P20 Unit 1 - Kinematics

Graphing Uniform Motion

Question!

Can objects traveling at the same speed have different velocities?

Graphing Uniform Motion

One main idea in physics is graphing data to discover patterns and relationships.

Suppose I hurl a curling stone down the ice sheet*. At measured time intervals, I measure how far the rock has gone.

***Assume the friction between ice and stone is negligable.**

We record the data into the following table:

Time (s)	Distance (m)
5.00	7.80
10.0	14.9
15.0	23.1
20.0	31.3
25.0	37.6
30.0	43.5
35.0	53.3
40.0	61.1

This is an example of uniform motion. This occurs when an object has a constant change of position over equal time intervals.

In each time frame, the rock moves about* the same distance.

*Most data will not be perfect, but this data is within error.

Time (s)	Distance (m)
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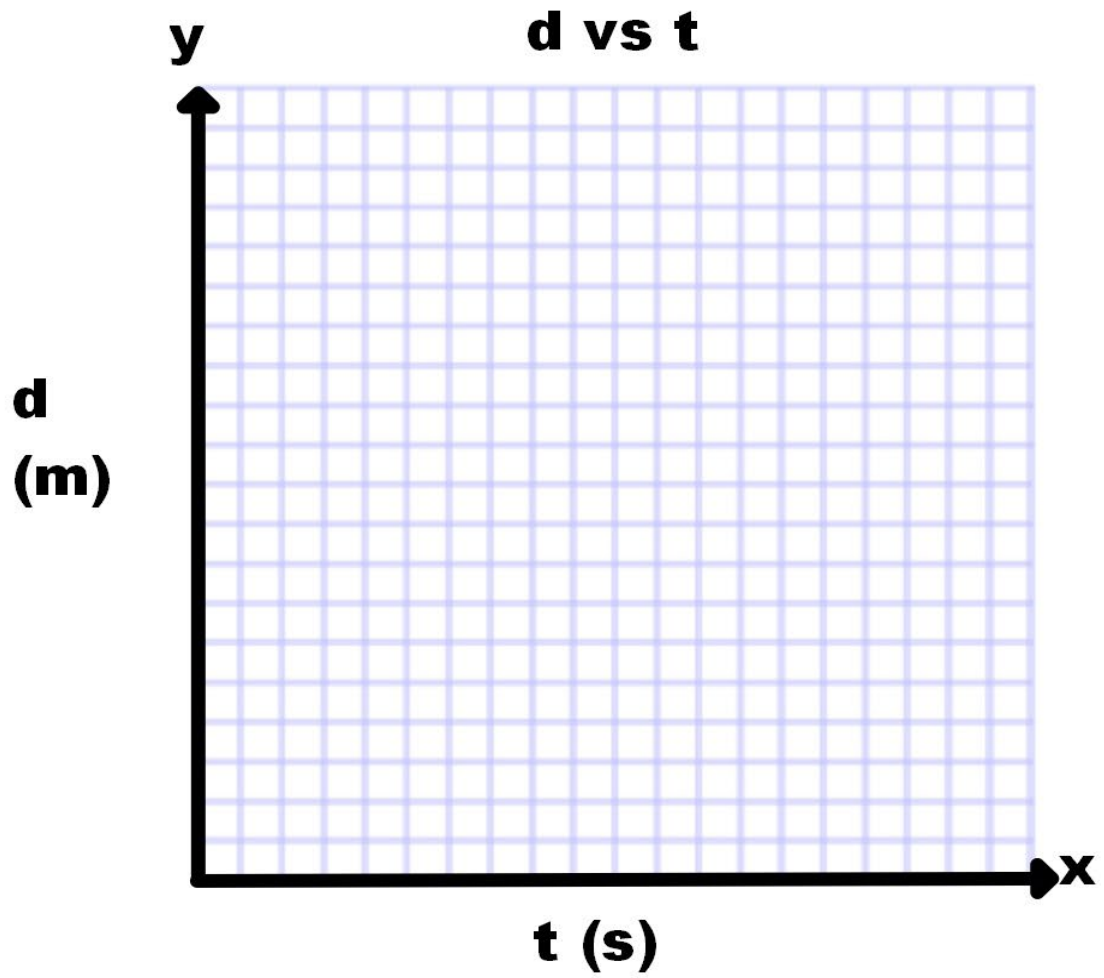
15.0	23.1
20.0	31.3
25.0	37.6
30.0	43.5
35.0	53.3
40.0	61.1



We get a straight line.

Now, lets graph the data.

*Other sources arrange title differently.

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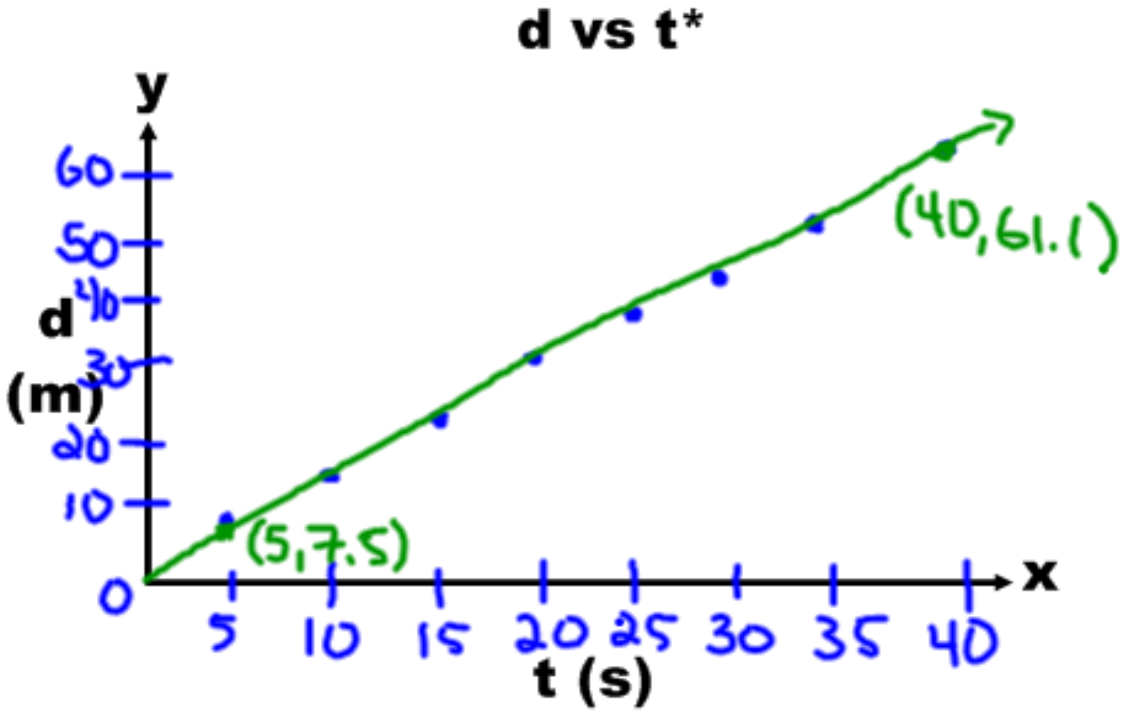


We get a straight line.

The straight line indicates uniform motion. The straight line also indicates a constant velocity. That is to say, the velocity of the object does not change throughout the experiment.

From this graph, we can find two different velocities:

1. Instantaneous Velocity: the velocity at any one time interval on the graph.
2. Average Velocity: an average of instantaneous velocity; also found by taking the slope of a d vs t graph.

To find instantaneous velocity: just use

$$\vec{v} = \frac{\vec{d}}{t} \quad *$$

*Note: although we've used distance up until now, we'll use displacement in the formula. The direction can be "down the ice".

To find average velocity, find the slope.

$$m = \frac{y_2 - y_1}{x_2 - x_1} \longrightarrow \vec{v} = \frac{\Delta\vec{d}}{\Delta t} \longrightarrow \vec{v} = \frac{\vec{d}_2 - \vec{d}_1}{t_2 - t_1}$$

ex) Determine;

a) the instantaneous velocity of the rock at 20.0 s.

b) the average velocity of the rock over the entire time.

Finding the velocity through the slope of this graph is common to many physics problems.

The slope of a distance/displacement vs. time graph gives velocity.

A +ive slope = moving forwards.
A -ive slope = moving backwards.

Memorize this! It is very important!

Question:

Which of the following is an example of uniform motion?

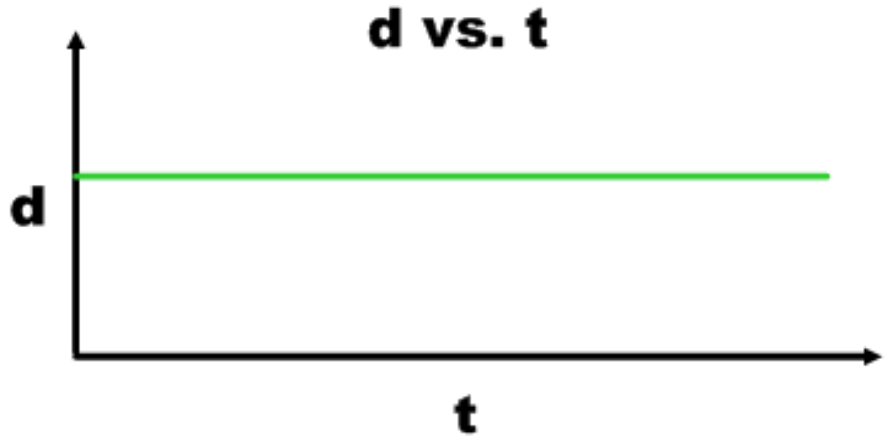
a) A robot moving 1.0 m every second.
b) A bird flying at a constant speed.
c) A car driving down the road at 100 km/h.
d) A slug standing still.
e) All of the above.

Answer: All of the above (e).

An object at rest or moving at a constant velocity undergoes uniform motion.

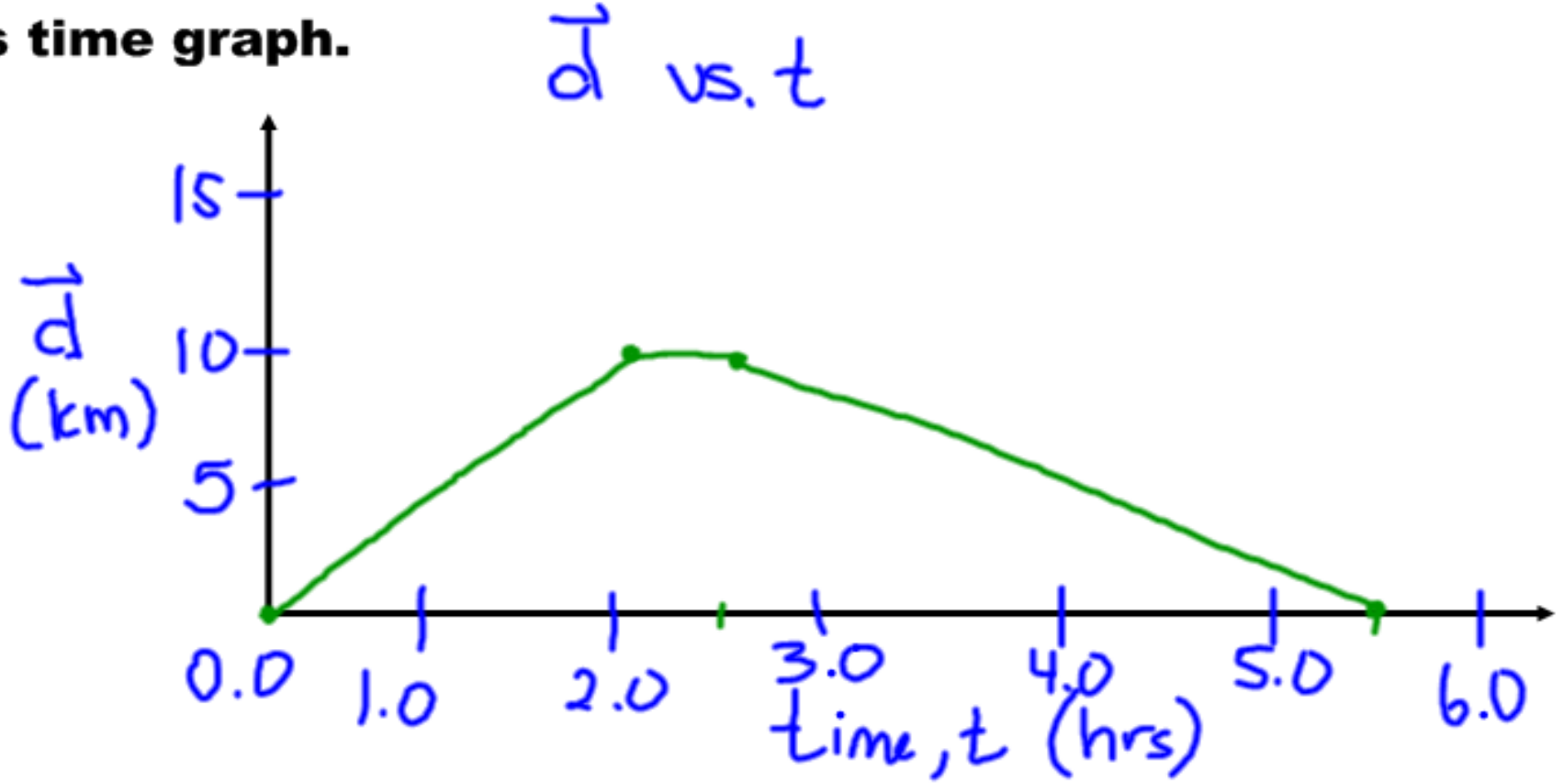
- Even if an object is moving 0.0 m every second, the amount change in position is still the same.
- d vs t graphs for objects at rest are horizontal lines.

example:



Uniform Motion

ex) Starting from t = 0.0 h, a hiker walks 10 km N in 2.0 h, stops for a 0.50 h, then walks 10 km S in 3 hours back to his starting position. Display this movement in a displacement vs time graph.

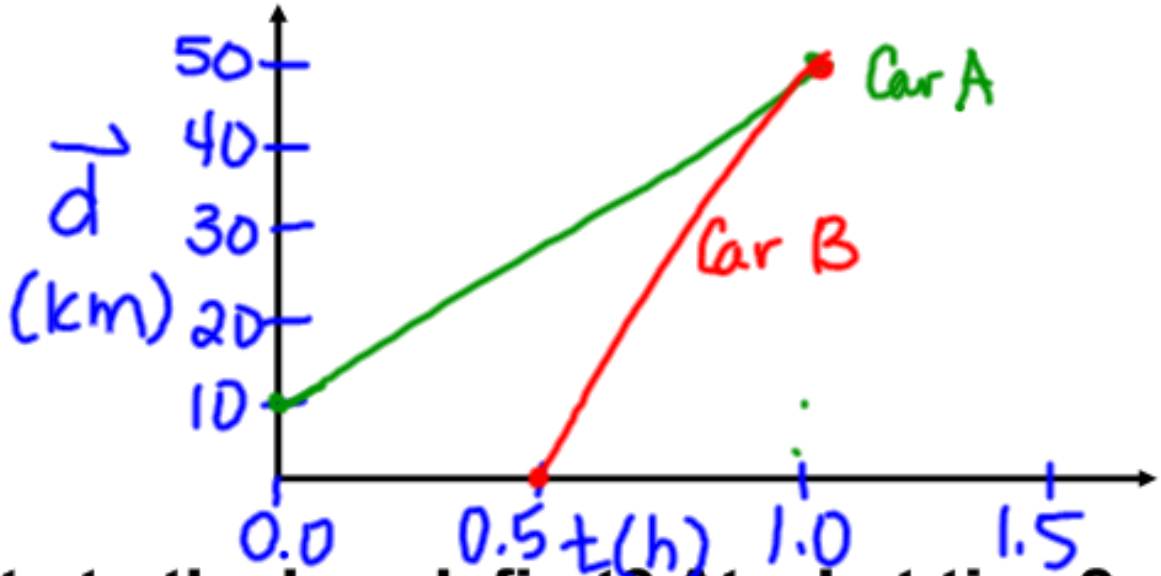


We could also graph the motion of more than one object on the same axis as long as the objects move in the same time frame.

By doing this, we can tell which object is moving faster (larger slope) and where the objects will meet (the intersection point of the two lines).

ex) Two cars drive towards a beach, 50 km from a school. Car A starts 10 km closer to the beach at noon and travels at 40 km/h. Car B starts from the school at 12:30 and drives at 100 km/h.

a) Draw a position vs. time graph for this movement.



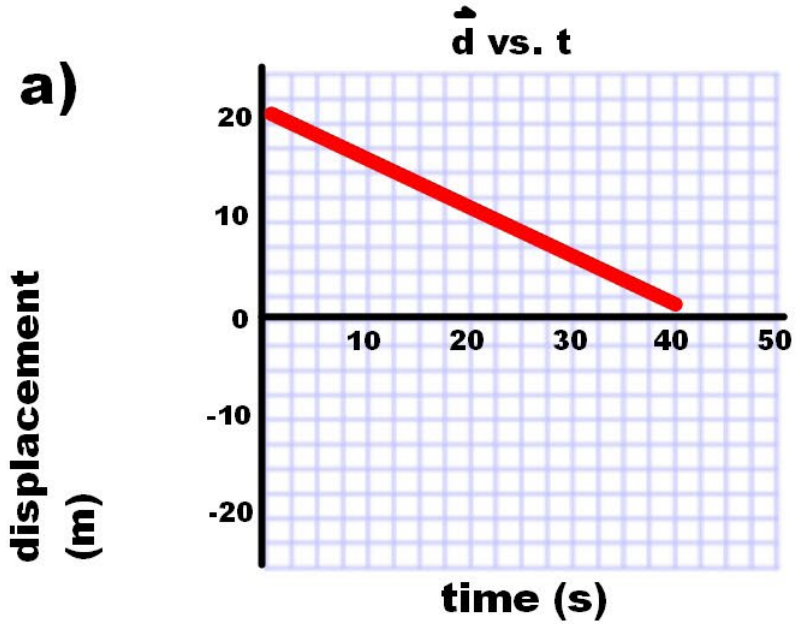
$d = vt$

b) Who gets to the beach first? At what time?

They both arrive at 1:00 pm.

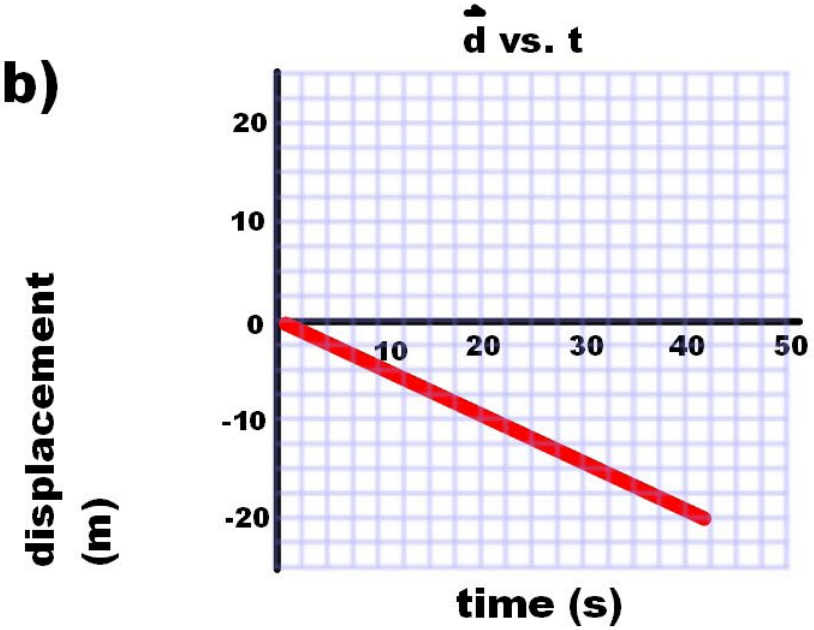
ex) Examine the graph. Describe in words the motion of the object producing each graph.

a)



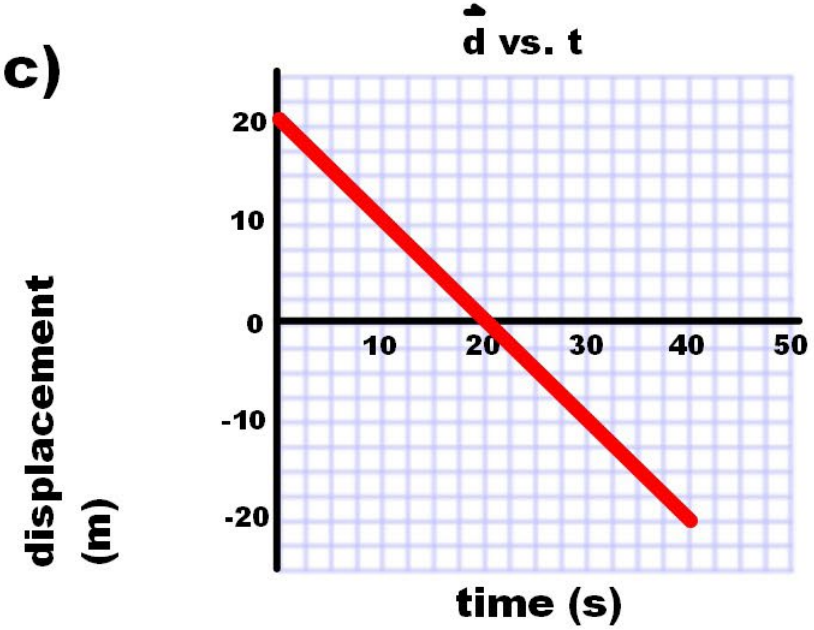
velocity : _____

b)



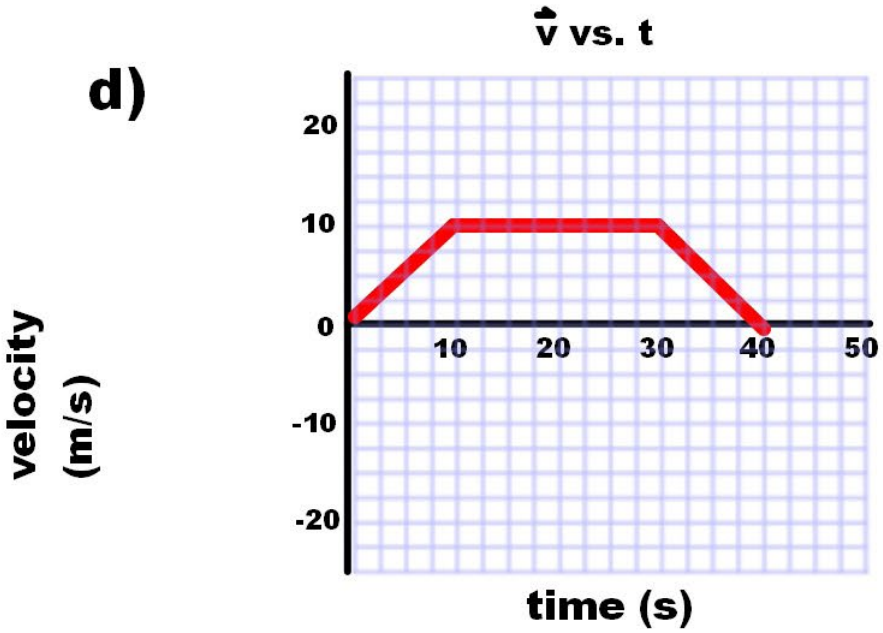
velocity : _____

c)



velocity : _____

d)



velocities : _____