CHAPTER

02

Motion in One Dimension

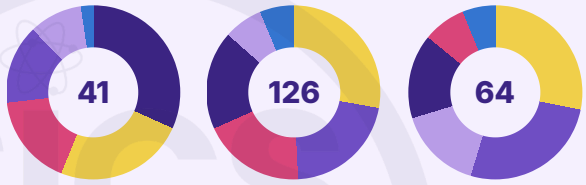
MHT CET · JEE · NEET Physics

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EXAM WEIGHTAGE



MHT CET 2020–2026 | **JEE Main** 2002–2026 | **NEET** 1988–2026

	CET	JEE	NEET
Motion Under Gravity	10 (24%)	35 (28%)	18 (28%)
Velocity, Acceleration & Variable Motion	6 (15%)	27 (21%)	17 (27%)
Equations of Kinematics	13 (32%)	23 (18%)	10 (16%)
Graphs of Motion	7 (17%)	24 (19%)	5 (8%)
Distance, Displacement & Average Speed	4 (10%)	9 (7%)	10 (16%)
Relative Velocity	1 (2%)	8 (6%)	4 (6%)

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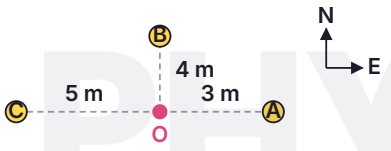
01 CONCEPT Distance, Displacement & Average Speed

IN ONE LINE

Distance is the path actually covered; displacement is the straight change in position. Average speed uses distance, average velocity uses displacement.

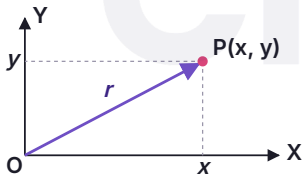
2.1.1 Position needs a reference

- Observers can describe the same point differently, and all be right.
- Position needs two things: **distance** from the observer and **direction**.
- So position is a vector, called the **position vector**.



Point O seen from A, B and C: three correct descriptions

$$\vec{r} = x\,\hat{i} + y\,\hat{j} + z\,\hat{k}$$



Position vector of P in the xy plane

2.1.2 Rest, motion and frame of reference

- **Frame of reference**: axes attached to an observer, used to describe an event.
- **Rest**: position does not change with time, relative to the frame.
- **Motion**: position changes with time, relative to the frame.
- A tree is at rest for a person on the platform and moving for a person in a train. Rest and motion are **relative**.

Motion	Coordinates changing	Example
1-D	one	car on a straight road, free fall
2-D	two	car on a circular turn, billiards ball
3-D	three	flying kite, flying insect

2.1.3 Particle or point object

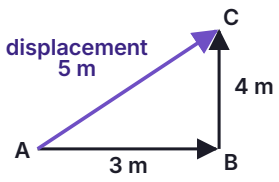
- A body is a particle if its size is negligible compared with its range of motion.
- Planets around the sun can be treated as particles.
- All parts of the body then have the same displacement, velocity and acceleration.

2.1.4 Distance

- Actual length of the path covered.
- **Scalar**. Dimension $[M^0L^1T^0]$. SI unit: metre.
- Going A to B to C below: distance = 3 + 4 = 7 m.

2.1.5 Displacement

- Change in position vector: from initial to final position.
- **Vector**. Dimension $[M^0L^1T^0]$. SI unit: metre.

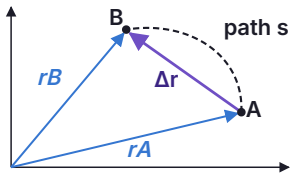


Distance 7 m, displacement 5 m

$$AC = \sqrt{(3^2 + 4^2)} = 5 \text{ m}$$

$$\Delta\vec{r} = \vec{r}_B - \vec{r}_A$$

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Displacement depends only on the end points; s depends on the path

- Net displacement is the vector sum: $\mathbf{S} = \mathbf{S}_1 + \mathbf{S}_2 + \ldots + \mathbf{S}_n$.

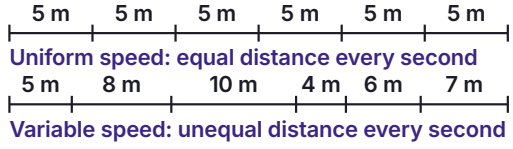
2.1.6 Distance vs displacement

Distance	Displacement
never negative or zero while moving	can be +, − or zero
depends on the path	single value between two points
never decreases with time	can decrease (moving back)
same as |displacement| only on a straight path without turning	minimum possible distance

$$\text{distance} \geq |\text{displacement}|$$

2.1.7 Speed

- Rate of covering distance. **Scalar**. Dimension $[M^0L^1T^{-1}]$. SI unit: m/s.
- **Uniform speed**: equal distances in equal intervals, however small.
- **Variable speed**: unequal distances in equal intervals.



Uniform and variable speed

2.1.8 Average speed

$$v_{av} = \frac{\text{total distance}}{\text{total time}} = \frac{\Delta s}{\Delta t}$$

- **Different times** t_1, t_2, t_3 at speeds v_1, v_2, v_3:

$$v_{av} = \frac{v_1t_1 + v_2t_2 + v_3t_3}{t_1 + t_2 + t_3}$$

- **Equal times** at v_1 and v_2:

$$v_{av} = \frac{v_1 + v_2}{2}$$

- **Different distances** d_1, d_2, d_3 at speeds v_1, v_2, v_3:

$$v_{av} = (d_1 + d_2 + d_3) \div \left(\frac{d_1}{v_1} + \frac{d_2}{v_2} + \frac{d_3}{v_3}\right)$$

- **Two equal distances** at v_1 and v_2:

$$v_{av} = \frac{2v_1v_2}{v_1 + v_2}$$

- **Three equal distances** at v_1, v_2 and v_3:

$$v_{av} = \frac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_3v_1}$$

2.1.9 Average velocity vs average speed

$$v_{av} = \frac{\text{displacement}}{\text{time taken}} = \frac{\Delta r}{\Delta t}$$

- Average speed is a scalar; average velocity is a vector.
- Back at the start: average velocity = 0, but average speed > 0.
- Average velocity can be +, − or zero; average speed cannot be negative.
- Equal only when moving straight without turning.

$$\text{average speed} \geq |\text{average velocity}|$$

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Solved Examples 01 Distance, Displacement & Average Speed

SOLVED 1 MHT CET 2026 · 15 May · Shift 2

A student runs along a circular track of diameter 80 m. The distance travelled and the magnitude of displacement when he covers $(\frac{3}{4})^{th}$ of the circle is (in m)

(a) 60π, 40√2 (b) 40π, 60√2
(c) 120π, 80√2 (d) 80π, 120√2

STEP 1 r = 40 m. Distance = ¾ × 2πr = 60π m
STEP 2 Start and end points subtend 90° at the centre
STEP 3 Displacement = r√2 = 40√2 m ⇒ **60π, 40√2**

Answer: **(a)**

SOLVED 2 MHT CET 2024 · 10 May · Shift 2

A vehicle runs on a straight road of length L. It travels half the distance with speed V and the remaining distance with speed $\frac{V}{3}$. Its average speed is

(a) $\frac{3V}{2}$ (b) V
(c) $\frac{V}{2}$ (d) $\frac{2V}{3}$

STEP 1 Equal distances: $v_{av} = \frac{2v_1v_2}{v_1 + v_2}$
STEP 2 $v_{av} = \frac{2V(\frac{V}{3})}{V + \frac{V}{3}}$
STEP 3 $v_{av} = \mathbf{\frac{V}{2}}$

Answer: **(c)**

SOLVED 3 MHT CET 2026 · 15 May · Shift 2

A person moves with uniform velocity V_1 for a distance x and with uniform velocity V_2 for the next $\frac{3x}{2}$ distance. The average velocity is $\frac{50}{7}$ m/s. If V_1 is 5 m/s then V_2 (in m/s) is

(a) 5 (b) 15
(c) 10 (d) 8

STEP 1 Total distance $\frac{5x}{2}$; total time $\frac{x}{5} + \frac{3x}{2V_2}$
STEP 2 $\frac{\frac{5}{2}}{\frac{1}{5} + \frac{3}{2V_2}} = \frac{50}{7} \Rightarrow \frac{1}{5} + \frac{3}{2V_2} = \frac{7}{20}$
STEP 3 $\frac{3}{2V_2} = \frac{3}{20} \Rightarrow V_2 = \mathbf{10\ m/s}$

Answer: **(c)**

SOLVED 4 NEET 2023

A vehicle travels half the distance with speed v and the remaining distance with speed 2v. Its average speed is

(a) $\frac{2v}{3}$ (b) $\frac{4v}{3}$
(c) $\frac{3v}{4}$ (d) $\frac{v}{3}$

STEP 1 $v_{av} = \frac{2v_1v_2}{v_1 + v_2}$
STEP 2 $= \frac{2(v)(2v)}{v + 2v}$
STEP 3 $= \mathbf{\frac{4v}{3}}$

Answer: **(b)**

SOLVED 5 JEE Main 2023 · 30 Jan · Shift 2

A vehicle travels 4 km with speed of 3 km/h and another 4 km with speed of 5 km/h, then its average speed is

(a) 3.75 km/h (b) 4.25 km/h
(c) 3.50 km/h (d) 4.00 km/h

STEP 1 Two equal distances
STEP 2 $v_{av} = \frac{2 \times 3 \times 5}{3 + 5}$
STEP 3 = **3.75 km/h**

Answer: **(a)**

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Solved Examples 01 Distance, Displacement & Average Speed (contd.)

SOLVED 6 AIPMT 1991

A car moves a distance of 200 m. It covers the first half at speed 40 km/h and the second half at speed v. The average speed is 48 km/h. The value of v is

(a) 56 km/h (b) 60 km/h
(c) 50 km/h (d) 48 km/h

STEP 1 $48 = \frac{2 \times 40 \times v}{40 + v}$
STEP 2 $48(40 + v) = 80v \Rightarrow 1920 = 32v$
STEP 3 $v =$ **60 km/h**

Answer: **(b)**

SOLVED 7 AIPMT 1991

A bus travels the first one-third distance at 10 km/h, the next one-third at 20 km/h and the last one-third at 60 km/h. The average speed of the bus is

(a) 9 km/h (b) 16 km/h
(c) 18 km/h (d) 48 km/h

STEP 1 Three equal distances: $v_{av} = \frac{3}{\frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}}$
STEP 2 $\frac{1}{10} + \frac{1}{20} + \frac{1}{60} = \frac{10}{60} = \frac{1}{6}$
STEP 3 $v_{av} = 3 \times 6 =$ **18 km/h**

Answer: **(c)**

SOLVED 8 JEE Main 2024 · 9 Apr · Shift 1

A particle covers half the distance with speed 6 m/s. The other half is covered in two equal time intervals with speeds 9 m/s and 15 m/s. The average speed during the motion is

(a) 9.2 m/s (b) 8.8 m/s
(c) 10 m/s (d) 8 m/s

STEP 1 Equal times: second half speed $= \frac{9 + 15}{2}$ = 12 m/s
STEP 2 Now two equal distances: $v_{av} = \frac{2 \times 6 \times 12}{6 + 12}$
STEP 3 = **8 m/s**

Answer: **(d)**

SOLVED 9 MHT CET 2026 · 19 May · Shift 2

The minute hand of a wall clock is 10 cm long. The average velocity of the tip of the minute hand between 6.00 am and 7.30 am is

(a) zero (b) $\frac{1}{270}$ cm/s
(c) $\frac{1}{180}$ cm/s (d) $\frac{1}{90}$ cm/s

STEP 1 In 90 min the tip goes from 12 to 6: displacement = 2r = 20 cm
STEP 2 Time = 90 × 60 = 5400 s
STEP 3 $v_{av} = \frac{20}{5400} = \frac{1}{270}$ **cm/s**

Answer: **(b)**

SOLVED 10 AIPMT 2006

A car runs at constant speed on a circular track of radius 100 m, taking 62.8 s for every lap. The average velocity and average speed for each lap are

(a) 10 m/s, 0 (b) 0, 0
(c) 0, 10 m/s (d) 10 m/s, 10 m/s

STEP 1 One full lap: displacement = 0 ⇒ average velocity = 0
STEP 2 Distance = 2π × 100 = 628 m
STEP 3 Average speed $= \frac{628}{62.8}$ = 10 m/s ⇒ **0, 10 m/s**

Answer: **(c)**

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02 CONCEPT Velocity, Acceleration & Variable Motion

IN ONE LINE

If position is given as a function of time, differentiate once for velocity and again for acceleration.

2.2.1 Velocity

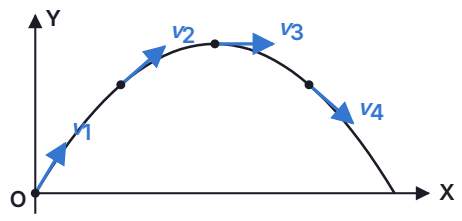
- Rate of change of position. **Vector**. Dimension $[M^0L^1T^{-1}]$. SI unit: m/s.
- **Uniform velocity**: magnitude and direction both constant. Possible only on a straight line without reversing.
- **Non-uniform velocity**: magnitude or direction or both change.

2.2.2 Instantaneous velocity and speed

$$v = \lim_{\Delta t \to 0} \frac{\Delta r}{\Delta t} = \frac{dr}{dt}$$

$$\text{speed } v = \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$$

- Instantaneous velocity is always **tangential** to the path.
- Its magnitude equals the instantaneous speed.
- Uniform circular motion: speed constant, velocity changing.
- Constant velocity: average and instantaneous velocity are equal.



v at each point lies along the tangent to the path

2.2.3 x(t) given: find v

- Differentiate x once.
- Example: $x = A_0 - A_1t + A_2t^2$ gives:

$$v = -A_1 + 2A_2t$$

- At t = 0: $v = -A_1$, speed = A_1.
- Moving in x and y: find v_x and v_y separately.

$$v = \sqrt{(v_x^2 + v_y^2)}$$

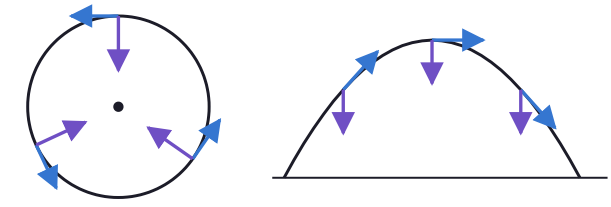
2.2.4 Acceleration

- Rate of change of velocity. **Vector**. Dimension $[M^0L^1T^{-2}]$. SI unit: m/s^2.
- Direction is that of the **change in velocity**, not of the velocity.
- **Uniform**: magnitude and direction constant. **Non-uniform**: either changes.

$$a_{av} = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{\Delta t}$$

$$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

What changes	Direction of a	Example
direction only	perpendicular to v	uniform circular motion
magnitude only	along or opposite to v	motion under gravity
both	two components	projectile motion



uniform circular: a ⊥ v | projectile: angle varies

Angle between a and v

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DIWALI HOMEWORK

Motion in One Dimension

LEVEL 1 · EASY

Topic-wise Previous Year Questions

MHT CET · NEET · JEE Main

124	23	6
questions	concepts	topics

CONTENTS

01	Distance, Displacement & Average Speed	Q 1–15	15 Qs
02	Velocity, Acceleration & Variable Motion	Q 1–25	25 Qs
03	Graphs of Motion	Q 1–24	24 Qs
04	Equations of Kinematics	Q 1–26	26 Qs
05	Motion Under Gravity	Q 1–28	28 Qs
06	Relative Velocity	Q 1–6	6 Qs
	Answer key		

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TOPIC 01

Distance, Displacement & Average Speed

15 PYQs · Easy 15 · Medium 0 · Difficult 0 | MHT CET 2 · NEET 8 · JEE 5

Concepts covered: Frame of reference, distance & displacement (1) · Average speed: equal distances (13) · Average velocity vs average speed (1)

LEVEL 1 · EASY 15 questions

◆ Frame of reference, distance & displacement 1 Q

1. A student runs along a circular track of diameter 80 m. The distance travelled and the magnitude of displacement of the student when he covers $\left(\frac{3}{4}\right)^{th}$ of the circle is (in m)

MHT CET 2026 · 15 MAY · SHIFT 2

(a) 60π, $40\sqrt{2}$ (b) 40π, $60\sqrt{2}$
(c) 120π, $80\sqrt{2}$ (d) 80π, $120\sqrt{2}$

◆ Average speed: equal distances 13 Qs

2. A vehicle runs on a straight road of length 'L'. It travels half the distance with speed V and the remaining distance with speed $\frac{V}{3}$. Its average speed is

MHT CET 2024 · 10 MAY · SHIFT 2

(a) $\frac{3V}{2}$ (b) V (c) $\frac{V}{2}$ (d) $\frac{2V}{3}$

3. A vehicle travels half the distance with speed v and the remaining distance with speed $2v$. Its average speed is:

NEET 2023

(a) $\frac{2v}{3}$ (b) $\frac{4v}{3}$ (c) $\frac{3v}{4}$ (d) $\frac{v}{3}$

4. A person travelling in a straight line moves with a constant velocity v_1 for certain distance 'x' and with a constant velocity v_2 for next equal distance. The average velocity v is given by the relation

NEET 2019

(a) $v = \sqrt{v_1 v_2}$ (b) $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2}$
(c) $\frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2}$ (d) $\frac{v}{2} = \frac{v_1 + v_2}{2}$

5. A particle covers half of its total distance with speed v1 and the rest half distance with speed v2. Its average speed during the complete journey is

AIPMT 2011 · MAINS

(a) $\frac{v_1+v_2}{2}$ (b) $\frac{v_1 v_2}{v_1+v_2}$ (c) $\frac{2v_1 v_2}{v_1+v_2}$ (d) $\frac{v_1^2 v_2^2}{v_1^2+v_2^2}$

6. A car moves from X to Y with a uniform speed vu and returns to X with a uniform speed vd. The average speed for this round trip is

AIPMT 2007

(a) $\sqrt{v_u v_d}$ (b) $\frac{v_d v_u}{v_d+v_u}$ (c) $\frac{v_u+v_d}{2}$ (d) $\frac{2v_d v_u}{v_d+v_u}$

7. A car moves a distance of 200 m. It covers the first half of the distance at speed 40 km/h and the second half of distance at speed v. The average speed is 48 km/h. The value of v is

AIPMT 1991

(a) 56 km/h (b) 60 km/h (c) 50 km/h (d) 48 km/h

8. A bus travelling the first one-third distance at a speed of 10 km/h, the next one-third at 20 km/h and at last one-third at 60 km/h. The average speed of the bus is

AIPMT 1991

(a) 9 km/h (b) 16 km/h (c) 18 km/h (d) 48 km/h

9. A car covers the first half of the distance between two places at 40 km/h and another half at 60 km/h. The average speed of the car is

AIPMT 1990

(a) 40 km/h (b) 48 km/h (c) 50 km/h (d) 60 km/h

10. A person travels x distance with velocity v_1 and then x distance with velocity v_2 in the same direction. The average velocity of the person is v, then the relation between v, v_1 and v_2 will be.

JEE MAIN 2023 · 10 APR · SHIFT 2

(a) $\mathbf{V} = \mathbf{V}_1 + \mathbf{V}_2$ (b) $V = \frac{v_1+V_2}{2}$
(c) $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2}$ (d) $\frac{2}{V} = \frac{1}{v_1} + \frac{1}{v_2}$

11. A vehicle travels 4 km with speed of 3 km/h and another 4 km with speed of 5 km/h, then its average speed is

JEE MAIN 2023 · 30 JAN · SHIFT 2

(a) 3.75 km/h (b) 4.25 km/h
(c) 3.50 km/h (d) 4.00 km/h

12. A car travels a distance of 'x' with speed v_1 and then same distance 'x' with speed v_2 in the same direction. The average speed of the car is:

JEE MAIN 2023 · 25 JAN · SHIFT 1

(a) $\frac{v_1 v_2}{2(v_1+v_2)}$ (b) $\frac{2v_1 v_2}{v_1+v_2}$ (c) $\frac{2x}{v_1+v_2}$ (d) $\frac{v_1+v_2}{2}$

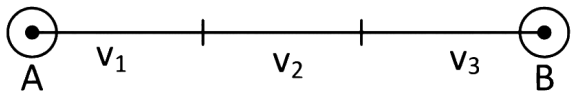
13. A person travelling on a straight line moves with a uniform velocity v_1 for a distance x and with a uniform velocity v_2 for the next $\frac{3}{2}x$ distance. The average velocity in this motion is $\frac{50}{7}$ m/s. If v_1 is 5 m/s then v_2 = _____ m/s.

JEE MAIN 2025 · 2 APR · SHIFT 1 *(Numerical)*

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14. A car covers AB distance with first one-third at velocity v1 ms^{-}1, second one-third at v2 ms^{-1} and last one-third at v3 ms^{-}1. If v3 = 3v1, v2 = 2v1 and v1 = 11 ms^{-1} then the average velocity of the car is _____ ms^{-}1.

JEE MAIN 2022 · 28 JUN · SHIFT 2 *(Numerical)*



◆ Average velocity vs average speed 1 Q

15. A car runs at a constant speed on a circular track of radius 100 m, taking 62.8 seconds for every circular lap. The average velocity and average speed for each circular lap respectively is

AIPMT 2006

(a) 10 m/s, 0 (b) 0, 0
(c) 0, 10 m/s (d) 10 m/s, 10 m/s.

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TOPIC 02

Velocity, Acceleration & Variable Motion

25 PYQs · Easy 25 · Medium 0 · Difficult 0 | MHT CET 4 · NEET 8 · JEE 13

Concepts covered: Speed, velocity & acceleration: concepts (1) · x(t) given: find v and a (19) · t(x) or v(x) given: a = v dv/dx (1) · Variable acceleration: integration (4)

LEVEL 1 · EASY 25 questions

◆ Speed, velocity & acceleration: concepts 1 Q

1. Which one of the following statements is Wrong?

MHT CET 2023 · 13 MAY · SHIFT 1

(a) A body can have zero velocity and still be accelerated.
(b) A body can have a constant velocity and still have a varying speed.
(c) A body can have a constant speed and still have a varying velocity.
(d) The direction of the velocity of a body can change when its acceleration is constant.

◆ x(t) given: find v and a 19 Qs

2. Two cars start from a point at the same time in a straight line and their positions are represented by $x_1(t) = at + bt^2$ and $x_2(t) = Ft - t^2$. At what time do the cars have the same velocity?

MHT CET 2024 · 11 MAY · SHIFT 2

(a) $\frac{a+F}{2(b-1)}$ (b) $\frac{a-F}{1+b}$ (c) $\frac{a+F}{2(1+b)}$ (d) $\frac{F-a}{2(1+b)}$

3. The position 'x' of a particle varies with a time as $x = at^2 - bt^3$ where 'a' and 'b' are constants. The acceleration of the particle will be zero at

MHT CET 2023 · 14 MAY · SHIFT 2

(a) $\frac{2a}{3b}$ (b) $\frac{a}{b}$ (c) $\frac{}{3b}{}^{a}$ (d) zero

4. Two cars A and B start from a point at the same time in a straight line and their positions are represented by $R_A(t) = at + bt^2$ and $R_B(t) = xt - t^2$. At what time do the cars have same velocity?

MHT CET 2023 · 11 MAY · SHIFT 2

(a) $\frac{x-a}{2(b+1)}$ (b) $\frac{x+a}{2(b-1)}$ (c) $\frac{x-a}{(b+1)}$ (d) $\frac{x+a}{(b-1)}$

5. A particle is moving along x-axis with its position (x) varying with time (t) as $x = \alpha t^4 + \beta t^2 + \gamma t + \delta$. The ratio of its initial velocity to its initial acceleration, respectively, is:

NEET 2024

(a) $2\alpha : \delta$ (b) $\gamma : 2\delta$ (c) $4\alpha : \beta$ (d) $\gamma : 2\beta$

6. The position of a particle is given by $\vec{r}(t) = 4t\hat{i} + 2t^2\hat{j} + 5\hat{k}$ where t is in seconds and r in metre. Find the magnitude and direction of velocity $v(t)$, at $t = 1$ s, with respect to x-axis

NEET 2023

(a) $4\sqrt{2}\ \text{ms}^{-1}, 45^\circ$ (b) $4\sqrt{2}\ \text{ms}^{-1}, 60^\circ$
(c) $3\sqrt{2}\ \text{ms}^{-1}, 30^\circ$ (d) $3\sqrt{2}\ \text{ms}^{-1}, 45^\circ$

7. Two cars P and Q start from a point at the same time in a straight line and their positions are represented by xP(t) = (at + bt2) and xQ(t) = (ft – t2). At what time do the cars have the same velocity?

NEET 2016 · PHASE 2

(a) $\frac{a-f}{1+b}$ (b) $\frac{a+f}{2(b-1)}$ (c) $\frac{a+f}{2(1+b)}$ (d) $\frac{f-a}{2(1+b)}$

8. The motion of a particle along a straight line is described by equation x = 8 + 12t – t3 where x is in metre and t in second. The retardation of the particle when its velocity becomes zero is

AIPMT 2012 · PRELIMS

(a) 24 m s−2 (b) zero
(c) 6 m s−2 (d) 12 m s−2

9. Motion of a particle is given by equation s = (3t3 + 7t2 + 14t + 8) m. The value of acceleration of the particle at t = 1 sec is

AIPMT 2000

(a) 10 m/s2 (b) 32 m/s2 (c) 23 m/s2 (d) 16 m/s2

10. The position x of a particle varies with time (t) as $x = at^2 - bt^3$. The acceleration will be zero at time t is equal to

AIPMT 1997

(a) $\frac{a}{3b}$ (b) zero (c) $\frac{2a}{3b}$ (d) $\frac{a}{b}$

11. A particle moves along a straight line such that its displacement at any time t is given by $s = (t^3 - 6t^2 + 3t + 4)$ metres. The velocity when the acceleration is zero is

AIPMT 1994

(a) 3 m/s (b) 42 m/s (c) −9 m/s (d) −15 m/s

12. A particle is moving in a straight line. The variation of position 'x' as a function of time 't' is given as $x = (t^3 - 6t^2 + 20t + 15)m$. The velocity of the body when its acceleration becomes zero is:

JEE MAIN 2024 · 29 JAN · SHIFT 2

(a) 6 m/s (b) 10 m/s (c) 8 m/s (d) 4 m/s

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13. The position of a particle related to time is given by $x = (5t^2 - 4t + 5)\text{m}$. The magnitude of velocity of the particle at $t = 2s$ will be:
JEE MAIN 2023 · 15 APR · SHIFT 1
(a) $14\ \text{ms}^{-1}$ (b) $16\ \text{ms}^{-1}$ (c) $10\ \text{ms}^{-1}$ (d) $06\ \text{ms}^{-1}$

14. The distance travelled by an object in time t is given by $s = (2.5)t^2$. The instantaneous speed of the object at t = 5 s will be:
JEE MAIN 2023 · 13 APR · SHIFT 2
(a) $5\ \text{ms}^{-1}$ (b) $12.5\ \text{ms}^{-1}$
(c) $62.5\ \text{ms}^{-1}$ (d) $25\ \text{ms}^{-1}$

15. The distance travelled by a particle is related to time t as $x = 4\text{t}^2$. The velocity of the particle at t=5s is :-
JEE MAIN 2023 · 25 JAN · SHIFT 2
(a) $25\ \text{ms}^{-1}$ (b) $20\ \text{ms}^{-1}$ (c) $8\ \text{ms}^{-1}$ (d) $40\ \text{ms}^{-1}$

16. Two buses P and Q start from a point at the same time and move in a straight line and their positions are represented by $X_P(t) = \alpha t + \beta t^2$ and $X_Q(t) = ft - t^2$. At what time, both the buses have same velocity?
JEE MAIN 2022 · 25 JUN · SHIFT 2
(a) $\frac{\alpha - f}{1+\beta}$ (b) $\frac{\alpha+f}{2(\beta-1)}$ (c) $\frac{\alpha+f}{2(1+\beta)}$ (d) $\frac{f-\alpha}{2(1+\beta)}$

17. The position of a particle as a function of time t, is given by
x(t) = at + bt2 – ct3
where a, b and c are constants. When the particle attains zero acceleration, then its velocity will be:
JEE MAIN 2019 · 9 APR · SHIFT 2
(a) $a + \frac{b^2}{c}$ (b) $a + \frac{b^2}{4c}$ (c) $a + \frac{b^2}{3c}$ (d) $a + \frac{b^2}{2c}$

18. The position vector of a particle changes with time according to the relation
$\vec{r}(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$
What is the magnitude of the acceleration at t = 1?
JEE MAIN 2019 · 9 APR · SHIFT 2
(a) 50 (b) 25 (c) 40 (d) 100

19. The co-ordinates of a moving particle at any time 't' are given by x = αt3 and y = βt3. The speed of the particle at time 't' is given by
AIEEE 2003
(a) $3t\sqrt{\alpha^2 + \beta^2}$ (b) $3t^2\sqrt{\alpha^2 + \beta^2}$
(c) $t^2\sqrt{\alpha^2 + \beta^2}$ (d) $\sqrt{\alpha^2 + \beta^2}$

20. A particle is moving in one dimension (along x axis) under the action of a variable force. Its initial position was 16 m right of origin. The variation of its position (x) with time (t) is given as $x = -3t^3 + 18t^2 + 16t$, where x is in m and t is in s.
The velocity of the particle when its acceleration becomes zero is _____ m/s.
JEE MAIN 2024 · 1 FEB · SHIFT 1 *(Numerical)*

◆ t(x) or v(x) given: a = v dv/dx 1 Q

21. A particle is moving in a straight line such that its velocity is increasing at 5 ms^{-1} per meter. The acceleration of the particle is _____ ms^{-2} at a point where its velocity is 20 $\text{ms}^{-}1$.
JEE MAIN 2022 · 25 JUL · SHIFT 2 *(Numerical)*

◆ Variable acceleration: integration 4 Qs

22. If the velocity of a particle is v = At + Bt2, where A and B are constants, then the distance travelled by it between 1 s and 2 s is
NEET 2016 · PHASE 1
(a) $\frac{3}{2}A + \frac{7}{3}B$ (b) $\frac{A}{2} + \frac{B}{3}$
(c) $\frac{3}{2}A + 4B$ (d) $3A + 7B$

23. The instantaneous velocity of a particle moving in a straight line is given as $V = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between 1s and 2s is:
JEE MAIN 2021 · 25 JUL · SHIFT 2
(a) $3\alpha + 7\beta$ (b) $\frac{3}{2}\alpha + \frac{7}{3}\beta$
(c) $\frac{\alpha}{2} + \frac{\beta}{3}$ (d) $\frac{3}{2}\alpha + \frac{7}{2}\beta$

24. The velocity of a particle is v = v0 + gt + Ft2. Its position is x = 0 at t = 0; then its displacement after time (t = 1) is:
JEE MAIN 2021 · 17 MAR · SHIFT 2
(a) v0 + g + f (b) $\text{v0} + \frac{g}{2} + \frac{F}{3}$
(c) v0 + 2g + 3F (d) $\text{v0} + \frac{g}{2} + \text{F}$

25. The velocity of a particle is v = v0 + gt + ft2. If its position is x = 0 at t = 0, then its displacement after unit time (t = 1) is
AIEEE 2007
(a) v0 + g/2 + f (b) v0 + 2g + 3f
(c) v0 + g/2 + f/3 (d) v0 + g + f

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TOPIC 03

Graphs of Motion

24 PYQs · Easy 24 · Medium 0 · Difficult 0 | MHT CET 6 · NEET 5 · JEE 13

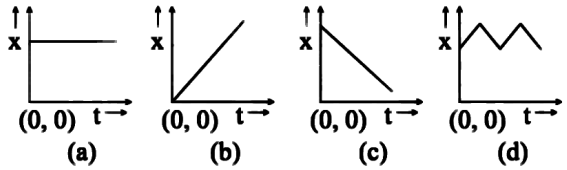
Concepts covered: Position-time graphs (5) · Velocity-time graphs: distance & displacement (10) · Velocity-time graphs: slope, a-t graphs (5) · Identifying and matching graphs (3) · Velocity-displacement graphs (1)

LEVEL 1 · EASY 24 questions

◆ Position-time graphs 5 Qs

1. The following figures show the variation of displacement with time of a particular object.

MHT CET 2024 · 9 MAY · SHIFT 2



(a) Figure (a) and (b) show object at rest and object moving with uniform velocity in positive x direction respectively.

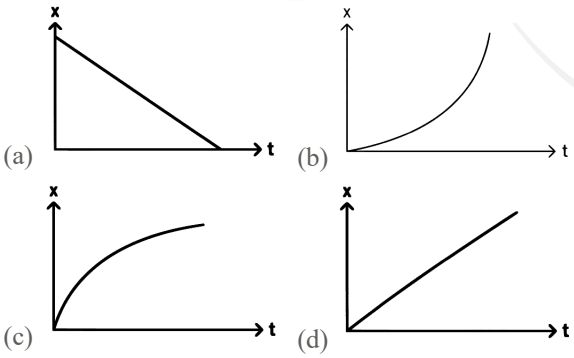
(b) Figure (b) and (c) show object at rest and object moving with uniform velocity in negative x direction respectively.

(c) Figure (c) and (d) show object at rest and object moving with uniform velocity in negative x direction respectively.

(d) Figure (a) and (b) show object at rest.

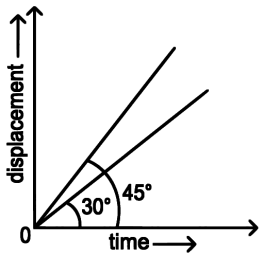
2. The position-time (x - t) graph for positive acceleration is

NEET 2022 · PHASE 2



3. The displacement-time graphs of two moving particles make angles of 30° and 45° with the x-axis as shown in the figure. The ratio of their respective velocity is

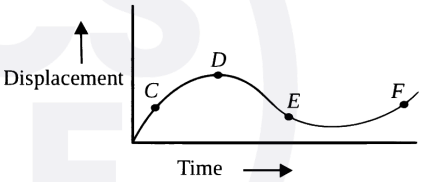
NEET 2022 · PHASE 1



(a) $\sqrt{3}$: 1 (b) 1: 1 (c) 1: 2 (d) 1: $\sqrt{3}$

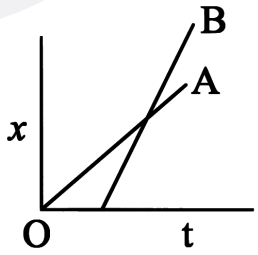
4. The displacement-time graph of a moving particle is shown below. The instantaneous velocity of the particle is negative at the point

AIPMT 1994



(a) E (b) F (c) C (d) D

5. The position-time graphs for two students A and B returning from the school to their homes are shown in figure.



(A) A lives closer to the school

(B) B lives closer to the school

(C) A takes lesser time to reach home

(D) A travels faster than B

(E) B travels faster than A

Choose the correct answer from the options given below:

JEE MAIN 2023 · 10 APR · SHIFT 1

(a) (A), (C) and (D) only (b) (A) and (E) only

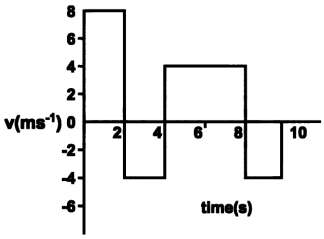
(c) (A), (C) and (E) only (d) (B) and (E) only

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◆ Velocity-time graphs: distance & displacement 10 Qs

6. The velocity time graph of a body moving in a straight line is shown in a figure. The ratio of displacement to distance travelled by the body in time 0 to 10 s is

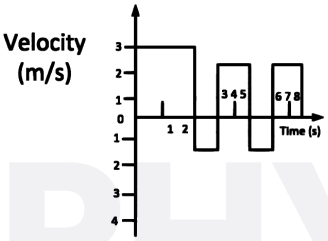
MHT CET 2026 · 13 APR · SHIFT 2



(a) 1 : 1 (b) 1 : 4 (c) 1 : 2 (d) 1 : 3

7. The velocity time graph of a body moving in a straight line is shown in figure. The ratio of displacement to distance travelled by the body in time 0 to 8 s is

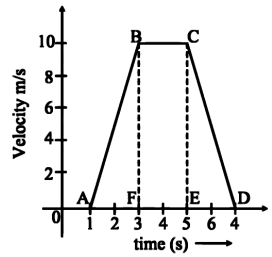
MHT CET 2025 · 21 APR · SHIFT 1



(a) 8 : 5 (b) 3 : 5 (c) 5 : 9 (d) 7 : 4

8. For the velocity-time graph shown in the figure below, the distance covered by the body in last two second of its motion is ' S_1 '. What is the ratio of ' S_1 ' to the total distance covered by it

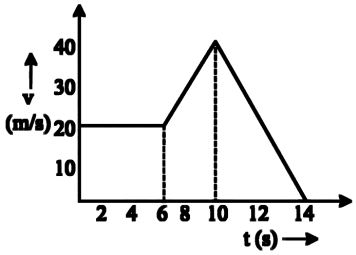
MHT CET 2024 · 11 MAY · SHIFT 1



(a) $\frac{1}{2}$ (b) $\frac{1}{4}$ (c) $\frac{1}{3}$ (d) $\frac{2}{3}$

9. A velocity - time graph of a body is shown below. The distance covered by the body from 6 second to 9 second is

MHT CET 2024 · 9 MAY · SHIFT 1

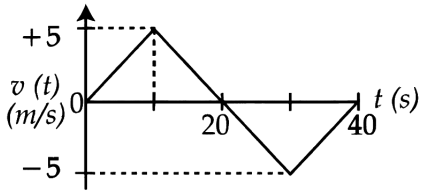


(a) 22.5 m (b) 90.0 m (c) 82.5 m (d) 120.0 m

10. The velocity (v) versus time (t) plot of a particle is shown in the figure, for a time interval of 40 s. The total distance travelled by the particle and the average velocity during this period are, respectively

____.

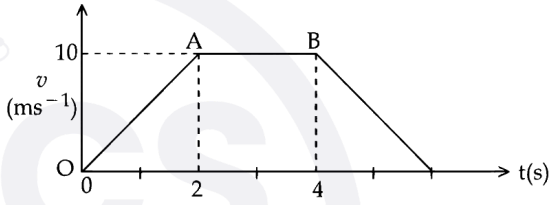
JEE MAIN 2026 · 5 APR · SHIFT 2



(a) 25 m and zero (b) 50 m and zero
(c) 100 m and zero (d) 100 m and 2.5 m/s

11. The velocity-time graph of an object moving along a straight line is shown in the figure. What is the distance covered by the object between $t = 0$ to $t = 4s$?

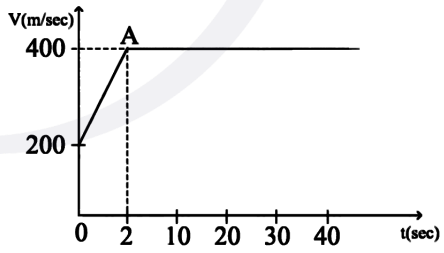
JEE MAIN 2025 · 28 JAN · SHIFT 2



(a) 11 m (b) 30 m (c) 13 m (d) 10 m

12. The motion of an airplane is represented by velocity-time graph as shown below. The distance covered by airplane in the first 30.5 second is_____ km.

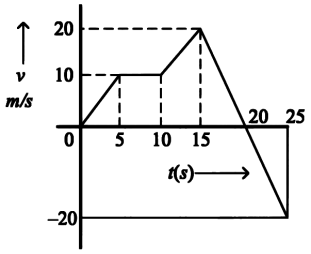
JEE MAIN 2025 · 23 JAN · SHIFT 1



(a) 12 (b) 6 (c) 3 (d) 9

13. From the v – t graph shown, the ratio of distance to displacement in 25 s of motion is:

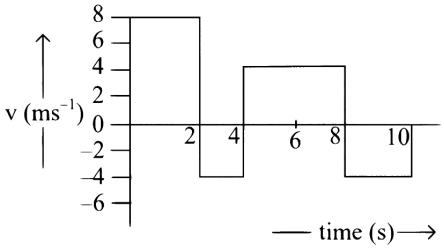
JEE MAIN 2023 · 11 APR · SHIFT 1



(a) 1 (b) $\frac{3}{5}$ (c) $\frac{1}{2}$ (d) $\frac{5}{3}$

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14. The velocity time graph of a body moving in a straight line is shown in the figure.



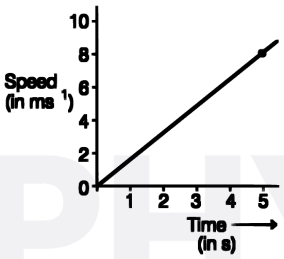
The ratio of displacement to distance travelled by the body in time 0 to 10s is:

JEE MAIN 2023 · 24 JAN · SHIFT 2

(a) 1: 1 (b) 1: 3 (c) 1: 4 (d) 1: 2

15. The speed versus time graph for a particle is shown in the figure. The distance travelled (in m) by the particle during the time interval t = 0 to t = 5 s will be_____.

JEE MAIN 2020 · 4 SEP · SHIFT 2 *(Numerical)*



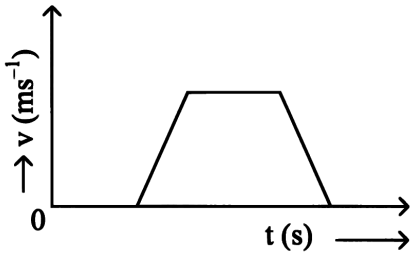
◆ Velocity-time graphs: slope, a-t graphs 5 Qs

16. The acceleration of a moving body can be found from

MHT CET 2024 · 2 MAY · SHIFT 1

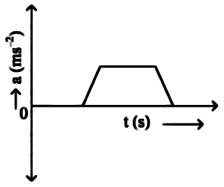
(a) area under velocity - time graph.
(b) area under distance - time graph.
(c) slope of the velocity - time graph.
(d) slope of the distance - time graph.

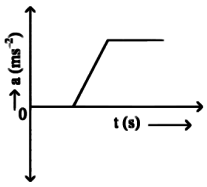
17. The velocity $(v)-$ time (t) plot of the motion of a body is shown below:

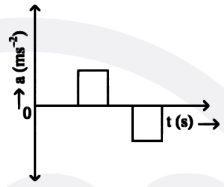


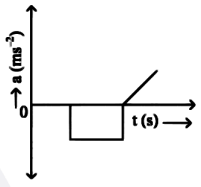
The acceleration $(a)-$ time (t) graph that best suits this motion is:

NEET 2024

(a)


(b)


(c)


(d)


18. Given below are two statements

Statement I: Area under velocity- time graph gives the distance travelled by the body in a given time.
Statement II: Area under acceleration- time graph is equal to the change in velocity in the given time.
In the light of given statements, choose the correct answer from the options given below.

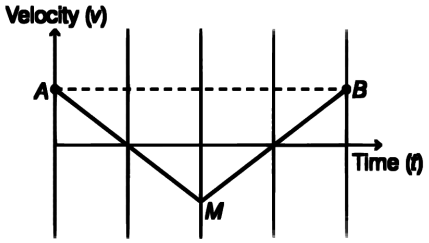
JEE MAIN 2023 · 8 APR · SHIFT 2

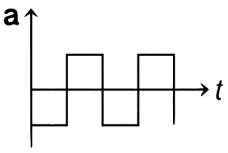
(a) Both Statement I and Statement II are False.
(b) Both Statement I and Statement II are true.
(c) Statement I is incorrect but Statement II is true.
(d) Statement I is correct but Statement II is false.

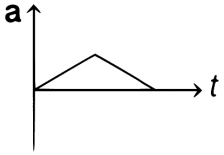
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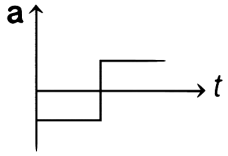
19. If the velocity-time graph has the shape AMB, what would be the shape of the corresponding acceleration-time graph?

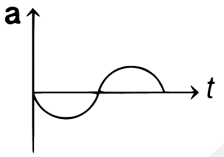
JEE MAIN 2021 · 24 FEB · SHIFT 1



(a) 

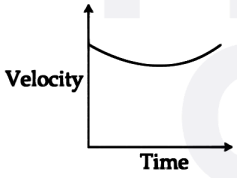
(b) 

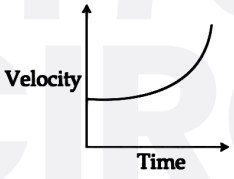
(c) 

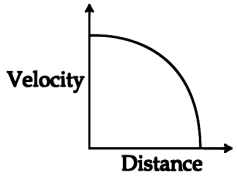
(d) 

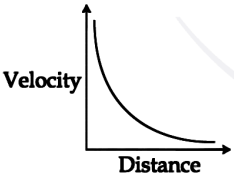
20. Which graph corresponds to an object moving with a constant negative acceleration and a positive velocity?

JEE MAIN 2017 · 8 APR · SHIFT 1

(a) 

(b) 

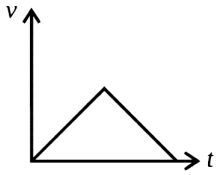
(c) 

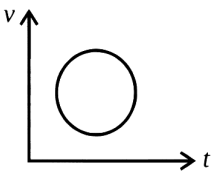
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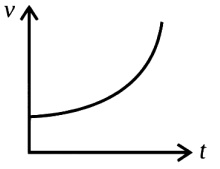
◆ Identifying and matching graphs 3 Qs

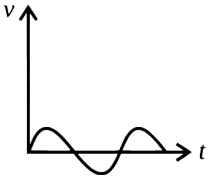
21. Which of the following curve does not represent motion in one dimension?

AIPMT 1992

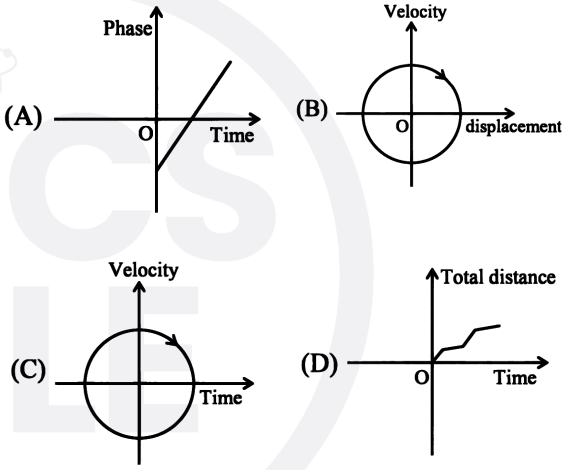
(a) 

(b) 

(c) 

(d) 

22. Which of the following curves possibly represent one-dimensional motion of a particle?



Choose the correct answer from the options given below:

JEE MAIN 2025 · 3 APR · SHIFT 1

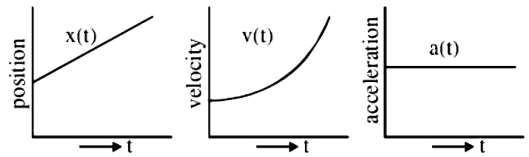
(a) A, B and C only
(b) A, C and D only
(c) A, B and D only
(d) A and B only

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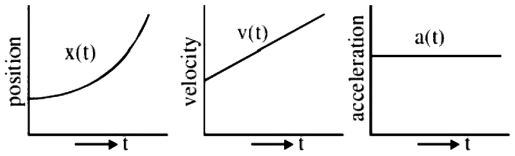
23. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by:

JEE MAIN 2021 · 18 MAR · SHIFT 1

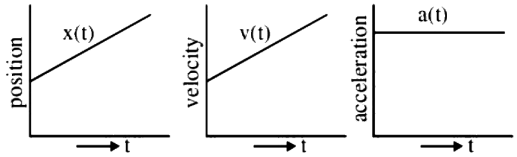
(a)



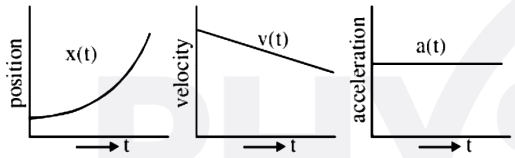
(b)



(c)



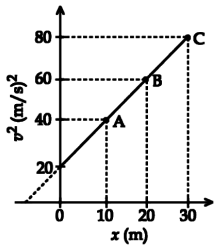
(d)



◆ Velocity-displacement graphs 1 Q

24. A particle is moving with constant acceleration 'a'. Following graph shows v2 versus x(displacement) plot. The acceleration of the particle is _____ m/s2.

JEE MAIN 2021 · 31 AUG · SHIFT 2 *(Numerical)*



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TOPIC 04

Equations of Kinematics

26 PYQs · Easy 26 · Medium 0 · Difficult 0 | MHT CET 4 · NEET 8 · JEE 14

Concepts covered: Equations of motion: direct use (7) · Stage motion & midpoint velocity (4) · Two bodies: meeting & chasing (5) · Stopping distance & penetration (7) · Distance in the nth second (3)

LEVEL 1 · EASY 26 questions

◆ Equations of motion: direct use 7 Qs

1. A moving body is covering distances which are proportional to square of the time. Then, the acceleration of the body is

MHT CET 2020 · 16 OCT · SHIFT 1

(a) zero (b) increasing
(c) constant but not zero (d) decreasing

2. A particle starts its motion from rest under the action of a constant force. If the distance covered in first 10 seconds is S1 and that covered in the first 20 seconds is S2, then

AIPMT 2009

(a) S2 = 3S1 (b) S2 = 4S1 (c) S2 = S1 (d) S2 = 2S1

3. A particle moves in a straight line with a constant acceleration. It changes its velocity from 10 ms^{-}1 to 20 ms^{-}1 while passing through a distance 135 m in t second. The value of t is

AIPMT 2008

(a) 12 (b) 9 (c) 10 (d) 1.8

4. If a car at rest accelerates uniformly to a speed of 144 km/h in 20 sec, it covers a distance of

AIPMT 1997

(a) 1440 cm (b) 2980 cm (c) 20 m (d) 400 m

5. The velocity of train increases uniformly from 20 km/h to 60 km/h in 4 hours. The distance travelled by the train during this period is

AIPMT 1994

(a) 160 km (b) 180 km (c) 100 km (d) 120 km

6. A particle starts with an initial velocity of $10.0\ \text{ms}^{-1}$ along x-direction and accelerates uniformly at the rate of $2.0\ \text{ms}^{-2}$. The time taken by the particle to reach the velocity of $60.0\ \text{ms}^{-1}$ is _____.

JEE MAIN 2023 · 6 APR · SHIFT 2

(a) 30s (b) 6s (c) 3s (d) 25s

7. A small toy starts moving from the position of rest under a constant acceleration. If it travels a distance of 10m in t s, the distance travelled by the toy in the next t s will be:

JEE MAIN 2022 · 29 JUN · SHIFT 2

(a) 10 m (b) 20 m (c) 30 m (d) 40 m

◆ Stage motion & midpoint velocity 4 Qs

8. A body travelling with uniform acceleration crosses two points A and B with velocities 20 m/s and 30 m/s respectively. The speed of the body at mid point of A and B is (nearly)

MHT CET 2024 · 16 MAY · SHIFT 2

(a) 25 m/s (b) 25.5 m/s
(c) 24 m/s (d) $10\sqrt{6}$ m/s

9. A car is moving along a straight road with a uniform acceleration. It passes through two points P and Q separated by a distance with velocity 30 km/h and 40 km/h respectively. The velocity of the car midway between P and Q is

AIPMT 1988

(a) 33.3 km/h (b) $20\sqrt{2}$ km/h
(c) $25\sqrt{2}$ km/h (d) 35 km/h

10. A scooter accelerates from rest for time t1 at constant rate a1 and then retards at constant rate a2 for time t2 and comes to rest. The correct value of $\frac{t_1}{t_2}$ will be:

JEE MAIN 2021 · 26 FEB · SHIFT 2

(a) $\frac{a_1+a_2}{a_2}$ (b) $\frac{a_1+a_2}{a_1}$ (c) $\frac{a_2}{a_1}$ (d) $\frac{a_1}{a_2}$

11. An engine of a train, moving with uniform acceleration, passes the signal-post with velocity u and the last compartment with velocity v. The velocity with which middle point of the train passes the signal post is:

JEE MAIN 2021 · 25 FEB · SHIFT 1

(a) $\frac{u+v}{2}$ (b) $\sqrt{\frac{v^2-u^2}{2}}$ (c) $\frac{v-u}{2}$ (d) $\sqrt{\frac{v^2+u^2}{2}}$

◆ Two bodies: meeting & chasing 5 Qs

12. Two bodies A and B start from the same point at the same instant and move along a straight line. Body A moves with uniform acceleration a and body B moves with uniform velocity v. They meet after time t. The value of t is

MHT CET 2023 · 13 MAY · SHIFT 2

(a) $\frac{2v}{a}$ (b) $\frac{a}{2v}$ (c) $\frac{v}{2a}$ (d) $\sqrt{\frac{v}{a}}$

13. Two bodies 'A' and 'B' start from the same point at the same instant and move along a straight line. 'A' moves with uniform acceleration (a) and 'B' moves with uniform velocity (V). They meet after time 't'. The value of 't' is

MHT CET 2021 · 20 SEP · SHIFT 1

(a) $\frac{2\,V}{a}$ (b) $\sqrt{\frac{V}{a}}$ (c) $\frac{a}{2\,V}$ (d) $\frac{V}{2a}$

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14. Two cars are travelling towards each other at speed of $20\ \mathrm{m\,s^{-1}}$ each. When the cars are $300\ \mathrm{m}$ apart, both the drivers apply brakes and the cars retard at the rate of $2\ \mathrm{m\,s^{-2}}$. The distance between them when they come to rest is:

JEE MAIN 2024 · 9 APR · SHIFT 2

(a) 25 m (b) 100 m (c) 50 m (d) 200 m

15. Two trucks A and B are approaching each other on a straight path with the velocities of $16\ \mathrm{m/s}$ and $20\ \mathrm{m/s}$ respectively. When they are $200\ \mathrm{m}$ apart their drivers see each other and applies the breaks simultaneously. If the truck A decelerates with $2\ \mathrm{m/s^2}$ and truck B decelerates with $4\ \mathrm{m/s^2}$, what is the distance between them when they finally stop?

JEE MAIN 2022 · 30 JUL · SHIFT 2

(a) 14 m (b) 114 m (c) 86 m (d) 64 m

16. A car is standing 200 m behind a bus, which is also at rest. The two start moving at the same instant but with different forward accelerations. The bus has acceleration 2 m/s2 and the car has acceleration 4 m/s2. The car will catch up with the bus after a time of:

JEE MAIN 2017 · 9 APR · SHIFT 1

(a) $\sqrt{110}\ s$ (b) $\sqrt{120}\ s$ (c) $10\sqrt{2}\ s$ (d) 15 s

◆ Stopping distance & penetration 7 Qs

17. A car moving with a speed of $40\ \mathrm{km/h}$ can be stopped by applying brakes after atleast $2\ \mathrm{m}$. If the same car is moving with a speed of $80\ \mathrm{km/h}$, what is the minimum stopping distance?

AIPMT 1998

(a) 8 m (b) 2 m (c) 4 m (d) 6 m

18. An automobile, travelling at 40 km/h, can be stopped at a distance of 40 m by applying brakes. If the same automobile is travelling at 80 km/h, the minimum stopping distance, in metres, is (assume no skidding):

JEE MAIN 2018 · 15 APR · SHIFT 1

(a) 45 m (b) 100 m (c) 150 m (d) 160 m

19. An automobile travelling with speed of 60 km/h, can brake to stop within a distance of 20 m. If the car is going twice as fast, i.e 120 km/h, the stopping distance will be

AIEEE 2004

(a) 60 m (b) 40 m (c) 20 m (d) 80 m

20. A car, moving with a speed of 50 km/hr, can be stopped by brakes after at least 6 m. If the same car is moving at a speed of 100 km/hr, the minimum stopping distance is

AIEEE 2003

(a) 12 m (b) 18 m (c) 24 m (d) 6 m

21. Speeds of two identical cars are u and $4u$ at the specific instant. The ratio of the respective distances in which the two cars are stopped from that instant is:

AIEEE 2002

(a) 1 : 1 (b) 1 : 4 (c) 1 : 8 (d) 1 : 16

22. A bus moving along a straight highway with speed of $72\ \mathrm{km/h}$ is brought to a halt within $4s$ after applying the brakes. The distance travelled by the bus during this time (Assume the retardation is uniform) is _____ m.

JEE MAIN 2024 · 4 APR · SHIFT 2 *(Numerical)*

23. A car is moving with speed of $150\ \mathrm{km/h}$ and after applying the brake it will move $27\ \mathrm{m}$ before it stops. If the same car is moving with a speed of one third the reported speed then it will stop after travelling _____ m distance.

JEE MAIN 2022 · 25 JUL · SHIFT 1 *(Numerical)*

◆ Distance in the nth second 3 Qs

24. The distance travelled by a particle starting from rest and moving with an acceleration $\frac{4}{3}$ m s^{-}2, in the third second is

AIPMT 2008

(a) $\frac{10}{3}$ m (b) $\frac{19}{3}$ m (c) 6 m (d) 4 m

25. A body starts from rest, what is the ratio of the distance travelled by the body during the 4th and 3rd second?

AIPMT 1993

(a) $\frac{7}{5}$ (b) $\frac{5}{7}$ (c) $\frac{7}{3}$ (d) $\frac{3}{7}$

26. A body travels $102.5\ \mathrm{m}$ in n^{th} second and $115.0\ \mathrm{m}$ in $(\mathrm{n}+2)^{\mathrm{th}}$ second. The acceleration is:

JEE MAIN 2024 · 4 APR · SHIFT 1

(a) $6.25\ \mathrm{m/s^2}$ (b) $5\ \mathrm{m/s^2}$
(c) $12.5\ \mathrm{m/s^2}$ (d) $9\ \mathrm{m/s^2}$

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TOPIC 05

Motion Under Gravity

28 PYQs · Easy 28 · Medium 0 · Difficult 0 | MHT CET 6 · NEET 13 · JEE 9

Concepts covered: Free fall: h, t and v (15) · Drops & balls at regular intervals (3) · Thrown vertically: up, down, tower (7) · Two bodies under gravity (1) · Bounce & graphs under gravity (2)

LEVEL 1 · EASY 28 questions

◆ Free fall: h, t and v 15 Qs

1. A ball is released from the top of a tower of height Hm. It takes T second to reach the ground. The height of the ball from the ground after $\frac{T}{4}$ second is

MHT CET 2024 · 15 MAY · SHIFT 2

(a) $\frac{13H}{14}$ (b) $\frac{15H}{16}$ (c) $\frac{11H}{12}$ (d) $\frac{9H}{10}$

2. A body is released from the top of a tower 'H' metre high. It takes t second to reach the ground. The height of the body $\frac{t}{2}$ second after release is

MHT CET 2023 · 10 MAY · SHIFT 1

(a) $\frac{H}{2}$ metre from ground

(b) $\frac{H}{4}$ metre from ground

(c) $\frac{3H}{4}$ metre from ground

(d) $\frac{H}{6}$ metre from ground

3. A body at rest falls through a height 'h' with velocity 'V'. If it has to fall down further for its velocity to become three times, the distance travelled in that interval is

MHT CET 2021 · 21 SEP · SHIFT 2

(a) 8 h (b) 6 h (c) 4 h (d) 12 h

4. When a ruler falls vertically, 5 different persons catch it with different reaction times. ($g = 9.8\ \text{m s}^{-2}$)

A. Person A has reaction time of 0.20 s.

B. Person B has reaction time of 0.22 s.

C. Person C has reaction time of 0.18 s.

D. Person D has reaction time of 0.19 s.

E. Person E has reaction time of 0.21 s.

What is the correct order of the distance travelled by the ruler for each person?

NEET 2026

(a) B > E > A > C > D (b) C > D > A > B > E

(c) B > E > A > D > C (d) C > D > A > E > B

5. The ratio of the distances travelled by a freely falling body in the 1st, 2nd, 3rd and 4th second

NEET 2022 · PHASE 1

(a) 1: 2: 3: 4 (b) 1: 4: 9: 16

(c) 1: 3: 5: 7 (d) 1: 1: 1: 1

6. A person standing on the floor of an elevator drops a coin. The coin reaches the floor in time t_1 if the elevator is at rest and in time t_2 if the elevator is moving uniformly. Then

NEET 2019

(a) $t_1 = t_2$

(b) $t_1 < t_2$ or $t_1 > t_2$ depending upon whether the lift is going up or down

(c) $t_1 < t_2$

(d) $t_1 > t_2$

7. A stone falls freely under gravity. It covers distances h1, h2 and h3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h1, h2 and h3 is

NEET 2013

(a) h2 = 3h1 and h3 = 3h2 (b) h1 = h2 = h3

(c) h1 = 2h2 = 3h3 (d) $h_1 = \frac{h_2}{3} = \frac{h_3}{5}$

8. A boy standing at the top of a tower of 20 m height drops a stone. Assuming g = 10 m s^{-}2, the velocity with which it hits the ground is

AIPMT 2011 · PRELIMS

(a) 10.0 m/s (b) 20.0 m/s (c) 40.0 m/s (d) 5.0 m/s

9. Two bodies A (of mass 1 kg) and B (of mass 3 kg) are dropped from heights of 16 m and 25 m, respectively. The ratio of the time taken by them to reach the ground is

AIPMT 2006

(a) 4/5 (b) 5/4 (c) 12/5 (d) 5/12

10. A body dropped from a height h with initial velocity zero, strikes the ground with a velocity 3 m/s. Another body of same mass dropped from the same height h with an initial velocity of 4 m/s. The final velocity of second mass, with which it strikes the ground is

AIPMT 1996

(a) 5 m/s (b) 12 m/s (c) 3 m/s (d) 4 m/s

11. What will be the ratio of the distance moved by a freely falling body from rest in 4th and 5th seconds of journey?

AIPMT 1989

(a) 4: 5 (b) 7: 9 (c) 16: 25 (d) 1: 1

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12. An NCC parade is going at a uniform speed of $9\ \mathrm{km/h}$ under a mango tree on which a monkey is sitting at a height of $19.6\ \mathrm{m}$. At any particular instant, the monkey drops a mango. A cadet will receive the mango whose distance from the tree at time of drop is: (Given $g = 9.8\ \mathrm{m/s^2}$)

JEE MAIN 2022 · 28 JUL · SHIFT 1

(a) 5 m (b) 10 m (c) 19.8 m (d) 24.5 m

13. A ball is released from the top of a tower of height h meters. It takes T seconds to reach the ground. What is the position of the ball in $\frac{T}{3}$ seconds?

AIEEE 2004

(a) $\frac{8h}{9}$ meters from the ground

(b) $\frac{7h}{9}$ meters from the ground

(c) $\frac{h}{9}$ meters from the ground

(d) $\frac{7h}{18}$ meters from the ground

14. From 18 m height above the ground a ball is dropped from rest. The height above the ground at which the magnitude of velocity equal to the magnitude of acceleration (in the same set of units) due to gravity is ____ m.

(Take $g = 10\ \mathrm{m/s^2}$ and neglect the air resistance)

JEE MAIN 2026 · 5 APR · SHIFT 1 *(Numerical)*

15. A ball of mass 0.5 kg is dropped from the height of 10 m. The height, at which the magnitude of velocity becomes equal to the magnitude of acceleration due to gravity, is _____ m. [Use g = 10 m/s2]

JEE MAIN 2022 · 26 JUN · SHIFT 1 *(Numerical)*

◆ Drops & balls at regular intervals 3 Qs

16. A student is throwing balls vertically upwards such that he throws the 2^{nd} ball when the 1^{st} ball reaches maximum height. If he throws balls at an interval of 3 second, the maximum height of the balls is $\left(g = 10\frac{\mathrm{m}}{\mathrm{s^2}}\right)$

MHT CET 2021 · 23 SEP · SHIFT 1

(a) 45 m (b) 35 m (c) 25 m (d) 30 m

17. The water drop falls at regular intervals from a tap 5 m above the ground. The third drop is leaving the tap at instant the first drop touches the ground. How far above the ground is the second drop at that instant?

AIPMT 1995

(a) 3.75 m (b) 4.00 m (c) 1.25 m (d) 2.50 m

18. Water drops are falling from a nozzle of a shower onto the floor, from a height of 9.8 m. The drops fall at a regular interval of time. When the first drop strikes the floor, at that instant, the third drop begins to fall. Locate the position of second drop from the floor when the first drop strikes the floor.

JEE MAIN 2021 · 27 AUG · SHIFT 2

(a) 4.18 m (b) 2.94 m (c) 2.45 m (d) 7.35 m

◆ Thrown vertically: up, down, tower 7 Qs

19. A boy throws a ball vertically upwards from a bridge with velocity $5\ \mathrm{m/s}$. It strikes water surface after 2 s. The height of the bridge is (Take $g = 10\ \mathrm{m/s^2}$)

MHT CET 2025 · 26 APR · SHIFT 1

(a) 20 m (b) 15 m (c) 12 m (d) 10 m

20. A ball is thrown vertically downward with a velocity of 20 m/s from the top of a tower. It hits the ground after some time with a velocity of 80 m/s. The height of the tower is: (g = 10 m/s2)

NEET 2020 · PHASE 1

(a) 340 m (b) 320 m (c) 300 m (d) 360 m

21. A ball is thrown vertically upward. It has a speed of 10 m/sec when it has reached one half of its maximum height. How high does the ball rise?

(Take g = 10 m/s2.)

AIPMT 2005

(a) 10 m (b) 5 m (c) 15 m (d) 20 m

22. A particle is thrown vertically upward. Its velocity at half of the height is 10 m/s, then the maximum height attained by it (g = 10 m/s2)

AIPMT 2001

(a) 8 m (b) 20 m (c) 10 m (d) 16 m

23. A ball is thrown vertically upward with an initial velocity of $150\ \mathrm{m/s}$. The ratio of velocity after 3 s and 5 s is $\frac{x+1}{x}$. The value of x is _____.

$\{$ take, $g = 10\ \mathrm{m/s^2}\}$

JEE MAIN 2023 · 12 APR · SHIFT 1

(a) -5 (b) 10 (c) 5 (d) 6

24. From a building two balls A and B are thrown such that A is thrown upwards and B downwards (both vertically with the same speed). If vA and vB are their respective velocities on reaching the ground, then

AIEEE 2002

(a) $v_B > v_A$

(b) $v_A = v_B$

(c) $v_A > v_B$

(d) their velocities depend on their masses.

25. From the top of a tower, a ball is thrown vertically upward which reaches the ground in 6 s. A second ball thrown vertically downward from the same position with the same speed reaches the ground in 1.5 s. A third ball released, from the rest from the same location, will reach the ground in _____ s.

JEE MAIN 2022 · 24 JUN · SHIFT 1 *(Numerical)*

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◆ Two bodies under gravity 1 Q

26. A stone falls from the top of a tower of height 100 m and at the same time another stone is projected vertically upwards from the ground with a velocity 25 m/s. The two stones meet after

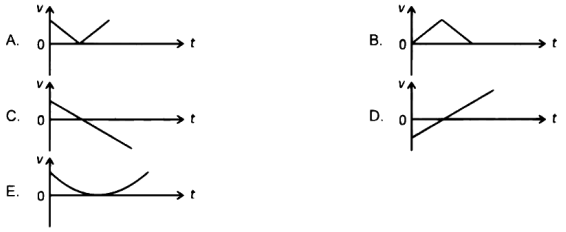
MHT CET 2026 · 15 APR · SHIFT 1

(a) 2 s (b) 5 s (c) 4 s (d) 3 s

◆ Bounce & graphs under gravity 2 Qs

27. The following plots show variation of velocity (v) with time (t) of a ball thrown vertically upward, and falling back. Which of the following plots is/are correct?

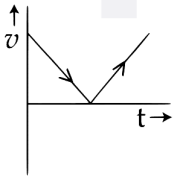
NEET 2026

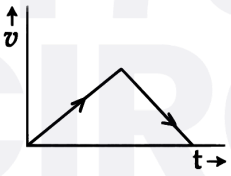


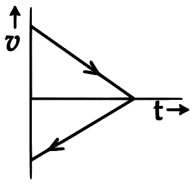
(a) C only (b) D only
(c) B only (d) A and E only

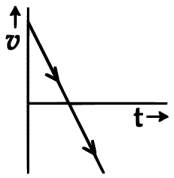
28. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time?

JEE MAIN 2017

(a) 

(b) 

(c) 

(d) 

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TOPIC 06

Relative Velocity

6 PYQs · Easy 6 · Medium 0 · Difficult 0 | MHT CET 1 · NEET 2 · JEE 3

Concepts covered: Relative velocity along a line (6)

LEVEL 1 · EASY 6 questions

1. Two trains, each $30\ \text{m}$ long are travelling in opposite directions with velocities $5\ \text{m/s}$ and $10\ \text{m/s}$. They will cross after

MHT CET 2023 · 10 MAY · SHIFT 2

(a) 4 s (b) 3 s (c) 2 s (d) 1 s

2. A bus is moving with a speed of 10 ms^{-}1 on a straight road. A scooterist wishes to overtake the bus in 100 s. If the bus is at a distance of 1 km from the scooterist, with what speed should the scooterist chase the bus?

AIPMT 2009

(a) 40 m s^{-}1 (b) 25 m s^{-}1
(c) 10 m s^{-}1 (d) 20 m s^{-}1

3. A train of 150 metre length is going towards north direction at a speed of 10 m/s. A parrot flies at the speed of 5 m/s towards south direction parallel to the railways track. The time taken by the parrot to cross the train is

AIPMT 1988

(a) 12 sec (b) 8 sec (c) 15 sec (d) 10 sec

4. Train A is moving along two parallel rail tracks towards north with speed $72\ \text{km/h}$ and train B is moving towards south with speed $108\ \text{km/h}$. Velocity of train B with respect to A and velocity of ground with respect to B are (in ms^{-1}):

JEE MAIN 2024 · 1 FEB · SHIFT 2

(a) -50 and -30 (b) -50 and 30
(c) -30 and 50 (d) 50 and -30

5. A passenger sitting in a train A moving at $90\ \text{km/h}$ observes another train B moving in the opposite direction for $8\ \text{s}$. If the velocity of the train B is $54\ \text{km/h}$, then length of train B is:

JEE MAIN 2023 · 13 APR · SHIFT 2

(a) 80 m (b) 200 m (c) 120 m (d) 320 m

6. Train A and train B are running on parallel tracks in the opposite directions with speeds of 36 km/hour and 72 km/hour, respectively. A person is walking in train A in the direction opposite to its motion with a speed of 1.8 km/ hour. Speed (in ms–1) of this person as observed from train B will be close to:
(take the distance between the tracks as negligible)

JEE MAIN 2020 · 2 SEP · SHIFT 1

(a) 30.5 ms–1 (b) 29.5 ms–1
(c) 31.5 ms–1 (d) 28.5 ms–1

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ANSWER KEY

Shaded by level: **Easy**

01 Distance, Displacement & Average Speed

1. (a)	2. (c)	3. (b)	4. (c)	5. (c)	6. (d)	7. (b)	8. (c)	9. (b)	10. (d)
11. (a)	12. (b)	13. 10	14. 18	15. (c)					

02 Velocity, Acceleration & Variable Motion

1. (b)	2. (d)	3. (c)	4. (a)	5. (d)	6. (a)	7. (d)	8. (d)	9. (b)	10. (a)
11. (c)	12. (c)	13. (b)	14. (d)	15. (d)	16. (d)	17. (c)	18. (a)	19. (b)	20. 52
21. 100	22. (a)	23. (b)	24. (b)	25. (c)					

03 Graphs of Motion

1. (a)	2. (b)	3. (d)	4. (a)	5. (b)	6. (d)	7. (c)	8. (b)	9. (c)	10. (c)
11. (b)	12. (a)	13. (d)	14. (b)	15. 20	16. (c)	17. (c)	18. (c)	19. (c)	20. (c)
21. (b)	22. (c)	23. (b)	24. 1						

04 Equations of Kinematics

1. (c)	2. (b)	3. (b)	4. (d)	5. (a)	6. (d)	7. (c)	8. (b)	9. (c)	10. (c)
11. (d)	12. (a)	13. (a)	14. (b)	15. (c)	16. (c)	17. (a)	18. (d)	19. (d)	20. (c)
21. (d)	22. 40	23. 3	24. (a)	25. (a)	26. (a)				

05 Motion Under Gravity

1. (b)	2. (c)	3. (a)	4. (c)	5. (c)	6. (a)	7. (d)	8. (b)	9. (a)	10. (a)
11. (b)	12. (a)	13. (a)	14. 13	15. 5	16. (a)	17. (a)	18. (d)	19. (d)	20. (c)
21. (a)	22. (c)	23. (c)	24. (b)	25. 3	26. (c)	27. (a)	28. (d)		

06 Relative Velocity

1. (a)	2. (d)	3. (d)	4. (b)	5. (d)	6. (b)				

Note: *"Bonus" = no option is correct as the question is printed (dropped in the official key). Numerical questions show the numerical answer.*

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