Class 9 Physics

Chapter 2 — Kinematics

Short Answer Questions (Exercise B) — Solved

2.1 Define scalar and vector quantities.

A scalar is a physical quantity that can be described completely by its magnitude (a number with a suitable unit) only — for example mass, length, time, speed, temperature and energy. Scalars are added by ordinary arithmetic (5 m + 3 m = 8 m).

A vector is a physical quantity that needs both magnitude and direction to be described completely — for example displacement, velocity, acceleration, force and weight. Vectors cannot be added like ordinary numbers; they are added by special (graphical) methods such as the head-to-tail rule.

2.2 Give 5 examples each for scalar and vector quantities.

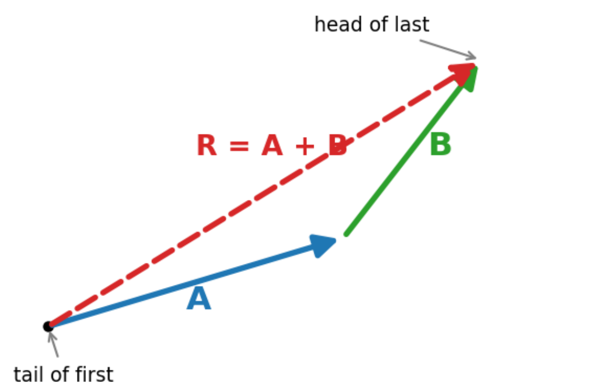
Scalars: mass, distance (length), time, speed, temperature.

Vectors: displacement, velocity, acceleration, force, weight.

2.3 State the head-to-tail rule for addition of vectors.

To add a number of vectors, redraw their representative lines (to a chosen scale) so that the head (arrow end) of one line coincides with the tail of the next. The resultant vector is the single vector drawn from the tail of the first vector to the head of the last vector. Its length (to scale) gives the magnitude of the resultant, and the angle it makes with the reference axis gives its direction. It is a graphical method of vector addition.

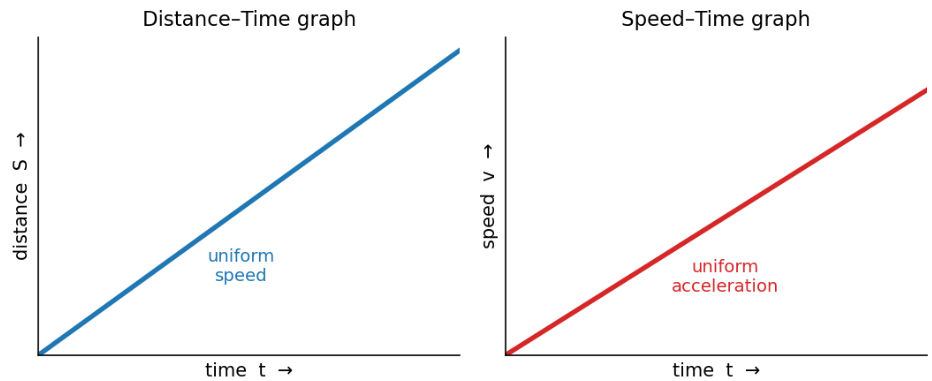
Head-to-tail rule: resultant R from tail of first to head of last



2.4 What are distance-time graph and speed-time graph?

Distance-time graph: a graph plotted between the distance S covered by a body (y-axis) and the time t taken (x-axis). Its slope (gradient) equals the speed of the body — a straight sloping line shows uniform speed, an upward curve shows increasing speed (acceleration), and a horizontal line shows the body is at rest.

Speed-time graph: a graph plotted between the speed v of a body (y-axis) and time t (x-axis). Its slope (gradient) equals the acceleration, and the area under the graph equals the distance covered. A horizontal line shows uniform speed (zero acceleration); a straight sloping line shows uniform acceleration.



2.5 Falling objects near the Earth have the same constant acceleration. Does this imply that a heavier object falls faster than a lighter one?

No. Near the Earth's surface all freely falling bodies fall with the same gravitational acceleration g (≈ 9.8 m s^{-2}, about 10 m s^{-2}), which is independent of mass. So a heavier object does not fall faster; ignoring air resistance, both reach the ground together when dropped from the same height.

Reason: the downward force on a falling body is its weight, F = mg. By Newton's second law:

$$\mathbf{a = F \div m = mg \div m = g}$$

The mass m cancels out, so the acceleration is the same for every body. A heavier body has more weight but also more inertia, and the two effects cancel exactly. A feather falls slower than a stone only because of air resistance — in a vacuum they fall together.

2.6 Vector quantities are sometimes written in scalar notation (not bold). How is the direction indicated?

Normally a vector is written in bold face (F, v) or with a small arrow over the letter ($\vec{F}$, $\vec{v}$). When it is written in scalar notation (an ordinary, non-bold letter such as F or v), its direction is shown by a positive or negative sign. One direction along the line or axis is taken as positive (+) and the opposite direction as negative (−). For example, in vertical motion upward may be +ve and downward −ve, so

+10 m s^{-1} means 10 m s^{-1} upward and −10 m s^{-1} means 10 m s^{-1} downward. Thus, the sign indicates the vector's direction along the reference line.

2.7 A body is moving with uniform speed. Will its velocity be uniform? Give reason.

Not necessarily. Velocity is uniform only if both the speed and the direction stay constant. A body moving with uniform speed has uniform velocity only if it moves in a straight line. If it moves along a curved or circular path at constant speed, its direction changes continuously, so its velocity keeps changing — the velocity is not uniform even though the speed is. Example: a body moving in a circle at constant speed has a continuously changing velocity (and hence acceleration) because its direction changes at every instant.

2.8 Is it possible for a body to have acceleration when moving with (i) constant velocity (ii) constant speed?

Acceleration is the rate of change of velocity:

$$\mathbf{a = \Delta v \div t = (vf - vi) \div t \text{ (vf = final velocity, vi = initial velocity)}}$$

(i) Constant velocity → No. If the velocity is constant, both its magnitude and direction are unchanged, so $\Delta v = 0$ and therefore $a = 0$.

(ii) Constant speed → Yes, possible. Speed is only the magnitude of velocity. If the speed is constant but the direction changes (e.g. circular motion), the velocity still changes, so $\Delta v \neq 0$ and the body has acceleration — directed towards the centre in circular motion — caused purely by the change in direction.