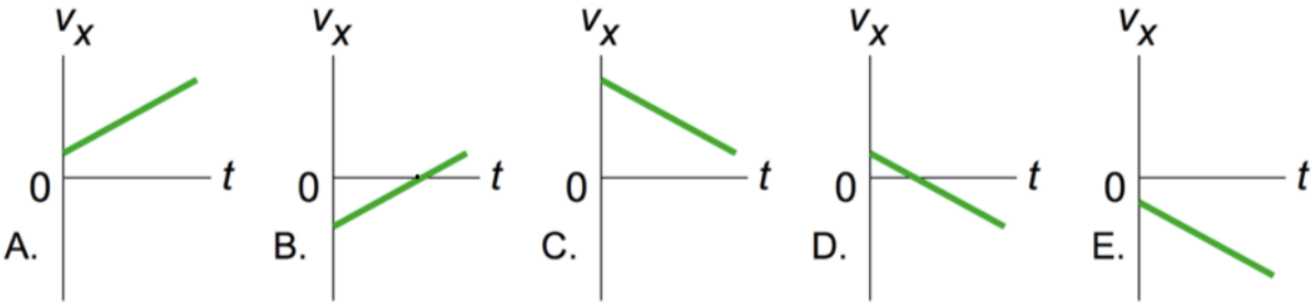
Poll Everywhere Checkpoint (pollev.com/ilovephysics)

This is a motion diagram of an object moving along the *x*-direction with constant acceleration. The dots 1, 2, 3, … show the position of the object at equal time intervals Δt starting at t=0 s.



Which of the following v_x against t graphs best matches the motion shown in the motion diagram?



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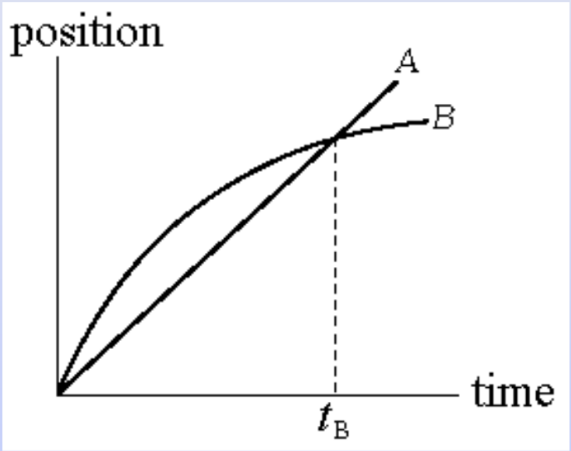
Reading graphs: additional problem

Concept Question: Instantaneous Velocity

The graph shows the position as a function of time for two trains running on parallel tracks. For times greater than $t = 0$, which of the following is true:



1. At time t_B, both trains have the same velocity.
2. Both trains speed up all the time.
3. Both trains have the same velocity at some time before t_B, .
4. Somewhere on the graph, both trains have the same acceleration.

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Preparing for next week's Kinematics Workshop

- The problems for the workshop are on Canvas.
- Have a go at the problems prior to your workshop, so you know in advance what you would like the DT's help with.
- Each workshop has a question marked out as the one you will be graded on.
- Upload your solution to this before the end of next week.

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Tips

- You will need to use the quadratic formula at least once, so remind yourself what that is and when it is useful.
- What information is given in the question? Write it down.
- What information is known but not given? Write it down.
- Underline or draw a box around your answer and take a photo of it (including working) and upload it to canvas.

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