Year 10 Physical Science Week 1

Vectors and Scalars (distance, displacement, speed, velocity)

Questions

1. A student takes 45.0 minutes to walk to school which is 2.60 km, due west from her house.

   a. What is her average velocity?

   t = 45.0 min
   = 2700 s
   s = 2.60 km
   = 2600 m

   $V_{av} = \frac{s}{t}$
   $= \frac{2600}{2700}$
   = 0.963 ms^{-1} west

   b. In reality the distance she travels is really 3.20 km, because of the route she takes, what is her average speed?

   t = 45.0 min
   = 2700 s
   d = 3.20 km
   = 3200 m

   $speed = \frac{d}{t}$
   $= \frac{3200}{2700}$
   = 1.19 ms^{-1}

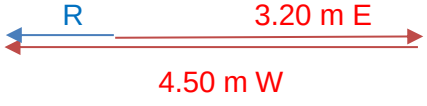
2. In an experiment on scalar and vector quantities, Tyler throws a ball 3.20 m east to Matthew who then throws it 4.50 m west to Daniel. The boys then measured the distance and displacement of the ball.

   a. What distance did the ball travel?

   distance = 3.20 + 4.50 = 7.70m

   b. What was the ball's displacement?

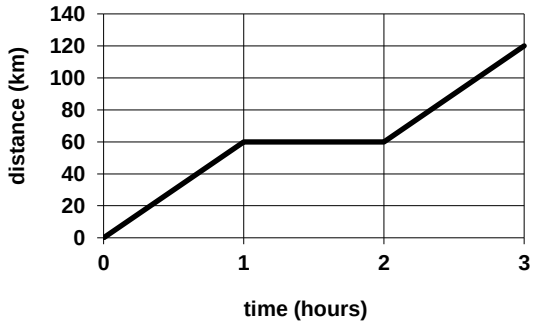
   Displacement = 3.20 m east + 4.50 m west
   = 3.20 m east – 4.50 m east
   = - 1.30 m east
   = 1.30 m west



3. A distance/time graph shows speed

Exercise: Consider the following graph of a families' 3 hour journey (leave in km, h, kmh^{-1})

Trip for a family in their car



Describe the journey.

The car travels a distance of 60 km in one hour.

Stops for one hour then travels 60 km for another hour

Calculate the speed in each of the three sections of the graph (leave in kmh^{-1}, h and km)

- section one: speed = 60 ÷ 1 = 60 kmh^{-1}
- section two: speed = 0 ÷ 1 = 0 kmh^{-1}
- section three: speed = 60 ÷ 1 = 60 kmh^{-1}

$$\text{speed} = \frac{\text{dist}}{\text{t}}$$

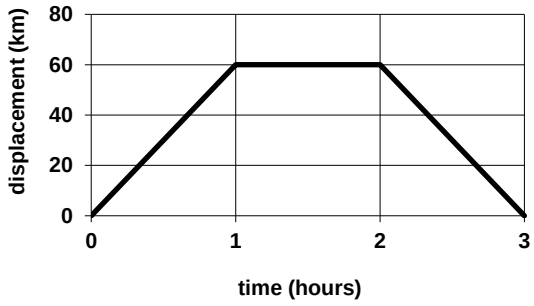
The problem with a distance/time graph is that it doesn't show direction of motion. In actual fact, the family travelled to the shopping centre, bought their weekly shopping, and then returned home to put the shopping away. To determine the actual direction something moved, we need a displacement/time graph.

4. A displacement/time graph shows velocity $\quad v = \frac{s}{t}$

This is shown in the graph below of our families shopping journey.

Exercise: The car travelled forward in the first hour, stopped to shop for an hour and then travelled back home in the last hour.

Trip for a family in their car



Now work out the velocity for each section (leave in kmh^{-1}, hours and km)

section one: v_{av} = 60 ÷ 1 = 60 kmh^{-1} forwards

section two: v_{av} = 0 ÷ 1 = 0 kmh^{-1}

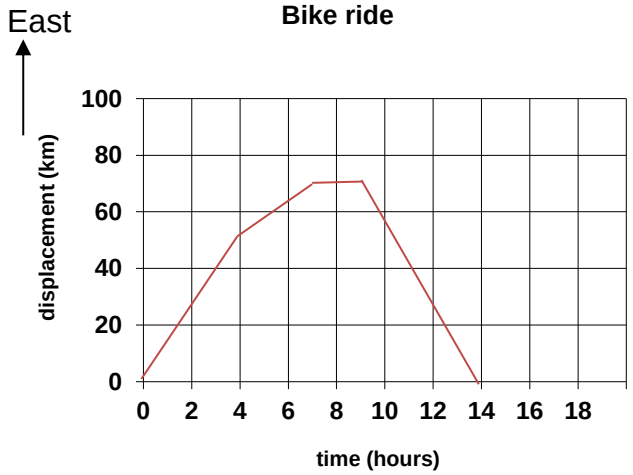
section three: v_{av} = - 60 ÷ 1 = - 60 kmh^{-1} forwards
or 60kmh^{-1} backwards

You can now see that the sign in front of the velocity gives the direction.

5. Exercise: List the differences between the two graphs of the same journey.

- No direction indicated in distance time graph while direction shown in s/t graph
- Distance is 120 km in distance time graph but displacement is zero in s/t graph

6. Exercise: Alan is practicing for a bicycle race. He starts out from home and rides 50 km east in 4.0 hours; he then travels at a comfortable 20 km east in 3.0 hours, he stops for lunch for 2 hours, then returns to his home in 5 hours.



Draw the graph then calculate the velocity for each section of the graph (leave in kmh^{-1}, hours and km)

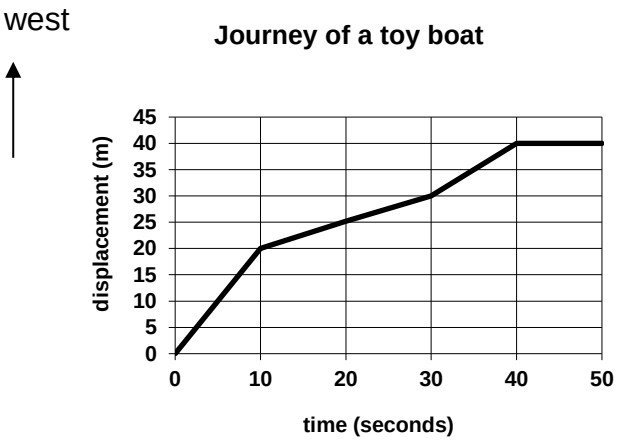
$$A: \frac{50}{4} = 12.5 kmh^{-1} East$$

$$B: \frac{20}{3} = 6.67 kmh^{-1} East$$

$$C: \frac{0}{2} = 0 kmh^{-1}$$

Calculate the total distance travelled = 50 + 20 + 0 + 70 = 140 km
and the total displacement = back to start so s = 0 km

7. Exercise: Consider the following graph which shows the journey of a toy boat on a large pond travelling west.



Describe the journey including the velocities.

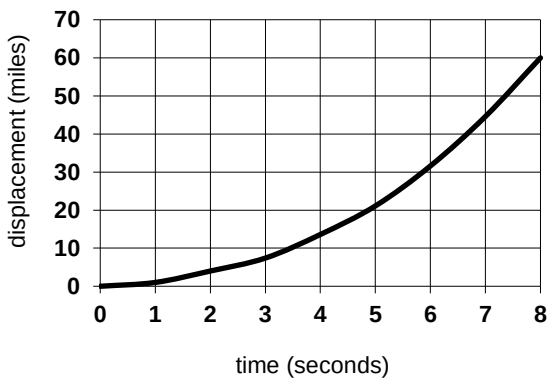
Travels 20 m in 10 s: $\frac{20}{10} = 2 ms^{-1}$ West

Travels 10 m in 20 s: $\frac{10}{20} = 0.5 ms^{-1}$ West

Travels 10 m in 10 s: $\frac{10}{10} = 1 ms^{-1}$ West

Stops for 10 s

8. Exercise: To determine the acceleration of a car, officials measure how long it takes for the car to get from a standstill to 60 miles per hour (96.56 kmh^{-1}).



Explain why this graph is curved then calculate this car's acceleration using the values in the question and graph.

The graph is curved as the velocity is not constant but increasing each second (accelerating).

$u = 0 ms^{-1}$

$v = 95.56 kmh^{-1} = 26.82 ms^{-1}$

$t = 8 s$

$$a = \frac{v - u}{t} = \frac{26.82 - 0}{8}$$

$$a = 3.35 ms^{-2}$$