Talent & Olympiad

Motion

1. A particle is travelling with a constant speed. What does this mean?
(a) The position of the particle remains constant as time passes.
(b) The particle covers equal distances in equal time intervals.
(c) The acceleration of the particle is zero.
(d) The particle does not change its direction of motion.

2. A particle shows a value of 46.0 $m\ s^{-1}$. What can it be?
(a) Force of the particle
(b) Velocity of the particle
(c) Acceleration of the particle
(d) Momentum of the particle

3. The positions of a particle moving along a straight line are $x_1 = 50\ m$ at 10.30 a.m. and $x_2 = 55\ m$ m at 10.35 a.m. respectively. What is the displacement of the particle between 10.30 a.m. and 10.35 a.m.?
(a) 2 m
(b) 5 m
(c) 7 m
(d) 9 m

4. A car covers 30 km at a uniform speed of 60 $km\ h^{-1}$ and the next 30 km at a uniform speed of 40 $km\ h^{-1}$. Find the total time taken.
(a) 30 min (b) 45 min
(c) 75 min (d) 120 min

5. A particle moving with an initial velocity of 5 $m\ s^{-1}$ is subjected to a uniform acceleration of –2.5 $m\ s^{-2}$. Find the displacement in the next 4 seconds.
(a) 40 m
(b) 0 m
(c) 20 m
(d) 60 m

6. An insect moves along a circular path of radius 10 cm with a constant speed. If it takes 1 minute to move from a point on the path to the diametrically opposite point, then what is the distance it travels and average velocity of the insect respectively?
(a) 3.14 $cm(\text{min})^{-1}$, 20 $cm(\text{min})^{-1}$
(b) 31.4 $cm(\text{min})^{-1}$, 0.33 $cm\ s^{-1}$
(c) 0.314 $cm(\text{min})^{-1}$, 1 $cm(\text{min})^{-1}$
(d) 314 $cm(\text{min})^{-1}$, 0.1 $cm(\text{min})^{-1}$

7. If the distance travelled by a body in the second is given by $(4 + 6n)m$, then find the initial velocity and acceleration of the body respectively.
(a) 3 $m\ s^{-1}$, 6 $m\ s^{-2}$
(b) 7 $m\ s^{-1}$, 4 s^{-2}
(c) 7 $m\ s^{-1}$, 6 $m\ s^{-2}$
(d) 7 $m\ s^{-1}$, 3 $m\ s^{-2}$

8. The length of a minute hand of a clock is $4\ cm$. Find the displacement and the average velocity of the tip of the minute hand when it moves from 3.15 p.m. to 3.30 p.m.

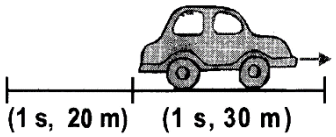
(a) $4\sqrt{2}cm,\ \frac{\sqrt{2}}{225}cm\ s^{-1}$

(b) $4\sqrt{2}cm,\ \frac{4}{225}cm$

(c) $2\sqrt{4}cm,\ \frac{1}{225}cm\ s^{-1}$

(d) $4\sqrt{2}cm,\ \frac{2}{225}cm\ s^{-1}$

9. A car moving on a road with uniform acceleration covers $20\ m$ in the first second and $30\ m$ in the next second.



What is its acceleration?

(a) $20\ m\ s^{-2}$ (b) $10\ m\ s^{-2}$

(c) $30\ m\ s^{-2}$ (d) $5\ m\ s^{-2}$

10. The velocity of a body is given by the equation $v = 6 - 0.02\ t$, where t is the time taken. What does the body undergo?

(a) Uniform retardation of $0.02\ m\ s^{-2}$

(b) Uniform acceleration of $0.02\ m\ s^{-2}$

(c) Uniform retardation of $-0.04\ m\ s^{-2}$

(d) Uniform acceleration of $-0.04\ m\ s^{-2}$

11. A race car accelerates uniformly from $18.5\ m\ s^{-1}$ to $46.1\ m\ s^{-1}$ in 2.47 seconds. What is the acceleration of the car?

(a) $11.2\ m\ s^{-2}$ (b) $12.3\ m\ s^{-2}$

(c) $14.5\ m\ s^{-2}$ (d) $16.7\ m\ s^{-2}$

12. A car covers the first half of the distance between two places at a speed of $40\ km\ h^{-1}$ and the second half at $60\ km\ h^{-1}$. Find the average speed of the car.

(a) $100\ km\ h^{-1}$ (b) $50\ km\ h^{-1}$

(c) $48\ km\ h^{-1}$ (d) $52\ km\ h^{-1}$

13. A particle is moving along a circular track of radius 1 m with uniform speed. Find the ratio of the distance covered and the displacement in half revolution.

(a) $1:1$ (b) $0:1$

(c) $\pi:1$ (d) $\pi:2$

14. A body travels $200\ cm$ in the first two seconds and $220\ cm$ in the next four seconds with constant acceleration. Find the velocity at the end of the seventh second from the start.

(a) $5\ cm\ s^{-1}$

(b) $10\ cm\ s^{-1}$

(c) $15\ cm\ s^{-1}$

(d) $20\ cm\ s^{-1}$

15. How do the directions of velocity and acceleration act when brakes are applied to a moving cycle?
(a) Opposite to each other
(b) In the same direction
(c) Perpendicular to each other
(d) Parallel to each other

16. A bus in motion increases its speed from $30\ km\ h^{-1}$ to $60\ km\ h^{-1}$ in 20 seconds. Find its acceleration.
(a) $0.21\ m\ s^{-2}$
(b) $0.42\ m\ s^{-2}$
(c) $0.63\ m\ s^{-2}$
(d) $0.84\ m\ s^{-2}$

17. An insect moves along the sides of a wall of dimensions $12\ m \times 5\ m$ starting from one corner and reaches the diagonally opposite corner in $2\ s$ .Find the ratio of the average speed to the average velocity of the insect.
(a) 17 : 13 (b) 12 : 5
(c) 13 : 5 (d) 17 : 12

18. An airplane accelerates down a runway at $3.2\ m\ s^{-2}$ for $32.8\ s$ until it finally lifts off the ground. Determine the distance travelled before take-off.
(a) 1323 m (b) 1527 m
(c) 1721 m (d) 1931 m

19. Which of the following shows the direction of the motion of a body?
(a) Velocity (b) Acceleration
(c) Speed (d) Both (a) and (b)

20. A train covers equal displacements in equal intervals of time. Which of the following does it *NOT* exhibit?
(a) Uniform acceleration
(b) Uniform speed
(c) Uniform velocity
(d) None of the above

21. When will a body have zero speed?
(a) When a body has uniform acceleration
(b) When a body has non-uniform acceleration
(c) When a body is always under rest
(d) When a body is always under motion

22. Match the entries in Column-I with those in Column-II.

	Column-I		**Column-II**
a.	Speed	1.	cm
b.	Acceleration	2.	s
c.	Displacement	3.	$m\ s^{-1}$
d.	Time	4.	$km\ h^{-2}$

(a) a - 2, b - 1, c - 4, d - 3
(b) a - 3, b - 4, c - 1, d - 2
(c) a - 4, b - 2, c - 3, d - 1
(d) a - 3, b - 2, c - 2, d - 1

23. What is the acceleration of a particle moving with uniform velocity?

(a) $1\ m\ s^{-2}$ (b) $2\ m\ s^{-2}$

(c) 0 (d) $\propto$

24-25: Questions 24 and 25 are based on the information given below.

A space shuttle is launched into space. During the first 8 minutes of its launch the average acceleration of the shuttle is $17.5\ m\ s^{-2}$.

24. What is its speed after 8 minutes?

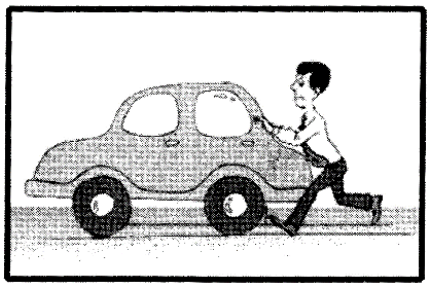
(a) $8000\ m\ s^{-1}$

(b) $8400\ m\ s^{-1}$

(c) $1200\ m\ s^{-1}$

(d) $1500\ m\ s^{-1}$

25. Ram's car does not start, so his friend helps him by pushing it for 10 seconds after which the car reaches a speed of $2\ m\ s^{-1}$.



Calculate the acceleration of the car.

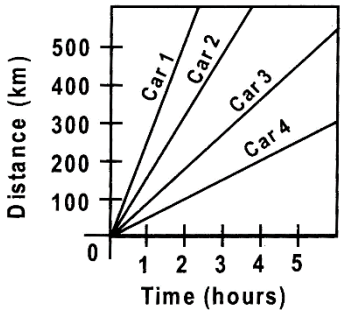
(a) $20\ m\ s^{-2}$

(b) $0.2\ m\ s^{-2}$

(c) $5\ m\ s^{-2}$

(d) $10\ m\ s^{-2}$

26. The graph below shows the distance travelled and the time taken by four cars.



Which car travelled the slowest?

(a) Car 1

(b) Car 2

(c) Car 3

(d) Car 4

27. The motion of the earth around the sun once in a year requires some force of attraction between them. What is the centripetal force acting between them?
(a) Gravitational force
(b) Weight of the sun
(c) Weight of the earth
(d) Density of the earth

28. The two ends of a train moving with uniform acceleration pass a certain point with velocities $6\ kmph$ and $8\ kmph$ respectively. What is the velocity with which the middle point of the train passes the same point?
(a) $14\ kmph$ (b) $5\ kmph$
(c) $10\sqrt{2} kmph$ (d) $10\ kmph$

29. How far does the space shuttle travel in the first 8 minutes?
(a) $8,000\ m$ (b) $80,000\ m$
(c) $2,016\ km$ (d) $2,600\ km$

30. What does the area of an 'acceleration- displacement' graph represent?
(a) Distance
(b) Velocity
(c) $\frac{v^2 - u^2}{2}$
(d) $\frac{v - u}{t}$

31. A For a moving particle, what does decrease in displacement with time mean?
(a) The particle is moving towards its initial position.
(b) The acceleration of the particle is approaching zero.
(c) The particle is moving with uniform speed.
(d) The particle is moving with non-uniform motion.

32. A car starts from rest and accelerates uniformly over a time of 5.21 seconds for a distance of $110\ m$. Determine the acceleration of the car.
(a) $6.10\ m\ s^{-2}$
(b) $8.10\ m\ s^{-2}$
(c) $10.10\ m\ s^{-2}$
(d) $12.10\ m\ s^{-2}$

33. The distance-time graphs of two cyclists moving along a straight line, meet at a point. What can be inferred from this?
(a) They collide.
(b) They move with the same speed.
(c) They are at rest.
(d) They start from rest.

34. A particle is pushed along a horizontal surface in such a way that it starts with a velocity of $12\ m\ s^{-1}$, and decreases at the rate of $0.5\ m\ s^{-2}$. Find the time it will take to come to rest.
(a) $6s$
(b) $12s$
(c) $24s$
(d) $48s$

35. A bike accelerates uniformly from rest to a speed of $7.10\ m\ s^{-1}$ over a distance of $35.4\ m$. Determine the acceleration of the bike.

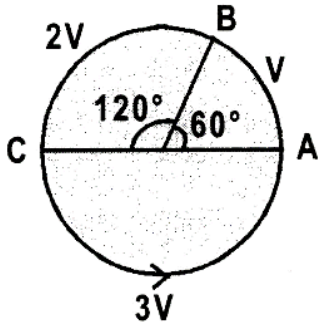
(a) $0.412\ m\ s^{-2}$

(b) $0.512\ m\ s^{-2}$

(c) $0.612\ m\ s^{-2}$

(d) $0.712\ m\ s^{-2}$

36. Sohail cycles on a circular track in anticlockwise direction as shown in the figure. He travels with a speed 'V' to cover the path AB, next with speed '$2V$' from B to C and with a speed of '$3V$' from C to A.



What is his average speed for the total journey?

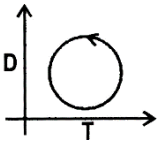
(a) $2V$

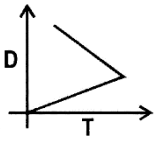
(b) $6V$

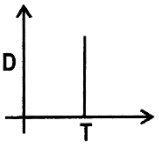
(c) $3V$

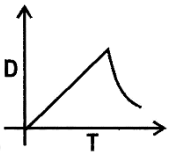
(d) $V/2$

37. The motion of an object is plotted in four distance – time graphs. Which of the following graphs given below correctly describes the possible motion of the object?

(a)


(b)


(c)


(d)


38. A man shot a bullet with a speed of $10\ ms^{-1}$ which just penetrates a plank of wood. With what speed should he shoot the bullet so that it passes through 10 similar planks?

(a) $100\ m\ s^{-1}$

(b) $104\ m\ s^{-1}$

(c) $10\sqrt{10} m\ s^{-1}$

(d) $5\sqrt{10} m\ s^{-1}$

39. While testing the safety of a car, a dummy driver is used and the car is propelled at different speeds to hit a rigid wall. In one such test, the dummy driver had a mass of $70\ kg$ and the speed of the car just before the impact was $40\ m\ s^{-1}$. If the time interval between the collision and the car coming to rest was $0.2\ s$, then find the deceleration of the car due to impact.

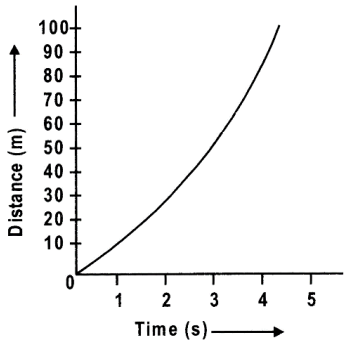
(a) $200\ m\ s^{-2}$

(b) $80\ m\ s^{-2}$

(c) $110\ m\ s^{-2}$

(d) $280\ m\ s^{-2}$

40. The distance versus time graph of a particle moving is shown below.



What does the graph indicate?

(a) The particle starts with certain velocity with retardation and finally comes to rest.

(b) The velocity of the particle is constant.

(c) The acceleration of the particle is non-uniform throughout.

(d) The particle starts with a certain velocity and finally becomes uniform after certain time.

Answers With Solutions

1. (b) A particle moving with constant speed covers equal distances in equal time intervals.

2. (b) A particle with a value of 46.0 ms^{-1} represents the velocity of the particle.

3. (b) $S = x_2 - x_1 = 55 - 50 = 5\ m$

4. (c) $S = v \times t$, For the first 30 km

$$30 = 60 \times t_2 \Rightarrow t_2 = 45 \text{ min}$$

For the next 30 km

$$30 = 40 \times t_2 \Rightarrow t_2 = 45 \text{ min}$$

Hence, $t = t_1 + t_2 = 30 + 45 = 75$ min

5. (b) $S = ut + \frac{1}{2}at^2 = (5 \times 4) + \frac{1}{2} \times (-2.5) \times 16 = 0$

6. (b) Distance $= \pi r = 3.14 \times 10 = 31.4\ cm$,

Displacement $= 2r = 2 \times 10 = 20\ cm$

$$\text{Average velocity} = \frac{S}{t} = \frac{20\ cm}{60\ s}$$

$$= 0.33\ cm\ s^{-1}$$

7. (c) $S_n = (4 + 6n)$ … (1)

$$S_n = u + \frac{a}{2}(2n - 1) = \left(u - \frac{a}{2}\right) + an \quad \ldots (2)$$

Comparing (1) and (2), we get

$$u = 7\ m\ s^{-1} \text{ and } a = 6\ m\ s^{-2}$$

8. (a) $S = \sqrt{l^2 + l^2} = \sqrt{2l^2} = l\sqrt{2} = 4\sqrt{2}$

$$\text{Average velocity} = \frac{S}{t}$$

$$= \frac{4\sqrt{2}}{15 \times 60\ s} = \frac{\sqrt{2}}{225} cm\ s^{-1}$$

9. (b) $a = \frac{S_2 - S_1}{\Delta t^2} = \frac{30 - 20}{1^2} = \frac{10}{1} m\ s^{-2}$

10. (a) Compare the given equation,

with $v = u + at$, we get

$$u = 6\ m\ s^{-1}; a = -0.02\ m\ s^{-2}$$

The - sign indicates retardation.

11. (a) $a = \dfrac{v-u}{t} = \dfrac{46.1-18.5}{2.47} = \dfrac{27.6}{2.47} = 11.2\ m\ s^{-2}$

12. (c) $V_{avg} = \dfrac{2\times u\times v}{u+v} = \dfrac{2\times 40\times 60}{(40+60)} = 48\ km\ h^{-1}$

13. (d) In a circular track,

(i) Distance covered in $\dfrac{1}{2}$ revolution $= \dfrac{2\pi r}{2} = \pi r$

(iii) Displacement in half revolution $= 2r$.

We have $r = 1$. $\therefore$ Ratio $= \pi : 2$

14. (b) We have, $S_1 = 200\ cm$; $t_1 = 2\ s$

$S_2 = 420\ cm$; $t_2 = 6\ s$

$$S_1 = ut_1 + \frac{1}{2}at_1^2 \Rightarrow u + a = 100 \quad \ldots (1)$$

$$S_2 = ut_2 + \frac{1}{2}at_2^2 \Rightarrow u + 3a = 70 \quad \ldots (2)$$

Solving (1) and (2), we get

$a = -15\ cm\ s^{-2}$ and $u = 115\ cm\ s^{-1}$

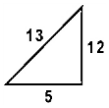
Since, $v = u + at$

$v = 115 - 15\times 7 = 10\ cm\ s^{-1}$

15. (a) When brakes are applied to a moving bicycle, its velocity starts decreasing while it moves in the same direction, i.e., it undergoes retardation. This indicates that its acceleration is in a direction opposite to that of its velocity.

16. (b) $a = \dfrac{60-30}{20}\times\dfrac{1000}{3600} = 0.42\ m\ s^{-2}$

17. (a) Ratio $= \dfrac{Average\ speed}{Average\ velocity} = \dfrac{17}{13}$



18. (c) $S = ut + \dfrac{1}{2}at^2 = 0\times 32.8 + 0.5\times 3.2(32.8)^2$

$= 0.5\times 3.2 = 1.6\times 1075.84 = 1721\ m$

19. (d) Speed (a scalar), gives only how fast a body is moving whereas velocity and acceleration have both magnitude and direction. So, velocity and acceleration are vectors.

20. (d) The body exhibits all the three.

21. (c) A body under rest always has zero speed and also zero acceleration.

22. (b) The correct sequence is:

$a-3,\ b-4,\ c-1,\ d-2$

Speed $-m\ s^{-1}$, Acceleration $-km\ h^{-2}$

Displacement $-cm$. Time - second(s)

23. (c) For a body moving with uniform velocity, change in velocity is zero. So, acceleration is also zero.

24. (b) $v = u + at = 0 + 17.5 \times (8 \times 60)$

$= 8400\ m\ s^{-1}$

25. (b) $a = \dfrac{v-u}{t} = \dfrac{2-0}{10} = 0.2\ m\ s^{-2}$

26. (d) In the given graph, car 4 has the least value of slope. Hence, car 4 travels the slowest.

27. (a) Centripetal force is the force acting towards the centre of a circle. The gravitational force between the sun and the earth provides the necessary centripetal force.

28. (c) Let the velocities of the two ends of the train be u and v and the velocity of the middle point be v_1.

$\therefore$ The acceleration of the mid-point of the train

$$= a = \frac{v_1^2 - u^2}{2s} = \frac{v^2 - v_1^2}{2s}$$

$$\Rightarrow \quad v_1 = \sqrt{\frac{v^2 + u^2}{2}} = \sqrt{\frac{6^2 + 8^2}{2}}$$

29. (c) $S = ut + \dfrac{1}{2}at^2 = 0 + \dfrac{1}{2}(17.5)(480)^2$

$= 2016000\ m$ or $2,016\ km$

30. (c) $v^2 - u^2 = 2aS$, $\therefore\ a \times S = \dfrac{v^2 - u^2}{2}$

($a \times S$ is the area of the acceleration-displacement graph).

31. (a) For a moving particle, if displacement decreases with time, the body is moving towards its initial position.

32. (b) $S = ut + \dfrac{1}{2}at^2$

$110 = 0 \times 5.21 + 0.5 \times a(5.21)^2$

$= \dfrac{110}{13.57} = 8.10\ m\ s^{-2}$

33. (a) If $s - t$ graphs of two cyclists meet at a point, at that time they either pass each other or they collide.

34. (c) $u = 12\ m\ s^{-1}$; $v = 0$; $a = -0.5\ m\ s^{-2}$

$v = u + at$

$0 = 12 - 0.5 \times t,\ 0.5t = 12,\ t = \dfrac{12}{0.5} = 24\ s$

35. (d) $v^2 - u^2 = 2aS,\ (7.10)^2 - (0)^2 = 2a \times 35.4$

$50.41 = a \times 70.8,\ a = \dfrac{50.41}{70.8} = 0.712\ m\ s^{-2}$

36. (a) (i) From A to B, Speed $= V$

$\text{Distance} = 2\pi R \times \dfrac{60^o}{360^o} = \dfrac{2\pi R}{6}$

$\text{Time} = \dfrac{D}{S} = \dfrac{2\pi R}{6 \times V}$

(ii) From B to C, Speed $= 2V$

$\text{Distance} = 2\pi R \times \dfrac{120^o}{360^o} = \dfrac{2\pi R}{2}$

(iii) From C to A, Speed $= 3V$

$\text{Distance} = 2\pi R \times \dfrac{180^o}{360^o} = \dfrac{2\pi R}{2}$

$\text{Time} = \dfrac{D}{S} = \dfrac{2\pi R}{2 \times 3V}$

$\therefore$ Average speed for total journey

$= \dfrac{\text{Total Distance}}{\text{Total Taken}} = \dfrac{2\pi R}{\dfrac{2\pi R}{6V} + \dfrac{2\pi R}{6V} + \dfrac{2\pi R}{6V}}$

$= \dfrac{2\pi}{\dfrac{6\pi R}{6V}} = 2\ V$

37. (d) Graph in option (d), shows that the object moves with uniform speed at first and then it decreases (slows down).

38. **(c) Case (i):** $S = x,\ v = 0,\ u = 10\ m\ s^{-1}$

$v^2 - u^2 = 2aS,\ 0^2 - 10^2 = 2ax$

$-100 = 2ax = -50 = ax$ … (1)

Case (ii): $S = 10x,\ v = 0$

$v^2 - u^2 = 2aS,\ 0^2 - u^2 = 2a(10x)$

$u^2 = 1000 \text{ or } u = 10\sqrt{10} m\ s^{-1}$

39. (a) Initial velocity of the car $= 40\ m\ s^{-1}$, Final velocity of the car $= 0$, Time $'t' = 0.2\ s$

$a = \dfrac{v - u}{t} = \dfrac{0 - 40}{0.2} = -200\ m\ s^{-2}$

$\therefore$ Deceleration $= 200\ m\ s^{-2}$

40. (c) The graph of distance versus time is a curve. Hence, the particle has non-uniform motion, (i.e., it has acceleration).