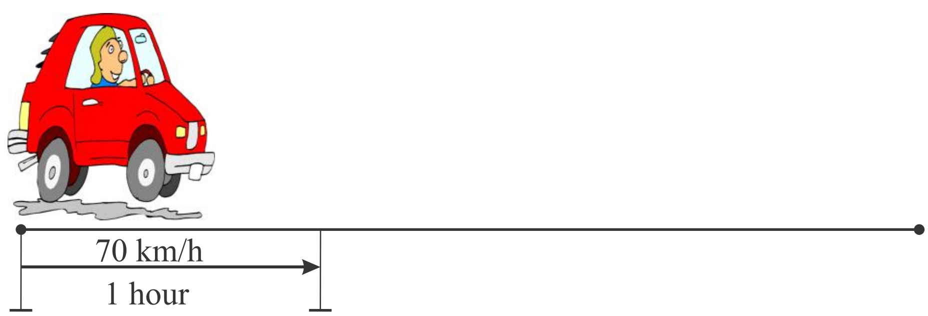
Math 4a, classwork 17.

Chapter 11

Speed, time, and distance.

The car moved for 3 hours at a speed of 70 km/h. How far did it travel? In this type of math problem, we typically assume that the car (or any other moving object) moves with constant speed along a straight line. Of course, this is rarely the case in reality, and in physics, you will study the laws of motion in a more in-depth manner.

Let's denote the rate (speed) of the car *v*, the time during which the car was moving *t*, and the distance it travelled, *S*. These letters are usually used for rate (speed), time and distance, but you can use any other letters as well.



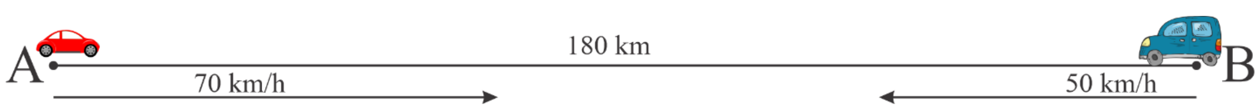
$$S = v \cdot t = vt$$

If $v = 70km/h$ and $t = 3h$, then $S = 70\frac{km}{h} \cdot 3h = 70km$.

This is simple. If we know two out of three parameters, we always can find the third one.

$$S = vt; \quad v = \frac{S}{t}; \quad t = \frac{S}{v};$$

***Problem** 1. Two cars start moving towards each other at the same time from the two cities, A and B. The distance between the cities is 180 km. The rate of the car that departed from the city A is 50 km/h, the speed of the car that left from the city B is 70 km/h. In how many hours will they meet? How far from the city A they will meet?*



In one hour the first car will cover 70 km, while the second car will cover 50 km. The distance between the cars will be now

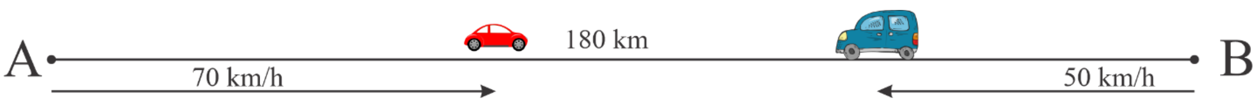
$$180 - (70 + 50) = 60\ km.$$

After time t, the distance between the cars (before they meet) will be

$$S_t = \ 180 - 70t - 50t$$

or the expression can be rewritten as

$$S_t = 180 - (70 + 50)t$$



The speed of the decreasing of the distance is $70 + 50 = 120\ km\ per\ hour\ \left(\frac{km}{h}\right)$, and at the moment they meet $S_t = 0$

$$S_t = 180 - 120t = 0; \qquad 180 = 120t$$

Time, needed to cover this distance is

$$t = \frac{S\ (distance)}{v(speed\ of\ decreasing)} = \frac{180}{120} = 1.5\ hour.$$

$$rate\ of\ decrease \rightarrow by\ how\ many\ kilometers\ it\ will\ decrease\ each\ hour$$

Problem *2. Peter was walking for 15 minutes with the speed of 5km/h. How far did he go?*
Be careful about the units of the distance, time and speed. In this problem time is representing in minutes, but the speed of walking in k.p.h ($\frac{km}{h}$). We have to either represent the time as 0.25 of an hour, or represent the speed as km per minute.

$$5\frac{km}{h} = \frac{5}{60}\frac{km}{min} = \frac{1}{12}\frac{km}{min}$$

$$S = 0.25h \cdot 5\frac{km}{h} = 1.25\ km = 15min \cdot \frac{1}{12}\frac{km}{min} = \frac{15}{12}\ km = \frac{5}{4}km = 1\frac{1}{4}km;$$

Problem *3. Represent speed as speed in km per hour*:

$$25\frac{m.}{min.} = 25 \cdot 60\frac{m}{h} = \frac{25 \cdot 60}{1000}\frac{km}{h} = 3.12\frac{km}{h}$$

***Problem** 4. The speed of the boat in a still water on a lake is 12 km/h. The speed of the river flow is 3 km/h. How many hours does the boat need to go from the city A to the city B if the distance between the two cities is 45 km and the city A is up on the river, i.e. the river flows from A to B?*

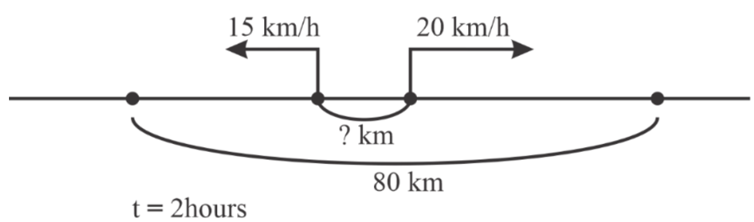
How many hours does this boat need to go back from the city B to the city A?

If the boat moves along with the river flow, their speeds are combined; in a unit of time the flow will move the boat by 3 km and boat motor will propel it by 12 km, so the speed of the boat downstream is $15\frac{km}{h}$. If the boat goes upstream, flow tries to move the boat down the stream by 3 km. every hour, but the motor propel it by 12 km. in the opposite direction. Total displacement will be $12 - 3 = 9\ km$ in 1 hour, therefore the speed of the boat moving upstream is $9\ \frac{km}{h}$. Time to go from A to B

$$45:15 = 3h.$$

Time needed to go back from B to A is $45:9 = 5h$.

***Problem** 5. Using the drawing create the problem and solve it.*



Problem: two cyclists simultaneously started moving in the opposite directions. In two hours, the distance between them became 80 km. What was the distance between the cyclists at the beginning?

In two hours, they will move by $(15 + 20) \cdot 2$, and distance between them will be

$$15 \cdot 2 + 20 \cdot 2 + x = 2 \cdot (15 + 20) + x = 80$$

$$70 + x = 80; \qquad x = 80 - 70 = 10$$

where *x* is the initial distance.

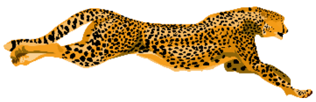
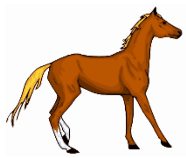
Exercises:

1. Meters, kilometers, centimeters:

$$1\ kilometer\ (km) = 1000\ meters(m)$$
$$1\ meter = 100\ centimeters\ (cm)$$
$$1\ hour\ (h) = 60\ minutes(min)$$
$$1\ minute\ (min) = 60\ seconds(s)$$

Represent speed in km.p.h units and find out who’s speeds are there.

$$a.\ 83\frac{cm.}{min.};\quad b.\ 83\frac{m.}{min.};\quad c.\ 31\frac{m.}{s.}\quad d.\ 83\frac{cm.}{s.};\quad e.\ 800\frac{m.}{min.};$$


2. Represent:

   Example:

$$15\frac{km}{h} = \frac{15\cdot 1000}{60}\frac{m}{min} = 250\frac{m}{min}$$

$a.\quad in\ meters\ per\ minute:\quad 6\frac{km}{h},\ 18\frac{km}{h},\quad 42\frac{km}{h};$

$b.\quad in\ meters\ per\ second:\quad 30\frac{m}{min},\ 180\frac{m}{min};\ \ 240\frac{m}{min};$

$c.\quad in\ kilometer\ per\ hour:\quad 4\frac{m}{s},\ 15\frac{m}{min};\ \ 50\frac{m}{min};$

3. Represent speed:

$36\frac{km}{h}\ as\quad \left(\frac{m(meter)}{s(second)}\right)$

$6\frac{m}{s}\ \ as\quad \left(\frac{km}{min}\right)$

4. A moving walkway at an airport moves at a pace of 0.55 meters per second. If Peter stands on the walkway as it moves, how long will it take to transport him 200 meters? If he walks on this walkway at a speed of 4 km/h, how long will it take him to get to the end of the 200-meter-long walkway?

5. At the end of the walkway, Peter remembers he forgot his luggage at the security checkpoint. He turns around and runs at a speed of 10 km/h. How fast will he reach the starting point of the walkway (same 200-meter-long walkway)?

6. The speed of a boat in a still water on a lake is 12 km/h. The speed of the river flow is 3 km/h. How many hours does the boat need to go from the city A to the city B if the distance between the two cities is 45 km and the city A is up on the river, i.e. the river flows from A to B?

   How many hours does this boat need to go back from the city B to the city A?

7. The speed of the boat going downstream the river is 19 km/h, and the speed of the same boat going upstream this river is 15 km/h. What is the speed of the river stream and what is the speed of the boat in a still water on a lake?

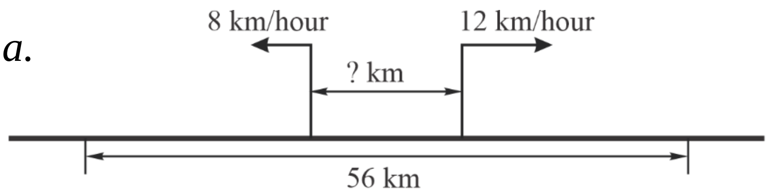
8. Two cars start moving at the same time in the same direction from cities A and B, as shown in the picture below.

How many hours will it take for the faster car to catch up with the slower car? How far from the city A will they meet? The distance between the Earth and Mars is 55,757,930 km. How fast the space ship should go to reach the red planet in 250 days? Represent the answer in the units of kilometers per hour.

9. A pedestrian covers a distance in 3 hours 45 minutes. The same distance can be covered by bicycle in 45 minutes. How many times faster does a cyclist ride than a pedestrian?

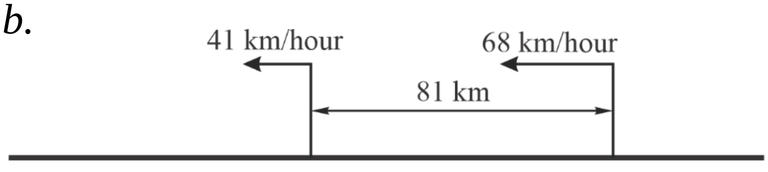
10. For the four pictures below, come up with the problem and solve it.

a.



t = 2.5 h.
distance in 2.5 hours = 56 km
distance at the beginning –> ?

b.



distance at the beginning = 81 km.
t meeting –> ? h.