1. A body of mass 1kg is attracted by the earth with a force which is equal to
   a. 9.8N
   b. 6.67×10^{11}
   c. 1 N
   d. 9.8m/s

2. What is the gravitational force between two objects?
   a. attractive at large distances only
   b. attractive at small distances only
   c. attractive at all distances
   d. attractive at large distances but repulsive at small distances

3. The value of 'g'
   a. Increases as we go above the earth's surface
   b. Decreases as we go to the centre of the earth
   c. Remains constant
   d. Is more at equator and less at poles

4. The ball is thrown up, the value of 'g' will be
   a. Zero
   b. positive
   c. negative
   d. negligible

5. The gravitational force causes
   a. Tides
   b. Motion of moon
   c. None of them
   d. Both a n b

6. The mass of the body on moon is 40kg, what is the weight on the earth.
   a. 240kg
   b. 392N
   c. 240N
   d. 400kg

7. Newton's law of gravitation applies to
   a. Small bodies only
   b. Plants only
   c. All bodies irrespective of their size
   d. For solar system

8. The gravitational force between two objects is F. If masses of both the objects are halved without altering the distance between them, then the gravitational force would become

a. f/4
b. f/2
c. f
d. 2f

9. The Earth attracts the moon with a gravitational force of 1020N. The moon attracts the earth with a gravitational force of

a. Less than 10^{20}N
b. 10^{20}N
c. Greater than 10^{20}N
d. 10^{-20}N

10. The distance between two bodies becomes 6 times more than the usual distance. The the F becomes

a. 36 times
b. 6 times
c. 12 times
d. 1/36 times

ANSWERS

1. A
2. C
3. B
4. C
5. D
6. B
7. C
8. A
9. C
10. D

Question 1. The value of acceleration due to gravity on the surface of the earth at sea level is

(a) 4.9 m/s^2
(b) 6 m/s^2
(c) 8 m/s^2
(d) 9.8 m/s^2

Answer. (d) 9.8 m/s^2

Question 2. When an object is thrown vertically upward, on reaching the highest point, the value of acceleration due to gravity will be

(a) 4.9 m/s^2
(b) 9.8 m/s^2 upwards
(c) 9.8 m/s^2 towards the ground
(d) 0 m/s^2

Answer. (c) 9.8 m/s^2 towards the ground

Question 3. In the polar regions, the value of acceleration due to gravity

(a) is same as at the equator
(b) Is more than at the equator
(c) Is less than at the equator
(d) zero

Answer. (b) Is more than at the equator

Question 4. Weight of an object on the surface of the moon is

(a) 1/2 th of the weight of object on the surface of the earth
(b) 1/4 th of the weight of object on the surface of the earth
(c) 1/6 th of the weight of object on the surface of the earth
(d) 1/8 th of the weight of object on the surface of the earth

Answer. (c) 1/6 th of the weight of object on the surface of the earth

Question 5. For an object, which is projected vertically upwards, the time of ascent when measured from the point of projection, will be

(a) less the Time of descent
(b) greater the Time of descent
(c) equal to the Time of descent
(d) None of the above

Answer. (c) equal to the Time of descent

Question 6. The force which keeps the body to move in circular motion when accelerated is

(a) Centripetal force
(b) Magnetic force
(c) Electrostatic force
(d) Force of gravitation

Answer. (a) Centripetal force

Question 7. The expression for finding the gravitational force of attraction between any two bodies is

(a) $F= Gm_1 m_2/r$
(b) $F= Gm_1 m_2/r^2$
(c) $F= Gm_1 /r^2$
(d) $F= Gm_1 m_2/r^3$

Answer. (b)$F= Gm_1 m_2/r^2$

Question 8. The reaction force, caused by expulsion of mass in one direction, applied on a surface in a direction perpendicular to the surface is called

(a) weight
(b) Pressure
(c) Centripetal force
(d) thrust

Answer. (d) thrust

Question 9. SI Unit of pressure is

(a) Pascal
(b) Newton

(c) Dyne
(d) barye

Answer. (a) Pascal

Question 10. The upward force exerted by the liquid displaced by the body when it is placed inside the liquid is called

(a) Gravitational force
(b) Force of gravitation
(c) Buoyant force
(d) Centripetal force

Answer. (c) Buoyant force

Question 11. An an object on moon surface weighs 66 kg , the the weight of same object, on surface of earth will be

(a) 6 kg
(b) 11 kg
(c) 33 kg
(d) 66 kg

Answer. (b) 11 kg

Question 12. $Wt_{(Moon)}$ - the weight of an object on moon and $Wt_{(Earth)}$ - the weight of an object on earth, are related to each other as per the expression :

(a) $Wt_{(Moon)} = {}^{1}/_{4}\, Wt_{(Earth)}$

(b) $Wt_{(Moon)} = 6\ Wt_{(Earth)}$

(c) $Wt_{(Moon)} = Wt_{(Earth)}$

(d) $Wt_{(Moon)} = {}^{1}/_{6}\, Wt_{(Earth)}$

Answer. (d) $Wt_{(Moon)} = {}^{1}/_{6}\, Wt_{(Earth)}$

Question 13. If the distance between objects decreases, then the gravitational force between the objects will:

(a) decrease
(b) Increase
(c) remain same
(d) none of the above

Answer. (b) increase

Question 14. Which of the following was not a contribution of Newton's to science?

(a) laws of motion
(b) the law of universal gravitation
(c) the first experiment to measure the accurate values of G, the gravitational constant of proportionality
(d) explanation of fundamental nature of light by means of different optical phenomena such as the refraction and diffraction etc.

Answer. c) the first experiment to measure the accurate values of G, the gravitational constant of proportionality

Question 15. The mass of an physical object is

(a) not the same thing as weight of an object
(b) The amount of matter contained in the object, independent of the position of object
(c) measure of the extent to which a particle or object resists a change in its direction or speed when a force is applied.
(d) All of the above

Answer. (d) All of the above

Two objects of different masses falling freely near the surface of moon would

- (a) have same velocities at any instant
- (b) have different accelerations
- (c) experience forces of same magnitude
- (d) undergo a change in their inertia

The value of acceleration due to gravity

- (a) is same on equator and poles
- (b) is least on poles
- (c) is least on equator
- (d) increases from pole to equator

The gravitational force between two objects is F. If masses of both objects are halved without changing distance between them, then the gravitational force would become

- (a) F/4
- (b) F/2
- (c) F
- (d) 2 F

A boy is whirling a stone tied with a string in an horizontal circular path. If the string breaks, the stone

- (a) will continue to move in the circular path
- (b) will move along a straight line towards the centre of the circular path
- (c) will move along a straight line tangential to the circular path
- (d) will move along a straight line perpendicular to the circular path away from the boy

An object is put one by one in three liquids having different densities. The object floats with 1 / 9, 2 / 11, 3 / 7, and parts of their volumes outside the liquid surface in liquids of densities d_1, d_2 and d_3 respectively. Which of the following statement is correct?

- (a) $d_1 > d_2 > d_3$
- (b) $d_1 > d_2 < d_3$
- (c) $d_1 < d_2 > d_3$
- (d) $d_1 < d_2 < d_3$

In the relation $F = G M m/d^2$, the quantity G

- (a) depends on the value of g at the place of observation
- (b) is used only when the earth is one of the two masses
- (c) is greatest at the surface of the earth
- (d) is universal constant of nature

 Law of gravitation gives the gravitational force between

- (a) the earth and a point mass only
- (b) the earth and Sun only
- (c) any two bodies having some mass
- (d) two charged bodies only

 The value of quantity G in the law of gravitation

- (a) depends on mass of earth only
- (b) depends on radius of earth only
- (c) depends on both mass and radius of earth
- (d) is independent of mass and radius of the earth

 Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will be

- (a) 1 / 4 times
- (b) 4 times
- (c) 1 / 2 times
- (d) unchanged

 The atmosphere is held to the earth by

- (a) gravity
- (b) wind
- (c) clouds
- (d) earth’s magnetic field

 The force of attraction between two unit point masses separated by a unit distance is called

- (a) gravitational potential
- (b) acceleration due to gravity
- (c) gravitational field

- (d) universal gravitational constant

 The weight of an object at the centre of the earth of radius R is

- (a) zero
- (b) infinite
- (c) R times the weight at the surface of the earth
- (d) $1/R^2$ times the weight at surface of the earth

 An object weighs 10 N in air. When immersed fully in water, it weighs only 8 N. The weight of the liquid displaced by the object will be

- (a) 2 N
- (b) 8 N
- (c) 10 N
- (d) 12 N

 A girl stands on a box having 60 cm length, 40 cm breadth and 20 cm width in three ways. In which of the following cases, pressure exerted by the brick will be

- (a) maximum when length and breadth form the base
- (b) maximum when breadth and width form the base
- (c) maximum when width and length form the base
- (d) the same in all the above three cases

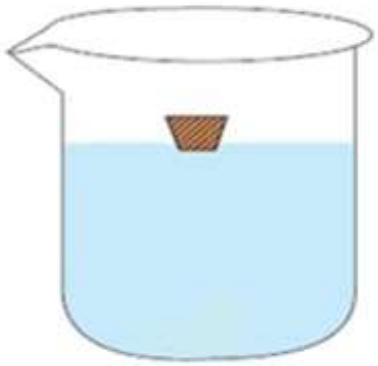
 An apple falls from a tree because of gravitational attraction between the earth and apple. If F_1 is the magnitude of force exerted by the earth on the apple and F_2 is the magnitude of force exerted by apple on earth, then

- (a) F_1 is very much greater than F_2
- (b) F_2 is very much greater than F_1
- (c) F_1 is only a little greater than F_2
- (d) F_1 and F_2 are equal

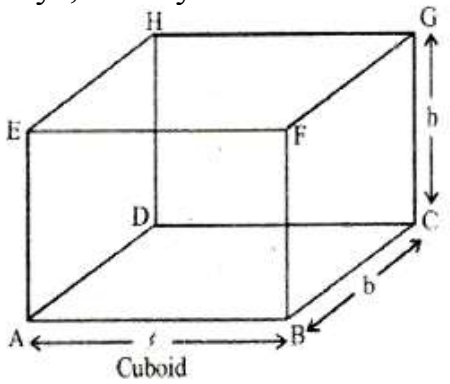
Answers to Multiple Choice Questions

1. (a)	2. (c)	3. (a)	4. (c)	5. (d)
6. (d)	7. (c)	8. (d)	9. (b)	10. (a)
11. (d)	12. (a)	13. (a)	14. (b)	15. (d)

1. The mass of moon is about 0.012 times that of the earth and its diameter is about 0.25 times that of earth. The value of G on the moon will be:
(a) Same as that on the earth
(b) About one-fifth of that on the earth
(c) About one-sixth of that on the earth
(d) About one-fourth of that on the earth
Answer: (a) Same as that on the earth
2. An apple falls from a tree because of the gravitational attraction between the earth and the apple. If F1 is the magnitude of the force exerted by the earth on the apple and F2 is the magnitude of the force exerted by the apple on the earth, then
(a) F1 is very much greater than F2
(b) F2 is very much greater than F1
(c) F1 and F2 are equal
(d) F1 is only a little greater than F2
Answer: (c) F1 and F2 are equal
3. The earth and the moon are attracted to each other by gravitational force. The earth attracts the moon with a force that is:
(a) More than that exerted by the moon
(b) Same as that exerted by the moon
(c) Less than that exerted by the moon
(d) Not related to that exerted by the moon
Answer: (b) Same as that exerted by the moon
4. A stone is released from the top of a tower of height 19.6 m. Then its final velocity just before touching the ground will be:
(a) 384.16 m/ s
(b) 196 m/s
(c) 19.6 m/s
(d) 3841.4 m/s
(Take $g = 9.8\ m/s^2$)
Answer: (c) 19.6 m/s
5. When a piece of cork is put into the water it starts floating on the surface of water due to the upward buoyant force from water.

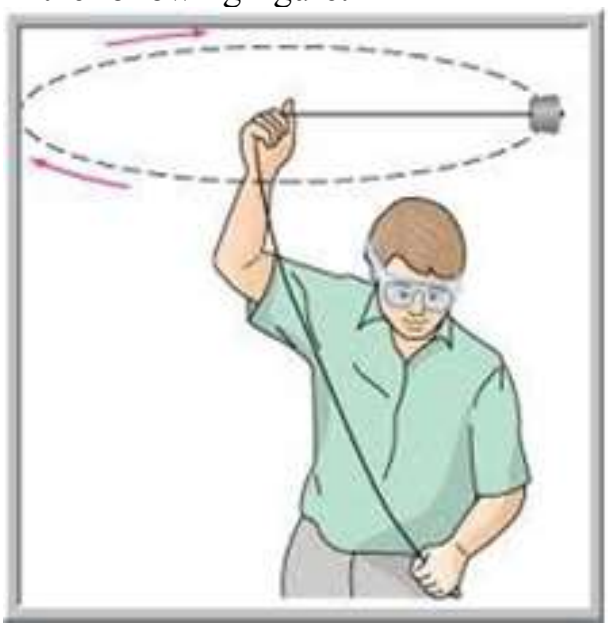


If the cork is pushed more inside the water by applying the force than the buoyant force:
(a) Will increase as the cork is immersed into the water
(b) Will decrease as the cork is immersed into the water
(c) Will first increase and then decrease as the cork is immersed more into the water
(d) Will remain the same as long as the cork is inside the water
Answer: (a) Will increase as the cork is immersed into the water
6. A rectangular wooden block has the length, breadth and height of 40 cm, 35 cm and 10 cm, respectively. This wooden block is kept on ground in three different ways, turn by turn.



Which of the following is the correct statement about the pressure exerted by this block on the ground?
(a) The maximum pressure is exerted when the length and breadth form the base
(b) The maximum pressure is exerted when the length and height form the base
(c) The maximum pressure is exerted when the breadth and height form the base
(d) The maximum pressure is exerted when the length and height form the base
Answer: (c) The maximum pressure is exerted when the breadth and height form the base
7. Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will be:

(a) 1/4 times
(b) 4 times
(c) 1/2 times
(d) Unchanged
Answer: (b) 4 times
8. A boy is whirling a stone tied with a string in a horizontal circular path as shown in the following figure:



If the string breaks the stone:
(a) Will move along a straight line towards the centre of the circular path
(b) Will move along a straight line the tangential to the circular path
(c) Will move along a straight line perpendicular to the circular path away from the boy
(d) Will continue to move in the circular path
Answer: (b) Will move along a straight line the tangential to the circular path
9. Following table represents the mass and volume data of the three liquids named A, B, C and D. Can you find which two liquids are identical?

Liquid	**Mass (in g)**	**Volume (in cm^3)**
A	80	100
B	100	100
C	80	80
D	100	80

(a) A and C

(b) B and C
(c) A and D
(d) B and D
Answer: (b) B and C
10. A ball weighing 4 kg of density 4000 kgm^{-3} is completely immersed in water of density10^3 kgm^{-3}. What will be the buoyant force acting on it?
(a) 100 N
(b) 10 N
(c) 1600N
(d) 16 N
Answer: (b) 10 N
11. Choose the correct unit for the relative density among the following:
(a) kg/cm
(b) unitless
(c) kg/cm
(d) kg/m^3
Answer: (b) unitless
12. An object having mass equal to 350 g occupies 200 cm^3 of the space. When this object is thrown into a river what will be the condition of this object there? (Density of water = 1 g/ cm^3)
(a) It will float on the surface of water
(b) It will float fully submerged in the liquid
(c) It will sink in the liquid
(d) It will float partially submerged in the liquid
Answer: (c) It will sink in the liquid
13. An object is put in three liquids having different densities, one by one. The object floats with 1/9, 2/11 and 3/7 parts of its volume outside the surface of liquids of densities d1, d2 and d3 respectively. Which of the following is the correct order of the densities of three liquids?
(a) d1 > d2 > d3
(b) d2 > d3 > d1
(c) d1 < d2 < d3
(d) d3 > d2 > d1
Answer: (c) d1 < d2 < d3
14. The school bags are generally provided with the broad strips because:
(a) It will spread the force of the bag over the large area of the shoulder of the child producing large pressure
(b) It will spread the force of the bag over the large area of the shoulder of the child producing less pressure
(c) It has become a trend among the students to carry the bags with wide strips

(d) It will spread the force of the bag over the small area of the shoulder of the child producing less pressure

Answer: (b) It will spread the force of the bag over the large area of the shoulder of the child producing less pressure

15. Two objects of different masses falling freely near the surface of moon would:

(a) Have different accelerations

(b) Undergo a change in their inertia

(c) Have same velocities at any instant

(d) Experience forces of same magnitude

Answer: (c) Have same velocities at any instant

Q.1. What is the mass per unit volume of a substance called?

(a) Pressure

(b) Force

(c) Night

(d) Density

Q.2. One SI Unit of thrust is equal to _____ CGS Unit of it?

(a) 10

(b) 10-5

(c) 105

(d) 107

Q.3. What is the units of relative density?

(a) kg/m3

(b) g/cm3

(c) g/m3

(d) no units

Q.4. Acceleration due to gravity of the Earth increases with

(a) decrease in the height from the surface of the Earth

(b) increase in the height from the surface of the Earth.

(c) increase in the depth from the surface of the Earth.

(d) increase in the temperature of the Earth.

Q.5. The upthrust that acts on a body placed in a liquid is due to _____.

(a) the volume of the displaced liquid

(b) the volume of the body floating above the liquid

(c) the volume of body inside the liquid
(d) both a and c

Q.6. What will happen when a body of relative density more than that of water is dropped into water?
(a) floats on the water.
(b) sinks into the water.
(c) suspends at the surface of the water.
(d) sinks into or suspends in the surface.

Q.7. The value of the universal gravitational constant is _____
(a) 6.67 x 10-11 Nm2/kg2
(b) 66.7 x 10-11 Nm2/kg2
(c) 0.6 x 10-11 Nm2/kg
(d) None of these

Q.8. A cuboid is resting on a table in a way that its greater surface is in contact with the table. If its position is changed, then the
(a) pressure applied by it on the table decreases.
(b) pressure applied by it on the table does not change.
(c) pressure applied by it on the table increases.
(d) Insufficient information.

Q.9. Pressure applied at any point of the liquid is transmitted equally and distributed in all directions is given by _____.
(a) Newton's law
(b) Pascal's law
(c) Archimedes' principle
(d) Universal law of gravitation

Q.10. Upthrust on a body immersed completely in the water is equal to
(a) the weight of the body.
(b) the weight of the water displaced.
(c) the weight of the water in which the body is immersed.
(d) None of these

Q.11. Earth moves in a circular motion around the Sun because of _____force,
(a) frictional
(b) static

(c) applied
(d) gravitational

Q.12. If two bodies of masses 2 kg and 4 kg are separated by 10 m, the gravitational force of attraction between them is _____N.
(a) 5.336 10-12
(b) 23.29 x 10–13
(c) 9.324 x 10-10
(d) 9.45 x 10-15

Q.13. Which of the following bodies can float in water?

Body	Mass	Volume
P	20 g	2 cm3
Q	5 g	2 cm3
R	120 g	1 m3
S	18 g	2 cm3

(a) S
(b) R
(c) Q
(d) P

Q.14. What will be the ratio of the time periods of revolution of two planets around the Sun if the ratio of their mean distances from the Sun is 3 : 5.
(a) 3355
(b) 2335
(c) 23 3/2
(d) 49 2/3

Q.15. The SI unit of mass is_____.
(a) milligram
(b) gram
(c) kilogram
(d) All of these

Answer Key for Class 9 Science Chapter 10 Gravitation MCQs

Q.	Ans	Q.	Ans
1	(d)	9	(b)
2	(c)	10	(b)
3	(d)	11	(d)
4	(a)	12	(a)
5	(d)	13	(b)
6	(b)	14	(a)
7	(a)	15	(c)
8	(c)		

1. An object weighing 5 N in air, weighs 4.5 N a liquid. The buoyant force experienced by the object is
(a) (5 + 4.5) N
(b) 4.5/5 N
(c) 5/4.5 N
(d) 0.5 N
► (d) 0.5 N
2. The density of copper is 9 g/cm^3. Then the volume of 90 g copper is
(a) 90 cm^3
(b) 9 cm^3
(c) 810 cm^3
(d) 10 cm^3
► (d) 10 cm^3
3. A heavy cylinder of length 1 is slowly taken out of a dense liquid. The weight felt as it is taken out of the liquid
(a) will remain the same
(b) increases as it comes out
(c) decreases as it comes out
(d) increases till it attains the weight in air
► (d) increases till it attains the weight in air
4. The constant G
(a) is a very small quantity

(b) is a force
(c) is the same as g
(d) decrease with increasing altitude
► (a) is a very small quantity
5. The value of ‘g’ is minimum:
(a) on hills
(b) in mines
(c) at equator of earth
(d) at poles of earth
► (c) at equator of earth
6. The tidal waves in the sea are primarily due to_____.
(a) atmospheric effect of Earth.
(b) gravitational effect of Mars on Earth.
(c) gravitational effect of Moon on Earth.
(d) None of the above.
► (c) gravitational effect of Moon on Earth.
7. The gravitational force between two bodies does not depend on
(a) their separation
(b) their masses
(c) the product of their masses
(d) the medium between the two bodies
► (d) the medium between the two bodies
8. An apple and a stone dropped from certain height accelerates
(a) equally
(b) differently
(c) depending on density
(d) depends on the position of the sun
► (a) equally
9. If the density of the object placed in a liquid is equal to the density of the liquid, the object will:
(a) Float half immersed
(b) Float wholly immersed
(c) Float completely above the liquid
(d) Sink
► (a) Float half immersed
10. Two particles are placed at some distance. If mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will become/remain
(a) 1/4 times
(b) 4 times

(c) 1/2 times
(d) unchanged
► (b) 4 times
11. A packet of 400 g and volume 200 cm^3 is put in a water tank. The relative density of packet is
(a) 200
(b) 2
(c) 4
(d) 400
► (b) 2
12. At which of the following locations is the value of g largest?
(a) On top of the Mount Everest
(b) On top of Qutub Minar
(c) At a place on the equator
(d) A camp site in Antarctica
► (d) A camp site in Antarctica
13. The magnitude of gravitational force between the earth and 10 kg body is:
(a) 98 N
(b) 90 N
(c) 9.8 N
(d) 100 N
► (a) 98 N
14. An object of weight 500 N is floating in a liquid. The magnitude of buoyant force acting on it is
(a) 500 N
(b) 400 N
(c) 200 N
(d) 100 N
► (a) 500 N
15. Universal law of gravitation does not explain
(a) the tides on earth due to the moon
(b) the motion of electrons in an atom
(c) the motion of planets around the Sun
(d) the motion of the moon around the earth
► (b) the motion of electrons in an atom
16. Acceleration due to gravity varies with
(a) height
(b) depth
(c) shape of the planet
(d) all of the above

► (d) all of the above
17. The sea water is denser than fresh water due to
(a) Mixing of sand
(b) Stagnation
(c) Mixing of salts
(d) Evaporation
► (c) Mixing of salts
18. The universal law of gravitation was postulated by
(a) Galileo
(b) Newton
(c) Copernicus
(d) Archimedes
► (b) Newton
19. Gravitational force does not depend on:
(a) Masses of two bodies.
(b) The gravitational constant.
(c) Charge on two bodies
(d) Separation between two bodies.
► (c) Charge on two bodies
20. The weight of an object_____.
(a) is the quantity of matter it contains.
(b) refers to its inertia.
(c) is the force with which it is attracted to the earth.
(d) is the same as the mass.
► (c) is the force with which it is attracted to the earth.
21. Two objects of different masses falling freely near the surface of moon would
(a) experience forces of different magnitudes
(b) have different accelerations
(c) have same velocities of any instant
(d) undergo a change in their inertia
► (c) have same velocities of any instant
22. The walls of a dam at the bottom are made thick because
(a) it looks attractive
(b) it is conventional
(c) it is convenient
(d) water exerts large pressure at the bottom
► (d) water exerts large pressure at the bottom
23. The same body is immersed in two liquids A and B in succession. The extent to which the body sinks in liquid B is less then in liquid A. What are the conclusions that could be derived from such an observation

(a) The density of liquid A is more then B
(b) The density of liquid B is more then A
(c) The density of solid is less then the liquid in both
(d) No such conclusion can be made
► (b) The density of liquid B is more then A
24. Archimedes' principle holds for
(a) liquids only
(b) gases only
(c) liquids and gases both
(d) neither liquids nor gases
► (c) liquids and gases both
25. If upthrust U is equal to 1/4 the weight of the object in air, then the weight felt in the liquid is
(a) 1/4W
(b) 3/4W
(c) 1/2W
(d) 2 W
► (b) 3/4W
26. Acceleration due to gravity on the surface of the moon is 1/6th of its value on the surface of the earth as they have different_____.
(a) mass
(b) density
(c) radius
(d) All of the above
► (d) All of the above
27. The force of attraction between two unit point masses separated by a unit distance is called
(a) gravitational potential
(b) acceleration due to gravity
(c) gravitational field
(d) universal gravitational constant
► (d) universal gravitational constant
28. Weight of an object is highest at
(a) Center of earth
(b) Poles
(c) Above the earth's surface
(d) Equator
► (b) Poles

Very Short Answer Questions

Question 1.
What will happen to the gravitational force between two bodies if the masses of one body is doubled?
Answer:
If the mass of one body is doubled, force is also doubled.

Question 2.
Why is ‘G’ called the universal gravitational constant?
Answer:
The constant ‘G’ is universal because it is independent of the nature and sizes of bodies, the space where they are kept and at the time at which the force is considered.

Question 3.
Who formulated the universal law of gravitation?
Answer:
Isaac Newton

Question 4.
How is gravitation different from gravity?
Answer:
Gravitation is the force of attraction between any two bodies while gravity refers to attraction between any body and the earth.

Question 5.
What does a small value of G indicate?
Answer:
A small value of G indicates that the force of gravitational attraction between two ordinary sized objects is a very weak force.

Question 6.
At what place on the earth’s surface is the weight of a body maximum?
Answer:
At the poles.

Question 7.
At what place on the earth’s surface is the weight of a body minimum?
Answer:
At the equator.

Question 8.
If the mass of a body is 9.8 kg on the earth, what would be its mass on the moon?

Answer:
It will remain the same on the moon, i.e., 9.8 kg.

Question 9.
Do fluids possess weight?
Answer:
Yes, fluids have weight.

Question 10.
Why can one jump higher on the surface of the moon than on the earth?
Answer:
Because the value of acceleration due to gravity (g) on the moon's surface is nearly l/6th to that of the surface of the earth.

Question 11.
Define the standard kilogram.
Answer:
The standard kilogram is the mass of a block of a platinum alloy kept at the international bureau of weights and measures near Paris in France.

Question 12.
If the earth attracts two objects with equal force, can we say that their masses must be equal?
Answer:
No

Question 13.
Is weight a force?
Answer:
Yes.

Question 14.
What keeps the moon in uniform circular motion around the earth?
Answer:
Gravitational force between moon and the earth keeps moon in uniform circular motion around the earth.

Question 15.
When a body is dropped from a height, what is its initial velocity?
Answer:
Zero.

Question 16.
When a body is thrown vertically upwards, what is its final velocity?
Answer:
Zero.

Question 17.
Is the time taken by a body to rise to the highest point equal to the time taken to fall from the same height?
Answer:
Yes.

Question 18.
Is the acceleration due to gravity acting on a freely falling body directly proportional to the (a) mass of the body? (b) time of fall of the body?
Answer:
(a) No
(b) No

Question 19.
Suppose gravity of earth suddenly becomes zero, then which direction will the moon begin to move if no other celestial body affects it?
Answer:
The moon will begin to move in a straight line in the direction in which it was moving at that instant because the circular motion of moon is due to centripetal force provided by the gravitational force of the earth.

Question 20.
The earth is acted upon by gravitation of sun, even though it does not fall into the sun. Why?
Answer:
The gravitational force is responsible for providing the necessary centripetal force which allows the earth to move around the sun at the defined path or orbit. So, the earth does not fall into the sun.

Question 21.
If the small and big stones are dropped from the roof of a house simultaneously, they will reach the ground at the same time. Why?
Answer:
The acceleration due to gravity does not depend upon the mass of the stone or body. Both the bodies fall with the same acceleration towards the surface of the earth. Thus a big stone will fall with the same acceleration as a small stone. So, both the stones will reach the ground at the same time when dropped simultaneously.

Short Answer Questions-I

Question 1.
The earth attracts an apple. Does the apple also attract the earth? If it does, why does the earth not move towards the apple?
Answer:
According to Newton's third law of motion, action and reaction are equal and opposite. It means that the force on the apple due to earth's attraction is equal to that on the earth due to apple's attraction. But we know, acceleration $\propto$ 1/m.
As the mass of the earth is very large as compared to that of the apple, the acceleration experienced by the earth will be so small that it will not be noticeable.

Question 2.
Mention any four phenomena that the universal law of gravitation was able to explain.
Answer:
The universal law of gravitation was able to explain successfully

- the force that binds us to the earth.
- the motion of the moon around the earth.
- the motion of planets around the sun.
- the tides due to the moon and the sun.

Question 3.
When does an object show weightlessness?
Answer:
Weightlessness is a state when an object does not weigh anything. It occurs only when a body is in a state of free fall under the effect of gravity alone.

Question 4.
Why does a body reach the ground quicker at poles than at the equator when dropped from the same height?
Answer:
The acceleration due to gravity is more at the poles than at the equator. The time taken for a body is less if the acceleration due to gravity is more when the initial velocities and the distance travelled are the same. So, when dropped from the same height a body reaches the ground quicker at the poles than at the equator.

Question 5.
What is the source of centripetal force that a planet requires to revolve around the sun? On what factors does that force depend?
Answer:
Gravitational force. This force depends on the product of the masses of the planet and sun and the distance between them.

Short Answer Questions-II

Question 1.
Suppose that the radius of the earth becomes twice of its original radius without any change in its mass. Then what will happen to your weight?
Answer:
We know that F = $GMmr^2$ as weight of a body is the force with which a body is attracted towards the earth,
∴ W = $GMmr^2$
If the radius of the earth becomes twice of its original radius, then
W = $GMm(2r)^2$
= $GMm4r^2$=W4
i.e., weight will be reduced to one-fourth of the original.
Question 2.
Prove that if the earth attracts two bodies placed at same distance from the centre of the earth with the same force, then their masses are equal.
Answer:
Let P and Q be the two bodies,
the mass of body P = m_1
And the mass of body Q=m_2
As per the universal law of gravitation, the force of attraction between the earth and the body P is given by,
$F_p = G \times M_e \times m_1 R^2$ .....(1)
Where, R is the distance of the body from the centre of the earth.
Similarly, the force of attraction between the earth and the body Q is given by
$F_Q = G \times M_e \times m_2 R^2$ .....(2)
Since, the two forces, i.e., F_p and F_Q are equal, thus from (1) and (2),
$G \times Me \times m_1 R^2 = G \times M_e \times m_2 R^2$
⇒ $m_1 = m_2$
Question 3.
Give three differences between acceleration due to gravity (g) and universal gravitational constant (G).
Answer:
Differences between g andG

Acceleration due to gravity (g)	Universal gravitational constant (G)

1. Acceleration due to gravity is the acceleration acquired by a body due to the earth's gravitational pull on it.	1. Gravitational constant is numerically equal to the force of attraction between two masses of 1 kg that are separated by a distance of 1 m.
2. g is a vector quantity.	2. G is a scalar quantity.
3. It is different at different places on the surface of the earth. Its value also varies from one celestial body to another.	3. The 'G' is a universal constant, i.e., its value is the same (i.e. 6.7×10^{-11} Nm^2 kg^{-2}) everywhere in the universe.

Question 4.
On the earth, a stone is thrown from a height in a direction parallel to the earth's surface while another stone is simultaneously dropped from the same height. Which stone would reach the ground first and why? [NCERT Exemplar]
Answer:
For both the stones
Initial velocity, u = 0
Acceleration in downward direction = g

Now, $h = ut + \frac{1}{2}gt^2$

$\Rightarrow h = 0 + \frac{1}{2}gt^2$

$\Rightarrow h = \frac{1}{2}gt^2$

$\Rightarrow t = \sqrt{\frac{2h}{g}}$

Both stones will take the same time to reach the ground because the two stones fall from the same height.

Question 5.
Calculate the average density of the earth in terms of g, G and R.
Answer:
We know that g = GMR^2 or M = gR^2G
⇒ Average density of the earth, D = $\text{Mass Volume} = gR^2G \times Ve$

(Where V_e is the volume of the earth)
or D = $gR2G43\pi R3=3g4\pi GR$
Question 6.
Prove that if a body is thrown vertically upward, the time of ascent is equal to the time of descent.
Answer:
Upward motion
$v = u + gt_1$
$0 = u – gt_1$
$t_1 = ug$ …(1)
Downward motion
$v = u + gt_2$
$v = 0 + gt_2$
As the body falls back to the earth with the same velocity it was thrown vertically upwards.
$\therefore v = u$
$u = 0 + gt_2$
$t_2 = u/g$ …(2)
From (1) and (2), we get $t_1 = t_2$
⇒ Time of ascent = Time of descent
Question 7.
Two objects of masses ml and m2 having the same size are dropped simultaneously from heights h_1 and h_2, respectively. Find out the ratio of time they would take in reaching the ground. Will this ratio remain the same if (i) one of the objects is hollow and the other one is solid; and (ii) both of them are hollow, size remaining the same in each case? Give reasons.
Answer:
As u = 0, $h_1 = 12gt21$
$h_2 = 12gt22$,
$\iota 1t2=h1h2--\sqrt{}$
Ratio will not change in either case because acceleration remains the same. In case of free fall acceleration does not depend upon mass and size.

Long Answer Questions

Question 1.
Derive expression for force of attraction between two bodies and then define gravitational constant.
Answer:
“Every body in the 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 the distance between them.” Let us consider two bodies A and B of masses m_1 and m_2 which are separated by a distance r. Then the force of gravitation (F) acting on the

two bodies is given by
$F \propto m_1 \times m_2$…(1)
ans $F \propto 1r_2$ ..(2)
Combining (1) and (2), we get
$F \propto m_1 \times m_2 r_2$
or $F = G \times m_1 m_2 r_2$ ……..(3)
where G is a constant known as universal gravitational constant.
Here, if the masses mx and m2 of the two bodies are of 1 kg and the distance (r) between them is 1 m, then putting m_1 = 1 kg, m_2 = 1 kg and r = 1 m in the above formula, we get
G = F
Thus, the gravitational constant G is numerically equal to the force of gravitation which exists between two bodies of unit masses kept at a unit distance from each other.
Question 2.
Define acceleration due to gravity. Derive an expression for acceleration due to gravity in terms of mass of the earth (M) and universal gravitational constant (G).
Answer:
The acceleration produced in the motion of a body falling under the force of gravity is called acceleration due to gravity. It is denoted by 'g'.
The force (F) of gravitational attraction on a body of mass m due to earth of mass M and radius R is given by
$F = GmMR_2$ …..(1)
We know from Newton's second law of motion that the force is the product of mass and acceleration.
∴ F = ma
But the acceleration due to gravity is represented by the symbol g. Therefore, we can write
F = mg …(2)
From the equation (1) and (2), we get
$mg = GmMR_2$ or $g = GMR_2$ …(3)
When body is at a distance V from centre of the earth then $g = GMr_2$
Question 3.
Show that the weight of an object on the moon is 16 th of its weight on the earth.
Answer:
Suppose the mass of the moon is M_m and its radius is R_m. If a body of mass m is placed on the surface of moon, then weight of the body on the moon is
$W_m = GM_m mR_{2m}$ …(1)
Weight of the same body on the earth's surface will be
$W_e = GM_e mR_{2e}$ …(2)
where M_e = mass of earth and R_e = radius of earth.
Dividing equation (1) by (2), we get
$W_m W_e = M_m M_e \times R_{2e} R_{2m}$ ….(3)
Now, mass of the earth, $M_e = 6 \times 10^{24}$ kg
mass of the moon, $M_m = 7.4 \times 10^{22}$ kg
radius of the earth, R_e = 6400 km
and radius of the moon, R_m = 1740 km

Thus, equation (3) becomes,

$$\frac{W_m}{W_e} = \frac{7.4 \times 10^{22}\ \text{kg}}{6 \times 10^{24}\ \text{kg}} \times \left(\frac{6400\ \text{km}}{1740\ \text{km}}\right)^2$$

or $$\frac{W_m}{W_e} \approx \frac{1}{6} \quad \text{or} \quad W_m \approx \frac{W_e}{6}$$

The weight of the body on the moon is about one-sixth of its weight on the earth.

Question 4.

How does the weight of an object vary with respect to mass and radius of the earth? In a hypothetical case, if the diameter of the earth becomes half of its present value and its mass becomes four times of its present value, then how would the weight of any object on the surface of the earth be affected?

Answer:

Weight of an object is directly proportional to the mass of the earth and inversely proportional to the square of the radius of the earth, i.e.,

Weight of a body $\propto \frac{M}{R^2}$

Original weight, $W_0 = mg = mG\frac{M}{R^2}$

When hypothetically M becomes 4 M and R becomes $\frac{R}{2}$.

Then weight becomes $W_n = mG\frac{4M}{(\frac{R}{2})^2} = (16\ m\ G)\frac{M}{R^2} = 16 \times W_0$

The weight will become 16 times.

Numericals

Question 1.

On the moon's surface, the acceleration due to gravity is 1.67 ms^{-2}. If the radius of the moon is 1.74×10^6 m, calculate the mass of the moon.

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

Answer:

Here, g = 1.67 ms^{-2}, R = 1.74×10^6 m and G = $6.67 \times 10^{-2}\ Nm^2\ kg^{-2}$

We know that $$g = \frac{GM}{R^2} \text{ or } M = \frac{gR^2}{G}$$

$$\therefore \quad M = \frac{1.67 \times (1.74 \times 10^6)^2}{6.67 \times 10^{-11}} = \mathbf{7.6 \times 10^{22}\ kg}$$

Question 2.

A force of 20 N acts upon a body whose weight is 9.8 N. What is the mass of the body and how much is its acceleration? Take g = 9.8 m/s^2.

Answer:

Weight, W = mg, m = $\frac{W}{g}$, m = $\frac{9.8}{9.8}$ = 1 kg

So, acceleration = $\frac{\text{Force}}{\text{Mass}} = \frac{20}{1}$ = 20 m/s^2

Question 3.

A stone is dropped from a cliff. What will be its speed when it has fallen 100 m?

Answer:

Here, s = 100 m, u = 0

So, $v^2 = u^2 + 2gs$,

$v^2 = 2gs = 2 \times 9.8 \times 100 = 1960$
$v = \sqrt{1960}$ m/s = 44.2 m/s
Question 4.
From a cliff of 49 m high, a man drops a stone. One second later, he throws another stone. They both hit the ground at the same time. Find out the speed with which he threw the second stone.
Answer:
For the first stone
$u = 0\ ms^{-1}$, h = 49 m,
As we know $s = ut + \frac{1}{2} gt^2$
$\therefore 49 = 0 \times t + \frac{1}{2} \times 9.8 \times t^2$
$\Rightarrow t^2 = \frac{98}{9.8} = 10$
$\Rightarrow t = \sqrt{10}$ = 3.16 s
i.e., First stone would take 3.16 s to reach the ground.
For the second stone,
the time taken by the second stone to reach the ground is one second less than that taken by the first stone as both the stones reach the ground at the same time.
That is, for the second stone, t = (3.16 – 1)s = 2.16s
∴ For the second stone,
$g = 9.8\ ms^{-2}$, h = 49 m, t = 2.16 s, u = ?

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

$\Rightarrow 49 = u \times 2.16 + \frac{1}{2} \times 9.8\ (2.16)^2$

$\Rightarrow 49 - 22.86 = 2.16u$ or, $26.14 = 2.16u$

$u = \frac{26.14}{2.16} = \mathbf{12.1\ ms^{-1}}$

i.e., the second stone was thrown downward with a speed of 12.1 ms^{-1}.
Question 5.
A stone is dropped from the top of a 40 m high tower. Calculate its speed after 2 s. Also find the speed with which the stone strikes the ground.
Answer:
(i) As v = u + gt
∴ $v = 0 + (-10) \times 2 = -20\ ms^{-1}$
(ii) As $v = u^2 + 2gs$
or, $v^2 - 0^2 = 2(-10) \times (-40)$
or, $v = \sqrt{800}$
$= \sqrt{202}\ ms^{-1}$
Question 6.
Calculate the value of acceleration due to gravity g using the relation between g and G.
Answer:
We know that $G = 6.67 \times 10^{-11}\ Nm^2\ kg^{-2}$
Mass of the earth, $M_e = 6 \times 10^{24}$ kg

And Radius of the earth, $R_e = 6.4 \times 10^6$ m

$$\text{As} \quad g = \frac{G \times M_e}{R_e^2}$$

$$\therefore \quad g = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24}}{(6.4 \times 10^6)^2} \text{ m/s}^2$$

$$\Rightarrow \quad g = \frac{6.67 \times 6 \times 10}{6.4 \times 6.4} \text{ m/s}^2 = \mathbf{9.8 \text{ m/s}^2}$$

Question 7.
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 its mass, what will happen to your weight?
Answer:
(i) Original weight = $GMmr^2$, where M is the mass of the earth.
When M changes to new mass M'
New mass, M'=M + 10% of M
= M + 10100M = M + $M10$ = $11M10$ = 1.1 M

$$\therefore \quad \text{New weight} = \frac{GM'm}{r^2} = \frac{G \times 1.1Mm}{r^2}$$

$$\text{Now,} \quad \frac{\text{New weight}}{\text{Original weight}} = \frac{1.1\,GMm/r^2}{GMm/r^2} = 1.1$$

New weight becomes 1.1 times.
i.e., weight will increase by 10%.
(ii) Weight = $GMmr^2$, where r is the radius of the earth.
When r changes to 2r, the new weight is given by

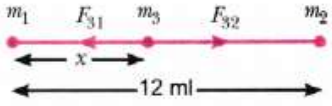
$$\text{New weight} = \frac{GMm}{4r^2}$$

$$\frac{\text{New weight}}{\text{Original weight}} = \frac{GMm/4r^2}{GMm/r^2} = \frac{\mathbf{1}}{\mathbf{4}}$$

∴ New weight becomes 4 times.
Question 8.
Two bodies of masses 3 kg and 12 kg are placed at a distance 12 m. A third body of mass 0.5 kg is to be placed at such a point that the force acting on this body is zero. Find the position of that point.
Answer:
Given m_1 = 3 kg; m_2 = 12 kg
Let the mass, m_3 = 0.5 kg be placed at a distance of 'x' m from m_1, as shown in figure. Then force acting on m_3 due to m_1, is equal and opposite to the force acting on m_3 due to m_2.

$$\therefore \quad F_{31} = F_{32}$$

$$\frac{Gm_1m_3}{x^2} = \frac{Gm_3m_2}{(12-x)^2}$$



$$\Rightarrow \quad \frac{3}{x^2} = \frac{12}{(12-x)^2}$$

$$\Rightarrow \quad \left(\frac{12-x}{x}\right)^2 = \frac{12}{3} = 4 \qquad \Rightarrow \quad \frac{12-x}{x} = 2$$

$$\Rightarrow \quad 12 - x = 2x \qquad \Rightarrow \quad 12 = 3x$$

$$\Rightarrow \quad x = \mathbf{4\ m}$$

The position of required point is at a distance of 4 m from mass of 3 kg.

Question 9.
A stone dropped from the roof of a building takes 4s to reach the ground. Calculate the height of the building.
Answer:
Here, initial velocity, u = 0
Time taken to reach the ground, t = 4 s
Acceleration, a = g = 9.8 m/s^2
Height of the building, h = ?

Using the equation of motion,

$$h = ut + \frac{1}{2}gt^2 = 0 + \frac{1}{2}gt^2$$

$$h = \frac{1}{2} \times 9.8\ \text{m/s}^2 \times (4\text{s})^2$$

$$= \frac{1}{2} \times 9.8 \times 16\ \text{m} = 78.4\ \text{m}$$

$$h = \mathbf{78.4\ m}$$

Question 10.
A ball is thrown up with a speed of 0.5 m/s.
(i) How high will it go before it begins to fall?
(ii) How long will it take to reach that height?
Answer:
Initial speed, u = 0.5 m/s
Acceleration, g = – 9.8 m/s^2
Final speed, v = 0
(i) We know $v^2 - u^2$
= $0 - (0.5)^2 = 2 \times (-9.8) \times h$
or – 0.25 = -19.6 h
or h = $\frac{0.25}{19.6}$ = 0.0127 m
h = 1.27 cm
(ii) Putting the values in the formula v = u + gt
0 = 0.5 – 9.8t
or t = $\frac{0.5}{9.8}$ = 0.05 s

Question 11.
Find the percentage change in the weight of a body when it is taken from the equator to the poles. The radius of the earth at the poles is 6357 km, the radius at the equator is 6378 km.
Answer:

$$g \text{ at equator, } g_e = \frac{GM_e}{R_e^2} \text{ ; } g \text{ at poles, } g_p = \frac{GM_e}{R_p^2}$$

$$\text{Variation in } g = g_p - g_e$$

$$= \frac{GM_e}{R_p^2} - \frac{GM_e}{R_e^2}$$

$$= GM_e\left(\frac{1}{R_p^2} - \frac{1}{R_e^2}\right) \% \text{ variation in } g$$

$$= \frac{GM_e\left(\frac{1}{R_p^2} - \frac{1}{R_e^2}\right)}{\frac{GM_e}{R_e^2}} \times 100$$

$$= \frac{R_e^2 - R_p^2}{R_p^2 R_e^2} \times 100 \times R_e^2$$

$$= \frac{(6378)^2 - (6357)^2}{(6357)^2} \times 100$$

$$= 0.66\% = \mathbf{0.7\%}$$

% Variation in the weight of a body = % Change in g = 0.7%.

HOTS (Higher Order Thinking Skills)

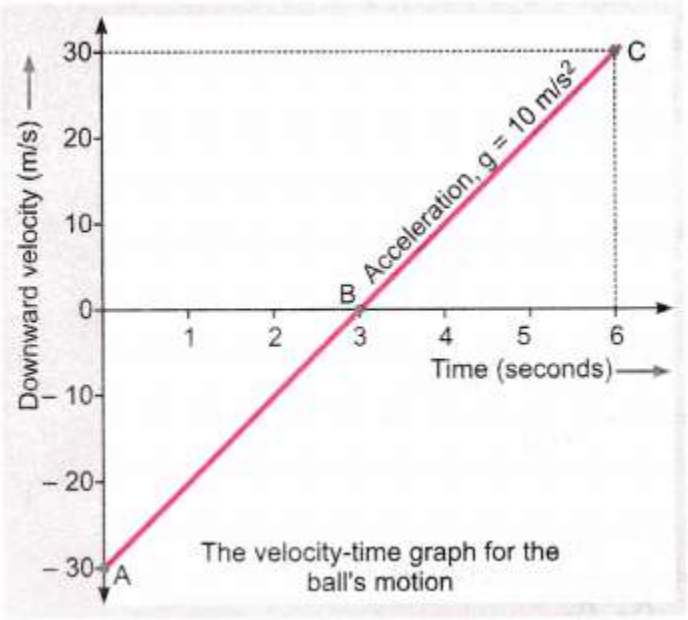
Question 1.
Why does formation of tides takes place in sea or ocean?
Answer:
The tides in the sea formed by the rising and falling of water level in the sea are due to the gravitational force of attraction which the sun and the moon exert on the water surface in the sea.

Question 2.
Why does a body orbiting in space possess zero weight with respect to a spaceship?
Answer:
The astronaut and the spaceship are orbiting with same acceleration hence, the body does not exert any force on the sides of the spaceship. Therefore, the body appears to

be floating weightlessly. It also implies that a body orbiting in space has zero weight with respect to a spaceship.

Question 3.
Identical packets are dropped from two aeroplanes—one above the equator and other above the north pole, both at height h. Assuming all conditions to be identical, will those packets take same time to reach the surface of earth? Justify your answer.
Answer:
The value of 'g' at the equator of the earth is lesser than that at poles. Therefore, the packets fall slowly at equator in comparison to the poles. Thus, the packets will remain in air for longer time interval, when it is dropped at the equator.

Question 4.
How does the force of attraction between the two bodies depend upon their masses and distance between them? A student thought that two bricks tied together would fall faster than a single one under the action of gravity. Do you agree with his hypothesis or not? Comment.
Answer:
$F \propto m_1 m_2$ and $F \propto \frac{1}{r^2}$
This hypothesis is not correct. The two bricks like a single body, fall with the same speed to reach the ground at the same time in case of free fall. This is because acceleration due to gravity is independent of the mass of the falling body.
Question 5.
Velocity-time graph for the ball's motion is shown in figure.



The velocity-time graph for the ball's motion

Observe the graph and answer the following questions.
Assume that g = 10 m/s² and that there is no air resistance.
(a) In which direction is the ball moving at point C?
(b) At which point is the bal 1 stationary?

(c) At which point is the bal 1 at its maximum height?
(d) What is the ball's acceleration at point C?
(e) What is the ball's acceleration at point A?
(f) What is the bal l's acceleration at point B?
(g) At which point does the bal 1 have the same speed as when it was thrown?
Answer:
(a) Downward
(b) At point B
(c) At point B
(d) Acceleration = 10 ms^{-2}
(e) Acceleration = -10 ms^{-2}
(f) Acceleration = 10 ms^{-2}
(g) At point C