NCERT solutions for class 9 science chapter 10 Gravitation

Q1. State the universal law of gravitation.

Answer:

The universal law of gravitation states that everybody in the universe attracts every other body by the virtue of its mass. This force is directly proportional to the product of the masses of the two bodies and inversely proportional to the square of the distance between them.

Let there be two bodies of masses m_1 and m_2 and let the distance between them be r. The gravitational force F_g between them would be given by

$$F_g = G\frac{m_1 m_2}{r^2}$$

where G is the universal gravitational constant and is equal to $6.67 \times 10^{-11} N\ m^2\ kg^{-2}$

Q2. Write the formula to find the magnitude of the gravitational force between the earth and an object on the surface of the earth.

Answer:

Let M_E and m be the masses of the earth and the body and let the distance between the centre of Earth and the body be d. The magnitude of the gravitational force between the earth and the object would be given by the relation.

$$F = G\frac{M_E m}{d^2}$$

Mass of Earth, $M_E = 5.972 \times 10^{24} kg$

d would be approximately equal to the radius of the earth.

Radius of Earth $= 6.378 \times 10^6 m$

$$G = 6.67 \times 10^{-11} N\ m^2\ kg^{-2}$$

$$F = 6.67 \times 10^{-11} \times \frac{5.972 \times 10^{24} \times m}{(6.378 \times 10^6)^2}$$
$$F = 9.8m\ N$$

Solutions for NCERT class 9 science chapter 10 Gravitation

Topic 10.2 Free fall

Q1. What do you mean by free fall?

Answer:

We say an object is freely falling when it is dropped from some height and is attracted by the gravitational force of earth only and is under the influence of no other considerable force.

Q2. What do you mean by the acceleration due to gravity?

Answer:

Each object on the Earth is under the influence of the gravitational force of the earth. The acceleration due to the earth's gravitational force is known as acceleration due to gravity.

CBSE NCERT solutions for class 9 science chapter 10 Gravitation

Topic 10.4 Weight

Q1. What are the differences between the mass of an object and its weight?

Answer:

The following are the differences between the mass of a body and its weight

Mass	**Weight**
(i) Mass is the amount of matter contained in the body.	(i) Weight is the gravitational force experienced by the body.
(ii) Mass of a body is always constant.	(ii) Weight of a body depends on the place where it is at.
(iii) Mass is the measure of the inertia of the body.	(iii) Weight is the measure of the gravitational force acting on the body.
(iv) Mass only has magnitude.	(iv) Since weight is a force it naturally has a direction associated with it as well
(v) It's SI unit is the kilogram (kg).	(v) It's SI unit is Newton (kg m s^{-2})

Q2. Why is the weight of an object on the moon $\frac{1}{6}th$ its weight on the earth?

Answer:

The weight of an object on the moon would be given by

$$W_M = G\frac{M_M m}{r_M^2}$$

where M_M is the mass of the moon, m is mass of the body, r_M is the radius of the moon and G is the gravitational constant.

The weight of an object on the Earth would be given by

$$W_E = G\frac{M_E m}{r_E^2}$$

where M_E and r_E are the mass and radius of the earth respectively.

$$\frac{W_M}{W_E} = \frac{M_M r_E^2}{M_E r_M^2}$$

The above ratio is approximately equal to 1/6 and this is why the weight of an object on the moon $(1/6)^{th}$ of its weight on the earth .

NCERT textbook solutions for class 9 science chapter 10 Gravitation

Topic 10.5 Thrust and Pressure

Q1. Why is it difficult to hold a school bag having a strap made of a thin and strong string?

Answer:

It is difficult to hold a school bag having a strap made of a thin and strong string because as the surface area of the string in contact with the shoulders is very less and due to this, its weight applies a large pressure on the shoulders.

Q2. What do you mean by buoyancy?

Answer:

When an object is placed in a fluid it displaces a volume of liquid equal to its own volume. Due to this, the liquid exerts an upward force on the body called the Buoyant force. This tendency of a liquid to exert the upward buoyant force is called buoyancy.

Q3. Why does an object float or sink when placed on the surface of the water?

Answer:

When an object is placed on the surface of the water it displaces a certain volume of water. If the density of the object is less than that of water the buoyant force due to this displacement of water is equal to the weight of the object and it floats on the surface of the water. If the density of the object is more than the density of water, the volume of water displaced would be equal to the volume of the object itself and the buoyant force acting upwards due to this displacement of water would be less than the weight of the object and the object would sink.

NCERT solutions for class 9 science chapter 10 Gravitation

Topic 10.6 Archimedes' Principle

Q1. You find your mass to be $42\ kg$ on a weighing machine. Is your mass more or less than $42\ kg$?

Answer:

The weighing scale shows the reading according to the weight applied to it. The weight on the weighing scale would be slightly less than our weight because there is a small upward force acting on us due to the buoyancy of the atmosphere and the reading would be slightly lower than our actual weight, therefore, our mass must be more than 42 kg.

Q2. You have a bag of cotton and an iron bar, each indicating a mass of $100\ kg$ when measured on a weighing machine. In reality, one is heavier than other. Can you say which one is heavier and why?

Answer:

The volume of the bag of cotton would be much more than the iron bar and the upward buoyant force on the bag of cotton would be more than that acting on the iron bar and therefore the value is shown in case of the bag of cotton must be lesser than the actual value by a larger amount and therefore the bag of cotton is heavier than the iron bar.

NCERT Solutions for Class 9 Science Chapter 10 Gravitation: Solved Exercise Questions

Q1. How does the force of gravitation between two objects change when the distance between them is reduced to half?

Answer:

Let there be two bodies of masses m_1 and m_2 and let the distance between them be r. The gravitational force F between them would be given by

$$F = G\frac{m_1 m_2}{r^2}$$

Let the distance between them be halved by two. The gravitational force between them would now be given by

$$F' = G\frac{m_1 m_2}{(\frac{r}{2})^2}$$
$$F' = 4G\frac{m_1 m_2}{r^2}$$
$$F' = 4F$$

The force of gravitation between two objects would increase by 4 times if the distance between them is halved.

Q2. Gravitational force acts on all objects in proportion to their masses. Why then, a heavy object does not fall faster than a light object?

Answer:

The gravitational force acting is definitely more in the case of a heavier object than a light object but the acceleration depends on the ratio of the force acting on the body to the mass of the body and since gravitational force acting on a body is proportional to its mass the acceleration due to gravity is the same for all bodies irrespective of their masses.

Q.3. What is the magnitude of the gravitational force between the earth and a $1\ kg$ object on its surface? (Mass of the earth is $6 \times 10^{24}\ kg$ and radius of the Q . earth is $6.4 \times 10^{6}\ m.$)

Answer:

Mass of Earth M_E is $6 \times 10^{24}\ kg$

Mass of the body m is 1 kg

The radius of the earth R_E is $6.4 \times 10^6\ m.$

Universal gravitational constant, G = $6.67 \times 10^{-11} N\ m^2\ kg^{-2}$

The magnitude of the gravitational force between the earth and the body would be

Q4. The earth and the moon are attracted to each other by gravitational force. Does the earth attract the moon with a force that is greater or smaller or the same as the force with which the moon attracts the earth? Why?

Answer:

The earth attracts the moon with the same force as the moon attracts the earth.

We know from the third law of motion that each force has an equal and opposite force and the universal gravitational law also states the same i.e. the gravitational force of attraction between two bodies is the same.

Q5. If the moon attracts the earth, why does the earth not move towards the moon?

Answer:

The moon and the earth attract each other with the same gravitational force. It is because of the much larger mass of the earth than the mass of the moon the earth does not move towards the moon.

Q6. (i) What happens to the force between two objects, if

- the mass of one object is doubled?

Answer:

As the force between the objects is directly proportional to the product of masses of the objects if the mass of one object is doubled the force between them will also double.

Q6.(ii) What happens to the force between two objects, if

The distance between the objects is doubled and tripled?

Answer:

The force between two objects is inversely proportional to the square of the distance between them. Therefore if the distance between the objects is doubled and tripled the force between them would become one fourth and one-ninth of the initial value respectively.

Q.6.(iii) What happens to the force between two objects, if

- the masses of both objects are doubled?

Answer:

As the force between the objects is directly proportional to the product of masses of the objects if the masses of both objects are doubled the force will become four times the initial value.

Q7. What is the importance of the universal law of gravitation?

Answer:

The importance of universal law of gravitation lies in the fact that it proves that every object in the universe is attracted by every other object in the universe by the virtue of their masses.

Q8. What is the acceleration of free fall?

Answer:

The acceleration of free fall on earth is 9.8 m s^{-2} and is the same for all objects i.e. its value is independent of their masses.

Q9. What do we call the gravitational force between the earth and an object?

Answer:

The gravitational force between the earth and an object is called the weight of the object.

Q10. Amit buys few grams of gold at the poles as per the instruction of one of his friends. He hands over the same when he meets him at the equator. Will the friend agree with the weight of gold bought? If not, why? [Hint: The value of g is greater at the poles than at the equator.]

Answer:

As the value of g is more at the poles than that at the equator the weight of the same amount of gold would be more at the poles than that at the equator and therefore the friend will not agree with the weight of gold bought.

Q11. Why will a sheet of paper fall slower than one that is crumpled into a ball?

Answer:

A sheet of paper has much more area than the same paper crumbled and due to this the sheet experiences more air resistance and thus falls at a speed slower than when it is crumbled.

Q12. The gravitational force on the surface of the moon is only $\frac{1}{6}$ as strong as gravitational force on the earth. What is the weight in newtons of a $10\ kg$ object on the moon and on the earth?

Answer:

The weight of an object on earth is given by w = mg where m is the mass of the object and g is the gravitational acceleration.

g = 9.8 m s $^{-2}$

Weight of a 10 kg object on earth = 10 X 9.8 = 98 N

As the gravitational force on the surface of the moon is only 1/6th of that on earth the gravitational accelerations on the moon would be equal to g/6.

Weight of an object of mass 10 kg on the moon is therefore given as follows

$$w = 10 \times \frac{g}{6}$$
$$w = 10 \times \frac{9.8}{6}$$
$$w = 16.33N$$

Q13.(i) A ball is thrown vertically upwards with a velocity of $49\ m/s$. Calculate

- the maximum height to which it rises,

Answer:

The initial velocity of the ball u = 49 m s^{-1}

Final velocity at the highest point would be v = 0

The magnitude of the acceleration is equal to the acceleration due to gravity g

Acceleration, a = -g = -9.8 m s^{-2}

Let the maximum height to which it rises be s

Using the third equation of motion we have

$$v^2 - u^2 = 2as$$
$$s = \frac{v^2 - u^2}{2a}$$
$$s = \frac{0^2 - 49^2}{2 \times -9.8}$$
$$s = 122.5m$$

The ball would rise to a maximum value of 112.5 m.

Q13.(ii) A ball is thrown vertically upwards with a velocity of $49\ m/s$. Calculate

- The total time it takes to return to the surface of the earth.

Answer:

Let the time taken by the ball to reach the highest point be t

$$v = u + at$$
$$0 = 49 + (-9.8) \times t$$
$$t = 5\ s$$

At the same time, t would be taken to come back to the ground from the highest point.

Therefore the total time it takes to return to the surface of the earth = 2t = 10 s.

Q14. A stone is released from the top of a tower of height $19.6\ m.$ Calculate its final velocity just before touching the ground.

Answer:

Initial velocity u = 0

Acceleration, a = g = 9.8 m s^{-2}

Distance travelled, s = 19.6 m

Let the final velocity be v

According to the third equation of motion

$$v^2 - u^2 = 2as$$
$$v^2 - 0^2 = 2 \times 9.8 \times 19.6$$
$$v = \sqrt{2 \times 9.8 \times 19.6}$$
$$v = 19.6\ m\ s^{-1}$$

Its final velocity just before touching the ground will be 19.6 m s^{-1} .

Q15. A stone is thrown vertically upward with an initial velocity of $40\ m/s.$ Taking $g = 10m/s^2$, find the maximum height reached by the stone. What are the net displacement and the total distance covered by the stone?

Answer:

Initial velocity u = 40 m s^{-1}

Acceleration a = -g = -10 m s^{-2}

Final velocity at the highest point would be v = 0

Let the maximum height reached be s

As per the third equation of motion

$$v^2 - u^2 = 2as$$
$$s = \frac{v^2 - u^2}{2a}$$
$$s = \frac{0^2 - 40^2}{2 \times -10}$$
$$s = 80m$$

The net displacement would be zero as the stone will return to the point from where it was thrown.

The total distance covered by the stone = 2s = 160 m

Q16. Calculate the force of gravitation between the earth and the Sun, given that the mass of the earth $= 6 \times 10^{24} kg$ and of the Sun $= 2 \times 10^{30} kg$ The average distance between the two is $1.5 \times 10^{11} m.$

Answer:

Mass of the earth, $M_E = 6 \times 10^{24} kg$

Mass of the Sun, $M_s = 2 \times 10^{30} kg$

Distance between the earth and the sun, $d = 1.5 \times 10^{11} m$

Universal gravitational constant, $G = 6.67 \times 10^{-11} N\ kg^{-2}\ m^2$

The force of gravitation between the earth and the Sun would be given as

Q17. A stone is allowed to fall from the top of a tower $100\ m$ high and at the same time, another stone is projected vertically upwards from the ground with a velocity of $25\ m/s$. Calculate when and where the two stones will meet.

Answer:

Let the distance travelled by the stone which is dropped from the top upto the instant when the two stones meet be x

Initial velocity u = 0

Acceleration a = g = 9.8 m s^{-2}

Using the second equation of motion

$$s = ut + \frac{1}{2}at^2$$
$$x = 0 \times t + \frac{1}{2} \times 9.8 \times t^2$$
$$x = 4.9t^2 \qquad (i)$$

The distance travelled by the stone which is projected vertically upwards from the ground up to the instant when the two stones meet would be equal to 100 - x

Initial velocity = 25 m s^{-1}

Acceleration a = -g = -9.8 m s^{-2}

Using the second equation of motion

(ii)

Equating x from (i) and (ii) we get

$4.9t^2 = 4.9t^2 - 25t + 100$

25t = 100

t = 4s

$x = 4.9t^2$

$x = 4.9 \times 4^2$

x = 78.4 m

100 - x = 100 - 78.4 = 21.6 m

The stones meet after a time of 4 seconds at a height of 21.6 meters from the ground.

Q18. A ball thrown up vertically returns to the thrower after 6 s. Find

(a) the velocity with which it was thrown up,

(b) the maximum height it reaches, and

(c) its position after 4 s.

Answer:

(a) Let the ball be thrown with initial velocity u

Time taken to get back to the thrower = 6 s

Time taken to reach the highest point is t = 6/2 = 3 s

Final velocity at the highest point is v = 0

Acceleration a = -g = -9.8 m s^{-2}

Using the first equation of motion

$$v = u + at$$
$$0 = u - 9.8 \times 3$$
$$u = 29.4\ m\ s^{-1}$$

(b) Let the maximum height it reaches be s

Using the second equation of motion

$$s = ut + \frac{1}{2}at^2$$
$$s = 29.4 \times 3 - 4.9 \times 3^2$$
$$s = 44.1m$$

(c) Out of the 4 seconds, 3 have been spent in reaching the highest point

The distance travelled by the ball in the next 1 second is s' given by

$$s' = ut + \frac{1}{2}gt^2$$
$$s = 0 \times +4.9 \times 1^2$$
$$s = 4.9m$$

Distance from the ground after 4 seconds = s - s' = 44.1 - 4.9 = 39.2 m

The position of the ball after 4 seconds is 39.2 m from the ground.

Q19. In what direction does the buoyant force on an object immersed in a liquid act?

Answer:

The buoyant force acts on an object in the vertically upward direction opposite to that of gravitational force.

Q20. Why does a block of plastic released under water come up to the surface of water?

Answer:

The density of plastic is less than that of water and due to which the upwards acting buoyant force is more than the downwards acting gravitational force. Due to this, a block of plastic released under water comes up to the surface of the water.

Q21. The volume of $50\ g$ of a substance is $20\ cm^3$. If the density of water is $1\ g\ cm^{-3}$, will the substance float or sink?

Answer:

Mass of the given amount of substance = 50 g

Volume of the given amount of substance = 20 cm^3

Density of the given substance is ρ

$$\rho = \frac{50}{20}$$
$$\rho = 2.5\ cm^3$$

As the given substance has a higher density than that of water it will be sinking in water.

Q22. T he volume of a $500\ g$ sealed packet is $350\ cm^3$. . Will the packet float or sink in water if the density of water is $1\ g\ cm^{-3}$? What will be the mass of the water displaced by this packet? What will be the mass of the water displaced by this packet?

Answer:

Mass of the packet = 500 g

Volume of the packet = 350 cm ^{3}

Density of the packet is given by

$$\rho = \frac{500}{350}$$
$$\rho = 1.428\ cm^3$$

As the density of the packet is less than that of water it will sink in water.

Volume of the water displaced by the packet = volume of the packet = 350 cm ^{3}

Mass of the water displaced by the packet = Volume of the water displaced by the packet X Density of water

= 350 X 1

= 350 g

Mass of water displaced is less than the mass of packet, so the packet will sink.