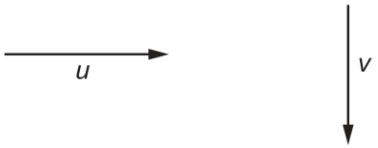
# 1. Physical Quantities and Units

## 1.4 Scalars and vectors

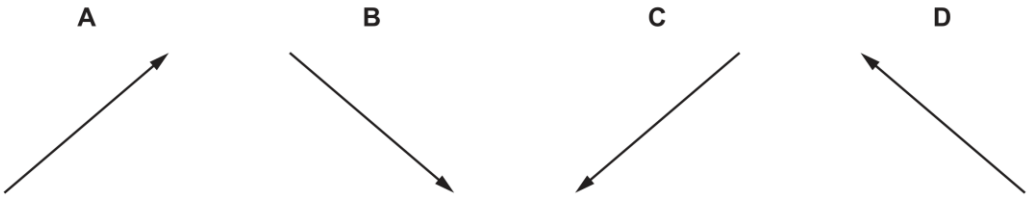
## Paper 1

Question Paper

**1** The velocity of an object changes from an initial velocity $u$ to a final velocity $v$. The vectors represent these velocities.




Which single vector represents the change in velocity of the object?




**2** Which calculation produces a vector quantity?

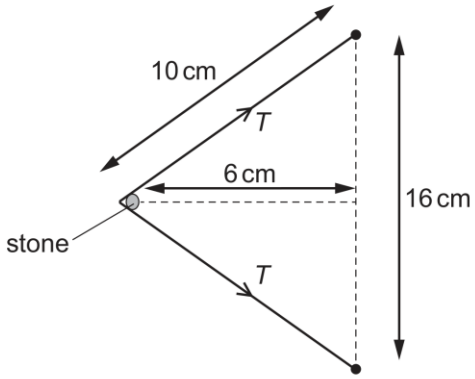
**A** current × time

**B** final displacement – initial displacement

**C** $\frac{\text{work done}}{\text{time}}$

**D** $\frac{1}{2} \times \text{mass} \times (\text{speed})^2$

**3** The diagram shows the dimensions of an elastic cord used to project a stone. The tension in the cord is $T$ when the cord is pulled into the shape shown.




Which force does the elastic cord exert on the stone?

**A** $\frac{3}{5}T$ **B** $\frac{6}{5}T$ **C** $\frac{8}{5}T$ **D** $2T$

**4** What is a scalar quantity?

**A** a quantity that can be represented as two perpendicular components

**B** a quantity that does **not** require a unit

**C** a quantity without a direction

**D** a quantity without a magnitude

**5** A ball collides with a wall. Before the collision, the ball moves with velocity $8\,\text{m}\,\text{s}^{-1}$ to the right. After the collision, it moves with velocity $3\,\text{m}\,\text{s}^{-1}$ to the left.

What is the change in velocity of the ball during the collision?

**A** $5\,\text{m}\,\text{s}^{-1}$ to the left

**B** $5\,\text{m}\,\text{s}^{-1}$ to the right

**C** $11\,\text{m}\,\text{s}^{-1}$ to the left

**D** $11\,\text{m}\,\text{s}^{-1}$ to the right

**6** Which statement about vector quantities is correct?

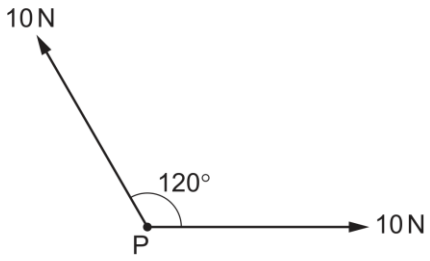
**A** Acceleration of free fall is a vector quantity because it has a constant magnitude.

**B** Temperature in °C is a vector quantity because it can be positive or negative.

**C** Time is a vector quantity because it can only go in the forwards direction.

**D** Weight is a vector quantity because it has a direction.

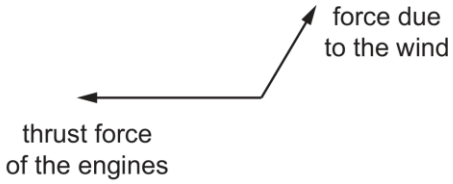
**7** Two forces, each of 10 N, act at a point P, as shown. The angle between the directions of the forces is 120°.




What is the magnitude of the resultant force?

**A** 5 N **B** 10 N **C** 17 N **D** 20 N

**8** An aircraft travels along a horizontal path. Two of the forces that act horizontally on the aircraft are the thrust force of the engines and the force due to the wind. The vector diagram for these forces is shown.




Which vector represents the resultant horizontal force acting on the aircraft due to these two forces?

**A**



**B**



**C**



**D**

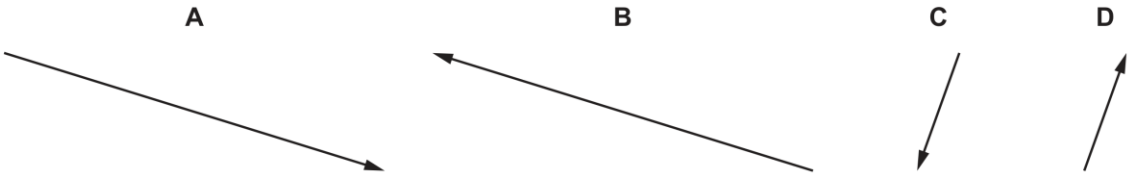


**9** The diagram shows two coplanar forces, $P$ and $Q$, drawn to scale.



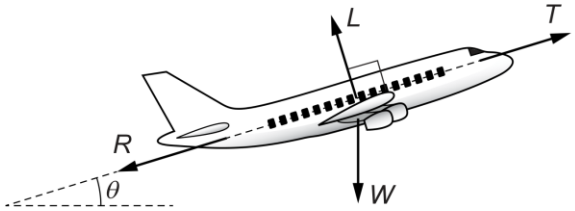

Force $R$ is given by $R = Q - P$.

Which diagram represents $R$?




**10** An aeroplane is moving at a constant speed in a straight line at an angle $\theta$ to the horizontal.

Four forces act on the aeroplane: thrust force $T$, weight $W$, lift force $L$ and resistive force $R$.




Which two equations must be correct?

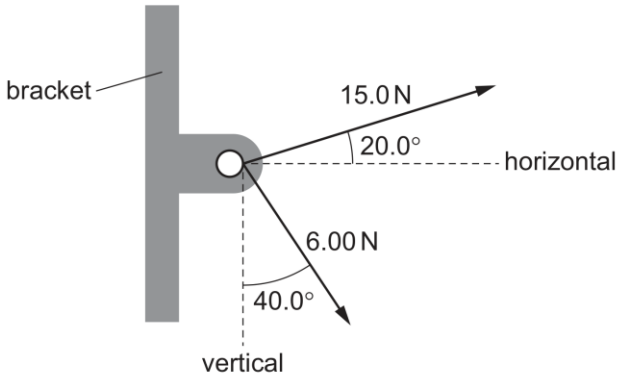
**A** $L = W\cos\theta$ and $T = R + W\sin\theta$

**B** $L = W\sin\theta$ and $T = R + W\cos\theta$

**C** $L = W\cos\theta$ and $T = R - W\sin\theta$

**D** $L = W\sin\theta$ and $T = R - W\cos\theta$

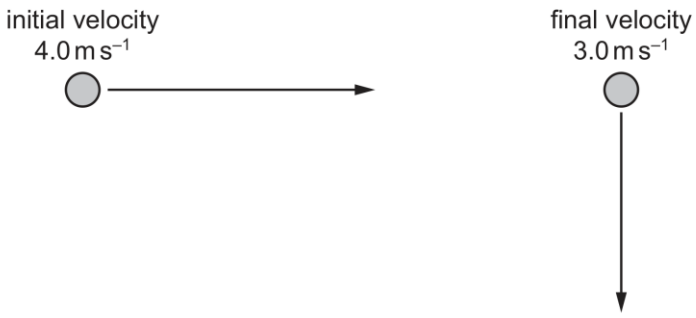
**11** Two cables are attached to a bracket and exert forces as shown.



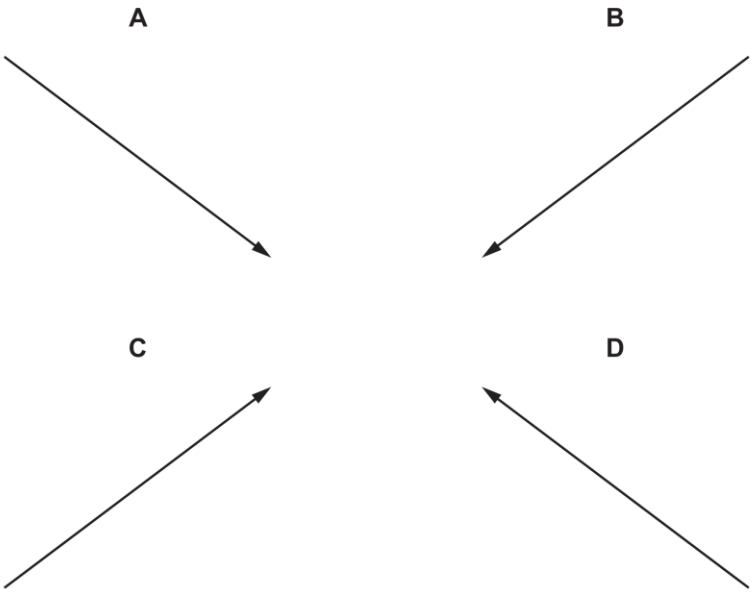

What are the magnitudes of the horizontal and vertical components of the resultant of the two forces?

| | horizontal component / N | vertical component / N |
|---|---|---|
| **A** | 9.73 | 0.534 |
| **B** | 9.73 | 10.2 |
| **C** | 18.0 | 0.534 |
| **D** | 18.0 | 10.2 |

**12** An object is moving with an initial velocity of $4.0\,m\,s^{-1}$ to the right. The velocity of the object changes so that its final velocity is $3.0\,m\,s^{-1}$ downwards, as shown.




Which arrow represents the change in velocity of the object?



**13** Which quantity is a vector?

**A** momentum

**B** speed

**C** temperature

**D** Young modulus

**14** What is the difference between a scalar quantity and a vector quantity?

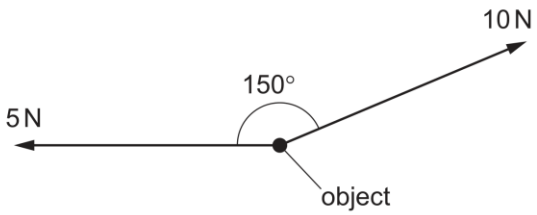
**A** A scalar quantity has direction but a vector quantity does not.

**B** A scalar quantity has magnitude but a vector quantity does not.

**C** A vector quantity has direction but a scalar quantity does not.

**D** A vector quantity has magnitude but a scalar quantity does not.

**15** A force of 10 N and a force of 5 N act on an object.



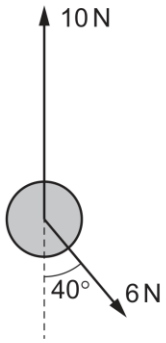

The angle between the forces is 150°.

The resultant force on the object can be resolved into a pair of perpendicular components.

Which row shows numerical expressions for a possible pair of perpendicular components?

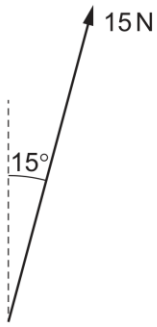
| | force component / N | force component / N |
|---|---|---|
| **A** | $10\cos 30° - 5$ | $10\cos 30°$ |
| **B** | $10\sin 30° - 5$ | $10\cos 30°$ |
| **C** | $10 - 5\cos 30°$ | $5\sin 30°$ |
| **D** | $10 - 5\sin 30°$ | $5\cos 30°$ |

**16** An object is acted upon by two forces, 10 N in the vertical direction and 6 N at 40° to the vertical, as shown.

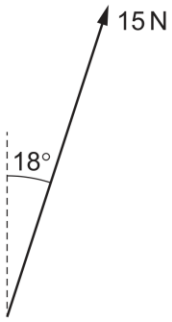



What is the resultant force acting on the object?

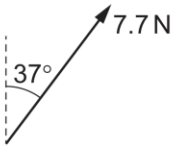
**A**




**B**



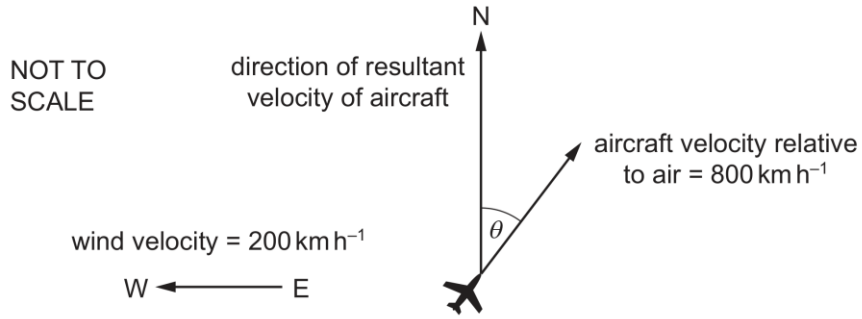

**C**




**D**



**17** An aircraft heads in a direction at an angle $\theta$ east of north with a horizontal velocity relative to the air of 800 km h$^{-1}$. The wind blows with a horizontal velocity of 200 km h$^{-1}$ from east to west, as shown.

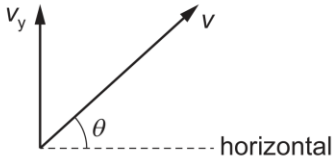



The resultant velocity of the aircraft is in a direction due north.

What is angle $\theta$ and what is the magnitude of the resultant velocity?

| | $\theta$ / ° | resultant velocity / km h$^{-1}$ |
|---|---|---|
| **A** | 14 | 770 |
| **B** | 14 | 820 |
| **C** | 76 | 770 |
| **D** | 76 | 820 |

**18** A tennis ball is hit so that it leaves the racket with velocity $v$ at an angle $\theta$ to the horizontal.




The vertical component of the velocity is $v_y$.

What is the magnitude of the horizontal component of $v$?

**A** $v\sin\theta$ **B** $v_y\cos\theta$ **C** $v_y\sin\theta$ **D** $(v^2 - v_y^2)^{\frac{1}{2}}$

**19** The power produced by a force moving an object is given by the equation shown.

$$\text{power} = \frac{\text{work}}{\text{time}} = \frac{\text{force} \times \text{displacement}}{\text{time}}$$

Which quantities are scalars and which are vectors?

| | scalars | vectors |
|---|---|---|
| **A** | displacement, time | force, power |
| **B** | power, work | displacement, force |
| **C** | power, force | displacement, work |
| **D** | work, time | power, displacement |

**20** Which quantity is a scalar?

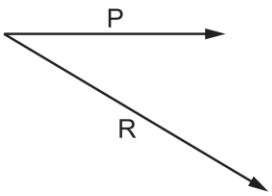
**A** acceleration

**B** force

**C** kinetic energy

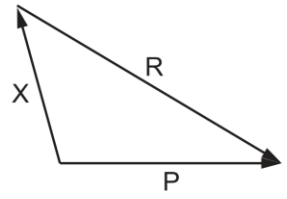
**D** momentum

**21** P and R are coplanar vectors.

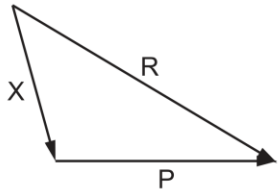



If X = P – R, which diagram best represents vector X?

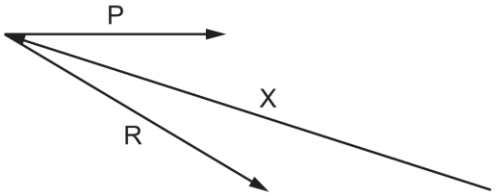
**A**



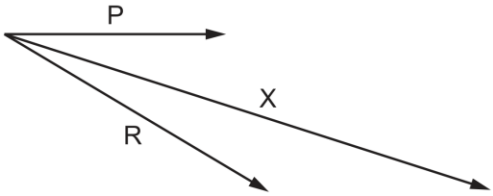

**B**



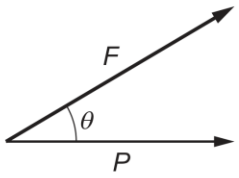

**C**




**D**

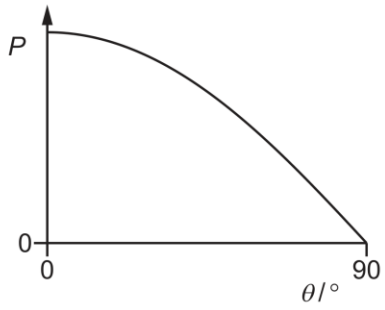


**22** The diagram shows a force *F*. *P* is the horizontal component of *F*, at an angle $\theta$ to *F*.

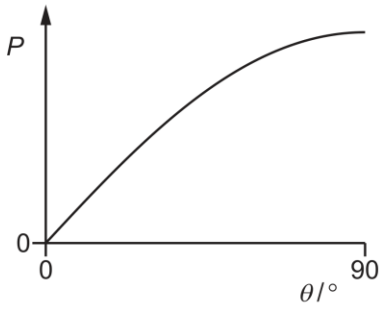



Which graph best shows the variation with $\theta$ of the magnitude of *P*?

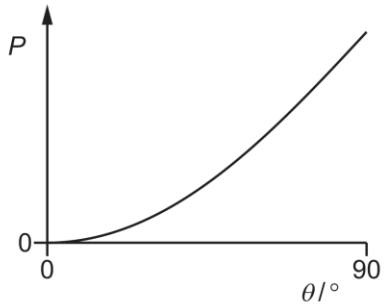
**A**



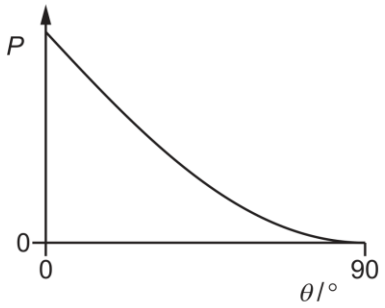

**B**




**C**

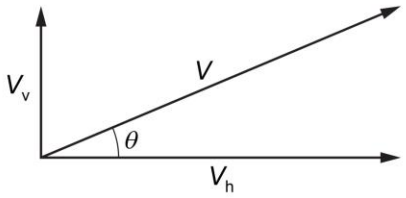



**D**



**23** A particle has velocity $V$ at an angle $\theta$ to the horizontal.

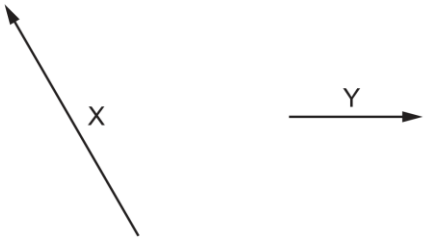
The components of the particle's velocity are $V_v$ upwards in the vertical direction and $V_h$ to the right in the horizontal direction, as shown.




What are expressions for the magnitude of $V$ and for the angle $\theta$?

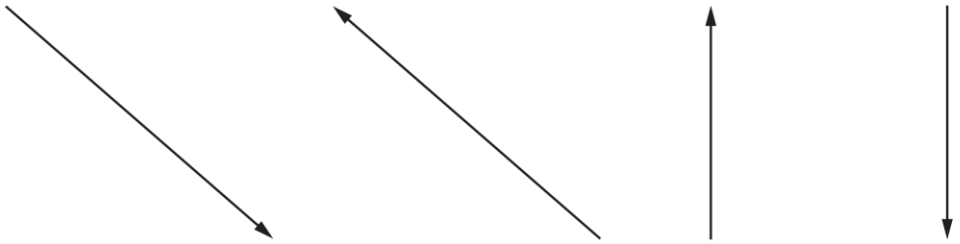
| | magnitude of $V$ | $\theta$ |
|---|---|---|
| **A** | $\sqrt{(V_v^2 + V_h^2)}$ | $\tan^{-1}\left(\frac{V_h}{V_v}\right)$ |
| **B** | $\sqrt{(V_v^2 + V_h^2)}$ | $\tan^{-1}\left(\frac{V_v}{V_h}\right)$ |
| **C** | $\sqrt{(V_v^2 - V_h^2)}$ | $\tan^{-1}\left(\frac{V_h}{V_v}\right)$ |
| **D** | $\sqrt{(V_v^2 - V_h^2)}$ | $\tan^{-1}\left(\frac{V_v}{V_h}\right)$ |

**24** The diagram shows two vectors X and Y, drawn to scale.




If X = Y – Z, which diagram best represents the vector Z?

**A** **B** **C** **D**



**25** Which list contains only scalar quantities?

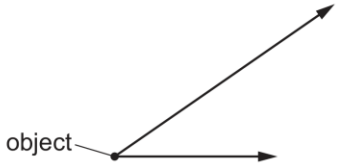
**A** area, length, displacement

**B** kinetic energy, speed, power

**C** potential energy, momentum, time

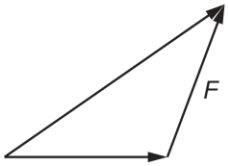
**D** velocity, distance, temperature

**26** Two coplanar forces act on an object as shown.

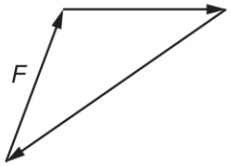



Which diagram shows the resultant *F* of these two forces?

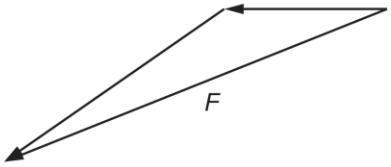
**A**



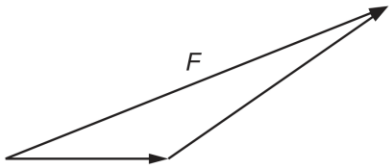

**B**




**C**




**D**



**27** Physical quantities can be classed as vectors or as scalars.

Which pair of quantities consists of two vectors?

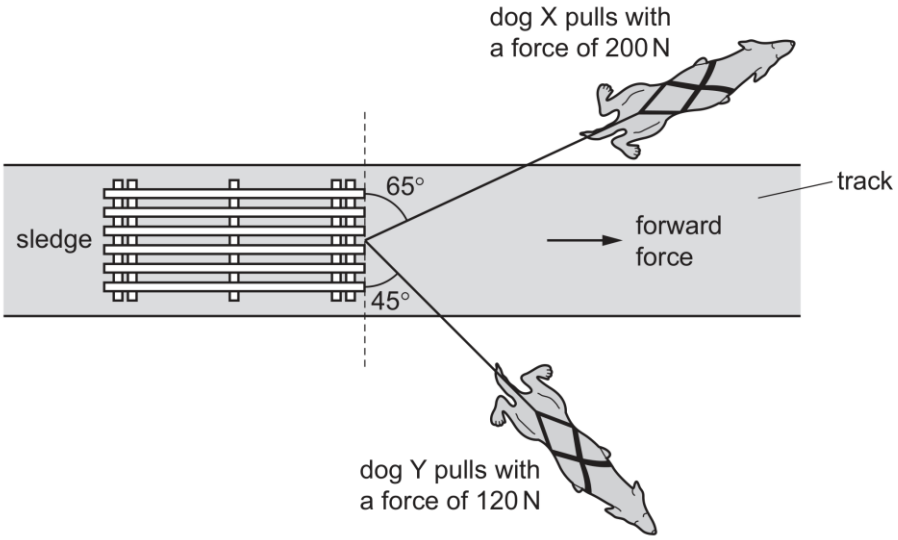
**A** kinetic energy and force

**B** momentum and time

**C** velocity and electric field strength

**D** weight and temperature

**28** Two dogs pull a sledge along an icy track, as shown.

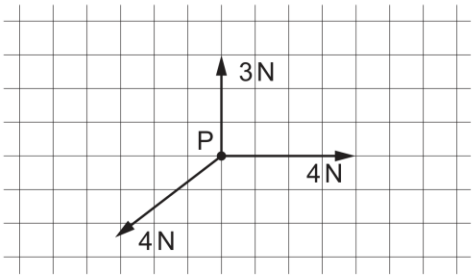



Dog X pulls with a force of 200 N at an angle of 65° to the front edge of the sledge. Dog Y pulls with a force of 120 N at an angle of 45° to the front edge of the sledge.

What is the resultant forward force on the sledge exerted by the two dogs?

**A** 80 N **B** 170 N **C** 270 N **D** 320 N

**29** The vector diagram shows three coplanar forces acting on an object at P.




The magnitude of the resultant of these three forces is 1 N.

What is the direction of this resultant force?

**A** ↙ **B** ↘ **C** ↖ **D** ↗

**30** A ship is travelling with a velocity of 8.0 km h$^{-1}$ in a direction 30° east of north.

What are the components of the ship's velocity in the east and north directions?

| | component of velocity in east direction / km h$^{-1}$ | component of velocity in north direction / km h$^{-1}$ |
|---|---|---|
| **A** | 4.0 | 4.0 |
| **B** | 4.0 | 6.9 |
| **C** | 4.6 | 6.9 |
| **D** | 6.9 | 4.0 |

**31** Which list contains both scalar and vector quantities?

**A** acceleration, momentum, velocity, weight

**B** area, current, force, work

**C** distance, kinetic energy, power, pressure

**D** mass, temperature, time, speed

**32** Vectors P and Q are drawn to scale.




Which diagram represents the vector (P + Q)?

**A**



**B**



**C**



**D**

