Ch 9 Gravitation Class 9 Important Questions NCERT Science

Q.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 = GMmr2 as weight of a body is the force with which a body is attracted towards the earth,
∴ W = GMmr2
If the radius of the earth becomes twice of its original radius, then
W = GMm(2r)2
= GMm4r2=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×Me×m1R2 .....(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×Me×m2R2 ....(2)
Since, the two forces, i.e., F_p and F_Q are equal, thus from (1) and (2),
G×Me×m1R2=G×Me×m2R2
⇒ $m_1 = m_2$

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.2. g is a vector quantity.3. It is different at different places on the surface of the earth. Its value also varies from one celestial body to another.	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 scalar quantity.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, $$h = ut + \frac{1}{2}gt^2$$

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

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

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

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 = GMR2 or M = gR2G
⇒ Average density of the earth, D = Mass Volume =gR2G×Ve
(Where V_e is the volume of the earth)
or D = gR2G43πR3=3g4πGR

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. [NCERT Exemplar]
Answer:
As u = 0, h_1 = 12gt21
h_2 = 12gt22,
ι1t2=h1h2−−√
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.

Question 8
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 ∝ 1r2 ..(2)
Combining (1) and (2), we get
F ∝ m1×m2r2
or F = G × m1m2r2 ....(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 9.
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 = GmMR2 .....(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 = GmMR2 or g = GMR2 ...(3)
When body is at a distance V from centre of the earth then g = GMr2

Question 10

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 + 12 gt^2
∴ 49 = 0 × t + 12 × 9.8 × t^2
⇒ t^2 = 989.8 = 10
⇒ t = 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 $$s = ut + \frac{1}{2}gt^2$$

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

$$\Rightarrow \quad 49 - 22.86 = 2.16u \text{ or, } 26.14 = 2.16u$$

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

i.e., the second stone was thrown downward with a speed of 12.1 ms^{-1}.