Assignments in Science Class IX (Term I)

10A Gravitation

IMPORTANT NOTES

1. **Force of gravitation :** The force of attraction which exists between all objects, big or small, not only on the surface of the earth, but anywhere and everywhere in the universe, irrespective of the distances separating them, is called force of gravitation.
2. **Newton's law of gravitation :** Every body in this universe attracts every other body with a force, which is directly proportional to the product of their masses and inversely proportional to the square of distance between their centres.
3. **Gravitational constant :** It is equal to the force of attraction between two unit masses, when they are separated by a unit distance, as measured from their centres.
4. **SI unit of gravitational constant :** The SI unit of gravitational constant is Nm^2/kg^2 or Nm^2kg^{-2}. Its value is 6.67×10^{-11} Nm^2/kg^2.
5. **Force of gravity :** It is a special case of force of gravitation, when one amongst the two bodies has an infinitely large mass as compared to the other body.
6. **Force of gravity of the earth :** The force of gravitation acting on the bodies close to the surface of the earth is called force of gravity of the earth.
7. **Acceleration due to gravity of the Earth :** The acceleration with which the bodies fall towards the earth is called acceleration due to gravity. Its average value is 9.81 ms^{-2}.
8. **Variation of acceleration due to gravity.**
   (i) Acceleration due to gravity changes with the change in distance from the centre of the earth.
   (ii) Acceleration due to gravity is maximum at the poles of the earth. Its value decreases as we move towards the equator, such that its magnitude is least at the equator.
   (iii) Acceleration due to gravity decreases as we move inside the earth, such as deep mines.
   (iv) Acceleration due to gravity decreases as we move away from the surface of the earth, such as on the mountains, in aeroplanes, in spaceships, etc.
9. **Mass :** The amount of matter contained in a body is called mass. It is a scalar quantity and is measured by a physical balance. It is always a constant quantity and its unit in SI system is kilogram.
10. **Weight :** The force with which a body is attracted towards the centre of the Earth is called weight.

ASSIGNMENTS FOR SUMMATIVE ASSESSMENT

I. VERY SHORT ANSWER QUESTIONS (1 Mark)

PREVIOUS YEARS' QUESTIONS

1. State a relation between thrust and pressure. **[2010 (T-I)]**
2. State any one phenomena related to the Universal Law of Gravitation. **[2010 (T-I)]**
3. State Archimedes principle. **[2010 (T-I)]**
4. State universal law of gravitation. **[2010 (T-I)]**
5. State two factors in which the gravitational force between two objects depends. **[2010 (T-I)]**
6. What is the gravitational force between the Earth and a body called? **[2010 (T-I)]**
7. Why are sleepers used below the rails? **[2010 (T-I)]**
8. The gravitational force between two objects is F. How will the force change when the distance between them is reduced to 1/4 th? **[2010 (T-I)]**
9. What is meant by buoyant force? **[2010 (T-I)]**
10. A body of weight 20 N floats half submerged in a liquid. What is the buoyant force on the body? **[2010 (T-I)]**

11. The G. Force between two objects is F. How will this force change when the distance between them is reduced to half? **[2010 (T-I)]**

12. Define mass of an object? **[2010 (T-I)]**

13. Why is G called the Universal Constant? **[2010 (T-I)]**

14. What is meant by free fall? **[2010 (T-I)]**

15. The Earth is acted upon by the gravitational force of attraction due to the Sun. Then why does the Earth not fall towards the Sun? **[2010 (T-I)]**

16. Two objects of masses M_1 and M_2 are dropped in vacuum from a height above the surface of Earth (M_1 is grater than M_2). Which one will reach the ground first and why? **[2010 (T-I)]**

17. An object of mass 2 kg falls with an acceleration of 9.8 m/s^2 towards the ground. With what acceleration will an object of mass 4 kg fall? **[2010 (T-I)]**

18. Write the units of 'g' and 'G'? **[2010 (T-I)]**

19. Mass of an object is 10 kg. What is its weight on the Earth? ($g = 9.8\ m/s^2$) **[2010 (T-I)]**

OTHER IMPORTANT QUESTIONS

1. What do you understand by the term 'force of gravitation'?

2. Is gravitation an attractive or repulsive force?

3. Does the force of gravitation exist at all the places of the universe?

4. Define the term gravitational constant.

5. What do you understand by the statement that gravitational constant is $6.67 \times 10^{-11}\ Nm^2kg^{-2}$?

6. How does the force of gravitation depend upon the masses of the two bodies?

7. When do we use the term ''force of gravity'', rather than ''force of gravitation''?

8. At which place on the Earth, the acceleration due to gravity is zero?

9. Where can the weight of a body be zero, apart from the centre of the Earth?

10. If the Earth attracts an apple, does the apple also attract the Earth. If yes, why does the Earth not move towards the apple?

11. Name the scientist who determined the value of Universal Gravitational constant.

12. What is the SI unit of Universal Gravitational Constant (G)?

II. SHORT ANSWER QUESTIONS – I (2 Marks)

PREVIOUS YEARS' QUESTIONS

1. Define thrust and pressure and state the SI units in which they are measured. **[2010 (T-I)]**

2. What is meant by relative density of a substance ? The relative density of mercury is 13.6. What is its density in SI units? Given that the density of water is 1000 kg/m^3. **[2010 (T-I)]**

3. State the source of centripetal force that our Earth requires to revolve around the Sun. List the factors on which this force depends. **[2010 (T-I)]**

4. Show that if the Earth attracts two bodies A and B placed at the same distance from the centre of the Earth with the same force, then their masses are equal. **[2010 (T-I)]**

5. (a) Name the two factors on which the buoyant force depends.

(b) State the relationship between the buoyant force on an object and weight of the liquid displaced by it? **[2010 (T-I)]**

6. A nail is driven into a wooden board by using a hammer. The impact of the hammer on the head of nail produces a thrust of 25 N. If the area of the head is 0.5 mm^2 and of the tip is 0.1 mm^2, find the pressure on the head and the tip of the nail. **[2010 (T-I)]**

7. A man weighs 600 N on Earth. What is his mass ? ($g = 10\ ms^{-2}$). On Moon his weight would be 100 N. What is acceleration due to gravity on the Moon? **[2010 (T-I)]**

8. (a) What is free-fall?

(b) Write the equations of motion if an object is thrown in vertically upward direction. **[2010 (T-I)]**

9. A stone fell from the top of a tower taking 5 seconds to reach the ground level calculate.

(i) The velocity of the stone on reaching the ground.

(ii) The height of the tower ($g = 9.8\ m/s^2$) **[2010 (T-I)]**

10. The mass of the Earth is 6×10^{24} kg. The radius of the Earth is 6.4×10^6 m, and the gravitational constant $6.7 \times 10^{-11}\ Nm^2/kg^2$, calculate the value of g. **[2010 (T-I)]**

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

[2010 (T-I)]

12. What is the difference between 'G' and 'g'?

[2010 (T-I)]

13. State Universal law of Gravitation. What is S.I. unit of G? **[2010 (T-I)]**

14. A ball is thrown vertically upwards with a velocity of 49 ms^{-1}. Calculate

(a) the maximum height to which it rises.

(b) the total time it takes to return to the surface of the Earth. **[2010 (T-I)]**

15. Distinguish between mass and weight.

[2010 (T-I)]

16. (i) State Universal law of Gravitation.

(ii) Express this law mathematically.

(iii) What is S.I. unit of G? **[2010 (T-I)]**

17. An object is thrown vertically upwards and rises to a height of 20 m. Calculate

(a) The velocity with which the object was thrown upwards.

(b) The time taken by the object to reach the highest point. [g = 10 m/s^2] **[2010 (T-I)]**

18. State Universal law of Gravitation. How the force between the two bodies is affected if the distance between them is tripled? **[2010 (T-I)]**

19. If a planet existed whose mass and radius were both half of that of Earth, what would be the acceleration due to gravity at the surface of the planet in terms of that on the surface of Earth ? **[2010 (T-I)]**

20. The Earth attracts the moon. Does the moon attract the Earth? If it does, why does the Earth not move towards the moon? **[2010 (T-I)]**

21. The Earth attracts an apple. Does the apple also attract the Earth? If it does, why does the Earth not move towards the apple? **[2010 (T-I)]**

22. Mention any two phenomena which will successfully explained on the basis of Universal law of gravitation. **[2010 (T-I)]**

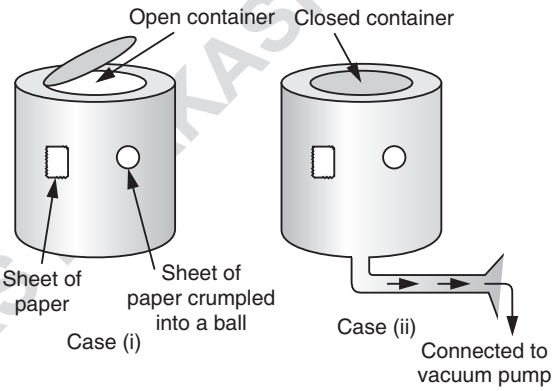
23. How is gravitational force of attraction between two bodies affected if

(i) Mass of both bodies is doubled.

(ii) Distance between them is halved.

[2010 (T-I)]

24. Look at the diagrams below :



A sheet of paper and a crumpled paper are thrown down from the same height and time is noted. Answer the following questions.

(a) Will the time taken to reach the bottom of the container be the same for the sheet of paper and crumpled paper? Why? Explain giving reason.

(b) What will happen in case (ii)? **[2010 (T-I)]**

OTHER IMPORTANT QUESTIONS

1. A bar of gold is found to have a mass of 100 g and weight of 0.98 N at some place. When the bar is taken to some place at the equator, it is found that the mass remains 100 g, but the weight is less than 0.98 N. Explain the above observations.

2. If the force of gravity somehow vanishes, why would we be sent flying in space?

3. A bag of sugar weighs W at a certain place on the equator. If this bag is taken to Antarctica, will it weighs the same or more or less. Give a reason for your answer.

4. Why do sledges used by Eskimos have no wheels?

5. Why are cutting instruments often sharpened?

6. Why is the butt of a rifle very broad, but the tip of a bullet pointed?

III. SHORT ANSWER QUESTIONS – II (3 Marks)

PREVIOUS YEARS' QUESTIONS

1. Distinguish between mass and weight of an object. How does weight of an object change on moving from equator to poles? When can the weight of an object be zero? **[2010 (T-I)]**

2. Explain why the value of 'g' differs while moving from poles to equator on the surface of the Earth. State how would it's value change on moving :

(a) towards the centre of Earth.

(b) away from the Earth. **[2010 (T-I)]**

3. Assuming that the mass of Earth is 100 times larger than the mass of Moon and the radius of Earth is about 4 times as that of Moon, show that the weight of an object on Moon is 1/6th of that on Earth. **[2010 (T-I)]**

4. State the source of centripetal force that a planet requires to revolve around the Sun. On what factors does that force depend? Suppose this force suddenly becomes zero, then in which direction will the planet begin to move if no other celestial body affects it? **[2010 (T-I)]**

5. (a) The Earth is acted upon by gravitation of Sun, even then does not fall into the Sun. Why?

(b) An object of mass 500 g is dropped from a tower of height 5 m. Calculate its momentum when it touches the ground (given g = 10 m/s^2). **[2010 (T-I)]**

6. State Archimede's Principle. A ball weighing 4 kg of density 4000 kg m^{-3} is completely immersed in water of density 1000 kg m^{-3}. Find the apparent weight of the ball in water. (g = 10 ms^{-2}). **[2010 (T-I)]**

7. (a) A body whose volume is 100 cm^3 weighs 10 N in air. Find its weight in water (Take g = 10 ms^{-2}, density of water = 1000 kg m^{-3}) **[2010 (T-I)]**

(b) A body is weighed first in air, then in liquid A and then in liquid B. The observations are 100 N, 50 N and 60 N respectively. Which liquid is denser? What is the ratio of density of liquid A to that of liquid B?

8. If the mass of the Moon is 1/100th the mass of the Earth and radius of moon is 1/4th the radius of the Earth, what is the weight of an object on the Moon as compared to that on the Earth? **[2010 (T-I)]**

9. A ball thrown up vertically returns to the thrower after 6s. Find : **[2010 (T-I)]**

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

(b) the maximum height it reaches.

(c) its position after 4s. (Given g = 9.8 m/s^2)

10. A solid body of density 5000 kg/m^3 weighs 5 N in air. It is completely immersed in water of density 1000 kg/m^3.

(i) Calculate the apparent weight of the solid in water.

(ii) What would happen to the body if water is replaced by a liquid of density 8000 kg/m^3 (Take g = 10 m/s^2) **[2010 (T-I)]**

11. State Universal law of Gravitation. Write SI unit of G. The gravitational force between two objects is 100 N. How should the distance between the objects be changed so that force between them becomes 50 N? **[2010 (T-I)]**

12. A particle is thrown up vertically with a velocity of 50 ms^{-1}. How high would the particle rise and what time would it take to reach the highest point? (g = 10 ms^{-2}) **[2010 (T-I)]**

13. (a) Differentiate between thrust and pressure. State the unit in which they are measured.

(b) Column of mercury of mass (10.2 g) is in a tube of uniform cross-section of 0.1 cm^2. Calculate the length of the column. (density of mercury = 13.6 g cm^{-3}) **[2010 (T-I)]**

14. (a) The weight of a man on the surface of Earth is 392 N. Find its mass [g = 9.8 m/s^2]

(b) If the man were taken to Moon, what would be

(i) his mass and

(ii) weight?

(iii) calculate acceleration due to gravity on the Moon. **[2010 (T-I)]**

15. (a) State Newton's universal law of gravitation **[2010 (T-I)]**

(b) Derive a mathematical expression for the Newton's law of gravitation.

16. Would the rate of fall of a sheet of paper and one that is crumpled into a ball be different in

(a) air

(b) vacuum? Why? **[2010 (T-I)]**

17. Show that the weight of an object on Moon is one-sixth of its weight on Earth. **[2010 (T-I)]**

Given

$$\begin{bmatrix} \text{Mass of Earth } 5.98\times10^{24}\,\text{kg} \\ \text{Radius of Earth } 6.37\times10^{6}\,\text{m} \\ \text{Mass of Moon } 7.36\times10^{22}\,\text{kg} \\ \text{Radius of Moon } 1.74\times10^{6}\,\text{m} \end{bmatrix}$$

18. (a) What is the unit of force? Define it. **[2010 (T-I)]**

(b) A stone is dropped from the edge of the rod. Find out the following

(i) How long does it take to fall 4.9 m?

(ii) How fast does it move at the end of that fall ?

(iii) How fast does it move at the end of 7.9 m ?

(iv) What is its acceleration after 1s and 2s?

19. A stone is allowed to fall down 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 ms^{-1}. Calculate when and where the two stones will meet? (Take g = 10 ms^{-2}) **[2010 (T-I)]**

20. A cube of side 5 cm is immersed in water and then in saturated salt solution. In which case will it experience a greater buoyant force. If each side of the cube is reduced to half and then immersed in water. What will be the effect on the buoyant force experienced by the cube as compared to the first case for water? Give reason for each. **[2010 (T-I)]**

21. A ball thrown up vertically returns to the thrower after 4 s. Find :

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

(b) the maximum height it reaches and

(c) its position after 3 s. **[2010 (T-I)]**

22. A cricket ball is dropped from a height 20 m.

(a) Calculate the speed of the ball when it hits the ground.

(b) Calculate the time it takes to fall through this height. (g = 10 m/s^2) **[2010 (T-I)]**

23. Derive an expression for acceleration due to gravity on the surface of Earth in terms of mass and radius of Earth. **[2010 (T-I)]**

24. A ball is thrown vertically upwards with a velocity of 48 m/s. Calculate :

(a) the maximum height to which it rises.

(b) the total time it takes to return to the surface of the Earth (g = 9.8 m/s^2) **[2010 (T-I)]**

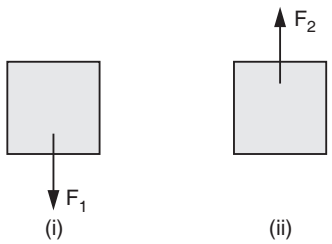
25. Using Newton's universal law of gravitation and second law of motion, find the mathematical expression for acceleration due to gravity on the surface of any planet. **[2010 (T-I)]**

26. A ball is thrown vertically upwards with a velocity of 49 m/s. Calculate : **[2010 (T-I)]**

(a) The maximum height to which it rises.

(b) The total time it takes to return to the surface of the Earth. (Take g = 9.8 m/s^2)

27. In the diagram below :



(a) Which one out of :

(i) or

(ii) represents weight of the box?

(b) If F_1 = 24 N on the surface of the Earth, what would be its value on the Moon?

(c) Calculate the mass of the object if the weight of the object is 24 N on Earth. (g = 10 m/s^2) **[2010 (T-I)]**

OTHER IMPORTANT QUESTIONS

1. A body weighs 25 kg on the surface of the Earth. If the mass of the Earth is 6×10^{29} kg, the radius of the Earth is 6.4×10^6 m and the gravitational constant 6.7×10^{-11} Nm^2kg^{-2}, calculate :

(i) The mutual force of attraction between the body and the Earth.

(ii) The acceleration produced in the body.

(iii) The acceleration produced in the Earth.

2. An imaginary planet has a mass 5 times and radius 3 times that of the Earth.

(i) What is the acceleration due to gravity on the planet, if the acceleration due to gravity on the Earth is 10 ms^{-2}.

(ii) Calculate the weight of a body on the planet, if the mass of the body is 8 kg.

3. An object has a mass of 30 kg. What is its weight (i) on the Moon (ii) on another planet? The value of 'g' on the Moon is 1/6 the value of 'g' on the Earth and the value of g on the planet is 3 times the value of 'g' on the Earth, $g_{Earth} = 10\ ms^{-2}$ (iii) Is mass a scalar or a vector quantity?

4. A person weighs 80 N on the surface of the Earth. What should be the distance of the person from the surface of the Earth, so that his weight is 5N? Radius of the Earth = 6400 km.

5. Calculate the gravitational force acting between the Earth and an object of mass 1000 g kept on its surface.

6. A person weighs 117.36 N on the Moon, whose acceleration due to gravity is 1/6 of that of the Earth. If the acceleration due to gravity on the Earth is 9.78 ms^{-2}, calculate (i) mass of the person (ii) weight of the person on the Earth.

7. Suggest a method for calculating the mass of the Moon.

8. (i) Calculate the force between two objects when
(a) mass of one of the objects is doubled
(b) masses of both the objects are doubled
(c) the distance between the objects is doubled
(d) the distance between the objects is halved.
(ii) What will be the acceleration of a body during a free fall?

IV. LONG ANSWER QUESTIONS (5 Marks)

PREVIOUS YEARS QUESTIONS

1. (a) A car falls off a ledge and drops to the ground in 0.5 s, let g = 10 m/s^2.
(i) What is its speed on striking the ground?
(ii) What is its average speed during the 0.5 s?
(iii) How high is the ledge from the ground ?
(b) Derive the expression for acceleration due to gravity. **[2010 (T-I)]**

2. (a) Differentiate between mass and weight [Four points].
(b) Show that weight of an object on Moon is equal to 1/6 of the weight of the object on the Earth. Given mass of Earth $= 6.5 \times 10^{24}$ kg Mass of moon $= 7.4 \times 10^{22}$ kg, Radius of Earth $= 6.4 \times 10^{6}$ m. **[2010 (T-I)]**

3. Will a sheet of paper fall slower than one that.
(a) is crumpled into a ball in vacuum? Write.
(b) Show mathematically that acceleration experienced by an object is independent of its mass.
(c) Show that value of g = 9.8 m/s^2
Given G = 6.7×10^{-11} $N\ m^2/kg^2$
M = 6×10^{24} kg
R = 6.4×10^{6} m **[2010 (T-I)]**

OTHER IMPORTANT QUESTIONS

1. (i) At some moment, two giant planets Jupiter and Saturn of the solar system are in the same line as seen from the Earth. Find the total gravitational force due to them on a person of mass 50 kg on the Earth. Could the force due to the planets be important?
Mass of the Jupiter = 2×10^{27} kg
Mass of the Saturn = 6×10^{26} kg
Distance of Jupiter from the Earth = 6.3×10^{11} m
Distance of Saturn from the Earth = 1.28×10^{12} m
Gravitational constant, G = 6.67×10^{-11} $Nm^2\ kg^{-2}$
Acceleration due to gravity on the Earth = 9.8 ms^{-2}
(ii) A bag of sugar weighs W at a certain place on the equator. If this bag is taken to Antarctica, will it weigh the same or more or less. Give a reason for your answer.

2. Calculate the percentage change in the weights of a body when it is taken from the equator to the poles. The radius of the Earth at equator is 6378 km and at the poles is 6357 km.

3. A ball is dropped from a height of 20 m. A second ball is thrown from the same height after one second with initial velocity 'u'. If both the balls reach the ground at the same time, calculate the initial velocity of the second ball. Do they hit the ground at the same velocity? [Take g = 10 ms^{-2}].

4. Prove that the weight of an object on the moon is $\frac{1}{6}$ th of its weight on the Earth.

[Given : Mass of the Earth = 5.98×10^{24} kg. Mass of the moon = 7.36×10^{22} kg Radius of the Earth = 6.37×10^{6} m, Radius of the moon = 1.74×10^{6} m]

5. (i) Suppose the mass of the Earth somehow increases by 10% without any change in its size. What would happen to your weight? Suppose the radius of the Earth becomes twice of its present radius without any change in mass, what will happen to your weight?

(ii) Why are big boulders carried in fast moving river water over hundreds of kilometres?

ASSIGNMENTS FOR FORMATIVE ASSESSMENT

A. Experiment

Objective

To prove that acceleration produced in freely falling bodies is the same for all bodies, irrespective of their masses.

Materials required

A long glass tube having one end closed. Vacuum pump, a coin and a feather.

Procedure

(i) Take long glass tube and set a vacuum pump at its one end.

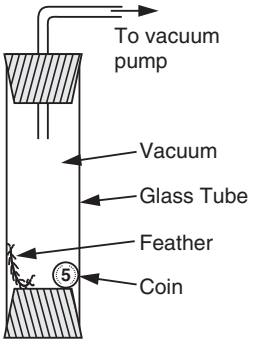
(ii) To create vacuum in the long glass tube with the help of vacuum pump.

(iii) Now allow the feather and the coin to fall simultaneously.

(iv) Observe how they fall on the bottom of the tube.

(v) Repeat the experiments four times more and observe their way of falling.

(vi) You will observe that both of them reached the ottom of the tube at the same time in each times.



Conclusion

Acceleration produced in freely falling bodies is the same for all bodies, irrespective of their masses.

Assignments in Science Class IX (Term II)

10B Floatation

IMPORTANT NOTES

1. **Pressure :** The thrust (force) acting normally on unit area of a surface is called pressure.
2. **SI unit of pressure** is newton/(metre)^2 or N/m^2. It is commonly called pascal (Pa).
3. **Definition of pascal :** When a force of 1 newton acts normally on an area of cross-section 1 m^2, then the pressure experienced by the surface is said to one pascal.
4. **Buoyancy :** The phenomenon due to which a body on being immersed in a fluid experiences an upward force is called buoyancy.
5. **Buoyant force or upthrust :** The upward force experienced by a body on being immersed in a fluid is called buoyant force or upthrust.
6. Buoyant force or upthrust acting on a body is always equal to the weight of the fluid displaced by the immersed part of the body in the fluid.
7. **Archimedes' Principle :** When a body is partially or wholly immersed in a fluid, it experiences an upthrust (or apparently loses its weight) which is equal to the weight of the fluid displaced by the immersed part of the body.
8. **Density :** Mass per unit volume of a substance is called density. Its unit in CGS system is g/cm^3 and in SI system is kg/m^3.
9. **Relative density :** The ratio between the density of a substance and the density of water at 4°C is called relative density.

   The relative density is a pure number and has no units.

ASSIGNMENTS FOR SUMMATIVE ASSESSMENT

I. VERY SHORT ANSWER QUESTIONS (1 Mark)

PREVIOUS YEARS' QUESTIONS

1. Give reason why, a block of plastic when released under water comes up to the surface of water. **[2011 (T-II)]**
2. Define density. What is the SI unit of density? **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. Name and define SI unit of pressure.
2. What do you understand by the term buoyancy?
3. Why does a mug full of water feel lighter inside water?
4. A perpendicular force of 50 N acting on a surface generates a pressure of 250 Pa. Calculate the area of cross-section of the surface on which pressure is acting.
5. What is a lactometer used for?
6. State the unit of density and relative density in SI system.
7. State Archimedes' principle.
8. What is meant by buoyant force?
9. A cork floats while the nail sinks in water. Give reason.
10. What is the principle of floatation?
11. A body of mass 400 g has a volume of 300 cm^3. Will body sink in water or not?
    [Density of water = 1000 kgm^{-3}]

II. SHORT ANSWER QUESTIONS - I (2 Marks)

PREVIOUS YEARS' QUESTIONS

1. When we stand on loose sand, our feet go deep into the sand. But when we lie down on the sand our body does not go that deep in the sand. Why? **[2011 (T-II)]**

2. Define relative density of a substance. Relative density of silver is 10.8. The density of water is 1000 kgm^{-3}. What is the density of silver in SI units? **[2011 (T-II)]**

3. A cork floats in water, while the iron nail sinks. Give reason. **[2011 (T-II)]**

4. State Archimedes' Principle. Based on this principle, write its two applications.

[2011 (T-II)]

5. (i) Define pressure.

(ii) Why is it easy to walk on sand with flat shoes, then with high heel shoes?

[2011 (T-II)]

6. (i) Define buoyant force.

(ii) Mention any two factors affecting the buoyant force. **[2011 (T-II)]**

7. Loaded test-tube placed in pure milk sinks to a certain mark (M). Now some water is mixed with the milk. Will the test tube sink more or less? Explain. **[2011 (T-II)]**

8. If two equal weights of unequal volumes are balanced in air, what will happen when these are completely dipped in water? **[2011 (T-II)]**

9. The volume of 40 g of a solid is 15 cm^3. If the density of water is 1 g/cm^3, will the solid float or sink? Why? **[2011 (T-II)]**

10. A steel needle sinks in water but a steel ship floats. Explain how. **[2011 (T-II)]**

11. (a) Name the forces acting on a body? When it is fully or partially immersed in a liquid.

[2011 (T-II)]

(b) Briefly explain, why some objects float and some sink?

12. A dining hall has dimension 50 m × 15 m × 3.5 m. Calculate the mass of air in the hall. (Given, density of air = 1.30 kg/m^3) **[2011 (T-II)]**

13. Relative densities of two substances A and B are 2.5 and 0.9 respectively. Find densities of A and B. Also find whether they will sink or float in water. (Density of water = 1000 kg/m^3)

[2011 (T-II)]

14. (a) List two factors on which buoyant force depends.

(b) Find pressure, when a thrust of 20 N is applied on a surface area of 10 cm^2.

[2011 (T-II)]

15. Which will exert more pressure 100 kg mass on 10 m^2 or 50 kg mass on 5 m^2? Give reason.

[2011 (T-II)]

16. (a) Explain why a truck or a motor bus has much wider tyres?

(b) Why do we feel lighter when we swim?

[2011 (T-II)]

17. You have a bag of cotton and an iron bar, each indicating a mass of a 100 kg when measure on a weighing machine. In reality, one is heavier than the other. Can you say which one is heavier and why? **[2011 (T-II)]**

18. Account for the statement : ''camel walks easily on sand but it is difficult for a man to walk on sand though a camel is much heavier than a man''. **[2011 (T-II)]**

19. A piece of stone is tied at one end of a rubber string and holding from other end, it is allowed to immersed partially then full into water. What difference if any, you will observe, and why?

[2011 (T-II)]

20. An object of 40 N weight when immersed in water losses 10 N weight. Will the object float or sink? Why? **[2011 (T-II)]**

21. Why is it easier to swim in sea water than in river water? **[2011 (T-II)]**

22. Differentiate between density and relative density? **[2011 (T-II)]**

23. What is Thrust? Why do buildings have wide foundation? **[2011 (T-II)]**

24. Lead has greater density than iron and both are denser than water. Is the buoyant force on a lead object greater than, or lesser than or equal to

the buoyant force on an iron object of the same volume? Explain your answer giving reason. **[2011 (T-II)]**

25. The wheels of a army tank rest on a steel belt, give reason. **[2011 (T-II)]**

26. While drawing water from a well, a bucket of water appears to be heavier as it comes out of the water. Explain giving reasons. **[2011 (T-II)]**

27. Why are railway tracks laid on large sized concrete sleepers? Explain. **[2011 (T-II)]**

28. What happens when :

(a) Buoyant Force exerted by the fluid is less than the weight of the body? **[2011 (T-II)]**

(b) Buoyant Force exerted by the fluid is equal to the weight of the body?

29. What is Relative Density? The relative density of a substance is greater than 1, what does it signify? **[2011 (T-II)]**

30. If relative density of aluminium is 2.7 and density of water is 1000 kg/m^3. What is the density of aluminium in SI unit? **[2011 (T-II)]**

31. The volume of a solid block is 300 cm^3, find the mass of water displaced when it is immersed in water? (Density of water is 1 g/cm^3)

[2011 (T-II)]

32. A solid object of mass 50 g and volume 100 cm^3 is put in water. Will the object float or sink? Give reasons for your answer. **[2011 (T-II)]**

33. Name the instrument used to determine the density of liquid in which balance and graduated cylinder are not required. Why this instrument is made heavy near the bottom? **[2011 (T-II)]**

34. A sphere of mass 5 kg and volume 2.2×10^{-4} m^3 is completely immersed in water. Find the buoyant force exerted by water on the sphere. Density of water = 1000 kgm^{-3}. (Given : g = 9.8 ms^{-2}) **[2011 (T-II)]**

35. A ship is loaded in sea water to maximum capacity. What will happen if this ship is moved to river water? Why? **[2011 (T-II)]**

36. (a) Differentiate between upthrust and weight.

(b) When does an object float or sink?

[2011 (T-II)]

37. A sealed can of mass 600 g has a volume of 500 cm^3. Will this can sink or float in water? [Density of water is 1 gcm^{-3}] Why?

[2011 (T-II)]

38. Explain the factors which determine whether an object floats or sinks when placed on the surface of water. **[2011 (T-II)]**

39. Two blocks, one of iron and other of wood are immersed in water at same depth. Which one will come upward? Why? **[2011 (T-II)]**

40. (a) Define relative density.

(b) If the relative density of a substance is less than 1, will it float or sink in water support your answer? (Density of water = 1000 kg m^3) **[2011 (T-II)]**

41. (a) Define relative density. **[2011 (T-II)]**

(b) Relative density of gold is 19.3. The density of water is 10.3 kg/m^3. What is the density of gold in S.I. units?

42. The mass of an empty 40 litre petrol tank of a vehicle is 8.0 kg. What will be its mass when filled completely with a fuel of density 700 kg/m^3. **[2011 (T-II)]**

43. (a) A floating boat displaces water weighing 6000 N. **[2011 (T-II)]**

(i) What is the buoyant force on the boat?

(ii) What is the weight of boat?

(b) What happens to the buoyant force as more and more volume of a solid object is immersed in a liquid?

OTHER IMPORTANT QUESTIONS

1. Why does a skier not sink in fresh snow?

2. Why do sledges used by Eskimos have no wheels?

3. Why are cutting instruments often sharpened?

4. Why is the butt of a rifle very broad, but tip of a bullet pointed?

5. Name the force experienced by a body when immersed in a fluid. What is the direction of force?

6. Explain why sheet of paper falls slower than a coin under through air.

7. A solid body of mass 150 g and volume 250 cm^3 is placed in a jar contains water. Will it float or

III. SHORT ANSWER QUESTIONS - II (3 Marks)

PREVIOUS YEARS' QUESTIONS

sink in water? Density of water is 1 g/cm^3.

1. An object is made to fall from different heights 20 cm, 40 cm and 60 cm on a wet sand. **[2011 (T-II)]**

(a) What do you observe on the sand?

(b) Explain the reasons of the observations.

2. (a) Define Buoyancy.

(b) A solid body of mass 150 g occupies 60 cm^3 volume. Will the solid sink or float? Given density of water is 1 gcm^{-3}. **[2011 (T-II)]**

OTHER IMPORTANT QUESTIONS

1. (a) State the SI units of thrust and pressure.

(b) In which situation we exert more pressure we stand on the foot or on the both feet? Justify your answer.

2. (a) State Archimedes' principle.

(b) Define relative density of substance, why it has no units?

3. (a) State Archimedes' principle.

(b) The relative density of silver is 10.8. The density of water is 10^3 kgm^{-3}. What is the density of silver in SI units?

4. Give reasons :

(a) Cutting tools have sharp edges.

(b) A sheet of paper falls slower than one is crumpled into a ball.

ASSIGNMENTS FOR FORMATIVE ASSESSMENT

A. Field Trip

Visit the nearest port or jetty where cargo is moved by boats or ships. Observe how the level of water around the boat changes when it is loaded or unloaded.

B. Group Discussions

(a) Discuss the following with your teacher.

1. Boats filled with people or cargo capsize in midstream.

2. White or yellow lines are marked around the hull of ocean going vessels.

3. Archimedes principle be used to find out the purity of gold.

(b) Discuss the following situations in groups.

1. Why are the rear wheels of tractors very wide?

2. Why do the army tanks move over broad steel chains?

3. Why do we often sharpen kitchen knives?

4. Why do the Eskimos not fix wheels to their sledges?

5. Why are the dams made very wide and thick at the base?

6. Why do skiers use wide and long skies?

7. Why are certain trailers provided with 16 wheels or more?

8. Why should we spread over the body as flat as possible, if we get struck in quicksand?

C. Activity

Activity

To find the change in pressure by a solid, by changing

(i) area of cross-section of solid

(ii) force exerted by solid.

Materials Required

(i) Three bricks of same size and weight

(ii) Soft mud about 2′ × 2′ × 4″

Part (a)

1. Place a brick gently on the mud, such that its maximum area touches the mud.

2. Place another brick gently on its side on the mud.
3. Place the third brick in upright position gently on the mud, such that its maximum area touches the mud.
4. Lift the bricks gently one by one. Look at the depression created in mud. You will notice that the depression created by the first brick is least and it is maximum in case of the third brick. From the above observations, it implies that more is the area of contact, less is the pressure exerted.

Part (b)

1. Place a brick gently on the mud, such that its maximum area touches the mud. Mark a line with a chalk upto which the brick sinks in mud.
2. Now place another brick on the first brick. Again mark a line with the chalk on the brick upto which it sinks.
3. Repeat the procedure with the third brick.
4. You will observe that with the increase in the number of bricks, the depression produced in the mud increases. From this activity, it implies that pressure increases with the increase in force. In the present case, it is the gravitational force.

Conclusions :

(i) Pressure exerted by a solid increase with the decrease in area of cross-section,

i.e., $P \propto \frac{1}{A}$

(ii) Pressure exerted by a solid increases with the increase in applied force (thrust),

i.e., $P \propto F$

D. Experiment

Objective : *To find the buoyancy offered by various liquids.*

Materials required :

A steel or a stiff plastic glass, 20 marbles of the same size and weight, a mm graph paper, cellotape, a pencil.

Procedure :

1. Cut 1 cm wide strip from the mm graph paper, equal to the length of glass. Mark on the strip 0, 1, 2, 3 - - - - - - - - - 14, 15 in centimetres.
2. By placing the zero end of the mm strip at the mouth of the glass, fix the mm strip along the length of glass with the help of cellotape.
3. Take water in a bucket and try to float the glass in an upright position. You will notice that the glass does not float upright. Drop one marble in the glass gently. See, if the glass floats upright. If not, go on dropping marbles till it floats upright. At this moment read and record the length of the glass outside the water from the mm strip and the number of marbles added.
4. Add one more marble. Read and record the length of glass and the number of marbles.
5. Repeat the experiment at least 6 more times. Read and record the lengths in each case and the number of marbles.
6. Empty the glass and try to float it in saturated salt solution. Add marbles, till it starts floating upright. Read and record the length of glass outside the salt solution and number of marbles added.
7. Repeat the experiment at least 6 more times. Read and record the lengths in each case and total number of marbles.

	Water		**Saturated Salt Solution**	
	Number of marbles	**Length outside water**	**Number of marbles**	**Length outside salt solution**
1				
2				
3				
4				
5				
6				
7				

Conclusions :

1. The glass initially does not float upright, because upthrust due to water or brine is more than the weight of glass.
2. When the glass just starts floating upright, the weight of the glass acting in the downward

direction is equal to the weight of the fluid (water or salt solution) acting in the upward direction.

3. When more weight is added to the glass, it slips more in water or salt solution. From this it implies that with the immersion of more volume of the vessel in a fluid, the upthrust increases.
4. The upthrust offered by brine is more than that by water. From this it implies that more is the density of a fluid, more is the upthrust it produces.

Science Quiz

1. Why does the empty glass not float upright in water?
2. How does the addition of marbles make the glass float in an upright position?
3. Why are more marbles required to make the glass float upright in the salt solution?
4. Why does the salt solution offer more upthrust than brine?

Class IX Chapter 10 – Gravitation Science

Question 1:

State the universal law of gravitation Answer:

The universal law of gravitation states that every object in the universe attracts every other object with a force called the gravitational force. The force acting between two objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centers.

For two objects of masses m_1 and m_2 and the distance between them r, the force (F) of attraction acting between them is given by the universal law of gravitation as:

$$F = \frac{Gm_1m_2}{r^2}$$

Where, G is the universal gravitation constant given by:

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

Question 2:

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 be the mass of the Earth and m be the mass of an object on its surface. If R is the radius of the Earth, then according to the universal law of gravitation, the gravitational force (F) acting between the Earth and the object is given by the relation:

$$F = \frac{Gm_1m_2}{r^2}$$

Question 1:

What do you mean by free fall?

Answer:

Gravity of the Earth attracts every object towards its centre. When an object is released from a height, it falls towards the surface of the Earth under the influence of

gravitational force. The motion of the object is said to have free fall.

Question 2:

What do you mean by acceleration due to gravity?

Answer:

When an object falls towards the ground from a height, then its velocity changes during the fall. This changing velocity produces acceleration in the object. This acceleration is known as acceleration due to gravity (g). Its value is given by 9.8 m/s^2.

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

Answer:

S. No.	Mass	Weight
I.	Mass is the quantity of matter contained in the body.	Weight is the force of gravity acting on the body.
II.	It is the measure of inertia of the body.	It is the measure of gravity.
III.	Mass is a constant quantity.	Weight is not a constant quantity. It is different at different places.
IV.	It only has magnitude.	It has magnitude as well as direction.
V.	Its SI unit is kilogram (kg).	Its SI unit is the same as the SI unit of force, i.e., Newton (N).

Question 2:

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

Answer:

Let M_E be the mass of the Earth and m be an object on the surface of the Earth. Let R_E be the radius of the Earth. According to the universal law of gravitation, weight W_E of the object on the surface of the Earth is given by,

$$W_E = \frac{GM_E m}{R_E^2}$$

Let M_M and R_M be the mass and radius of the moon. Then, according to the universal

law of gravitation, weight W_M of the object on the surface of the moon is

given by:

$$W_M = \frac{GM_M m}{R_M^2}$$

$$\frac{W_M}{W_E} = \frac{M_M R_E^2}{M_E R_M^2}$$

Where, $M_E = 5.98 \times 10^{24}$ kg, $M_M = 7.36 \times 10^{22}$ kg

$R_E = 6.4 \times 10^6$ m, $R_M = 1.74 \times 10^6$ m

$$\therefore \frac{W_M}{W_E} = \frac{7.36 \times 10^{22} \times (6.37 \times 10^6)^2}{5.98 \times 10^{24} \times (1.74 \times 10^6)^2} = 0.165 \approx \frac{1}{6}$$

Therefore, weight of an object on the moon is $\frac{1}{6}$ of its weight on the Earth.

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 thin strap because the pressure on the shoulders is quite large. This is because the pressure is inversely proportional to the

surface area on which the force acts. The smaller is the surface area; the larger will be the pressure on the surface. In the case of a thin strap, the contact surface area is very small. Hence, the pressure exerted on the shoulder is very large.

Question 2:

What do you mean by buoyancy?

Answer:

The upward force exerted by a liquid on an object immersed in it is known as buoyancy. When you try to immerse an object in water, then you can feel an upward force exerted on the object, which increases as you push the object deeper into water.

Question 3:

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

Answer:

If the density of an object is more than the density of the liquid, then it sinks in the liquid. This is because the buoyant force acting on the object is less than the force of gravity. On the other hand, if the density of the object is less than the density of the liquid, then it floats on the surface of the liquid. This is because the buoyant force acting on the object is greater than the force of gravity.

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

Answer:

When you weigh your body, an upward force acts on it. This upward force is the buoyant force. As a result, the body gets pushed slightly upwards, causing the weighing machine to show a reading less than the actual value.

Question 2:

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 iron bar is heavier than the bag of cotton. This is because the surface area of the cotton bag is larger than the iron bar. Hence, more buoyant force acts on the bag than that on an iron bar. This makes the cotton bag lighter than its actual value. For this reason, the iron bar and the bag of cotton show the same mass on the weighing

machine, but actually the mass of the iron bar is more that that of the cotton bag.

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

Answer:

According to the universal law of gravitation, gravitational force (F) acting between two objects is inversely proportional to the square of the distance (r) between them,

i.e.,

$$F \propto \frac{1}{r^2}$$

If distance r becomes r/2, then the gravitational force will be proportional to

$$\frac{1}{\left(\frac{r}{2}\right)^2} = \frac{4}{r^2}$$

Hence, if the distance is reduced to half, then the gravitational force becomes four times larger than the previous value.

Question 2:

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:

All objects fall on ground with constant acceleration, called acceleration due to gravity (in the absence of air resistances). It is constant and does not depend upon the mass of an object. Hence, heavy objects do not fall faster than light objects.

Question 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 6×10^{24} kg and radius of the earth is 6.4×10^{6} m).
Answer:

According to the universal law of gravitation, gravitational force exerted on an object of mass m is given by:

$$F = \frac{GMm}{r^2}$$

Where,

Mass of Earth, M = 6×10^{24} kg

Mass of object, m = 1 kg

Universal gravitational constant, G = 6.7×10^{-11} $Nm^2 kg^{-2}$

Since the object is on the surface of the Earth, r = radius of the Earth (R)

r = R = 6.4×10^{6} m

Gravitational force, $F = \frac{GMm}{R^2}$

$$= \frac{6.7 \times 10^{-11} \times 6 \times 10^{24} \times 1}{(6.4 \times 10^{6})^2} = 9.8 \text{ N}$$

Question 4:

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:

According to the universal law of gravitation, two objects attract each other with equal force, but in opposite directions. The Earth attracts the moon with an equal force with which the moon attracts the earth.

Question 5:

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

Answer:
The Earth and the moon experience equal gravitational forces from each other. However, the mass of the Earth is much larger than the mass of the moon. Hence, it accelerates at a rate lesser than the acceleration rate of the moon towards the Earth.

For this reason, the Earth does not move towards the moon.

Question 6:

What happens to the force between two objects, if (i) the mass of one object is doubled?

(ii) the distance between the objects is doubled and tripled?

(iii) the masses of both objects are doubled?

Answer:

(i) Doubled (ii) One-fourth and one-ninth (iii) four times

According to the universal law of gravitation, the force of gravitation between two

objects is given by:

$$F = \frac{Gm_1m_2}{r^2}$$

(i) F is directly proportional to the masses of the objects. If the mass of one object is doubled, then the gravitational force will also get doubled.

(ii) F is inversely proportional to the square of the distances between the objects. If the distance is doubled, then the gravitational force becomes one-fourth of its

original value.

Similarly, if the distance is tripled, then the gravitational force becomes one-ninth of its original value.

(iii) F is directly proportional to the product of masses of the objects. If the masses of both the objects are doubled, then the gravitational force becomes four times the original value.

Question 7:

What is the importance of universal law of gravitation?

Answer:

The universal law of gravitation proves that every object in the universe attracts every other object.

Question 8:

What is the acceleration of free fall?

Answer:

When objects fall towards the Earth under the effect of gravitational force alone, then they are said to be in free fall. Acceleration of free fall is 9.8 m s^{-2}, which is constant for all objects (irrespective of their masses).

Question 9:

What do we call the gravitational force between the Earth and an object?

Answer:

Gravitational force between the earth and an object is known as the weight of the object.

Question 10:

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:

Weight of a body on the Earth is given by:

W = mg Where, m = Mass of

the body g = Acceleration due to

gravity

The value of g is greater at poles than at the equator. Therefore, gold at the equator weighs less than at the poles. Hence, Amit's friend will not agree with the weight of the gold bought.

Question 11:

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

Answer:
When a sheet of paper is crumbled into a ball, then its density increases. Hence, resistance to its motion through the air decreases and it falls faster than the sheet of paper.

Question 12:

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:

Weight of an object on the moon $= \frac{1}{6} \times$ Weight of an object on the Earth

Also,

Weight = Mass × Acceleration

Acceleration due to gravity, g = 9.8 m/s^2

Therefore, weight of a 10 kg object on the Earth = 10 × 9.8 = 98 N

And, weight of the same object on the moon $= \frac{1}{6} \times 98 = 16.3\ \text{N}$

Question 13:

A ball is thrown vertically upwards with a velocity of 49 m/s. Calculate (i) the maximum height to which it rises.

(ii)the total time it takes to return to the surface of the earth.

Answer:

(i) 122.5 m (ii) 10 s

According to the equation of motion under gravity:

$v^2 - u^2 = 2$ gs Where,
u = Initial velocity of the ball v

= Final velocity of the ball s =

Height achieved by the ball g

= Acceleration due to gravity

At maximum height, final velocity of the ball is zero, i.e., v = 0 u

= 49 m/s

During upward motion, g = − 9.8 m s^{-2}

Let h be the maximum height attained by the ball.

Hence,

$$0-(49)^2=2\times(-9.8)\times h$$

$$h=\frac{49\times 49}{2\times 9.8}=122.5\text{ m}$$

Let t be the time taken by the ball to reach the height 122.5 m, then according to the equation of motion:

v = u + gt

We get,

$$0=49+t\times(-9.8)$$

$$9.8t=49$$

$$t=\frac{49}{9.8}=5\text{ s}$$

But,

Time of ascent = Time of descent

Therefore, total time taken by the ball to return = 5 + 5 = 10 s Question 14:

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:
According to the equation of motion under gravity: v^2 − u^2 = 2 gs Where,

u = Initial velocity of the stone = 0 v =

Final velocity of the stone s = Height of the

stone = 19.6 m g = Acceleration due to

gravity = 9.8 m s^{-2} ∴ $v^2 - 0^2 = 2 \times 9.8 \times$

19.6 v^2 =

2 × 9.8 × 19.6 = $(19.6)^2$ v =

19.6 m s^{-1}

Hence, the velocity of the stone just before touching the ground is 19.6 m s^{-1}.

Question 15:

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

Answer:

According to the equation of motion under gravity: $v^2 - u^2 = 2gs$ Where,

u = Initial velocity of the stone = 40 m/s

v = Final velocity of the stone = 0 s = Height of the stone g = Acceleration due to gravity = −10 m s^{-2}

Let h be the maximum height attained by the stone.

Therefore,

$$0-(40)^2 = 2\times h\times(-10)$$

$$h = \frac{40\times 40}{20} = 80 \text{ m}$$

Therefore, total distance covered by the stone during its upward and downward journey

= 80 + 80 = 160 m

Net displacement of the stone during its upward and downward journey

= 80 + (−80) = 0 Question 16:

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

Answer:

According to the universal law of gravitation, the force of attraction between the Earth

and the Sun is given by:

$$F = \frac{G\, M_{Sun} M_{Earth}}{R^2}$$

Where,

M_{Sun} = Mass of the Sun = 2×10^{30} kg

M_{Earth} = Mass of the Earth = 6×10^{24} kg

R = Average distance between the Earth and the Sun = 1.5×10^{11} m G = Universal gravitational constant = 6.7×10^{-11} Nm^2 kg^{-2}

$$F = \frac{6.7\times10^{-11}\times2\times10^{30}\times6\times10^{24}}{(1.5\times10^{11})^2} = 3.57\times10^{22}\ \text{N}$$

Question 17:

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 two stones meet after a time t.
(i) For the stone dropped from the tower:

Initial velocity, u = 0

Let the displacement of the stone in time t from the top of the tower be s.
Acceleration due to gravity, g = 9.8 m s^{-2} From the equation of motion,

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

(ii) For the stone thrown upwards:

Initial velocity, u = 25 m s^{-1}

Let the displacement of the stone from the ground in time t be s'.

Acceleration due to gravity, g = −9.8 m s^{-2}

Equation of motion,

$$s' = ut + \frac{1}{2}gt^2$$

$$= 25t - \frac{1}{2} \times 9.8 \times t^2$$

$$\therefore s' = 25t - 4.9t^2 \qquad (2)$$

The combined displacement of both the stones at the meeting point is equal to the height of the tower 100 m.

$$\therefore s + s' = 100$$

$$\frac{1}{2}gt^2 + 25t - \frac{1}{2}gt^2 = 100$$

$$\therefore t = \frac{100}{25} = 4 \text{ s}$$

$$s = \frac{1}{2} \times 10 \times 4^2 = 80 \text{ m}$$

equation (1) as In 4 s, the falling stone has covered a distance given by

Therefore, the stones will meet after 4 s at a height (100 – 80) = 20 m from the ground

Question 18:

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) 29.4 m/s (b) 44.1 m (c) 39.2 m above the ground

(a) Time of ascent is equal to the time of descent. The ball takes a total of 6 s for its upward and downward journey.

Hence, it has taken 3 s to attain the maximum height.

Final velocity of the ball at the maximum height, v = 0

Acceleration due to gravity, g = −9.8 m s^{-2}

Equation of motion, v = u + gt will give,

0 = u + (−9.8 × 3) u = 9.8

× 3 = 29.4 ms^{-1}

Hence, the ball was thrown upwards with a velocity of 29.4 m s^{-1}.
(b) Let the maximum height attained by the ball be h.

Initial velocity during the upward journey, u = 29.4 m s^{-1}
Final velocity, v = 0

Acceleration due to gravity, g = −9.8 m s^{-2}

From the equation of motion, $s = ut + \frac{1}{2}at^2$

$$h = 29.4 \times 3 + \frac{1}{2} \times -9.8 \times (3)^2 = 44.1 \text{ m}$$

(c) Ball attains the maximum height after 3 s. After attaining this height, it will start falling downwards. In this case,

Initial velocity, u = 0

Position of the ball after 4 s of the throw is given by the distance travelled by it during its downward journey in 4 s − 3 s = 1 s.

Equation of motion, $s = ut + \frac{1}{2}gt^2$ will give,

$$s = 0 \times t + \frac{1}{2} \times 9.8 \times 1^2 = 4.9 \text{ m}$$

Total height = 44.1 m
This means that the ball is 39.2 m (44.1 m − 4.9 m) above the ground after 4 seconds.

Question 19:

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

Answer:

An object immersed in a liquid experiences buoyant force in the upward direction.

Question 20:

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

Answer:
Two forces act on an object immersed in water. One is the gravitational force, which pulls the object downwards, and the other is the buoyant force, which pushes the object upwards. If the upward buoyant force is greater than the downward gravitational force, then the object comes up to the surface of the water as soon as it is released within water. Due to this reason, a block of plastic released under water comes up to the surface of the water.

Question 21:

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:

If the density of an object is more than the density of a liquid, then it sinks in the liquid. On the other hand, if the density of an object is less than the density of a liquid, then it floats on the surface of the liquid.

Here, density of the substance = $\frac{\text{Mass of the substance}}{\text{Volume of the substance}} = \frac{50}{20} = 2.5 \text{ g cm}^{-3}$

The density of the substance is more than the density of water (1 g cm^{-3}). Hence, the substance will sink in water.

Question 22:

The 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?

Answer:

$$= \frac{\text{Mass of the packet}}{\text{Volume of the packet}} = \frac{500}{350} = 1.428 \text{ g cm}^{-3}$$

Density of the 500 g sealed packet 1 g cm^{-3}
The density of the substance is more than the density of water ( ). Hence, it will sink in water.

The mass of water displaced by the packet is equal to the volume of the packet, i.e., 350 g.