Solution

GRAVITATION

Class 09 - Science

Section A

1. **(a)** Less
   Explanation:
   Pressure is inversely proportional to cross- sectional area.
2. **(d)** Weight
   Explanation:
   Loss of weight is equal to the upthrust.
3. **(b)** zero
   Explanation:
   The weight of the object is zero
   Because weight = mg
   And r = 0 so g = zero at the center of earth
   Then w = zero
4. **(c)** 2.45 ms^{-2}
   Explanation:
   g is inversely proportional to the square of the distance between the earth and the body. As the distance gets twice the g will become one - fourth.
5. **(d)** least in salt solution
   Explanation:
   The buoyant force acting on the solid depends on the factors such as the density of fluid and volume of solid. As the density of saltwater is highest among the given options, the buoyant force is maximum in the case of saltwater and the reading of spring balance would be least in this case.
6. **(b)** All of these
   Explanation:
   Acceleration due to gravity varies with height, depth and shape of the planet as follows-
   - As the height (altitude) increases acceleration due to gravity (g) decreases.
   - As the depth increases acceleration due to gravity (g) decreases.
   - Acceleration due to gravity is inversely proportional to the radius.
7. **(c)** at poles
   Explanation:
   F = G (mM/R^2), acts along the line joining the centre of the earth and the centre of the body. This force produces an acceleration 'g' in the body of mass m. Also, Acceleration due to gravity is proportional to the mean density of the earth, and its radius.

8. **(a)** Difference in density of the body and half the density of the liquid.
Explanation:
Weight = W - U
$V\rho g - \frac{V}{2}\sigma g = Vg\left(\rho - \frac{\sigma}{2}\right)$

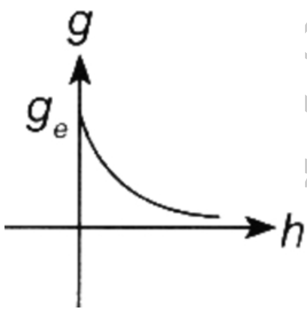
9.
(c) $P_A = P_B$
Explanation:
Pressure varies with height of liquid in a container and height is same for both the points so pressure at both points remain same.

10.
(b) $W_A > W_B$
Explanation:
As density of salty water is more than the density of tap water. It will exert a greater buoyant force (upthrust) and, So, W_A is greater than W_B.

11. **(a)** Statement (iv) is correct.
Explanation:
The acceleration due to gravity is always directed downwards towards the centre of the Earth for a freely falling body.

12. **(a)** 100 N
Explanation:
Weight = Mg = 10 $\times$ 10 = 100 N

13. **(a)** Both statement 1 and statement 2 are true but statement 2 is not the correct explanation of statement 1.
Explanation:
Variation of g with depth from surface of earth is given by $g' = g\left(1 - \frac{d}{R}\right)$
At the centre of earth, d = R, $\therefore g' = g\left(1 - \frac{R}{R}\right) = 0$
$\therefore$ Apparent weight of body = mg' = 0

14. **(a)**


Explanation:
Value of g decreases with height.

15.
(b) any body thrown vertically up against gravity.
Explanation:
When an object is thrown vertically upwards at the maximum height the velocity is going to be zero, however, acceleration is not zero. If there is no velocity, there can not be acceleration.

16.
(c) 2 N
Explanation:
Weighs of air = 10 N
When immersed fully in water = 8N
The weight displaced = 10N – 8N = 2N

17. **(a)** 10 kg

Explanation:

Gravity on the Moon has approximately 1/6th of the strength of gravity on Earth, a man who weighs 60kg on Earth would weigh approximately 10kg on the Moon. His mass, however, remains constant.

18.

(c) revolution of the earth around the sun

Explanation:

The revolution of the earth around the sun takes place in a trajectory orbit. The average distance between the earth and the sun is approximately 150 million km.

19.

(b) $\frac{10^6}{5}$

Explanation:

Area $=\pi r^2$= 0.50 mm^2 = 0.5 x 10^{-6} m^2

Let L be its length.

So volume, V = 0.5 x 10^{-6}Lm^3

Weight in air, W_a= 75 N

Weight in water, W_W = 65 N

So buoyant force by water = W_a - W_W = 10 N

= V $\times$ density of water $\times$ g

or 10 = 0.5 $\times$ 10^{-6}L $\times$ 1000 $\times$ 10

$L=\frac{10}{0.5\times10^{-2}}=\frac{10\times10^2}{0.5}=\frac{10^4}{5}\text{ m}=\frac{10^6}{5}\text{ cm}$

20. **(a)** 0.55 kg

Explanation:

Initially, weight of A = 0.2 kg wt

Weight of B = 0.5 kg wt

After complete immersion of A in water,

Weight of A = 0.15 kg wt

Reduction in weight of A = 0.2 - 0.15 = 0.05 kg wt

So, buoyant force applied on A by water = 0.05 kg wt

Required weight = weight of B + buoyant force on A = 0.5 + 0.05 = 0.55 kg wt

The reading of X = 0.55 kg

21.

(c) A is true but R is false.

Explanation:

A is true but R is false.

22. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

When a piece of cork is held below the surface of the water by applying the force of our thumb and then released, the cork immediately rises to the surface because the upward force is exerted by water on the cork which pushes it to the surface.

23. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

The weight of an object on the moon is less than that on the earth because the mass and radius of the moon are less than that of earth.

24.

(c) A is true but R is false.

Explanation:

The gravitational force of attraction is the reason behind the formation of tides. It is a weak force.

25.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

Net force = real weight - upthrust (weight of the liquid displaced).

The object rises above the liquid surface to an extent that the weight of the liquid displaced by the part of the object. Thus, an object will float when upward thrust is greater than its actual weight. (The density of the object must be less than the density of the liquid).

26.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation:

The value of g changes with height, depth and is zero at the centre of the earth.

27. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

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

28. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

Since the earth's mass is much more than that of the moon, the gravitational force exerted by the earth on the spaceship is much greater than that exerted by the moon. The work done is much greater.

29. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

The change in direction involves a change in velocity or acceleration. The force that causes this acceleration and keeps the body moving along the circular path is acting towards the centre. This force is called the centripetal force.

The motion of the moon around the earth is due to the centripetal force.

30. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

At the centre of the earth value of g is zero, weight of the body is also zero but its mass remains the same. The centre of mass of the body thus remains unchanged.

31.

(c) Statement B

Explanation:

The value of g decreases as we move at a higher altitude, so 'g' is less at Ooty than Delhi. Weight will be less in Ooty than Delhi. Mass is measured by pan of beam balance and weight is measured by spring balance.

32. **(a)** Statement B

Explanation:

The force of attraction is always attractive. The law of the inverse square means that the force by which two objects attract each other is inversely proportional to the square of the distance between them.

33. **(a)** Statement A

Explanation:

Mass of a body always remains the same. Mass is independent of other factors. Hence mass is a fundamental property. On the other hand weight of the body is the force by which it is attracted by the earth that depends upon the value of 'g'. So, weight is not a fundamental factor.

34. No, his weight will not remain same as that at the poles. There will be a decrease in his weight at the equator. As the radius of the earth increase from the poles to the equator, the value of 'g' becomes greater at poles decreasing towards equator. Also, the force of gravity decrease from poles to the equator.
35. It is a state when objects do not weigh anything. This occurs when bodies are in a state of free fall under the effect of gravity.
36. An object immersed in a liquid experiences buoyance force In the upward direction only.
37. Henry Cavendish

38. Both will reach the ground at the same time because acceleration due to gravity is independent of the masses of freely falling bodies.
39. 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 Earth does not move towards the moon.
40. According to Archimedes Principle when a body is partially or completely immersed in a fluid at rest is acted upon by an upward, or buoyant, force the magnitude of which is equal to the weight of the fluid .
41. Stone falls due to gravitation force exerted by the earth. Earth do not move towards the stone as the mass of earth is much more than that of the stone.
42. When an object is immersed partially or fully in a liquid, it experiences an upward force. This upward force is known as buoyant force and this phenomenon is known as buoyancy. Buoyancy is also known as up thrust
43. The mass of the two bodies are very small. Therefore, the force of attraction between them is very small. So, both the objects do not move towards each other.

Section B

44. We know, that G = 6.67×10^{-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

    We know that, acceleration due to gravity, g = $\frac{G \times M_e}{R_e^2}$.

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

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

    Therefore, the value of acceleration due to gravity, g on the surface of earth= 9.8 m/s^2.
45. Initial velocity of stone (u) = 0

    Final velocity of stone (v) = ?

    Height attained (S) = 19.6 m

    Acceleration due to gravity (g) = + 9.8 ms^{-2}

    We know : $v^2 = u^2 + 2\ gS$

    $v^2 = (0)^2 + 2 \times 9.8 \times 19.6$

    $v^2 = 19.6 \times 19.6$

    v = $\sqrt{19.6 \times 19.6}$

    v = 19.6 ms^{-1}
46. Initial velocity, u = 0

    Let A fall for 't' seconds

    acceleration,a = -9.8 m/s^2

    For Object A, Distance travelled = S_1

    $S_1 = ut + \frac{1}{2}gt^2$

    $\Rightarrow S_1 = 0 - \frac{1}{2} \times 9.8t^2$

    $\Rightarrow S_1 = -\frac{1}{2} \times 9.8t^2$ ...(i)

    For object B, time = (t - 1)s

    Distance travelled = S_2

    $S_2 = ut + \frac{1}{2}gt^2$

    $\Rightarrow S_2 = -\frac{1}{2}9.8(t-1)^2$ ...(ii)

    Subtracting equation (ii) from (i)

    $S_1 - S_2 = -10$ m

    $\Rightarrow -10 = \frac{1}{2} \times 9.8 \left[(t-1)^2 - t^2\right]$

    $\Rightarrow$ -10 = 4.9 [t^2 - 2t + 1 - t^2]

    $\Rightarrow$ -10 = 4.9[-2t + 1]

    $\Rightarrow$ -10 = -9.8 t + 4.9

    $\Rightarrow$ -9.8 t = -14.9

$\Rightarrow$ = 1.5 sec

The objects will be 10 m apart 1.52 s after A is dropped.

47. Here, initial velocity of stone, u = 0

Time is taken by stone to reach the ground, t = 4 s

Acceleration, a = g = 9.8 m/s^2

Let, the height of the building, h =?

Using the equation of motion, S =ut + $\frac{1}{2}at^2$.

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

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

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

$\Rightarrow$ h = 78.4 m.

Therefore, height of the building, h = 78.4m.

48. Initial velocity of stone (u) = 40 m/s

at maximum height stone will be at rest so v= 0

v = u + gt

$0 = 40 + (-10) \times t$

10t = 40

t = 40/10 = 4 s

distance covered /maximum height

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

$= 40 \times 4 + \frac{1}{2} \times (-10) \times 4 \times 4$

= 160 - 80 = 80 m

net displacement of stone = 0(thrown upwards then falls back to same place)

Total distance covered by the stone = 80 + 80 = 160 m

49. i. Upthrust = loss in weight = 100 - 88 = 12 gf

ii. Weight of water displaced = upthrust = 12 gf

Since density of water is 1 gcm^{-3} therefore volume of water displaced = 12 cm^{-3}

But the solid displaces water equal to its own volume. Therefore the volume of solid = 12 cm^{-3}

iii. RD of solid = $\frac{weight\ in\ air}{weight\ in\ air\ -\ weight\ in\ water} = \frac{100}{100\ -88}$ = 8.33

50. Let acceleration due to gravity at the equator (g_e). Let acceleration due to gravity at the pole = g_p

Now. g = $\frac{GM}{R^2}$ Therefore we have $\frac{g_p}{g_e} = \frac{GM}{R_p^2} \times \frac{R_e^2}{GM} \times \frac{R_e^2}{R_p^2} = \frac{(6378)^2}{(6357)^2}$ = 1.0066

$\therefore$ Percentage change in the acceleration due to gravity at the poles

$\frac{g_p - g_e}{g_e} \times 100 = \frac{1.0066 g_e - g_e}{g_e} \times 100$ = 0.66%

51. i. Initial velocity of the ball (u) = 49 ms^{-1}

Final velocity of the ball (v) = 0

Acceleration due to gravity (g) = -9.8 ms^{-2}

[In upward direction g is -ve]

Height attained by the ball (S) = ?

Time for rising up (t) =?

We know : $v^2 - u^2 = 2\ gS$

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

S = $\frac{-49 \times 49}{-2 \times 9.8}$

S = 122.5 m

We know v = u + gt

0 = 49 - 9.8 $\times$ t

$\Rightarrow$ t = $\frac{49}{9.8}$

$\Rightarrow$ t = 5 s

ii. Now, time for upward journey of the ball
= the time for downward journey of the ball.
$\therefore$ Total time is taken by the ball to return to the surface of earth = 2 $\times$ t = 2 $\times$ 5 = 10 s

52. Initial speed of a ball, u = 0.5 m/s

Since the ball is thrown upward, so negative Acceleration, g = - 9.8 m/s^2

Let at height 'h' a ball is at rest, so Final speed of ball at height 'h' is v = 0

i. We know $v^2 - u^2 = 2gh$
$0 - (0.5)^2 = 2 \times (-9.8) \times h$
or -0.25 = -19.6 A
or h = $\frac{0.25}{19.6}$ =0.0127 m
$\Rightarrow$ h = 1.27 cm

ii. Let, 't' be the time to reach the height 'h' . Now, Putting the values in the formula v = u + gt
0 = 0.5 - 9.8t
or t = $\frac{0.5}{9.8}$ = 0.05 s

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

Here, g = 1.67 ms^{-2}, R = 1.74×10^6 m and

G = 6.67×10^{-11} Nm^{2}kg^{-2}

Therefore we have

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

Section C

54. (a) $\frac{The\ Density\ of\ the\ floating\ body}{Density\ of\ fluid\ in\ which\ it\ floats} = \frac{Height\ immersed}{Total\ height}$

$\frac{0.8}{1.0} = \frac{h}{4.2}$

$h = 4.2 \times 0.8 = 3.36m$

b) Mass of the block of wood = 100 Kg

Mass of water displaced = 100 Kg

Mass of lead placed on the block of wood = 10 Kg

Total mass of the block of wood + weight placed on it = 110 Kg

Mass of water now displaced = 110 Kg

When 100 Kg of water was displaced, 3.36 m was submerged

When 110 Kg of water is to be displaced,

$\frac{110 \times 3.36}{100}$ m will be damaged.

= 3.696 m will be submerged.

Height seen above water = 4.2 – 3.696

= 0.504 m

55. For the first stone, Initial velocity u = 0

Let the stone take t s to reach the ground

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

$-49 = \frac{1}{2}(-9.8)t^2$

$t^2 = 10$

$t = 3.162s$

For the second stone, the initial velocity = u_0

Time of flight = 3.162-1 s

= 2.162s

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

$-49 = -u_0(2.162) + \frac{1}{2}(-9.8)(2.16^2)^2$

$-49 = -2.16u_0 - 22.9$

$u_0 = \frac{26.1}{2.162} = 12.1m/s$

The second stone was thrown downward with a velocity of 12.1 m/s

56. i. The mass of the body will be 30Kg because mass remains the same as it is constant.

ii. The distance of the body from the centre of the earth = 6370 + 230 Km

= 6600Km = 6.6×10^6 m

Acceleration due to gravity = g = $\frac{Gme}{r^2}$

$g = \frac{6.673\times10^{-11}\times5.98\times10^{24}}{(6.6\times10^6)^2}$

$g = 9.16 m/s^2$

iii. Weight at that height = mg

= 30×9.16

= 274.8 N

57. Given that mass of Jupiter, $M_1 = 1.9 \times 10^{27}$ kg

mass of sun, $M_2 = 1.99 \times 10^{30}$ kg

Distance between Jupiter and sun, $r = 7.8 \times 10^{11}$m and

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

Using F = $\frac{GM_1M_2}{r^2}$ we have

F = $\frac{6.67\times10^{-11}\times1.9\times10^{27}\times1.99\times10^{30}}{(7.8\times10^{11})^2}$

= 4.416×10^{23} N

58. Let the initial velocity = u

Let the maximum height reached = h m

When it reached , the velocity = 10m/s

Now $v^2 = u^2 + 2gh$

$(10)^2 = (u)^2 + 2(-10) \times \frac{h}{2}$

$(u)^2 = 100 + h \times 10$

When the ball reaches the highest point, v = 0

$v^2 - u^2 = 2gh$

$o^2 - u^2 = 2(-10)h$

$-u^2 = -2(10)h$

$\Rightarrow (100 + 10h) = 20h$

$100 = 20h - 10h$

$100 = 10h$

Height = 10 m

Maximum height reached = 10m

$u^2 = 100 + 10h$

$u^2 = 100 + 10 \times 10$

$u^2 = 200$

$u = \sqrt{200} = 14.14 m/s$

Initial velocity of the ball when it was thrown up = 14.14 m/s.

Velocity after 1s

$v = u + at$

$v = 14.14 + (-10) \times 1$

$= 4.14 m/s$

Acceleration after 1s = $-10 m/s^2$

59. Height of coconut (S) = 15 m

Acceleration due to gravity (g) = $-10\ ms^{-2}$

Time (t) = ?

Initial velocity (u) = $20\ ms^{-1}$

Using S = ut + $\frac{1}{2}at^2$ we have

$15 = 20 \times t + \frac{1}{2} \times (-10)t^2$. This is a quadratic equation in time.

Simplifying we have

$5t^2 - 20t + 15 = 0$ or $t^2 - 4t + 3 = 0$

$t = \frac{-(-4)\pm\sqrt{(-4)^2-4\times1\times3}}{2} = \frac{4\pm2}{2}$ = 1 or 3 s = 1 or 3 s

Thus the projectile will pass the coconut 1s after it is thrown while moving in the upward direction and 3 s while moving in the downward direction on its return journey.

60. i. Gravitational force is the weakest force in nature, yet it helps in holding massive bodies in place throughout the universe. Due to this reason, table and chair do not collide.
    ii. Given, h = 12 m, v = 0, g = -9 .8 m/s^2, u = ? and t = ?
        a. $\therefore v^2 - u^2 = 2gh, 0 - u^2 = 2 \times (-9.8) \times 12$
           $\Rightarrow$ u = 15.33 m/s
        b. $\therefore$ v = u - gt
           $\Rightarrow t = \frac{u}{g} = \frac{15.33}{9.8} = 1.56\text{s}$

61. v = Initial velocity
s = Distance
t = Time
g = Acceleration due to gravity
Let two stones meet after t s.
$s = ut + \frac{1}{2}gt^2$
$u = 0$
$s = \frac{1}{2}(-10)t^2$
Magnitude of height through which the stone falls = 5t^2
Height reached by the stone moving up is t s
$s = ut + \frac{1}{2}gt^2$
$s = 50t + \frac{1}{2}(-10)t^2$
$s = 50t - 5t^2$
Total distance travelled by 2 stones = 50m
5t^2 + 50t - 5t^2 = 50
t = 1
The stones meet 1 s after they are dropped or thrown up
The height through which the stone moves up is 1s
S = 50t – 5t^2
= 50 – 5
= 45 m
Therefore, the stones meet 45m above the ground.

62. $\because$ The ball returns back to the thrower in 6s, the time for its upward journey = 6/2 = 3s
For the upward motion of the ball
Initial velocity (u) = ?
Final velocity (v) = 0 ($\because$ Ball comes to rest)
Time (t) = 3s
Acceleration due to gravity (g) = - 10 ms^{-2} [In upward direction g is -ve]
    i. We know:
       v = u + gt
       $\Rightarrow$ 0 = u - 10 $\times$ 3
       $\Rightarrow$ -u = -30
       $\Rightarrow$ u = 30 ms^{-1}
    ii. We know:
       S = ut + 1/2 gt^2
       S = 30 $\times$ 3 - $\frac{1}{2}$ $\times$ 10 $\times$ (3)^2
       $\Rightarrow$ S = 90 - 45
       S = 45 m
    iii. For the downward motion of ball
       Initial velocity (u) = 0

Time for downward fall (t) = 4 - 3 =1 s

Acceleration due to gravity (g) = 10 ms^{-1}

Distance covered in downward direction (S) = ?

We know:

$S = ut + 1/2\ gt^2$

$S = 0 + t + \frac{1}{2} \times 10 \times (1)^2$

$\Rightarrow S = 0 + 5$

$\Rightarrow S = 5$ m

Position of ball after 4s from ground

= 45 - 5

= 40 m.

63. The up thrust = weight of the air displaced

Mass of air displaced = 120 ×1.14

= 136.8Kg

Weight of air displaced = 136.8×9.8N = (Mg)

= 1340.6N

Downward force = weight of the balloon + weight of H_2

Now, Mass of the balloon + Mass of H_2

= 75+120 (0.081)

= 84.72 Kg

Weight of the balloon and H2 filling it = 84.72×9.8

= 830.3 N

Net up thrust = 1340.6 – 830.3

= 510.3N

Maximum weight the balloon can lift = 510.3N

Section D

64. i. Mass refers to the amount of matter present in an object. It is an intrinsic property and is a measure of how much substance is in an object, regardless of its location..For example, an object's mass on Earth would be the same as its mass on the Moon or any other planet

Weight refers to the force exerted on an object due to gravity. It is the gravitational force acting on an object's mass. Weight depends on both the mass of the object and the strength of the gravitational field it's in. Weight is usually measured in newtons (N) in the SI system.

ii. The weight of an object is the gravitational force acting on it. Since, the gravitational force of the moon is $\frac{1}{6}$th of earth. The weight of an object on moon is also $\frac{1}{6}$th as compared to its weight on earth.

iii. $g = \frac{GM_e}{R_e^2}$ and $g_p = \frac{G \times \frac{M_e}{4}}{(\frac{Re}{8})^2}$

$= \frac{64GM_e}{4R_e^2} = 16\frac{GM_e}{R_e^2}$ = 16g

OR

The weights of an object depend on following factors

a) mass

b) Acceleration Due to Gravity

65. i. No, the value of g is different at different places on the surface of the earth. The acceleration due to gravity is smaller at the equator than at the poles. This is because g is inversely proportional to the radius and the radius of the earth is smaller at the poles and larger at the equator.

ii. $F_g = G \cdot \frac{m_1 \times m_2}{r^2} =$ 10 N

where, F = Gravitational force

m_1, m_2 = Masses of two bodies

r = Distance

G = Gravitational constant = 6.673 $\times$ 10^{-11} Nm^2kg^{-2}

From the above equation, we can conclude that if distance between the object is reduced to half then force would become four times.

$F'_g = G \cdot \frac{m_1 \times m_2}{r^2/4}$

Therefore, $F'_g = 4 \times F_g$

So, new force = 40 N

iii. According to the laws of gravitation,

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

Where m_1 and m_2 are the masses of the objects.

r = the distance between the two masses.

The gravitational force of attraction is directly proportional to the product of masses.

If the masses of both the objects are doubled then the force between them becomes four times.

Hence, if the masses of both objects is doubled the force of attraction will become 4 times of its original value.

OR

The SI unit of the gravitational constant G is Newton-meter squared per kilogram squared (Nm^2/kg^2), and the SI unit of the acceleration due to gravity g is meters per second squared (m/s^2).

Section E

66. **For the first stone :**

Initial velocity, u = 0 ms^{-1}, Height of cliff, h = 49 m, g= 9.8m/s^2

As we know, $S = ut + \frac{1}{2}at^2$.

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

$\therefore 49 = 0 \times t + \frac{1}{2} \times 9.8 \times t^2$

$\Rightarrow t^2 = \frac{9.8}{9.8} = 10$

$\Rightarrow t = \sqrt{10} = 3.16$ 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 from the same height, h= 49m.

That is, for the second stone, time, t = (3.16 - 1) s = 2.16 s

$\therefore$For the second stone,

g = 9.8 ms^{-2}, h = 49 m, t = 2.16 s, u = ?

Using, $S = ut + \frac{1}{2}at^2$.

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

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

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

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

Therefore, the speed with which he threw the second stone = 12.1 ms^{-1}

67.

Mass	Weight
Mass is a property of matter. The mass of an object is the same everywhere,	Weight depends on the effect of gravity. Weight varies according to location.
Mass can never be zero.	Weight can be zero if no gravity acts upon an object, as in space.
Mass does not change according to location.	Weight increases or decreases with higher or lower gravity.
Mass is a scalar quantity. It has magnitude.	Weight is a vector quantity. It has magnitude and is directed toward the center of the Earth or other gravity well.
Mass may be measured using an ordinary balance.	Weight is measured using a spring balance.
Mass usually is measured in grams and kilograms.	Weight often is measured in newtons, a unit of force.

68. i. a. Gravitational force acting on the 50 kg,

$F = mg = 50 \times 9.8 = 490$ N

b. Gravitational force acting on the 50 kg mass due to jupiter,

$F_{Jupiter} = \frac{G \times M_{jupiter} \times M_{person}}{(\text{distance of jupiter from the earth})^2}$

$F_{Jupiter} = \frac{6.67 \times 10^{-11} \times 2 \times 10^{27} \times 50}{6.3 \times 10^{11} \times 6.3 \times 10^{11}}$

$F_{Jupiter} = 1.68 \times 10^{-5}$ N

c. Gravitational force acting on the 50 kg mass due to saturn

$F_{saturn} = \frac{G \times M_{saturn} \times M_{person}}{(\text{distance of saturn from the earth})^2}$

$F_{saturn} = \frac{6.67 \times 10^{-11} \times 6 \times 10^{26} \times 50}{1.28 \times 10^{12} \times 1.28 \times 10^{12}}$

$F_{saturn} = 1.12 \times 10^{-6}$ N

$\therefore$ Total gravitational force due to the Jupiter and the Saturn = $(1.68 \times 10^{-5} + 1.12 \times 10^{-6}) = 1.8 \times 10^{-5}$ N

Thus, the combined force due to the planets Jupiter and Saturn (1.8×10^{-5}) N is negligible as compared to the gravitational force i.e. 490 N due to the earth.

ii. We know that g at the equator is less than g at poles (Antarctica). Thus, weight at the equator is less than weight at the pole (Antarctica). A bag of sugar weighs 'w' at a certain place on the equator. If this bag is taken to Antarctica, then it will weigh more due to the greater value of g.

69. Since the weight of any person on the moon is about 1/6 times that on the earth, hence acceleration due to gravity at the moon is 1/6 of that on earth. This means that by applying the same force a person can lift six times heavier objects on the moon than what he could lift on the earth. So, the maximum mass which can be lifted by the same force applied by the person on the moon is 6×15 kg = 90 kg.

70. The value of g on the earth is 9.8 m/s^2

i. a. g on the moon is given by

$g' = \frac{g}{6} = \frac{9.8}{6} = 1.63$ m/s^2

b. Mass of the person on the moon = $\frac{110.84}{1.63} = 68$ kg

c. Mass will be constant and does not change from place to place. Hence the mass of the person on the earth is the same that on the moon.

Weight of person on the earth $= mg = 68 \times 9.8$ = 666.4 N

ii. According to the Newton's law of gravitation, the force of attraction between earth and the body is given by

$F = \frac{GMm}{R^2}$ ...(i)

where, M = mass of the earth, R = radius of the earth, m = mass of person and G = 6.67×10^{-11} N-m^2/kg^2

Force produces an acceleration 'g'. So from Newton's second law, F = mg ....(ii)

Equating (i) and (ii) we get,

$mg = \frac{GMm}{R^2}$

$\therefore\ g = \frac{GM}{R^2}$

71. i. Ship displaces more water than needle as the volume of the ship is more than that of the needle. Since upthrust depends on the volume of the object (U= Vdg), so more the volume of the object, more upthrust act on it and object floats.

ii. Since, pressure act on the body is inversely proportional to the surface area of contact, i.e.

$P \propto \frac{1}{A}$

It means that more the area of contact, less pressure will act on the body. As the broad and the thick handle of our suitcase has a large area, due to which less pressure acts on our hand and it is very easy to take from one place to another.

72. We have given that,

Time taken , t = $\frac{1}{2}$ second

Initial velocity, u = 0 ms^{-1}

Acceleration due to gravity, g = 10 ms^{-2}

Acceleration of the car, a = + 10 ms^{-2} (downward)

i. speed v = at

v = 10 ms^{-2} $\times$ 0.5 s

= 5 ms^{-1}

Thus,

Its speed on striking the ground = 5 ms^{-1}

ii. Average spped = $\frac{u+v}{2}$

= $\frac{(0ms^{-1}+5ms^{-1})}{2}$

= 2.5 ms^{-1}

Thus,

Its average speed during the 0.5 s = 2.5 ms^{-1}

iii. Distance travelled, s = $\frac{1}{2}at^2$

= $\frac{1}{2} \times 10ms^{-2} \times (0.5s)^2$

= $\frac{1}{2} \times 10\text{ms}^{-2} \times 0.25\text{s}^2$

= 1.25m

Thus,

Height of the ledge from the ground = 1.25 m

73. i. We know that, Original weight,W_o = mg = $\frac{GMm}{R^2}$, where M is the mass of the earth, m= mass of body.

Let the new mass of earth = M'

According to question, New mass, M' = M + 10% of M = M + $\frac{10}{100}$M = M + $\frac{M}{10}$ = $\frac{11M}{10}$ = 1.1M

∴New weight, W_n= $\frac{GM'm}{R^2}$ = $\frac{G\times1.1Mm}{R^2}$

Now, Ratio of new weight to original weight = $\frac{New\ weight}{Original\ weight}$ = $\frac{1.1GMm/R^2}{GMm/R^2}$ = 1.1

New weight becomes 1.1 times the original weight of body.

i.e., weight of body will increase by 10%.

ii. Again, Original Weight, W_o = $\frac{GMm}{R^2}$, where R is the radius of the earth.

According to question, when R changes to 2R, the new weight is given by,

New weight,W_n = $\frac{GMm}{4R^2}$

Now, Ratio of new weight to original weight =$\frac{New\ weight}{Original\ weight}$ = $\frac{GMm/4R^2}{GMm/R^2}$ = $\frac{1}{4}$

Therefore, New weight becomes $\frac{1}{4}$ times of original weight

74. i. The cube will experience a greater buoyant force in saturated salt solution than in water because density of saturated salt solution is more than the density of water. If each side of the cube is reduced to 4 cm, it will result in reduction in volume of the cube. Hence, the buoyant force experienced by it will reduce in water.

ii. Buoyant force = weight of displaced water

= density of water × volume of displaced water × g

= 1000 × $\frac{4}{4000}$ × 10 [∵ volume = $\frac{weight}{density}$]

= 10 N

75. A stone is dropped from the edge of a roof.

Given, initial velocity $u = 0$

Acceleration $g = 9.8$ m/s^2

i. Displacement =$s = 4.9$ m

We have, s = ut + $\frac{1}{2}$gt^2

4.9 = 0 × t + $\frac{1}{2}$ × 9.8 × t^2

t^2 = $\frac{9.8}{9.8}$ = 1

$\Rightarrow t = 1$ s

The stone takes 1 s to fall 4.9 m

ii. We have, $v^2 - u^2 = 2as$

$v^2 - 0^2$ = $2 \times 9.8 \times 4.9$

$v^2 = 96.04$

⇒ v = $\sqrt{96.04} = 9.8$ m/s

At the end of 4.9 m, stone will be moving at a speed of 9.8 m/s

iii. We have, $v^2 - u^2 = 2as$

$v^2 - 0^2 = 2 \times 9.8 \times 7.9$

$v^2 = 154.84$

$\Rightarrow v = 12.44$ m/s

The stone will be moving with a speed of 12.44 m/s at the end of 7.9 m.

iv. During the free fall the acceleration produced in a body remains constant.

So, acceleration after 1 s = 9.8 m/s^2

Acceleration after 2 s = 9.8 m/s^2