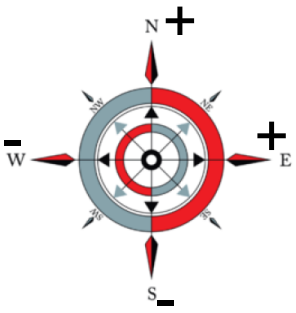
Position & Displacement

Grade: 11

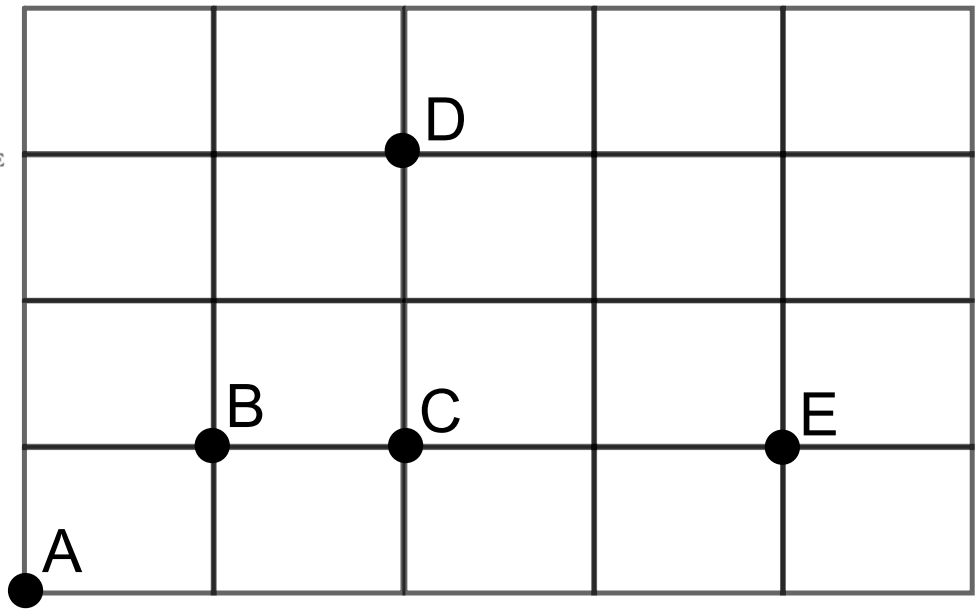
Subject: Physics 112

Date: Sept. 2014



Each grid is 1km x 1km.

Cannot move digonally.



1 Calculate the shortest distance from A to E

A 5 km [E]

B 5 km

C 1 km [N] then 4 km [E]

2 Position C is -2 km North from D.

True

False

3 A person ran from C, to D, back to C, and finally to E. What was their resulting displacement from C?

A 2 km [E]

B 2 km

C 6 km [E]

D 6 km

4 Position E is South-West relative to D.

True

False

5 Calculate the shortest distance from B to D and finally to A.

A 2 km

B 5 km

C 8 km

6 Position B is -3km [W] of point E.

True

False

7 Point C is the same distance from D and E.

True

False

8 Point C is the same position from D and E.

True

False

4.4 Speed

- Define speed, and give the SI unit for speed.
- Show how to calculate average speed from distance and time.
- Describe instantaneous speed.
- Show how to calculate distance or time from speed when the other variable is known.

Introducing Speed

How fast or slow something moves is its **speed**. Speed determines how far something travels in a given amount of time. The SI unit for speed is meters per second (m/s). Speed may be constant, but often it varies from moment to moment.

Average Speed

Even if speed varies during the course of a trip, it's easy to calculate the average speed by using this formula:

Average

$$speed = \frac{distance}{time}$$

Instantaneous Speed

When you travel by car, you usually don't move at a constant speed. Instead you go faster or slower depending on speed limits, traffic lights, the number of vehicles on the road, and other factors. For example, you might travel 65 miles per hour on a highway but only 20 miles per hour on a city street (see the pictures in the **Figure** 4.6.) You might come to a complete stop at traffic lights, slow down as you turn corners, and speed up to pass other cars. Therefore, your speed at any given instant, or your instantaneous speed, may be very different than your speed at other times. Instantaneous speed is much more difficult to calculate than average speed. If you want to learn more about calculating speed, watch the video at this URL:

http://www.youtube.com/watch?v=a8tIBrj84II

FIGURE 4.6

Cars race by in a blur of motion on an open highway but crawl at a snail's pace when they hit city traffic.

4.6 Velocity

- Distinguish between velocity and speed.
- Represent velocity with vector arrows.
- Describe objects that have different velocities.
- Show how to calculate average velocity when direction is constant.

Speed and Direction

The Speed tells you only how fast or slow an object is moving. It doesn't tell you the direction the object is moving. The measure of both speed and direction is called **velocity**. Velocity is a vector. A **vector** is measurement that includes both size and direction. Vectors are often represented by arrows. When using an arrow to represent velocity, the length of the arrow stands for speed, and the way the arrow points indicates the direction. If you're still not sure of the difference between speed and velocity, watch the cartoon at this URL:

http://www.youtube.com/watch?v=mDcaeO0WxBI&feature=related

Using Vector Arrows to Represent Velocity

The arrows in the **Figure** 4.10 represent the velocity of three different objects. Arrows A and B are the same length but point in different directions. They represent objects moving at the same speed but in different directions. Arrow C is shorter than arrow A or B but points in the same direction as arrow A. It represents an object moving at a slower speed than A or B but in the same direction as A.

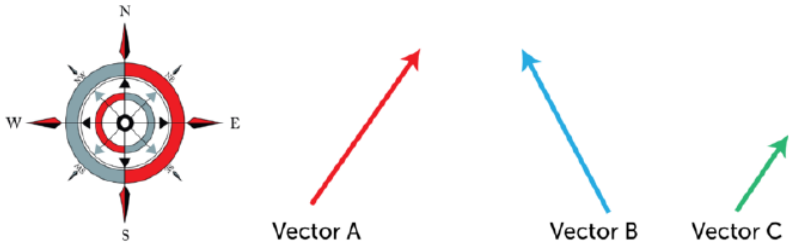


FIGURE 4.10

Differences in Velocity

Objects have the same velocity only if they are moving at the same speed and in the same direction. Objects moving at different speeds, in different directions, or both have different velocities. Look again at arrows A and B from the **Figure** 4.10. They represent objects that have different velocities only because they are moving in different directions. A and C represent objects that have different velocities only because they are moving at different speeds. Objects represented by B and C have different velocities because they are moving in different directions and at different speeds.

Calculating Average Velocity

Average Velocity

$$\vec{v}_{avg} = \frac{\vec{d}}{t} \quad \text{where} \quad \vec{d} = \vec{d}_f - \vec{d}_o$$

Final Position

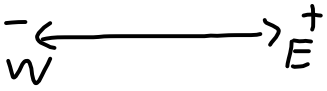
Initial Position

If the object does not change direction the displacement will be the same value as the distance.

Guided Practice

A person drives the following in 3.5 hours:

- 25 km [E]
- 40 km [W]
- 30 km [W]
- 60 km [E]



1. Calculate the total distance traveled. (Does direction matter?) No, direction does not matter.

$$d = 25 + 40 + 30 + 60 = \boxed{155\ \text{Km}}$$

2. Calculate the displacement. (How do we adjust for different directions in the same dimension?) rewrite relative to East.

25 km [E]
60 km [E]
-30 km [E]
-40 km [E]

$$\vec{d} = 25 + (-30) + (-40) + 60$$

$$\boxed{\vec{d} = 15\ \text{Km}\ [E]}$$

3. Calculate the average speed. (check handbook/notes for formula)

$$v_s = \frac{d}{t} = \frac{155}{3.5} = \boxed{44.3\ \text{km/h}}$$

4. Calculate the average velocity. (check handbook/notes for formula)

$$\vec{v}_{avg} = \frac{\vec{d}}{t} = \frac{\vec{d}_f - \vec{d}_o}{t}$$

$\vec{d}_o = 0$ unless told otherwise

$$= \frac{15\ \text{km}\ [E]}{3.5\ \text{h}} = \boxed{4.3\ \text{km/h}\ [E]}$$

Guided Displacement and Velocity Problems

Note how we approach physics problems using the handbook

1 a) Fred averages 92 km/h [E] and drives for 4.1 hours. Calculate his displacement in that time.

List given and asked quantities

$\vec{v}_{avg}$ = 92 km/h [E]

t = 4.1 h

$\vec{d}$ = ? km

Locate appropriate section of the handbook

Check for a relationship that uses the given information

$$\vec{v}_{avg} = \frac{\vec{d}}{t}$$

Plug 'n chug - substitute known quantities and solve for the unknown

$92 \times 4.1 = \frac{\vec{d}}{4.1} \times 4.1$

$\vec{d} = 377$ km

b) Calculate the length of time necessary for Fred to drive 1375 km assuming no change in average velocity.

List given and asked quantities

$\vec{v}_{avg}$ = 92 km/h [E]

$\vec{d}$ = 1375 km

t = ? h

Locate appropriate section of the handbook

Check for a relationship that uses the given information

$$\vec{v}_{avg} = \frac{\vec{d}}{t}$$

Plug 'n chug - substitute known quantities and solve for the unknown

$92 \times t = \frac{1375}{t} \times t$

$92t = 1375$

$t = \frac{1375}{92} = 15$ h

Motion Practice

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