Lesson 1 - Introduction to Vectors

PART A: Scalar compared to Vector Quantities

Scalar Quantity: length, mass and temperature are quantities with magnitude (size) but *not* direction

100 km/h

Vector Quanity: velocity, acceleration and force are quantities with both magnitude *and* direction

100 kph [N]

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Example 1: State whether each of the following is a *vector* or a *scalar* quantity.

a)	A car travelling 50 km/hr to the east	Vector
b)	A child pulling a wagon with a force of 100 N at 30 degrees to the horizontal	Vector
c)	A man's mass of 88 kg	scalar
d)	A woman skiing at a speed of 25 km/hr	scalar
e)	A parachutist falling at 20 km/h downward	Vector
f)	Acceleration due to gravity on Earth of 9.8 m/s^2 downward	Vector
g)	The number 5	scalar
h)	Your weight on a bathroom scale	Vector

↓ 9.8 m/s^2

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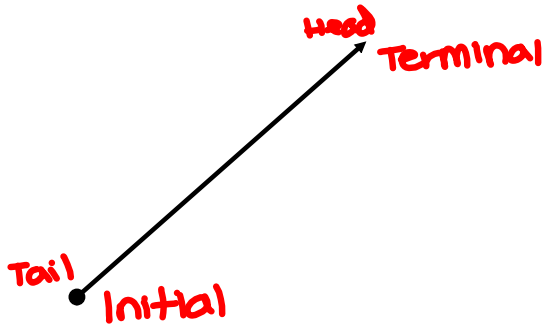
PART B: Representations of Vectors

A vector is represented geometrically by a *directed line segment*. To say that it is directed, means that one end of it has been designated as its tail (initial point), and the other end as its head (terminal point). The direction of a directed line segment is from its tail to its head.



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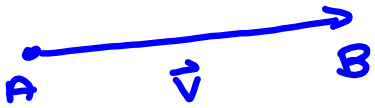
Vector Notation

The notation used to describe the vector above is: $\overrightarrow{AB}$, where A represents the tail of the vector (initial point) and the second letter, B, represents the head of the vector (the terminal point). Single letter notation is also commonly used, for example $\vec{v}$.

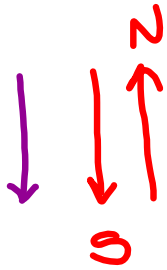
The length or **magnitude** of $\overrightarrow{AB}$ is denoted as $|\overrightarrow{AB}|$
The length or **magnitude** of $\vec{v}$ is denoted as $|\vec{v}|$



$|\vec{AB}| = 5$
$|\vec{v}| = 5$

Equivalent Vectors

Vectors only tell us about *magnitude* and *direction*. They **do not** specify where the quantity is applied. This means that a person running 10km/h due south in Ottawa and a person running 10km/h due south in Toronto have the same vector.



Two vectors $\overrightarrow{AB}$ and $\overrightarrow{CD}$ are **equal** iff (if and only if):

1. $\overrightarrow{AB}$ is parallel to $\overrightarrow{CD}$
2. $\overrightarrow{AB}$ has the same length as $\overrightarrow{CD}$ (ie. $|\overrightarrow{AB}| = |\overrightarrow{CD}|$)
3. The direction from A to B is the same as from C to D.

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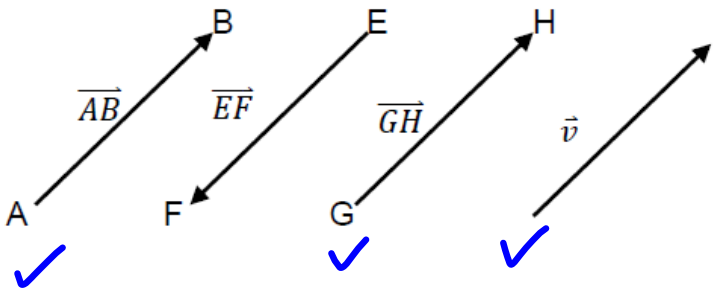
Example 2: Identify the equivalent vectors.



$\overrightarrow{AB} = \overrightarrow{GH} = \vec{v}$

All three are parallel, same length, same direction.

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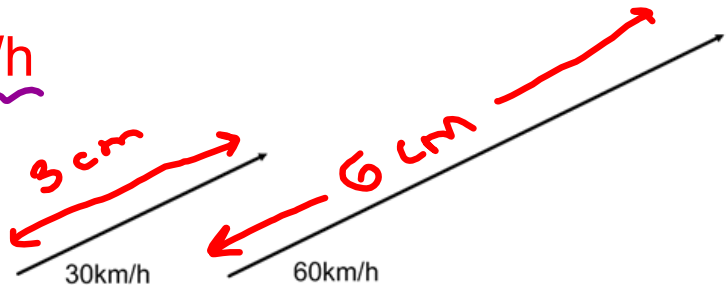
Proportionality

When vectors are represented as directed line segments, the lengths of the line segments are proportional to the magnitude of the vectors.

1 cm = 10 km/h



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Opposite Vectors

Vectors that have the same magnitude, but which act in opposite directions.

We write: $\vec{a} = -\vec{b}$ and $\overrightarrow{AB} = -\overrightarrow{BA}$

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Direction of Vectors

The direction of vectors can be described using *quadrant* or *true bearings*.

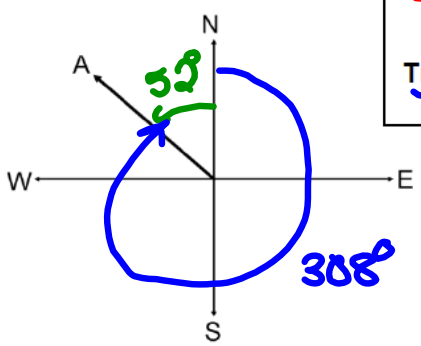
- ***Quadrant bearings:*** are compass measurements between 0° and 90° east or west of the north-south line.
- ***True bearings:*** a compass measurement beginning at the north and *rotating clockwise*.

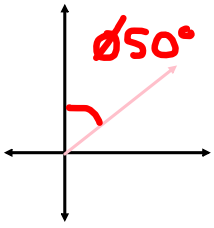
N or S is always written first

Quadrant Bearing – Point A is located at $N52^\circ W$
(and while $N308^\circ E$ is correct, we will use an angle θ, where $0^\circ \leq \theta \leq 90^\circ$ → always use acute angle

True Bearing – Point A has a bearing of 308° Always 3 digits

Example 3





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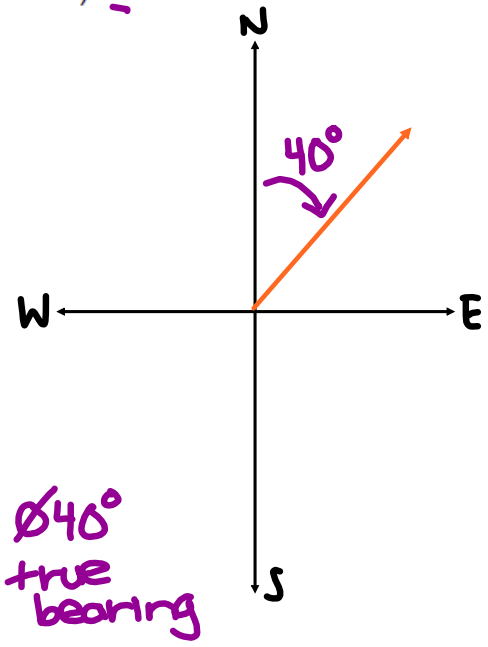
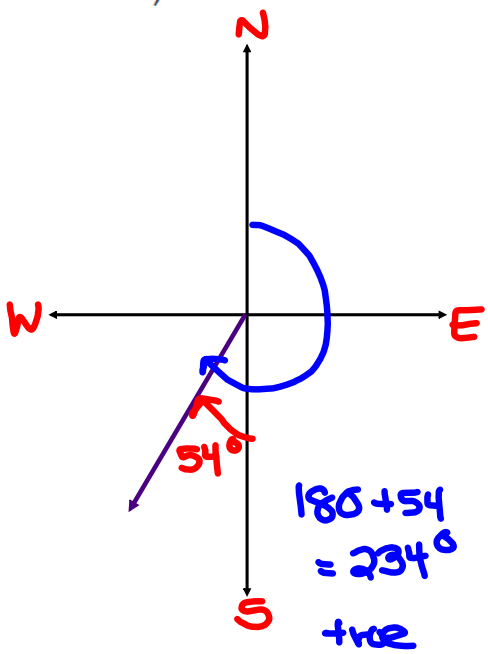
Example 4: Convert each quadrant bearing to its equivalent true bearing.

a) $N40^{\circ}E$



Ø40° true bearing

b) $S54^{\circ}W$



180+54 = 234° true bearing

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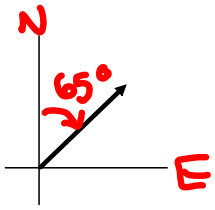
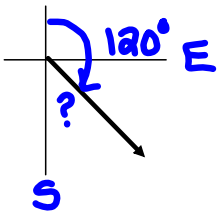
Example 5: Convert each true bearing to its equivalent quadrant bearing.

a) 65°



N 65° E

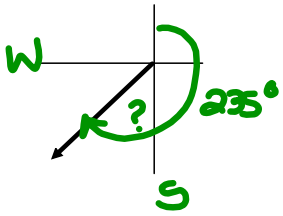
b) 120°



180-120 = 60°

S 60° E

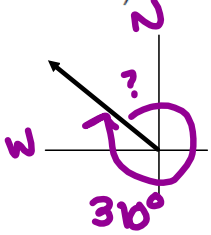
c) 235°



235°-180° = 55°

S 55° W

d) 310°



360-310 = 50°

N 50° W

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Example 6: Use an appropriate scale to draw each vector. Label magnitude/direction/scale.

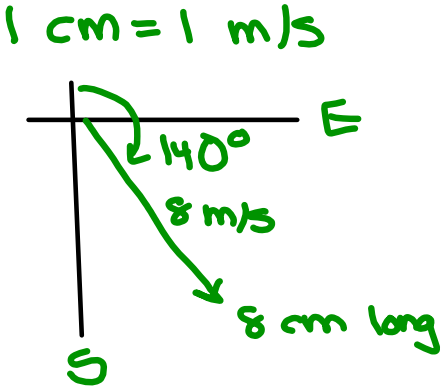
a) Displacement of 50 km west

b) Velocity of 8 m/s on a bearing of 140°

a)

1cm = 50 km

b)



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