DEVIL PHYSICS
THE BADDEST CLASS ON CAMPUS

IB PHYSICS

LSN 2-1A, KINEMATICS

Questions From Reading Activity?

Essential idea

- Motion may be described and analyzed by the use of graphs and equations.

Nature of science:

- Observations: The ideas of motion are fundamental to many areas of physics, providing a link to the consideration of forces and their implication. The kinematic equations for uniform acceleration were developed through careful observations of the natural world.

Understandings:

- Distance and displacement
- Speed and velocity
- Graphs describing motion

Applications and skills:

- Determining instantaneous and average values for velocity and speed
- Sketching and interpreting motion graphs

International-mindedness:

- International cooperation is needed for tracking shipping, land-based transport, aircraft and objects in space

Utilization:

- Biomechanics (see Sports, exercise and health science SL sub-topic 4.3)

Guidance:

- Calculations will be restricted to those neglecting air resistance

Aims:

- Aim 2: much of the development of classical physics has been built on the advances in kinematics
- Aim 6: experiments, including use of data logging, could include (but are not limited to): determination of g, estimating speed using travel timetables, analyzing projectile motion, and investigating motion through a fluid

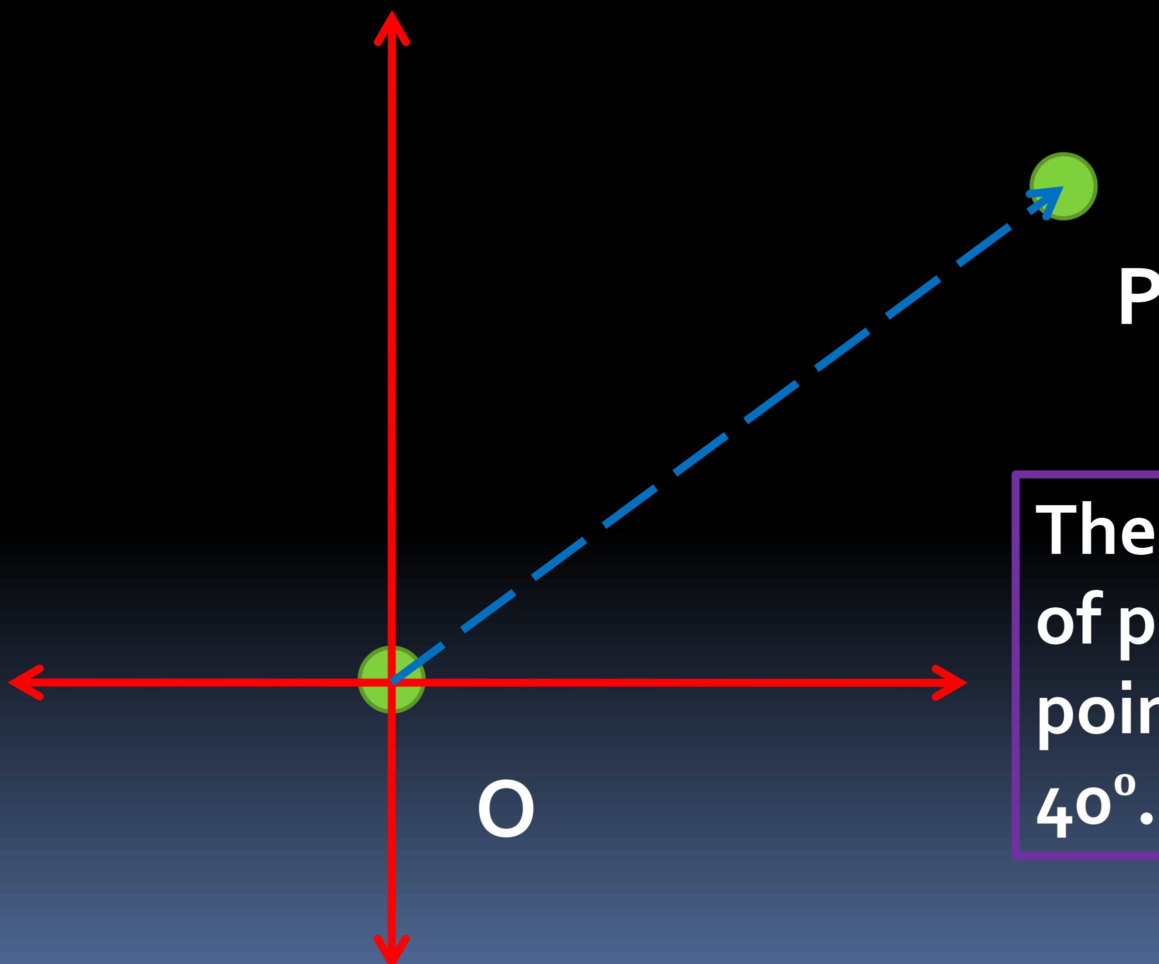
Introductory Video

this video is a dirty little review of basic physics topics. these videos are not meant to be stand-alone learning tools, but complementary aids to class lectures and a good textbook. enjoy.

Displacement

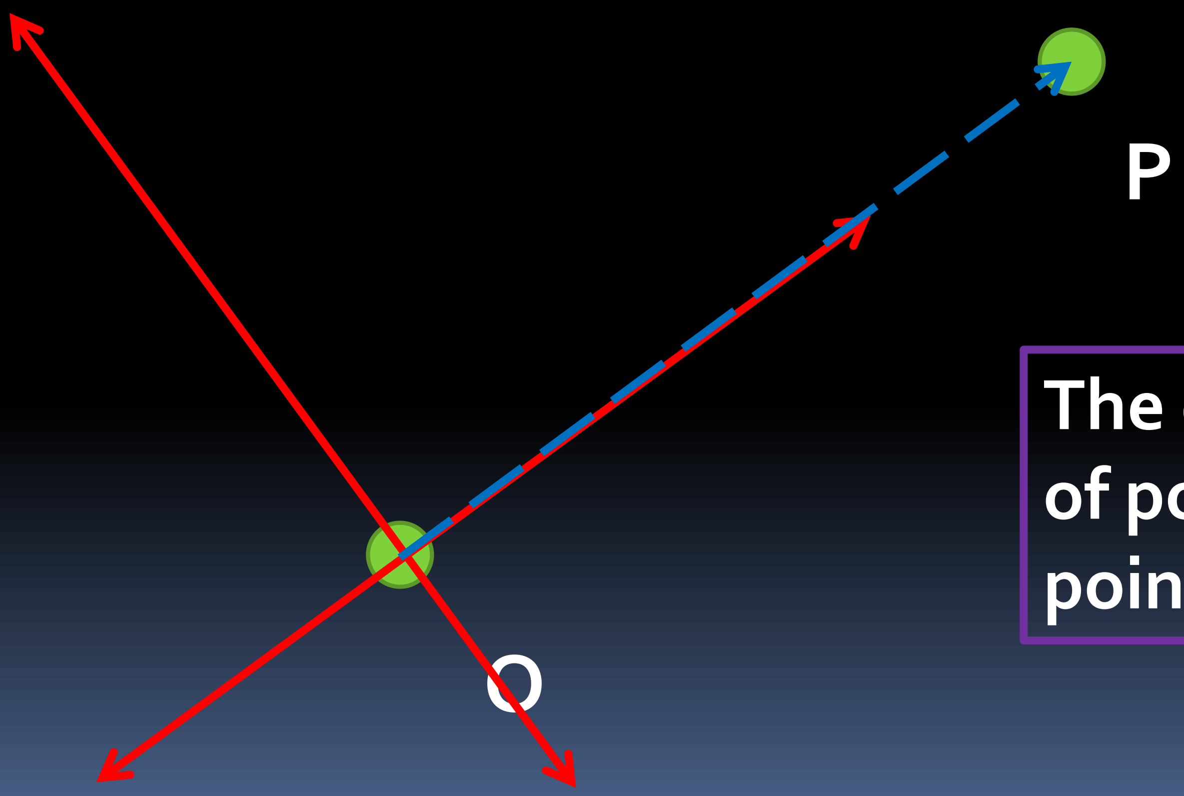
- The displacement of a point from a given reference point will be given by a magnitude and a direction.
  - The magnitude indicates the distance from the reference point to the given point
  - The direction may be either a sign (+ or -) or a degree measurement from a defined a coordinate plane centered at the reference point.

Displacement – Example 1



The displacement of point P from point O is 10m at 40°.

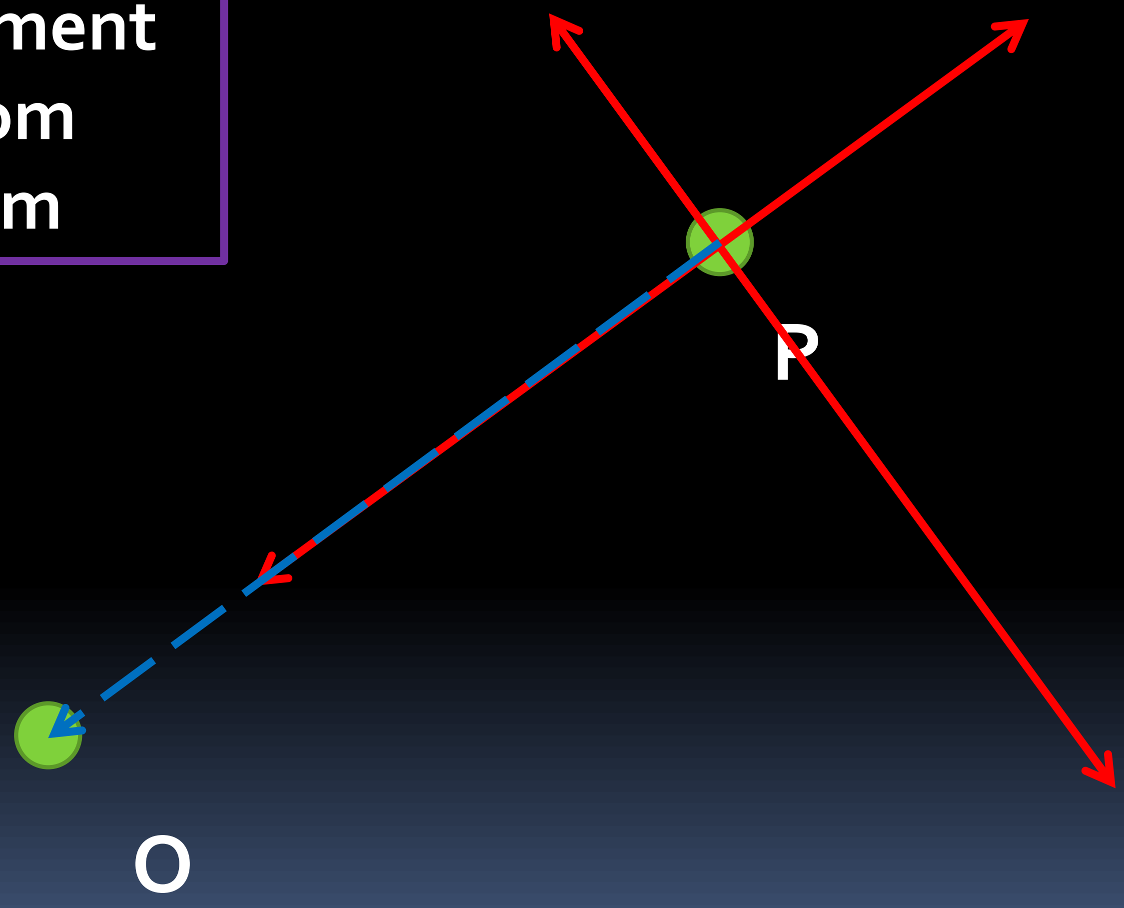
Displacement – Example 2



The displacement of point P from point O is 10m

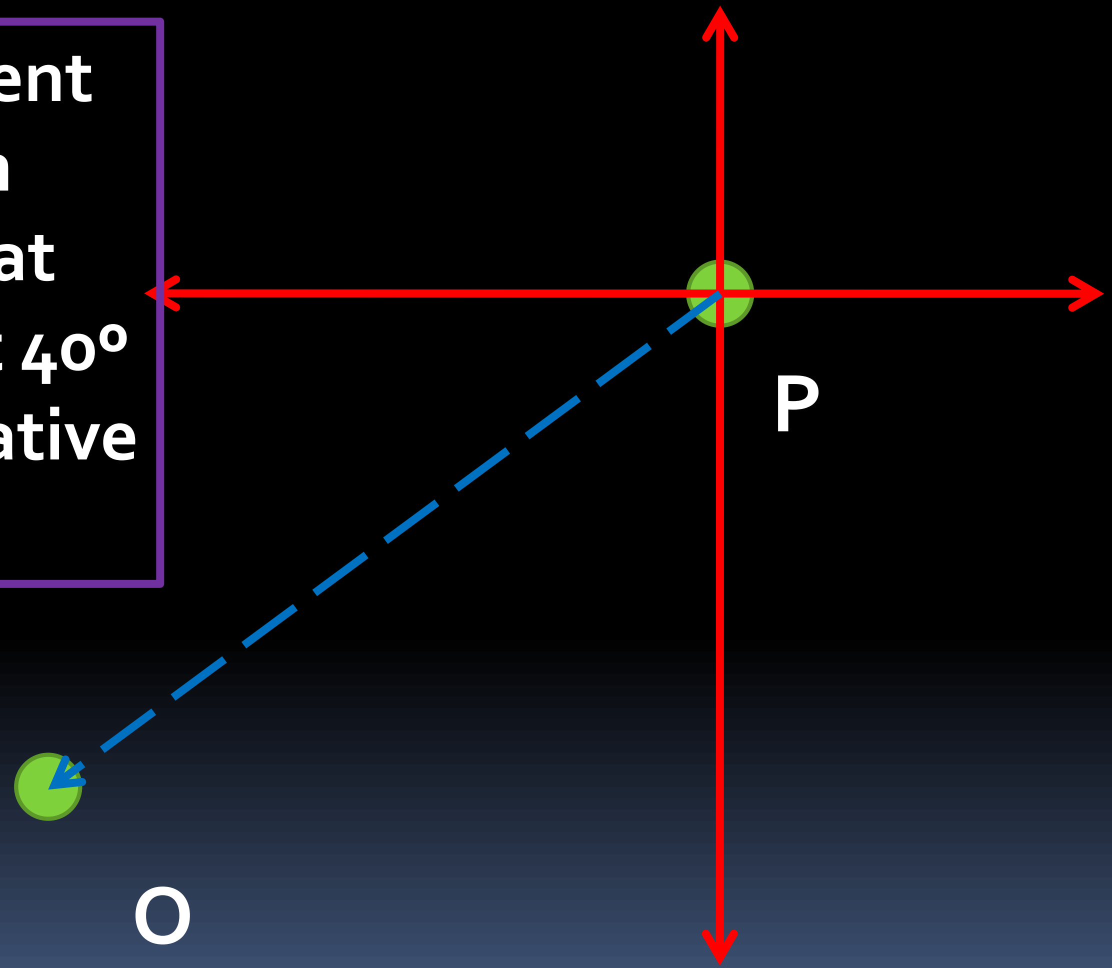
Displacement – Example 3

The displacement of point O from point P is -10m



Displacement – Example 4

The displacement of point O from point P is 10m at 220º or, 10m at 40º below the negative x-axis.



Displacement – Example 5

- *From a reference point, a completely fictional character named Reid moves 6m left and 3m down. What is his distance and displacement?*

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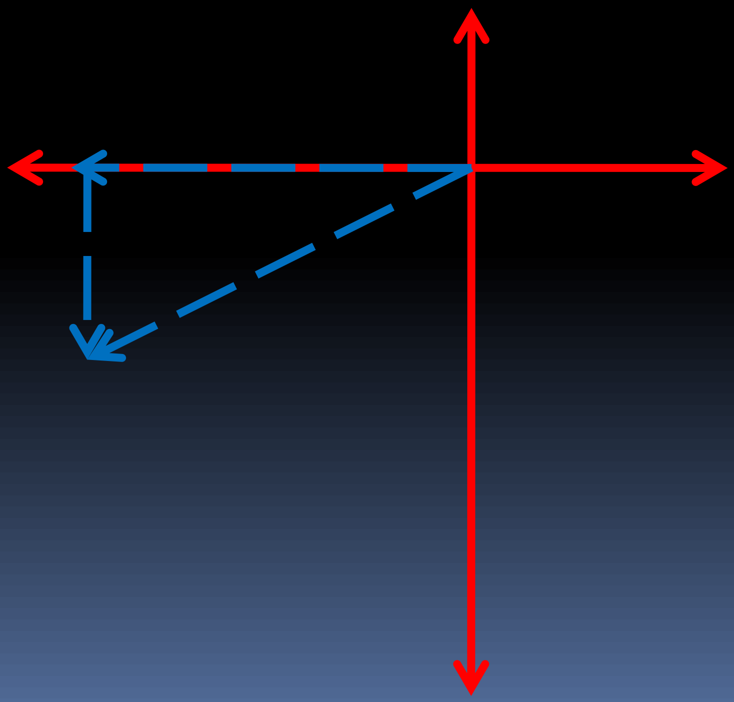
- *From a reference point, a completely fictional character named Reid moves 6m left and 3m down. What is his distance and displacement?*

- *Distance is based on total length travelled so,*

  $d = 6m + 3m = 9m$

- *Displacement is based on length from initial position to final position. What do you use for magnitude?*



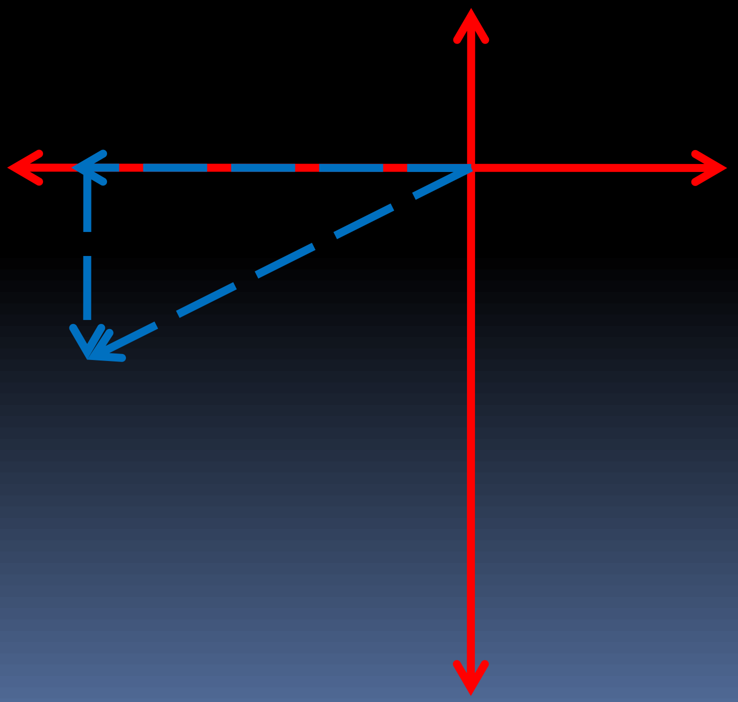
Displacement – Example 5

- *From a reference point, a completely fictional character named Reid moves 6m left and 3m down. What is his distance and displacement?*

- *Displacement is based on length from initial position to final position. Use Pythagorean theorem for magnitude.*

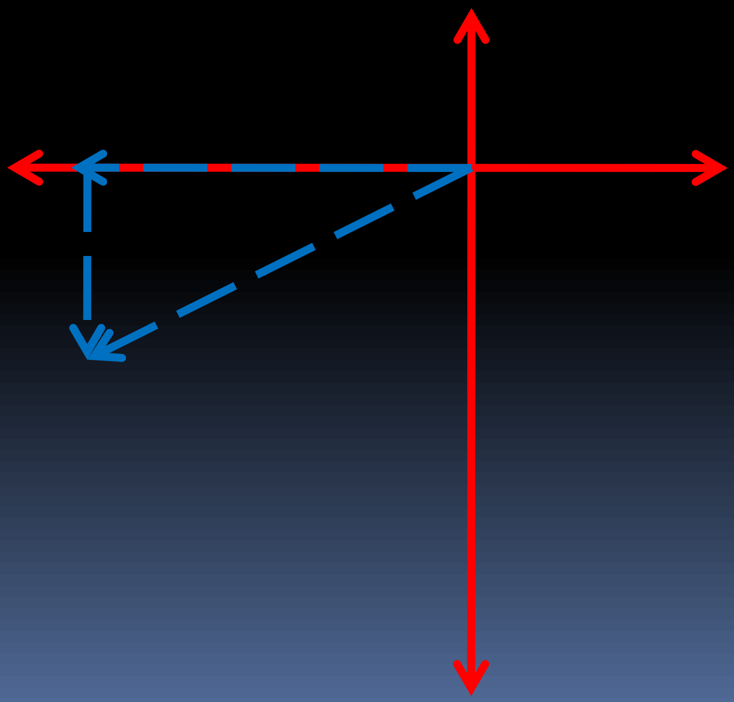
$$c^2 = a^2 + b^2$$

$$c = \sqrt{6^2 + 3^2} = 6.71m$$



Displacement – Example 5

- *From a reference point, a completely fictional character named Reid moves 6m left and 3m down. What is his distance and displacement?*
- *What about direction?*



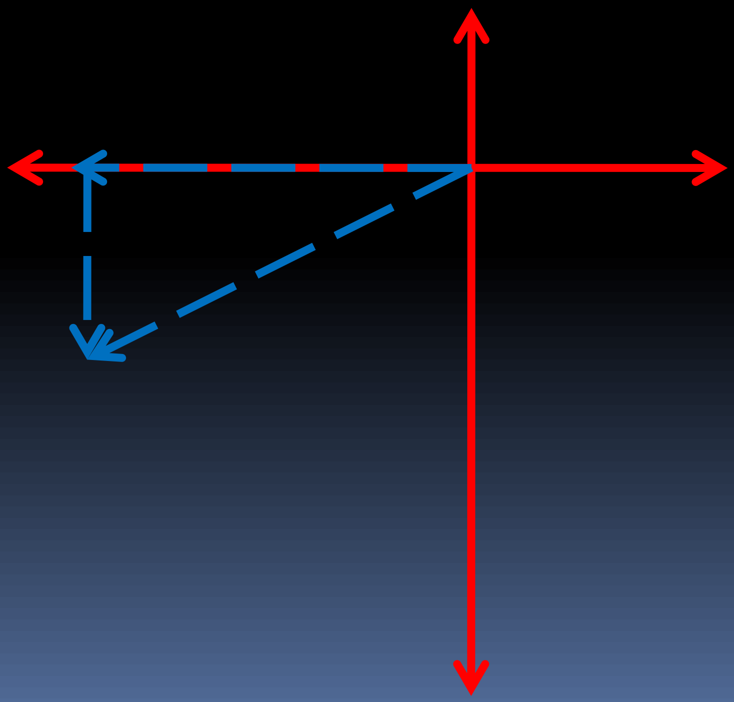
Displacement – Example 5

- *From a reference point, a completely fictional character named Reid moves 6m left and 3m down. What is his distance and displacement?*

- *What about direction?*
- *Use tangent.*

$$\tan\theta = \frac{opp}{adj}$$

$$\theta = \tan^{-1}\frac{3}{6} = 26.6°$$



Displacement vs. Distance

- *Displacement* is the distance from initial position to final position regardless of path taken. $\Delta x = x - x_o$
- *Distance* is total length travelled along path taken.
- *Displacement* is a vector (magnitude and direction).
- *Distance* is a scalar (magnitude only).

Speed

- ***Average*** speed is equal to the total distance travelled divided by the total time

$$\bar{v}_s = \frac{d}{t}$$

- ***Instantaneous*** speed is like measuring your speed in a split second. Mathematically it is,

$$v = \lim_{\Delta t \to 0} \frac{\Delta d}{\Delta t}$$

Velocity

- ***Average*** velocity is equal to displacement divided by time

$$\bar{v} = \frac{\Delta s}{\Delta t} = \frac{s - s_0}{t - t_0}$$

- Similarly, ***instantaneous*** velocity is like measuring the velocity in a split second.

$$v = \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t}$$

Velocity

- When we just use the term “velocity” the implication is that it is constant, i.e. not increasing (acceleration) or decreasing (deceleration)

$$v = \frac{\Delta s}{\Delta t} = \frac{s - s_0}{t - t_0}$$

Speed vs. Velocity

Speed

- Based on ***distance***
- A scalar quantity (magnitude only)
- Always positive

Velocity

- Based on displacement
- A vector quantity (magnitude and direction)
- Can be positive or negative

Speed vs. Velocity

- For both, it is important to know whether they are constant, average, or instantaneous.
- I.e., you must know if there is any acceleration

Speed vs. Velocity

- An athlete runs one lap around an Olympic track (400m) in 50 seconds. What is his speed and velocity?

Speed vs. Velocity

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$$\bar{v}_s = \frac{d}{t} = \frac{400m}{50s} = 8\, m/s$$

$$v = \frac{s - s_0}{t - t_0} = \frac{0m}{50s} = 0$$

How far?

- Suppose you want to know how far you have travelled in a certain time, t ($t_o = 0$)?

How far?

- Suppose you want to know how far you have travelled in a certain time, *t* (t_o = 0)?

$$v = \frac{x - x_0}{t - t_0} = \frac{x - x_0}{t}$$

$$vt = x - x_0$$

$$x_0 + vt = x$$

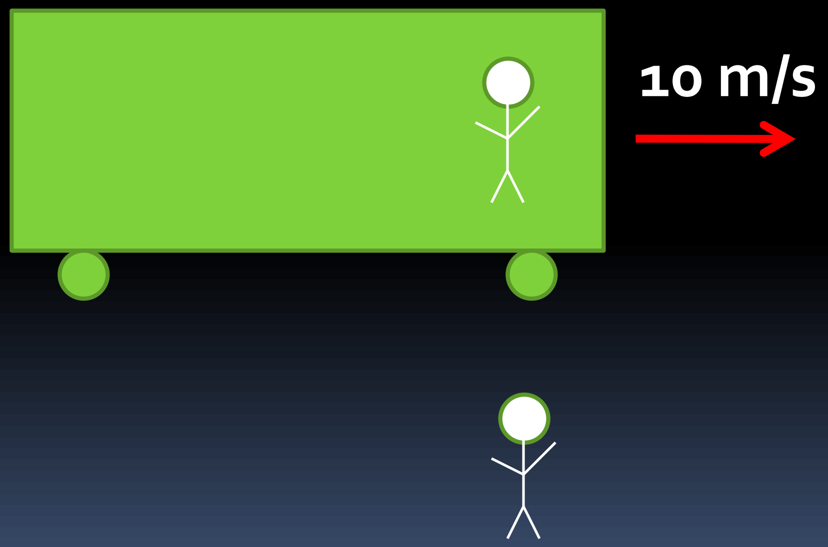
$$x = x_0 + vt$$

Frame of reference

- Frame of reference refers to the origin from which measurements are made.
  - A student in a classroom appears to be stationary
  - To an observer on the moon, the student appears to be rotating about the earth's axis even as the earth is itself is moving away as the moon orbits the earth
  - To an observer on the sun, the student is rotating about the earth's axis as the earth orbits the sun
  - To an observer in another galaxy, the student is rotating about the earth's axis as the earth orbits the sun and the whole galaxy is moving away
  - To the teacher, the student is a lump of coal

Frame of reference

- A fictitious student named Jack is riding on a train travelling at 10m/s. Another fictitious student named Caitlin is standing still, watching the train go by.
- *According to Caitlin, what is Jack's velocity?*



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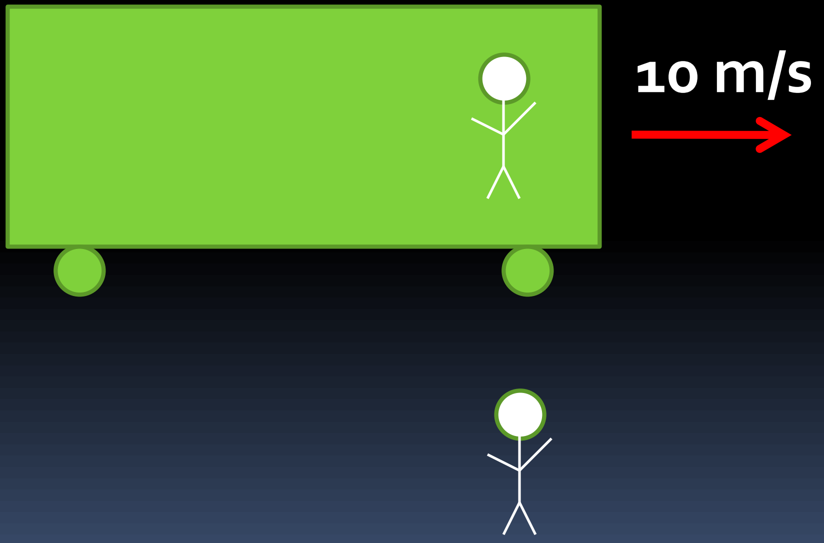
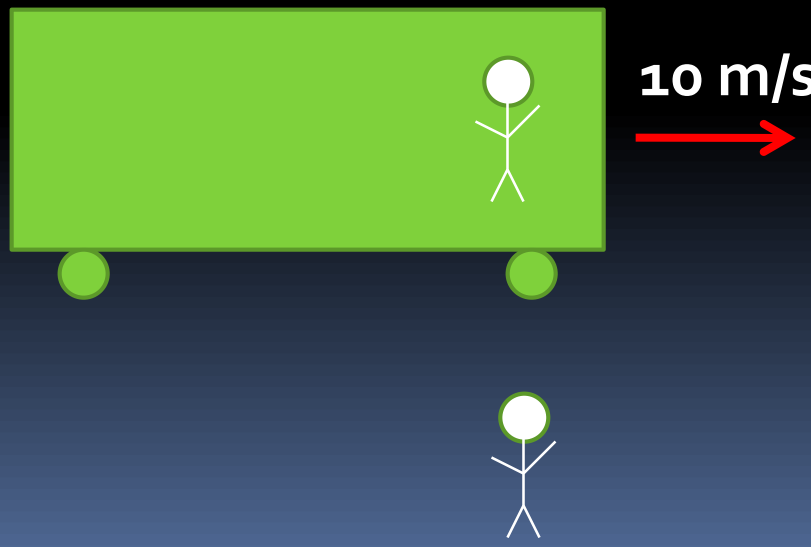


10m/s from left to right

Frame of reference

- A fictitious student named Jack is riding on a train travelling at 10m/s. Another fictitious student named Caitlin is standing still, watching the train go by.
- *According to Caitlin, what is her velocity in relation to the train?*



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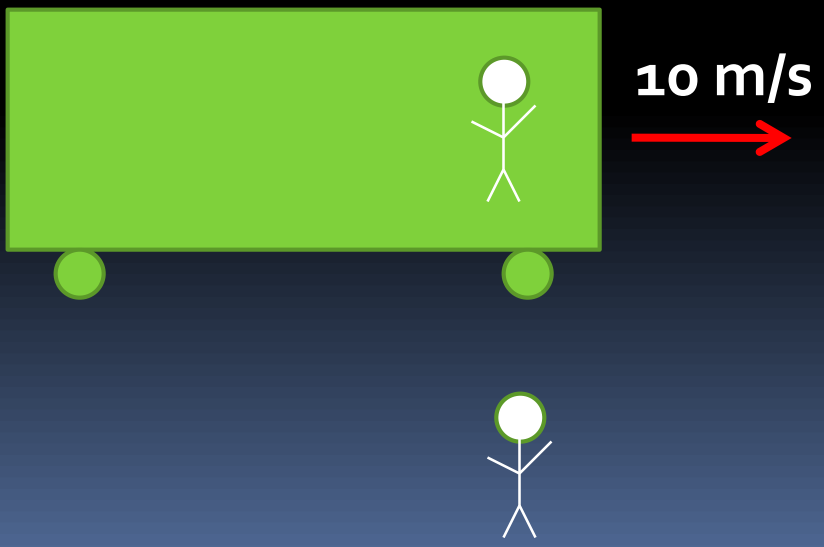

0 m/s, stationary

Frame of reference

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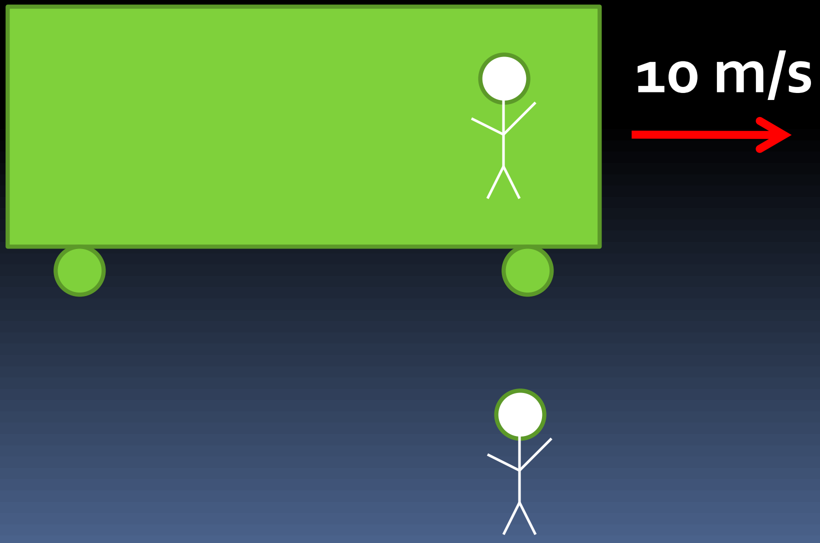

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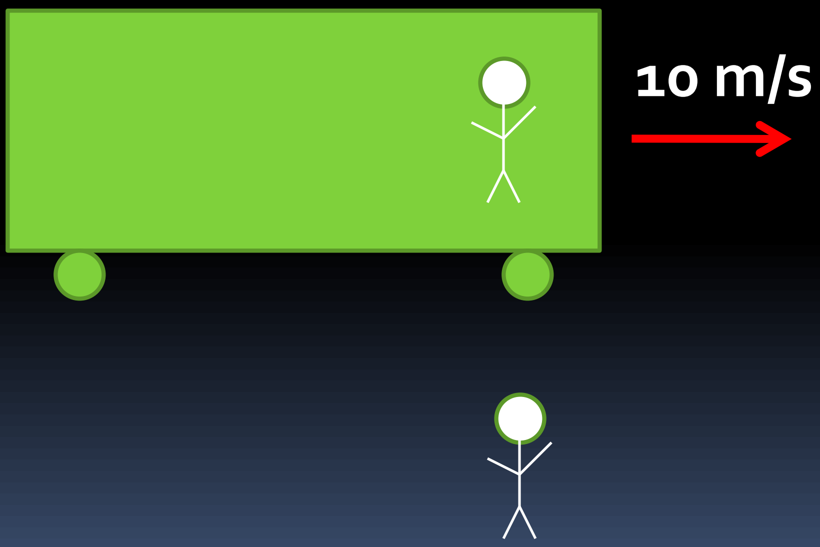
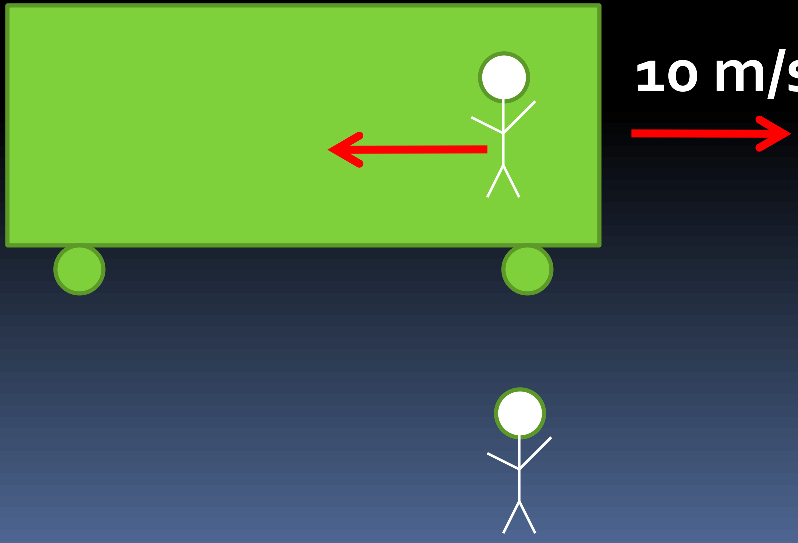


10m/s from *his* left to *his* right

Frame of reference

- A fictitious student named Jack is riding on a train travelling at 10m/s. Another fictitious student named Caitlin is standing still, watching the train go by.
- *Jack moves to the back of the train at 3m/s. According to Jack, what is his velocity in relation to the train?*



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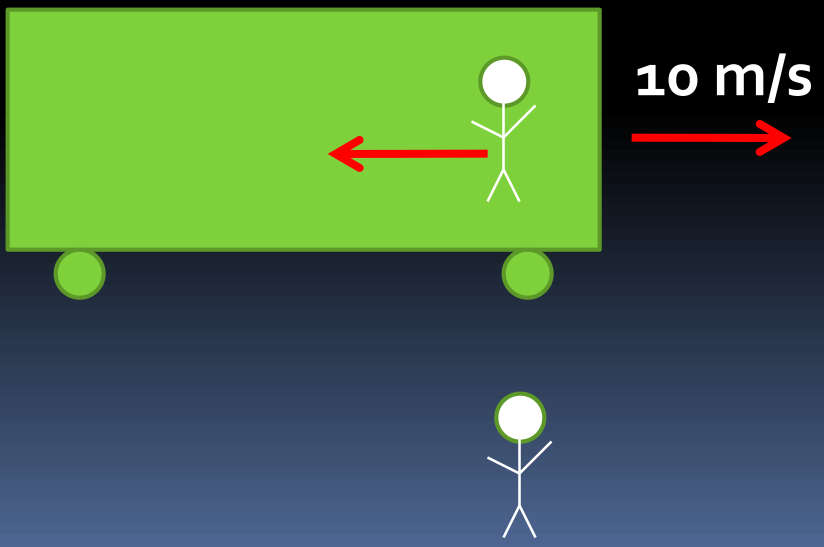

3m/s, forward

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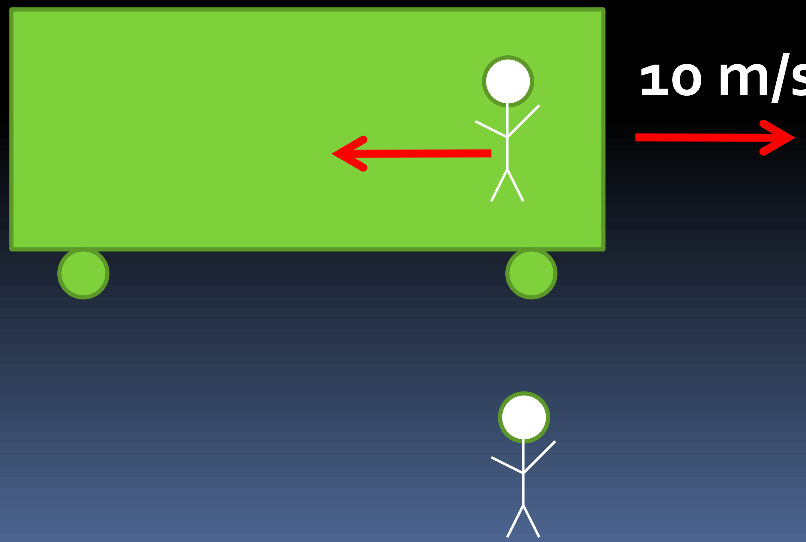

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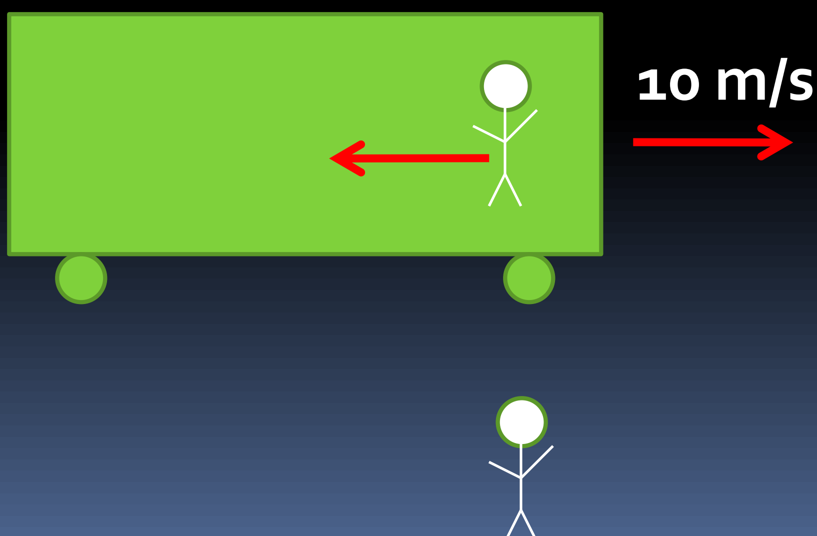
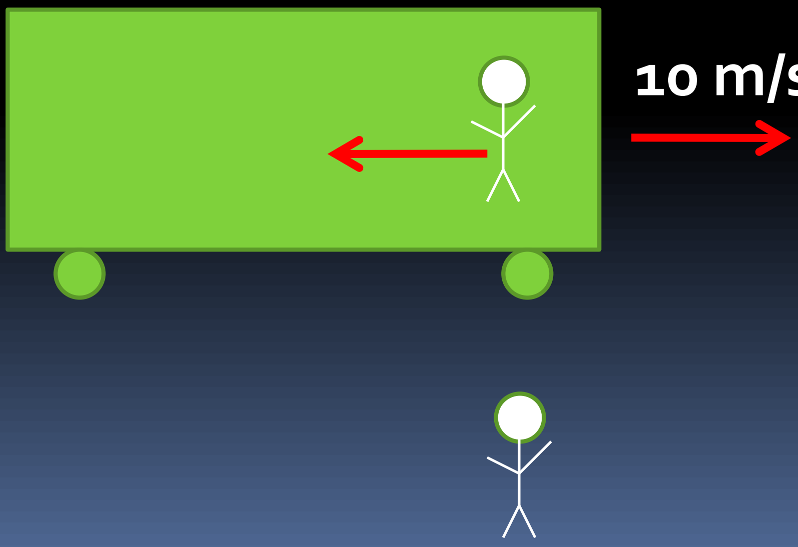


7 m/s, from *his* left to *his* right

Frame of reference

- A fictitious student named Jack is riding on a train travelling at 10m/s. Another fictitious student named Caitlin is standing still, watching the train go by.
- *Jack moves to the back of the train at 3m/s. According to Caitlin, what happens next?*



Next

Applications and skills:

- Determining instantaneous and average values for velocity and speed
- Sketching and interpreting motion graphs

Understandings:

- Distance and displacement
- Speed and velocity
- Graphs describing motion

Essential idea

- Motion may be described and analyzed by the use of graphs and equations.

QUESTIONS?

Homework

Pg. 53-57, #1-4