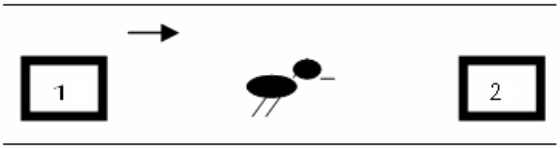
Conceptual Questions

1. A car travels a distance of 500. km in 8.0 h. Can you determine how far it went in 4.0 h? Explain.
   NO – you cannot be certain that the speed of the car was constant during the entire trip.

2. A car travels a distance of 500. km in 8.0 h at constant speed. Can you determine how far it went in 4.0 h? Explain.
   YES – since the speed of the car was constant during the entire trip, the distance after 4 hours (and at any other time) can be easily calculated using v=d/t.

3. a) Does the odometer of a car measure a vector or a scalar quantity? Explain.
   Scalar – odometer simply adds up the total distance of all trips with no regard for the direction when moving or any initial and final positions.
   b) Does the speedometer measure a vector or a scalar quantity? Explain
   Scalar – a speedometer measures moving mechanical parts in a car and in no way acquires any information with regards to the direction the car is traveling.

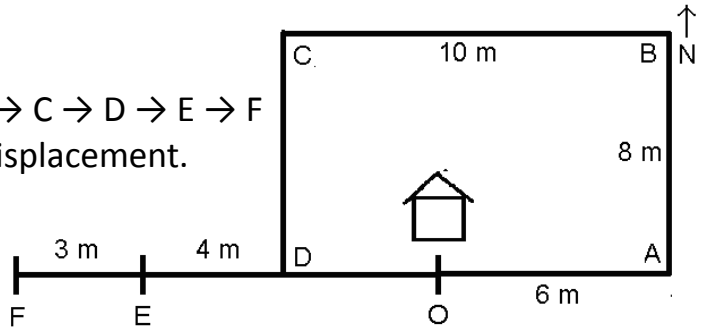
4. You are standing on a river bank. The river is flowing at a rate of 2.0 m/s. You see a duck in the river. You throw two pieces of bread at the duck. One piece lands in front of the duck, and the other an equal distance behind it, as shown. The duck can swim at 1.0 m/s. The duck is hungry, and wants to reach the bread in the shortest amount of time. What should the duck do?



   A) Pick one and swim for it. It takes the same time to reach both.
   B) Swim towards piece 1.
   C) Swim towards piece 2.
   D) The duck should not swim at all. It cannot reach either piece since it cannot swim as fast as the river is flowing.
   E) The duck should not swim at all. It should wait for piece 1 to come to it.

Problems

5. A youth starts at A and moves from A → B → C → D → E → F
   Determine the youth's total distance and displacement.
   Assume two sig digs.



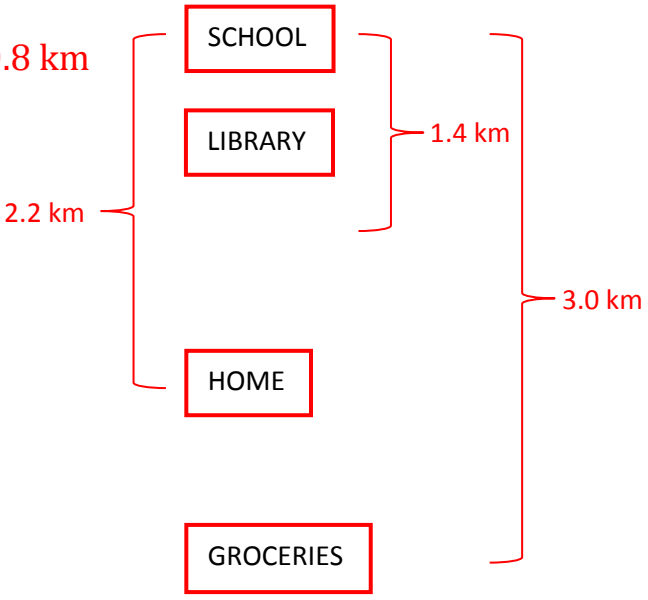
$$d = 8\text{ m} + 10\text{ m} + 8\text{ m} + 4\text{ m} + 3\text{ m}$$
$$d = 33\text{ m}$$

$$\Delta\vec{d} = \vec{d}_f - \vec{d}_i$$
$$\Delta\vec{d} = 11\text{ m [W]} - 6\text{ m [E]}$$
$$\Delta\vec{d} = 11\text{ m [W]} - (= 6\text{ m [W]})$$
$$\Delta\vec{d} = 17\text{ m [W]}$$

6. A school principal is already at school, which is located 2.2 km [N] of her home. During lunch, she walks 1.4 km [S] to the library and then back to school. After school, she walks 3.0 km [S] to buy some groceries, then finally goes home.
   a) what was the total distance of the principal's journey?
   b) what was the principal's total displacement?

a) $$d = 1.4\text{ km} + 1.4\text{ km} + 3.0\text{ km} + 0.8\text{ km}$$
$$d = 6.6\text{ km}$$

b) $$\Delta\vec{d} = \vec{d}_f - \vec{d}_i$$
$$\Delta\vec{d} = 0\text{ m [N]} - 2.2\text{ km [N]}$$
$$\Delta\vec{d} = 2.2\text{ km [S]}$$



7. You are driving home from school steadily at 95 km/h for 130 km. It then begins to rain and you slow to 65 km/h. You arrive home after driving 3 hours and 20 minutes.

   a) How far is your home from school?

Before rain:

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

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

$$t = \frac{130\ km}{95\ km/h}$$

$$t = \frac{130\ km}{95\ km/h}$$

$$t = 1.37\ \text{h} = \frac{130\ km}{95\ km/h}$$

time driving in rain:

$$t_{rain} = t_{total} - t_{no\ rain}$$

$$t_{rain} = 3.33\ \text{h} - 1.37\ h$$

$$t_{rain} = 1.96\ h$$

distance traveled in rain:

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

$$d = vt$$

$$d = (65\ km/h\ )(1.96\ h)$$

$$d = 127.4\ km$$

$$d = 130\ km$$

Total distance (school to home)

$$d = 130\ \text{km} + 130\ \text{km}$$

$$d = 260\ \text{km}$$

   b) What was your average speed‘?

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

$$v = \frac{260\ km}{3.33\ h}$$

$$v = 78\ \text{km/h}$$

8. A runner runs one half a lap of a circular track that has a radius of 1.00×10^{2} m in 5.0×10^{1} s. If she starts from the southern-most end of the track, calculate

   a) the average speed of the journey

$$\mathrm{v} = \frac{d}{t}$$
$$\mathrm{v} = \frac{\left(2\pi r/_{2}\right)}{t}$$
$$\mathrm{v} = \frac{\left(2\pi(100\ m)/_{2}\right)}{50\ s}$$
$$\mathrm{v} = 2\pi\ m/s = 6.3\ m/s$$

   b) the average velocity of the journey.

$$\vec{\mathrm{v}} = \frac{\Delta\vec{\mathrm{d}}}{t}$$
$$\vec{\mathrm{v}} = \frac{2(1.00\times10^{2}\ \mathrm{m})\ [\mathrm{S}]}{5.0\times10^{1}\ \mathrm{s}}$$
$$\vec{\mathrm{v}} = 4.0\ \mathrm{m/s}\ [\mathrm{E}]$$

9. A rabbit and a turtle are practicing for their big race. The rabbit covers a 30. m practice course in 5.0 seconds, the turtle covers the same distance in 120 seconds. If the actual race is run on a 96 m course, by how many seconds will the rabbit beat the turtle?

$$\vec{\mathrm{v}}_{rabbit} = \frac{\Delta\vec{\mathrm{d}}}{t}$$
$$\vec{\mathrm{v}}_{rabbit} = \frac{30\ m}{5.0\ s}$$
$$\vec{\mathrm{v}}_{rabbit} = 6.0\ \mathrm{m/s}$$

$$\vec{\mathrm{v}}_{turtle} = \frac{\Delta\vec{\mathrm{d}}}{t}$$
$$\vec{\mathrm{v}}_{turtle} = \frac{30\ m}{120\ s}$$
$$\vec{\mathrm{v}}_{turtle} = 0.25\ \mathrm{m/s}$$

$$t_{rabbit} = \frac{\Delta\vec{\mathrm{d}}}{\vec{v}}$$
$$t_{rabbit} = \frac{96\ \mathrm{m}}{6.0\ m/s}$$
$$t_{rabbit} = 16\ \mathrm{s}$$

$$t_{turtle} = \frac{\Delta\vec{\mathrm{d}}}{\vec{v}}$$
$$t_{turtle} = \frac{96\ \mathrm{m}}{0.25\ m/s}$$
$$t_{turtle} = 384\ \mathrm{s}$$

$$t = t_{turtle} - t_{rabbit}$$
$$t = 384\ \mathrm{s} - 16\ \mathrm{s}$$
$$t = 368\ \mathrm{s}$$

10. Two cyclist race with nearly uniform speed on a 500. m course. The blue bicycle crosses the finish line 2.00 s ahead of the red bicycle. If the red bicycle, maintained an average speed of 10.0 m/s. what was the average speed of the blue bicycle?

$$t_{red} = \frac{\Delta\vec{d}}{\vec{v}} \qquad t_{blue} = t_{red} - 2.00\ s$$
$$t_{red} = \frac{500\ \text{m}}{10.0\ m/s} \qquad t_{blue} = 50.0\ \text{s} - 2.00\ s$$
$$t_{red} = 50.0\ \text{s} \qquad t_{blue} = 48.0\ s$$

$$\vec{v}_{blue} = \frac{\Delta\vec{d}}{t}$$
$$\vec{v}_{blue} = \frac{500\ m}{48.0\ s}$$
$$\vec{v}_{blue} = 10.4\ \text{m/s}$$

11. A student of physics sees a lightning bolt strike the ground. She hears the sound of the thunder 4.0 s after she sees the lightning. If the speed of sound is 340 m/s and you assume the speed of light to be infinite, how far away was she from the place the lightning struck?

$$\vec{v} = \frac{\Delta\vec{d}}{t}$$
$$\Delta\vec{d} = \vec{v}t$$
$$\Delta\vec{d} = (340\ \text{m/s})(4.0\ s)$$
$$\Delta\vec{d} = 1400\ m$$

12. An arrow is fired horizontally with a constant speed at a target that is 50. m away. The sound of the arrow striking the target is heard 1.5 s after the arrow was fired. If the speed of sound is 340 m/s, how fast was the arrow travelling?

$$t_{sound} = \frac{\Delta\vec{d}}{\vec{v}} \qquad t_{arrow} = 1.5\ \text{s} - t_{sound}$$
$$t_{sound} = \frac{50\ \text{m}}{340\ m/s} \qquad t_{arrow} = 1.5\ \text{s} - 0.147\ \text{s}$$
$$t_{sound} = 0.147\ \text{s} \qquad t_{arrow} = 1.353\ s$$

$$\vec{v}_{arrow} = \frac{\Delta\vec{d}}{t}$$
$$\vec{v}_{blue} = \frac{50\ m}{1.353s}$$
$$\vec{v}_{blue} = 37\ \text{m/s}$$