CLASS: IX
SUBJECT: PHYSICS
WORK BOOK-2

Hints & Solutions

1. **(B)**
Mass of both objects and the distance between them

2. **(D)**
It becomes one-fourth

3. **(A)**
9.8 m/s²

4. **(C)**
It becomes double

5. **(B)**
The force becomes three times

6. Gravitational force is the attractive force between two objects with mass. It is responsible for the weight of an object and is directly proportional to the product of the masses of the two objects and inversely proportional to the square of the distance between their centers. The formula for gravitational force is given by Newton's law of gravitation: $F = G \cdot m_1 \cdot m_2 / r_2$, where F is the gravitational force, G is the gravitational constant, $1m_1$ and $2m_2$ are the masses of the two objects, and r is the distance between their centers.

7. The value of gravitational acceleration, denoted as g, varies on different celestial bodies due to differences in their masses and radii. On Earth, g is approximately 9.8 m/s². It is less on celestial bodies with smaller masses or larger radii, such as the Moon (where *g* is about 1.6 m/s²) and more on celestial bodies with larger masses or smaller radii, such as Jupiter.

8. Free fall is the motion of an object solely under the influence of gravity, with no other forces acting on it. In a vacuum, all objects fall at the same rate regardless of their masses. The acceleration due to gravity (g) causes free fall, and near the surface of the Earth, it is approximately 9.8 m/s². Objects in free fall experience an increase in velocity and cover equal distances in equal time intervals.

9. According to Newton's law of gravitation, the gravitational force between two objects is inversely proportional to the square of the distance between their centers. As the distance between two objects increases, the gravitational force decreases. Specifically, if the distance is doubled, the force becomes one-fourth, and if the distance is tripled, the force becomes one-ninth.

11. Astronauts experience weightlessness in space because they are in a state of continuous free fall around the Earth. While they are subject to the gravitational force of the Earth, they are also moving forward at a sufficient velocity that the curvature of their trajectory matches the curvature of the Earth. As a result, they are in a constant state of falling towards Earth, creating a sensation of weightlessness.

11 The mass of an object directly influences its gravitational force. According to Newton's law of gravitation, the force of gravity between two objects is directly proportional to the product of their masses. If the mass of one or both objects increases, the gravitational force between them also increases. This relationship is expressed in the formula $2F = G \cdot r_2 m_1 \cdot m_2$, where $1m_1$ and $2m_2$ are the masses of the objects.

12. Kepler's laws of planetary motion describe the motion of planets around the Sun.

- Kepler's First Law states that each planet moves in an elliptical orbit with the Sun at one of the two foci. This means that the orbit of a planet is not a perfect circle but an elongated ellipse.
- Kepler's Second Law, also known as the Law of Equal Areas, states that a line segment joining a planet and the Sun sweeps out equal areas during equal intervals of time. This implies that a planet moves faster when it is closer to the Sun and slower when it is farther away.
- Kepler's Third Law, also known as the Law of Harmonies, establishes a mathematical relationship between the orbital period of a planet (T) and the semi-major axis of its orbit (a). The square of the orbital period is directly proportional to the cube of the semi-major axis, expressed as $T^2 \propto a^3$.

13 Free fall is the motion of an object solely under the influence of gravity, with no other forces acting on it. In free fall, the only acceleration acting on the object is the acceleration due to gravity (9.8 m/s^2 on Earth), and the object experiences a constant acceleration downward.
When an object is thrown horizontally, it still experiences the force of gravity acting vertically downward. However, it also has an initial horizontal velocity imparted by the throw. The vertical motion is influenced by gravity, causing the object to fall vertically, while the horizontal motion continues at a constant velocity. The resulting path is a curved trajectory called a projectile motion.

14. The gravitational force between two objects is determined by the masses of the objects and the distance between their centers. Newton's law of universal gravitation expresses this relationship mathematically as:
$F = G \cdot m_1 \cdot m_2 / r_2$
where:

- F is the gravitational force between the two objects,
- G is the gravitational constant (6.67×10^{-11} Nm^2/kg 26.67×10^{-11} Nm^2/kg^2),
- $1m_1$ and $2m_2$ are the masses of the two objects,
- r is the distance between the centers of the two masses.

Therefore, the factors affecting gravitational force are:

- Masses of the objects: Gravitational force is directly proportional to the product of the masses. If one or both masses increase, the gravitational force increases.
- Distance between the objects: Gravitational force is inversely proportional to the square of the distance between the centers of the masses. As the distance increases, the gravitational force decreases rapidly.

These factors highlight the universal nature of gravity and its dependence on the masses and separation of objects.

15. To calculate Maya's weight on Mars, we can use the formula:
Weight = mass × acceleration due to gravity
Maya's weight on Mars (W_{Mars}) can be calculated using the formula:
W_{Mars} = mass × g_{Mars}
Given that her weight on Earth (W_{Earth}) is 400 N, we can use the formula W_{Earth} = mass × g_{Earth}.
Now, rearranging the formula to solve for mass:

$$\text{mass} = \frac{W_{Earth}}{g_{Earth}}$$

Substitute the values:

$$\text{mass} = \frac{400\text{N}}{9.8\,\text{m/s}^2}$$

$$\text{mass} \approx 40.82\,\text{kg}$$

W_{Mars} = 40.82 kg × 3.7 m/s^2.
W_{Mars} ≈ 150.89 N
Therefore, Maya's weight on Marsh is approximately 150.89 N

16. **(A)**
The weight of an object is given by the formula W = mg, where W is the weight, m is the mass, and g is the acceleration due to gravity. On the Moon, the value of 'g' is less than on Earth. This is because the Moon has less mass than Earth, and gravity is directly proportional to the mass of the celestial body. Therefore, the weight of an object on the Moon is less than its weight on Earth, and the reason is that the gravitational acceleration on the Moon is less.