

PV1.2: SUBTRACTION OF VECTORS

Subtracting vectors

When subtracting or finding the change in a vector, the initial value is taken away from the final value. The change in velocity Δv , for example, is the final velocity v_f minus the initial velocity v_i , or:

$$\vec{\Delta v} = \vec{v}_f - \vec{v}_i$$

Other symbols used: initial velocity u
final velocity v

Putting it another way we have

$$\vec{\Delta v} = \vec{v}_f - \vec{v}_i = \vec{v}_f + (-\vec{v}_i)$$

Thus, the change in velocity is the same as the final velocity plus the negative of the initial velocity. *Recall:* The negative of a vector is simply a vector that points in the opposite direction to the original vector.

Example 1 A golf ball is dropped onto a concrete floor and strikes the floor at 5 m/s. It then rebounds at 5 m/s.

What is the change in **speed** of the ball?

$$\Delta v = \text{final speed} - \text{initial speed} = 5 - 5 = 0$$

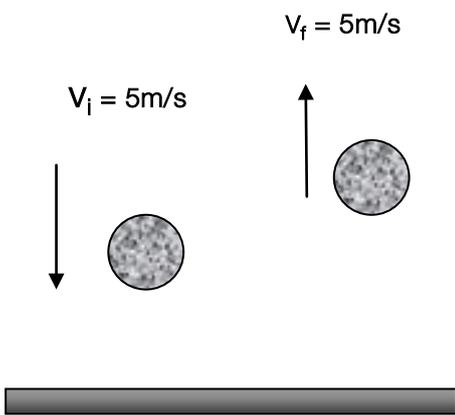
Note: Since speed is a scalar quantity, the direction of motion of the ball is not a consideration, only its magnitude. Hence the change in speed is zero.

What is the change in **velocity** of the ball?

$$\begin{aligned} \Delta v &= v_f - v_i \\ \Delta v &= 5 \uparrow - 5 \downarrow \\ &= 5 \uparrow + -5 \uparrow = 10 \uparrow \end{aligned}$$

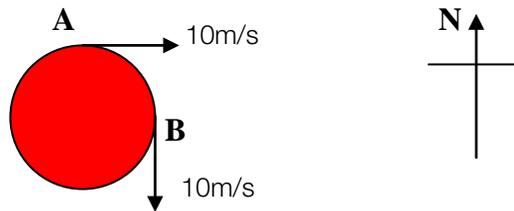
Since velocity is a vector, direction **is** a consideration. Hence vector subtraction is carried out.

Answer Change in velocity is 10 m/s up.



Example 2

A car is travelling at a uniform speed of 10m/s in a circle as shown below. Find the (a) change in **speed**, and (b) change in **velocity** of the car as it turns from A to B.

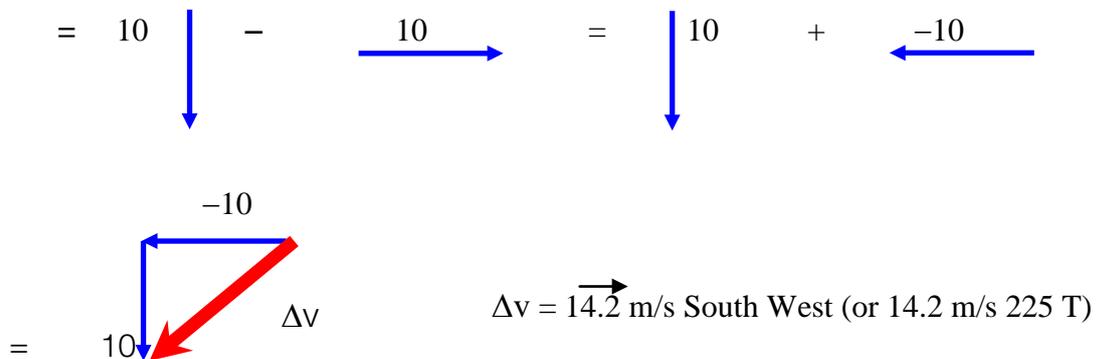


(a) Since speed is a scalar (direction is irrelevant), then the change in speed is given by:

$$(\text{final speed})_B - (\text{initial speed})_A = 10 - 10 = 0$$

(b) Change in velocity is given by

$$\Delta v = v_B - v_A$$



Multiplying vectors

When a vector is multiplied by a scalar (number) the magnitude of the vector changes accordingly. For example, if "x" is a displacement of 5 m North, then 4x is 20 m North.

Exercise

- Carry out the following vector subtractions:
 - 24 m N minus 18 m North, (b) 48 m N minus 22 m South, (c) 13.8 ms⁻¹ East minus 9.4 ms⁻¹ North.
- A ball is thrown in an Easterly direction and strikes a wall at 12.5 ms⁻¹. If it rebounds at the same speed, what is its (a) change in speed, (b) change in velocity.
- From $\vec{14.14 \text{ kmh}^{-1} \text{ East}}$ subtract $\vec{14.14 \text{ kmh}^{-1} \text{ North}}$.
- What is the change in velocity when an aeroplane travelling at 250 kmh⁻¹ West alters its course to 350 kmh⁻¹ North?

Answers

Exercise 1. (a) 6m North (b) 70 m North (c) 16.7 ms⁻¹ S56E (or 124°T) 2. (a) zero (b) 25 ms⁻¹ West
3. 20 kmh⁻¹ South East 4. 430 kmh⁻¹ North 35° East (035°T).