1. Laws of Motion

1. Match the first column with appropriate entries in the second and third columns and remake the table.

S. No.	Column 1	Column 2	Column 3
1	Negative acceleration	The velocity of the object remains constant	A car, initially at rest reaches a velocity of 50 km/hr in 10 seconds
2	Positive acceleration	The velocity of the object decreases	A vehicle is moving with a velocity of 25 m/s
3	Zero acceleration	The velocity of the object increases	A vehicle moving with the velocity of 10 m/s, stops after 5 seconds.

Ans.

S.no	Column 1	Column 2	Column 3
1	Negative acceleration	The velocity of the object decreases.	A vehicle moving with the velocity of 10 m/s, stops after 5 seconds.
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3	Zero acceleration	The velocity of the object remains constant.	A vehicle is moving with a velocity of 25 m/s.

2. Clarify the differences

A. Distance and displacement

Ans.

Distance	Displacement
It is defined as the length of the actual path travelled by an object in motion.	It is defined as the shortest distance between the starting and finishing points.
It is a scalar quantity.	It is a vector quantity.
The values of distance are always positive.	The values of displacement can be positive, negative or zero.

B. Uniform and non-uniform motion.

Ans.

Uniform motion	Non-uniform motion
1. When an object covers an equal distance in equal time intervals, it is said to be in uniform motion.	1. When an object covers an unequal distance in an equal time interval, it is said to be in non-uniform motion.
2. The distance-time graph obtained in the case of uniform motion is a straight-line graph.	2. The distance-time graph obtained in the case of non-uniform motion can be of any shape depending on how the acceleration changes with time.
3. The acceleration of uniform motion is zero.	3. The acceleration of the non-uniform motion is not zero.
4. eg: A car running on a straight road without any change in its speed.	4. eg: A car running on a road with different speeds in different intervals of time.

3. Complete the following table.

u (m/s)	a (m/s^2)	t (sec)	v = u + at (m/s)
2	4	3	–
–	5	2	20

u (m/s)	a (m/s^2)	t (sec)	$s = ut + \frac{1}{2} at^2$ (m)
5	12	3	–
7	–	4	92

u (m/s)	a (m/s^2)	s (m)	$v^2 = u^2 + 2as$ $(m/s)^2$
4	3	–	8
–	5	8.4	10

Ans.

u (m/s)	**a (m/s^2)**	**t (sec)**	**v = u + at (m/s)**
2	4	3	**14**
10	5	2	20

Explanation:

(i)

u = 2; a = 4; t = 3; v = u + at (m/s) = ?

v = u + at (m/s)

$= 2 + 4 \times 3$

$= 2 + 12$

$\therefore$ **v = 14**

(ii)

u = ?; a = 5; t = 2; v = u + at (m/s) = 20

v = u + at (m/s)

$\Rightarrow 20 = u + 5 \times 2$

$\Rightarrow 20 = u + 10$

$\Rightarrow 20 - 10 = u$

$\therefore$ **u = 10**

u (m/s)	a (m/s^2)	t (sec)	$s = ut + \frac{1}{2}at^2$ (m)
5	12	3	**69**
7	**8**	4	92

Explanation:

(i) u = 5, a = 12, t = 3, s = ?

$s = ut + \frac{1}{2}at^2$ (m)

$= 5 \times 3 + \frac{1}{2} \times 12 \times (3)^2$

$= 15 + \frac{1}{2} \times 12 \times 9$

$= 15 + 54$

$\therefore s = 69$

(ii) u = 7, a = ?, t = 4, s = 92

$s = ut + \frac{1}{2}at^2$ (m)

$\Rightarrow 92 = 7 \times 4 + \frac{1}{2} \times a \times (4)^2$

$\Rightarrow 92 = 28 + \frac{1}{2} \times a \times 16$

$\Rightarrow 92 = 28 + 8 \times a$

$\Rightarrow 92 - 28 = 8 \times a$

$\Rightarrow 64 = 8 \times a$

$\Rightarrow \frac{64}{8} = a$

$\therefore a = 8$

u (m/s)	a(m/s^2)	s(m)	$v^2 = u^2 + 2as$ (m/s)^2
4	3	**8**	8
4	5	8.4	10

Explanation:

(i) u = 4, a = 3, v = 8, s = ?

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

$\Rightarrow (8)^2 = (4)^2 + 2 \times 3 \times s$

$\Rightarrow 64 = 16 + 6s$

$\Rightarrow 64 - 16 = 6s$

$\Rightarrow 48 = 6s$

$\Rightarrow \frac{48}{6} = s$

$\therefore s = 8$

(ii) $a = 5$, $s = 8.4$, $v = 10$, $u = ?$

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

$\Rightarrow (10)^2 = u^2 + 2\,(5 \times 8.4)$

$\Rightarrow 100 = u^2 + 84$

$\Rightarrow 100 - 84 = u^2$

$\Rightarrow 16 = u^2$

$\therefore$ **u = 4**

4. Complete the sentences and explain them.

a. The minimum distance between the start and finish points of the motion of an object is called the **displacement** of the object.

Explanation:

Displacement means the shortest distance between the start and end points of the motion. Displacement is a scientific term related to speed and distance. This displacement represents how the body moves from one position to another, that is, the shortest distance between its motion's start and end points.

b. Deceleration is **negative** acceleration

Explanation:

When the speed of an object decreases over a period of time, it is said to have a negative acceleration. The final velocity of the object is less than the initial velocity. i.e., $v < u$, according to the formula,

The acceleration, $a = \frac{v - u}{t}$ becomes negative.

c. When an object is in uniform circular motion, its **velocity** changes at every point.

Explanation:

In a uniform circular motion, the direction of motion of the body changes at every instant of time. This continuous change in the direction of motion of the body at every instant accounts for the change in its velocity at every point of instant.

d. During collision **total momentum** remains constant.

Explanation:

According to the law of conservation of momentum, momentum is redistributed between colliding objects. When the momentum of one object decreases, the momentum of the other object increases. As a result, momentum remains constant even when objects collide.

e. The working of a rocket depends on Newton's **third** law of motion.

Explanation:

Newton's third law plays an important role in the acceleration of fire. When fuel is heated in a fire, a chemical reaction takes place and it burns. Free gases escape through a small hole in the tail on the ground side of the fireball. They exert an equal and opposite reaction force on fire. Due to this reaction force, the fire arrow accelerates forward.

5. Give scientific reasons.

a. When an object falls freely to the ground, its acceleration is uniform.

Ans.

When an object falls freely to the ground, it is under the effect of a constant force known as the force of gravity. No other forces act on it. Hence, from Newton's second law of motion, we can say that this constant force of gravity accelerates the freely falling object uniformly. This uniform acceleration is known as acceleration due to gravity which acts towards the centre and is denoted by g.

b. Even though the magnitudes of action force and reaction force are equal and their directions are opposite, their effects do not get cancelled.
Ans.

When two bodies interact, the action and reaction forces come into action. Even though their magnitude is the same and their direction is opposite, their effects do not get cancelled because these action and reaction forces do not act on the same body.

c. It is easier to stop a tennis ball as compared to a cricket ball, when both are travelling with the same velocity.
Ans.

- The momentum of a body is the product of its mass and velocity, i.e., p = mv and the rate of change of momentum of a body is equal to the force applied, i.e., $F = \frac{m(v-u)}{t}$.
- In the given information, both the balls move with the same velocity and finally stop; thus, the force applied to stop the ball will be directly proportional to the mass of the ball.
  $F \propto m$
- It is easier to stop a tennis ball than a cricket ball moving with the same speed because the momentum of a cricket ball will be higher than that of the tennis ball, as the mass of the cricket ball is more than tennis ball. Therefore, less force is required to stop the tennis ball when compared to the cricket ball.

d. The velocity of an object at rest is considered to be uniform.

Ans.

1. The velocity of an object is said to be in uniform motion when its speed is constant all the time.
2. The object at rest has a uniform speed of zero all the time and does not even change direction.
3. Hence, the velocity of an object at rest is considered to be uniform.

6. Take 5 examples from your surroundings and give explanation based on Newtons laws of motion.

Ans.

A. **Example 1:**

When we travel by bus, the stopped bus first feels backwards as it starts. This is an example of Newton's first law of motion.

Explanation:

1. When an object is at rest or in motion, the object does not change its state by its own inertia.
2. When the bus is at rest, we are also at rest inside that bus.
3. When the bus starts, sitting in the bus also gives us speed; But the upper part of the body tries to remain in a state of rest.
4. As a result, inertia at rest tends to push us back. So, the bus starts in the next direction.

B. **Example 2:**

When the carpet is lifted and shaken, the dust in it falls down. This is an example of Newton's first law of motion.

Explanation:

1. When the carpet is lifted and cleaned, its speed increases.
2. There is dust on the carpet and it is at rest due to inertia.
3. Shaking removes the dust particles from the carpet, gravity causes the loose particles to fall, and the carpet is cleaned.

C. **Example 3:**

Players withdraw their hands while catching the ball. This is an example of Newton's second law of motion.

Explanation:

1. Players move their arms backwards to catch the ball, allowing more time for the hands to catch the ball.
2. According to Newton's second law of motion, the change in momentum is proportional to the magnitude of the force.
3. Taking more time to catch the ball results in a very small change in momentum. Therefore, the player catches the ball with less force and his hand is not jerked.

D. **Example 4:**

The book placed on the table remains the same. This is an example of Newton's third law.

Explanation:

1. A book placed on a table has some weight because this weight is the force exerted on the table.
2. According to Newton's third law of motion, action and reaction forces act simultaneously.
3. Hence, the force exerted on the book towards the table and the weight of the book balance.
4. Also, the two forces are balanced, and there is no acceleration. Hence, the book placed on the table remains stationary.

E. **Example 5:**

A balloon filled with air goes forward when released from the hand. This is an example of Newton's third law of motion.

Explanation:

As the air is released downward, it exerts an equal opposite force on the balloon, pushing the balloon forward.

7. Solve the following examples.

a) An object moves 18 m in the first 3 s, 22 m in the next 3 s and 14 m in the last 3 s. What is its average speed?

Ans.

Given, $s_1 = 18$ m, $t_1 = 3$ s, $s_2 = 22$ m, $t_2 = 3$ s, $s_3 = 14$ m, $t_3 = 3$ s

Average speed = ?

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total Time}}$$

$$\text{Average speed} = \frac{s_1 + s_2 + s_3}{t_1 + t_2 + t_3}$$

$$= \frac{18 + 22 + 14}{3 + 3 + 3}$$

$$= \frac{54}{9}$$

= 6 m/s.

b) An object of mass 16 kg is moving with an acceleration of 3 m/s^2 . Calculate the applied force. If the same force is applied on an object of mass 24 kg, how much will be the acceleration?

Ans.

Given: $m_1 = 16$ kg, $a_1 = 3\ m/s^2$, $m_2 = 24$ kg

Find: a_2 = ?, F = ?

Applied force, $F = m_1a_1 = 16\ kg \times 3\ m/s^2 = 48\ N$

$\therefore F = m_2a_2$

$$\therefore \text{Acceleration, } a_2 = \frac{F}{m_2}$$

$$= \frac{48N}{24kg}$$

$= 2\ m/s^2$

c) A bullet having a mass of 10 g and moving with a speed of 1.5 m/s, penetrates a thick wooden plank of mass 900 g. The plank was initially at rest. The bullet gets embedded in the plank and both move together. Determine their velocity.

Ans.

According to Question:

$m_1 = 10g = 10 \times 10^{-3}$ kg

$u_1 = 1.5$ m/s

$m_2 = 90g = 90 \times 10^{-3}$ kg

$u_2 = 0$ m/s,

$v_1 = v_2 = v = ?$

Based on the law of conservation of momentum,

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

But $u_2 = 0$ m/s and $v_1 = v_2 = v$

$m_1u_1 = (m_1 + m_2)v$

$v = \dfrac{m_1u_1}{m_1 + m_2}$

$= \dfrac{10 \times 10^{-3}kg \times 1.5m/s}{10 \times 10^{-3}kg + 90 \times 10^{-3}kg}$

$= \dfrac{10 \times 10^{-3}kg \times 1.5m/s}{10^{-3}(10 + 90)kg}$

$= \dfrac{10 \times 1.5}{100}$ m/s

$= 0.15$ m/s

d) A person swims 100 m in the first 40 s, 80 m in the next 40 s and 45 m in the last 20 s. What is the average speed?

Ans.

Given: $s_1 = 100$ m, $t_1 = 40$ s, $s_2 = 80$ m, $t_2 = 40$ s, $s_3 = 45$ m, $t_3 = 20$ s

Average speed = ?

Average speed = $\dfrac{\text{Total distance}}{\text{Total time}}$

Average speed = $\dfrac{s_1 + s_2 + s_3}{t_1 + t_2 + t_3}$

$= \dfrac{100 + 80 + 45}{40 + 40 + 20}$

$= \dfrac{225}{100}$

$= 2.25$ m/s