# Chapter 3 Model With Vectors
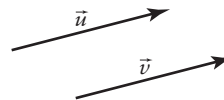
3.1 Vectors

KEY CONCEPTS

- A scalar is a quantity—such as time, temperature, or volume—that describes magnitude.

- A vector is a quantity—such as displacement or velocity—that has both magnitude and direction.

- A vector, $\vec{v}$, can be represented as a directed line segment with an arrowhead that indicates the direction. The magnitude of the vector, $|\vec{v}|$, is represented by the length of the directed line segment.

- The tail of a vector is defined as the origin of the vector. The head of the vector is defined as the tip or the arrowhead.
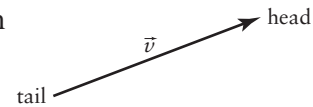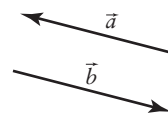
- Vector $\overrightarrow{AB}$ has magnitude $|\overrightarrow{AB}|$.

- Equivalent vectors, or equal vectors, have the same magnitude and direction, but may have different positions.

- Opposite vectors have the same magnitude, but are opposite in direction.

- Direction can be expressed as a true bearing (or bearing) or as a quadrant bearing. A bearing is an angle measured clockwise from north and expressed as a three-digit number. A quadrant bearing is an angle between 0° and 90° measured east or west of the north-south line.
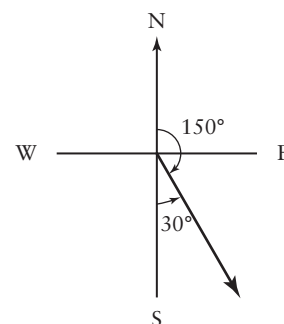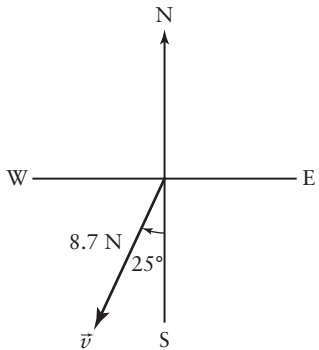
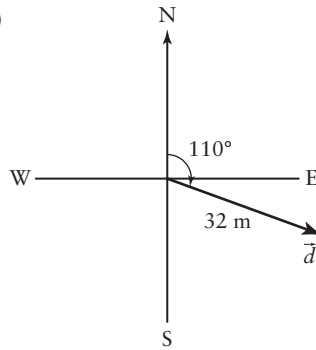The bearing 150° is equivalent to the quadrant bearing S30°E

Example

Describe each vector in words.

a)

b)

Solution

a) A force of 8.7 N on a quadrant bearing of S25°W.

b) Displacement of 32 m at a bearing of 110°.

A

1. Classify each quantity as a vector or a scalar. Explain your choice.

a) the time on an alarm clock

b) the force of gravity

c) the temperature of a room

d) a car travelling north at 100km/h

e) a mass of 9 kg

f) a weight of 9 N

g) a car travelling at 60 km/h

2. Draw each vector, and then state its opposite.
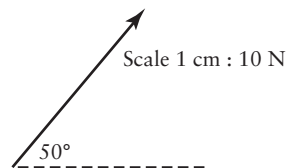
a) displacement of 500 km east

b) force of 400 N on a bearing of 135°

c) velocity of 250 km/h on a quadrant bearing of N35°W

d) velocity of 50 mph on a bearing of 080°
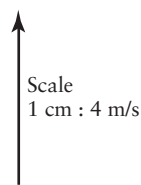
3. Classify each quantity as a vector or a scalar.

a) 15 km^2 **b)** 8 m/s NE

c) 20 °C   **d)** 12 km up

e) $-\vec{q}$ **f)** 70 km/h

4. Describe the magnitude and direction of each vector in words and in symbols.

a)

Scale 1 cm : 10 N

50°

b)

Scale
1 cm : 4 m/s

5. Express as a quadrant bearing.

a) 030°   **b)** 150°

c) 225°   **d)** 325°

6. Express as a true bearing.

a) S40°E   **b)** N30°W

c) S60°W   **d)** N70°E

B

7. Choose an appropriate scale. Draw and label a diagram.

a) 80 km/h on a bearing of 210°

b) 5 m/s^2 on a bearing of 060°

c) 50 m N40°W

**d)** 500 N 25° up from the horizontal

★**8.** Determine whether a vector is a suitable mathematical model to represent each situation. Explain your reasoning.

a) A marble rolls across a table at 1 cm/s.

b) Dan pushes a box with a force of 100 N toward the east.

c) An alarm has an intensity of 70 dB.

d) A car travels southwest at 100 km/h.

e) A plane flies 200 m east.

f) A package has a weight of 50 N.

g) A dog has a mass of 13 kg.

h) A bus drives north for 2 h.

9. For each vector,
i) Write a vector that is the opposite.
ii) Write a vector that is parallel to, but not equivalent to, the given vector.
iii) Write a vector with the same magnitude as the given vector, but with a different direction.

a) 200 m/s on a bearing of 130°

b) 25 km in the direction S35°E

★**10.** Al drove 7 km east, then 24 km south.

a) Calculate the magnitude of the displacement vector, to the nearest tenth of a kilometre.

b) Determine the bearing of Al's car, to the nearest degree.

c) Is the distance that Al travelled the same as the magnitude of the displacement vector? Explain.

11. Is each statement reasonable? Explain.

a) $|\vec{u}| > |\vec{v}|$
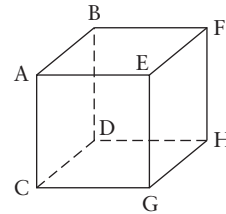
b) $\vec{u} > \vec{v}$

c) $|\vec{u}| = -3$ cm/s

12. ABCD is a rhombus.
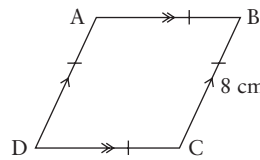
a) Which vector is equivalent to $\overrightarrow{AB}$?

b) Which vector is opposite to $\overrightarrow{AD}$?

c) Is each statement true? Explain.

i) $\overrightarrow{DA} = \overrightarrow{CB}$ **ii)** $\overrightarrow{AB} = -\overrightarrow{CD}$
iii) $\overrightarrow{DC} = -\overrightarrow{BA}$ **iv)** $\overrightarrow{AC} = \overrightarrow{BD}$

C

13. The edges of this cube are vectors.

a) State an equivalent vector.

i) $\overrightarrow{AB}$ **ii)** $\overrightarrow{DH}$
iii) $\overrightarrow{AC}$ **iv)** $\overrightarrow{DG}$

b) State an opposite vector.

i) $\overrightarrow{FH}$ **ii)** $\overrightarrow{FG}$
iii) $\overrightarrow{BE}$ **iv)** $\overrightarrow{DG}$

14. These vectors are equivalent. Determine the missing coordinates.