Board – CBSE	Class – 9th	Topic – Motion

Q.1 A tortoise moves a distance of 100 meters in 15 minutes. What is the average speed of tortoise in km/h?

Ans: Total distance $= 100\ m = 0.1\ km$

Total time taken $=$ 15 minutes $= \frac{15}{60} = 0.25$ hour

Average speed = Total distance travelled/ Total time taken

$= \frac{0.1}{0.25} = 0.4\ km/h$

Q.2 An aircraft travelling at $600\ km/h$ accelerates steadily at $10\ km/h$ per second. Taking the speed of sound as $1100\ km/h$ at the aircraft's altitude, how long will it take to reach the 'sound barrier'?

Ans: Initial velocity, $u = \frac{600\ km}{h}$

Final velocity, $v = \frac{1100\ km}{h}$

Acceleration $= \frac{\frac{10\ km}{h}}{s} = \frac{600\ km}{h^2}$

From relation, $a = \frac{v-u}{t}$

$t = \frac{v-u}{a}$

$t = \frac{1100-600}{600} = \frac{500}{600} = \frac{5}{6} hr = 50 sec$

Q.3 Explain :

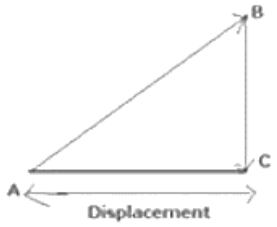
(a) What is the difference between 'distance travelled' by a body and its 'displacement'? Explain with the help of a diagram.

(b) An ant travels a distance of 8 cm from P to Q and then moves a distance of 6 cm

at right angles to PQ. Find its resultant displacement.

Ans: (a) Distance travelled is the actual length of the indirect path covered by the body, whereas displacement refers to the straight-line path between the initial and final positions. E.g. In the figure given below, a

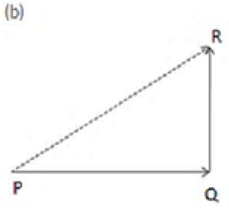
body moves from point A to point B and then from point B to point C. Here, the distance travelled by the body is $AB + BC$ and displacement is AC.



(b) $PQ = 8\ cm$

$QR = 6\ cm$

Resultant Displacement $PR = \sqrt{8^2 + 6^2} = \sqrt{100} = 10\ cm$



Q.4 Define motion. What do you understand by the terms 'uniform motion' and 'non-uniform motion'? Explain with examples.

Ans: A body is in motion when its position changes continuously with respect to a stationary object taken as the reference point.

A body has uniform motion if it travels equal distances in equal time intervals, no matter how small these time intervals may be. For example, a car running at a constant speed of 10 m/s will cover an equal distance of 10 m every second, so its motion will be uniform. Non-uniform motion: A body has a non-uniform motion if it travels unequal distances in equal time intervals. For example: dropping the ball from the roof of a tall building.

Q.5 (a) Define speed. What is the SI unit of speed?

(b) What is meant by

(i) average speed, and (ii) uniform speed?

Ans: (a) Speed of a body is the distance travelled by it per unit time. The SI unit of speed is m/s.

(b) (i) Average speed of a body is the total distance travelled divided by the total time taken to cover this distance.

$$Average = \frac{Total\ distance\ travelled}{Total\ time\ taken}$$

(ii) Uniform speed refers to the constant speed of a moving body. A body has a uniform speed if it travels an equal distance in equal intervals of time, no matter how small these time intervals may be.

Q.6 (a) Define velocity. What is the SI unit of velocity?

(b) What is the difference between speed and velocity?

Ans: (a) Velocity of a body is the distance travelled by it per unit time in a given direction. SI unit of velocity is m/s.

(b) (i) Speed is a scalar quantity, whereas velocity is a vector quantity.

(ii) Speed of a body is the distance travelled by it per unit time whereas the velocity of a body is the distance travelled by it per unit of time in a given direction.

(iii) Speed is always positive, whereas velocity can be both positive as well as negative.

Q.7 Explain

(a) What is meant by the term 'acceleration'? State the SI unit of acceleration.

(b) Define the term 'uniform acceleration'. Give one example of a uniformly accelerated motion.

Ans: (a) Acceleration of a body is defined as the rate of change of its velocity with time.

SI unit of acceleration is m/s^2.

(b) A body has uniform acceleration if it travels in a straight line. Its velocity

increases by equal amounts in equal intervals of time. For example motion of a freely falling body.

Q.8 A body travels a distance of 3 km towards East, then 4 km towards North and finally 9 km towards East.

(i) What is the total distance travelled?

(ii) What is the resultant displacement?

Ans: (i) Total distance travelled $= 3 + 4 + 9 = 16\ km$

(ii) The body travels a total distance of 12 km in the east direction, i.e. towards the x -axis.

And it travels a distance of 4 km in the North direction, i.e. towards the y-axis. Hence,

resultant displacement is $= \sqrt{12^2 + 4^2} = \sqrt{144 + 16} = \sqrt{160} = 12.6\ km$

Q.9 An object has moved through a distance. Can it have zero displacement? If yes, support your answer with an example.

Ans: An object can have zero displacement even when it has moved a distance and shown some displacement. This takes place when the final position of an object coincides with its initial position. If a person moves around a circular area and comes back to the place from where he started, then the displacement will be zero.

Q.10 Which of the following is true for displacement?

(a) It cannot be zero.

(b) Its magnitude is greater than the distance travelled by the object.

Ans: None of the above statements is true for displacement.

The first statement is completely false because displacement can be zero in the case of a circular path. The second statement is also false because displacement is less than or equal to the distance travelled by the object in case of motion in the opposite direction.

Q.11 During an experiment, a signal from a spaceship reached the ground station in five minutes. What was the distance of the spaceship from the ground station? The signal travels at the speed of light, that is, $3\times10^{8}\ m\ s^{-1}$.

Ans: Speed $= 3\times108\ m\ s^{-1}$

Time $= 5\ min\ = 5\times60\ = 300$ seconds.

Distance= Speed x Time

Distance $= 3\times10^{8}\ m\ s^{-1}\times300 secs. = 9\times10^{10}\ m$

Q.12 A bus starting from rest moves with a uniform acceleration of $0.1\ m\ s^{-2}$ for 2 minutes.

Find (a) the speed acquired, (b) the distance travelled.

Ans: Initial speed of the bus, $u\ = \frac{0\ m}{s}$

Acceleration, $a\ = \frac{0.1\ m}{s^{2}}$

Time taken, $t\ =\ 2$ minutes $=\ 120\ s$

(a) $v\ =\ u\ +\ at$

$v\ =\ 0\ +\ 0\times1\times120$

$v\ =\ 12\ ms^{-1}$

(b) According to the third equation of motion, $v^{2}\ -\ u^{2}\ =\ 2as$ s is the distance covered by the bus

$(12)^{2}\ -\ (0)^{2}\ =\ 2(0.1)s$

$s\ =\ 720\ m$

Speed acquired finally by the bus is $12\ m/s$.

The distance travelled by bus is $720\ m$.

Q.13 A train is travelling at a speed of $90\ km\ h^{-1}$. Brakes are applied to produce a uniform acceleration of $0.5\ m\ s^{-2}$. Find how far the train will go before it is brought to rest?

Ans: Initial speed of the train, $u\ = \frac{90\ km}{h} = \frac{25\ m}{s\left(\frac{1\ km}{hr}=\frac{\frac{5}{18}m}{s}\right)}$

The final speed of the train, $v = 0$ (finally the train comes to rest, and its velocity becomes (0)

Acceleration $= -\ 0.5\ m\ s^{-2}$

According to the third equation of motion:

$v^2 = u^2 + 2as$

$(0)^2 = (25)^2 + 2(-\ 0.5)s$

Where s is the distance covered by the train

$s = \frac{25^2}{2(0.5)} = 625\ m$

The train will cover a distance of 625 m before coming to rest.

Q.14 A motorboat starting from rest on a lake accelerates in a straight line at a constant rate of 3. 0 $m\ s^{-2}$ for 8. 0 s. How far does the boat travel during this time?

Ans: Given the Initial velocity of a motorboat, $u = 0$

Acceleration of motorboat, $a = 3.0\ m\ s^{-2}$

Time under consideration, $t = 8.0\ s$

Distance, $s = ut + \left(\frac{1}{2}\right)at^2$

Therefore, distance travel by motorboat $= 0\times8 + \left(\frac{1}{2}\right)3.0\times82$

$= \left(\frac{1}{2}\right)\times3\times8\times8\ m = 96\ m$

Q.15 An artificial satellite is moving in a circular orbit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth.

Ans: Radius of a circular orbit, $r = 42250\ km$

Time taken to revolve around the earth, $t = 24\ h$

Speed of a circular moving object, $v = \frac{2\pi r}{t}$

$= \frac{\left[2\times\left(\frac{22}{7}\right)\times42250\times1000\right]}{24\times60\times60}$

$= \frac{(2\times22\times42250\times1000)}{7\times24\times60\times60}\ m\ s^{-1}$

$= 3073.74\ m\ s^{-1}$

Q.16 Find the initial velocity of a car that is stopped in 10 seconds by applying brakes. The retardation due to brakes is $2.5\ m/s^2$.

Ans: Initial velocity, u =?

Final velocity, $v = 0\ m/s$ (car is stopped)

Retardation, $a = -\frac{2.5\ m}{s^2}$

Time, $t = 10\ s$

$v = u + at$

$0 = u + (-2.5) \times 10$

$u = 25\ m/s$

Q.17 A car is travelling along the road at $8\ ms^{-1}$. It accelerates at $1\ ms^{-2}$ for a distance of 18 m. How fast is it than travelling?

Ans: Initial velocity, $u = \frac{8\ m}{s}$

Acceleration, $a = \frac{1\ m}{s^2}$

Distance, $s = 18\ m$

Using relation

$v^2 = u^2 + 2as$

$v^2 = (8)^2 + 2 \times 1 \times 18$

$v = \sqrt{100} = 10\ m/s$

Q.18 When will you say a body is in

(i) uniform acceleration?

(ii) Non-uniform acceleration?

Ans: (i) A body is said to be in uniform acceleration if it travels in a straight line, and its velocity increases or decreases by equal amounts in equal time intervals.

(ii) A body is said to be in non-uniform acceleration if the rate of change of its velocity is not constant that it differs in different time intervals.

Q.19 A trolley, while going down an inclined plane, has an acceleration of 2 $cm\,s\,-\,2$. What will be its velocity 3 s after the start?

Ans: Initial Velocity of the trolley, $u\,=\,0cms^{-1}$

Acceleration, $a\,=\,2\,cm\,s^{-2}$

Time, $t\,=\,3\,s$

It is known that final velocity, $v\,=\,u\,+\,at\,=\,0\,+\,2{\times}3cms^{-1}$

Therefore, the velocity of the train after 3 seconds is $6cms^{-1}$

Q.20 Bus X travels a distance of 360 km in 5 hours, whereas bus Y travels a distance of 476 km in 7 hours. Which bus travels faster?

Ans: For bus X

$Speed \quad = \frac{Distance}{Time}$

$Speed \quad = \quad 360/5 \,=\, 72\ km/h$

Speed $= \frac{360}{5} = \frac{72\ km}{h}$

For bus Y,

Speed= Distance/Time

Speed $= \frac{476}{7} = \frac{68\ km}{h}$

The speed of bus X is more than that of bus Y. Hence; bus X travels faster.

Q.21 Under what condition(s) is the magnitude of the average velocity of an object equal to its average speed?

Ans: The magnitude of the average velocity of an object is equal to its average speed, only in one condition when an object is moving in a straight line.