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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) From Universal law of , force exerted on an object of mass m by earth is given by

$$F = G\frac{M\ x\ m}{R^2} \ldots 1$$

(i) When mass of the object say m is doubled than

$$F' = G\frac{M\ x\ 2\ m}{R^2} = 2F$$

So as the mass of any one of the object is doubled the force is also doubled
(ii) The force F is inversely proportional to the distance between the objects. So if the distance between two objects is doubled then the gravitational force of attraction between them is reduced to one fourth of its original value. Similarly f the distance between two objects is tripled , then the gravitational force of attraction becomes one ninth of its original value.
(iii) Again fron Universal law of attraction from equation 1 force F is directly proportional to the product of both the masses. So if both the masses are doubled then the gravitational force of attraction becomes four times the original value.

Question 7. What is the importance of universal law of gravitation?
Answer: Universal law of Gravitation is important because it it tells us about

- the force that is responsible for binding us to Earth.
- the motion of moon around the earth
- the motion of planets around the sun
- the tides formed by rising and falling of water level in the ocean are due to the gravitational force exerted by both sun and moon on the earth.

Question 8. What is the acceleration of free fall?
Answer: Acceleration of free fall is the acceleration produced when a body falls under the influence of the force of gravitation of the earth alone. It is denoted by g and its value on the surface of the earth is 9.8 ms^{-2}.

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 gis 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 gis 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 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 = 1/6 x Weight of an object on the Earth
Also,
Weight = Mass x Acceleration
Acceleration due to gravity, g = 9.8 m/s^2
Therefore, weight of a 10 kg object on the Earth = 10 x 9.8 = 98 N
And, weight of the same object on the moon= 1.6 x 9.8 = 16.3 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: According to the equation of motion under gravity:
$v^2 - u^2 = 2gs$
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 x (- 9.8)
9.8t = 49

t = 49 / 9.8= 5s
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:
$v^2 - u^2 = 2gs$
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}
$\therefore v^2 - 0^2 = 2 \times 9.8 \times 19.6$
$v^2 = 2 \times 9.8 \times 19.6 = (19.6)^2$
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 x h x (-10)
h= 40 x 40 / 20 = 80 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 × 10m^{30} kg. The average distance between the two is 1.5 × 1011 m.
Answer: According to question,
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
From Universal law of gravitation,

$$F = G\frac{M x m}{R^2}$$

Therefore, putting all the values given in question in above equation we get

$$F = 6.67 \times 10^{-11}\frac{(6 x 10^{24}) x (2 x 10^{30})}{(1.5 x 10^{11})^2} = 3.56 \times 10^{22}\ N$$

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 t be the point at which two stones meet and let h be their height from the ground. It is given in the question that height of the tower is H = 100m
Now first consider the stone which falls from the top of the tower. So distance covered by this stone at time t can be calculated using equation of motion

$x - x_0 = u_0 t + \frac{1}{2}gt^2$

Since initial velocity $u = 0$ so we get

$100 - x = \frac{1}{2}gt^2$ ... (1)

The distance covered by the same stone that is thrown in upward direction from ground is

$x = u_0 t - \frac{1}{2}gt^2$

In this case initial velocity is 25 m/s. So,

$x = 25\ t - \frac{1}{2}gt^2$ ... (2)

Adding equations (1) and (2) we get,

$100 = 25t$

Or, $t = 4s$

Putting value in equation (2),

$x = 25 \times 4 - \frac{1}{2} \times 9.8 \times (4)^2 = 100 - 78.4 = 21.6m$

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) 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,
$0 = u + (-9.8 \times 3)$
$u = 9.8 \times 3 = 29.4\ ms^{-1}$
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, $s = ut + 1/2\ at^2$
$h = 29.4 \times 3 + 1/2 \times -9.8 \times (3)^2 = 44.1$ 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, $s = ut + 1/2\ gt^2$ will give,
$s = 0 \times t + 1/2 \times 9.8 \times 1^2 = 4.9$ 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: For an object immersed in water two force acts on it

- gravitational force which tends to pull object in downward direction
- buoyant force that pushes the object in upward direction here in this case buoyant force is greater than the gravitational pull on the plastic block. This is the reason the plastic block comes up to the surface of the water as soon as it is released under 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 = Mass of the substance / Volume of the substance
= 50 / 20
= 2.5 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:
Density of the 500 g sealed packet= Mass of the Packet / Volume of the Packet
= 500 / 350
= 1.428 g cm^{-3}
The density of the substance is more than the density of water (1 g cm^{-3}). 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.

********** END **********