Chapter - 2

1 Tick (✓) the best answer

a. Which of the following is the correct relation between masses of two bodies and gravitational force between them?

i. $F \propto \frac{m_1}{m_2}$ ii. $F \propto \frac{m_2}{m_1}$ iii. $F \propto \frac{1}{(m_1 m_2)^2}$

iv. $F \propto m_1 m_2$ ✓

b. If the gravitational force between two bodies lying on the earth is 72N, what will be gravitational force on the surface of the moon?

i. 12N ✓ ii. 720N iii. 72N iv. 7.2N

(Explaination : Earth's to moon gravitation force is in ratio 1:6) ($\frac{g_e}{g_m} = \frac{9.8}{1.67} \approx 6$)

c. If the both masses are doubled and distance between their centres is also doubled, what will be the effect in gravitational force?

Ans

$m_1 = 2m_1$ $\quad d = 2d$

$m_2 = 2m_2$

$$F = \frac{G m_1 m_2}{d^2} = \frac{G\, 2m_1\, 2m_2}{(2d)^2} = \frac{G\, 4 m_1 m_2}{4d^2} = F$$

i. There will be no change ✓

ii. Force increase by 16 times

iii. Force increase by 4 times

iv. Force decrease by one-Fourth

d. In which of the following places will you find your highest weight?

i. Kechana Kabal of Jhapa (terai region) ✓
ii. Top of Mt. everest (weight decreases in higher places)
iii. Rara lake
iv. Kathmandu valley

explanation: Jhapa is at lowest point out of options.

e. If the earth coere expanded uniformly to attain the size that is double of present size, what will be value of accelration due to gravity of such earth?

→ $m = 2m$

$$g = \frac{Gm}{r^2}, g' = \frac{G2m}{r^2}, g' = 2\frac{Gm}{r^2} = 2g$$

i. 1.67 m/s²
ii. 9.8 m/s² (~~2×g = 2×9.8~~ =
iii. ~~6.67 × 10⁻¹¹~~ At 4.9 m/s²
iv. 19.6 m/s² ✓

explanation → $2g$ → 2×9.8 → 19.6 m/s²

f. What is value of Gravitational constant on surface of moon?

i. 1.67 m/s² ii. 9.8 m/s² iii. 6.67×10^{-11} Nm²/kg² ✓
iv. 1.11×10^{-11} Nm²/kg²

g. what is the relation between weight of a body and accelration due to gravity?

i. $w \propto \frac{1}{g}$ ii. $w \propto g$ iii. $w \propto g$ ✓

iv. $w \propto \frac{kg}{g^2}$

explanation → ▷ $[w = mg]$

h) ~~h)~~ when does a falling object have zero accelr ation?

→

i. Freefall ii. weightlessness ~~iii~~

iii. when weight of body is equal to the air resistance. ✓

iv. when weight of body is less than air resistance.

explanation → i→ under freefall there will be accelration, ii→ In weightlessness force is only not felt, iii→ upper and lower force is equal so net force is 0 $a = F/m = 0/m$ =

iv → body will decelrate.

i. while observing a body at each second of free fall, which of the following conclusion is correct?

i. accelration increases uniformly (accelration is co
ii. velocity increased uniformly ✓ (a is changed
iii. Distance increases uniformly (v increases d isn't
iv. Displacement increased uniformly (same as iii).

2 Answer these questions in one sentence

a. Define gravity
→ The force with which the earth or any heavenly body attracts other object towards its centre is called gravity.

b. What is gravitation?
→ Gravitation is defined as the force of attraction between any two objects of the universe due to their masses.

c. State Newton's law universal law of gravitation.
→ Newton's universal law of gravitation states that every object in the universe attracts every other object with a force proportional to the product of their masses and inversely proportional to the square of distance between them

d. Why is there no atmosphere on the moon?
→ Gravity on the moon is too weak to hold onto gas molecule.

e. Although USA lies just opposite of Nepal in a globe people of both the countries have their head facing the sky while standing? Why?
→ Gravity of earth pulls everything towards center of the Earth so down is always towards center and up is always sky.

f. What is the effect of gravity on the falling object?

→ Effec Accelration due to gravity is the effect of gravity on the falling object

g. Write the factors that affect gravity of planet.

⇒ mass of planet, Radius of planet, affect the gravity of planet.

h. What is freefall?

→ Falling of body under the effect of gravity without any external resistance is called free fall

i. Give an example of free fall.

→ A body falling in vacuum is an example of freefall.

J. What is weightlessness?

→ Weightlessness of body is a state in which the body experiences having no weight.

3. Answer these questions in brief

a. What are the factors that affect the gravitation force between celestial bodies?

→ The factors that affect gravitational force between celestial bodies are:-

1. mass of bodies → Greater mass increases gravitational force.
2. Distance between them → It reduces Gravitation force.

b. What is Newton's gravitational Constant(G)? Write down its numeric value and SI unit.

→ Universal gravitational constant(G) maybe defined as the force of gravitation between any two bodies of each unit mass separated by unit distance from their centres.

The SI unit of universal Constant (G) is Nm^2/kg^2.

Numeric value of Newton's gravitational Constant is $6.67 \times 10^{-11} Nm^2/kg^2$

c. write down the nature of gravitational force.

→ The nature of gravitational force is given below:-

1. Attractive → It always pull objects toward each other.
2. Universal → Acts between all objects in universe with mass.
3. Weak force → ~~It~~ is needs very big masses to show noticeable effects.

d. The value of universal gravitation constant is $6.67 \times 10^{-11}\ Nm^2/kg^2$. what does it mean?

→ The gravitational force between two objects of 1kg ~~m~~ each mass, kept at 1 meter apart is 6.67×10^{-11} newtons.

e. Calculate the change in the gravitational force between any two objects when the distance between them is doubled?

→ The change in Gravitational force between any two objects when the distance between them is doubled is given as:

Suppose,

m_1 and m_2 be masses separated by distance 'd'. Now, According to newton's law of Gravitation Force is 'F_1' is given by:-

$$F_1 = \frac{Gm_1m_2}{d^2},$$

Given → $d = 2d$ Now, Change in force of gravitation F_2 is :

$$F_2 = \frac{G m_1 m_2}{(2d)^2}$$

$$F_2 = \frac{G m_1 m_2}{4d^2}$$

$$F_2 = \frac{1}{4} \frac{G m_1 \cdot m_2}{d^2}$$

$$F_2 = \frac{1}{4} F_1$$

It shows that force of gravitation between two bodies decreases by four time when distance between them is doubled.

f. What is accelration due to gravity? What are the value of 'g' on equatorial region and polar region of the earth?

→ The accelration produced on a freely falling body due to the influence of gravity is called accelration due to gravity.

The value of 'g' at the pole is $9.83\ m/s^2$ and value of 'g' at the equator is $9.78\ m/s^2$.

g. Derive an expression to show that the accelration due to gravity of the earth is inversely proportional to the square of its radius?

⇒

Suppose an object of mass 'm_2' is placed on the surface of earth. Let the mass of earth be 'm_1' and its radius 'R'.

According to Newton's universal law of gravitation, the force of gravitation between the earth and object is given by:-

$$F = \frac{G m_1 m_2}{R^2} \quad \text{— (i)}$$

When an object is allowed to fall freely toward the earth, it falls with acceleration equal to 'g'. Again according to Newton's second law of motion, the force applied by the earth 'F' is obtained as follows:-

$$F = mg \quad \text{— (ii)}$$

Force obtained from equation (i) and equation (ii) are identical. Hence,

$$mg = \frac{G m m}{R^2}$$

$$g = \frac{G m}{R^2}$$

Since G and m are constants for Earth.

$$g \propto \frac{1}{R^2}$$

h) When a man travels from hilly region to terai region, what will happen to his weight? Explain with reason.

→ The value of g increases as we go from higher altitude to lower altitude due to g being inversely proportional to the square of distance from the Earth's center given by:-

$$g = \frac{Gm}{(R+h)^2}$$

where,

weight = mg

So, when a man moves from hilly region to terai region this weight increases slightly.

i) In which condition do a feather and coin dropped from the same height fall at the same speed, why?

→ In vacuum a feather and coin dropped from same height fall at same speed because acceleration of freely falling bodies remains same for all bodies irrespective of their masses given by:-

$$g = \frac{Gm}{R^2}$$

m = mass of heavenly body

R = Radius of heavenly body

J. How does parachute fall towards surface of moon?

→ Parachute falls freely on the surface of moon due to absence of external resistance of air.

K. What are conditions necessary for weightlessness?

→ Conditions necessary for weightlessness are given as:-

a. A body feels weightlessness during freefall because of lack of reaction force.

b. A body experience weightlessness when it is null point in space.

c. When a body is inside spaceship which is orbiting around a heavenly body, it feels weightlessness.

4. Give reasons

a. Newton's law of gravitation is called universal law.
→ This law is called universal law because it is applicable to all bodies in the universe.

b. G is called universal gravitational constant.
→ G is called universal gravitational constant because its value 6.67×10^{-11} Nm^2/kg^2 is constant throughout the universe.

c. The effect of gravitation on the liquid is felt more than on the solid.
→ Since the liquids have weaker intermolecular forces of attraction, they are loosely bound which makes them easy to move whereas on solid they have strong intermolecular forces of attraction so, effect of gravitation on the liquid is felt more than on the solid.

d. Tides are observed on the sea but not on a lake.
→ The gravitational force of attraction between any two masses is directly proportional to the product of their masses. Since there is huge mass of water in the sea they experience greater force of attraction. However, water of small lakes cannot experience gravitational pull because of its less mass and tides don't occur.

e. The possibility of getting hurt is more if jumped from greater height.

→ Since earth is pulling objects at its centre at accelration $9.8 m/s^2$ which means greater falling velocity from greater height causing stronger impact than from smaller height.

f. If the same object is dropped from same height separately on the pole and equator region of the earth, the object will fall fastrer at the polar region.

→ The earth isnot perfectly round, it is flattened at pole and buldged at the equator; thus the radius at pole is less, whereas more at equator. As a result, value of 'g' of the earth is more at the pole and less at the equator. Because of the higher value of g at the pole, a body falls slightly faster at the pole than at the equator.

g. A feather and marble reach the ground simultaneously inside vacuum.

→ Accelration due to gravity is affected by mass and Radius of heavenly body given by:-

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

Since, feather and marble are masses of smaller bodies which are being pulled towards centre aren't neglected factors of accelration due to gravity they will fall simultaneously inside vacuum as no external air resistance to affect freefall of those bodies.

h. A feather and coin fall simultaneously on the surface of the moon.

→ moon doesn't have atmosphere, there is no air resistance which will affect falling of feather and coin. Feather and coin will fall freely and as g accelration due to gravity doesn't depends upon ~~fallin~~ masses of falling objeck. So, they fall simultaneously.

i. The weight of backpack decreases gradually while climbing mt. sagarmatha.

→ Since, accelration due to gravity decreases with increase in height from its surface and weight is product of mass & and accelration due to gravity, decrease in accelration due to gravity means decrease in weight of backpack, mt everest being upper than surface of Earth.

J. Value of 'g' is more at terai than at hilly region

→ accelration due to gravity 'g' is given by

$$g = \frac{GM}{(R+h)^2}$$

where m is mass of heavenly body.

R is Radius of ~~Earth~~. heavenly body

h is height above earth's surface or heavenly body.

Since, at terai ~~is~~ h is ~~least~~ less than hilly region value of 'g' is more at terai, g being inversely proportional to $(R+h)^2$

k. The value of 'g' varies from place to place on the surface of earth.

→ The earth isnot perfectly round, it is flattened at pole and buldged at the equator. Now value of 'g' is given by

$$g \propto \frac{1}{R^2}$$

Value of R varies from place to place on earth surface. Therefore 'g' of earth is inversely proportional to the square of its radius

l. Weight of body is found less at the top of mountain than at the bottom of it.

→ Value of 'g' is less at the top of mountain than at the bottom of it and weight(w) is given as:-

$$w = mg$$

where,

m is mass of smaller body

so, $w \propto g$

As weight is directly proportional to g. Weight of body is found less at the top of mountain than at the bottom of it.

m. It is difficult to lift a larger stone than a smaller one on the surface of the earth.

→ A larger stone has more mass than smaller one and their weight (w) is given by product of mass of it (m) and acceleration due to gravity of Earth (g)

$$w = mg$$

Since, larger stone has greater mass it will be weigh more and Force should be applied to lift larger than smaller one so, its difficult to lift a larger stone than smaller one.

n. A person can jump higher on moon's surface than on earth's surface.

→ Moon's gravity is ~~be~~ 6 about 6 times less than that of earth which means less weight of person on moon's surface than on earth's surface because of the less force is required to jump on moon's surface allows person to jump higher on moon's surface than on Earth's surface.

o. The mass of jupiter is 319 times more than that of earth but its gravity is only 2.5 times more than that of earth.

→ Since, gravity depends on both mass and Radius of body, ie its 'g' is give by

$$g = \frac{Gm}{R^2}$$

Even though jupiter's mass is huge, its radius is also huge and since gravity decreases with square of radius the increase in gravity is only 2.5 times that of Earth.

P. It is difficult to drink water inside an artificial satellite in the space.

→ Because of microgravity in the satellite, In the absence of gravity, water doesnot flow downward like on earth, so water doesn't flow naturally into the mouth. So, it is difficult to drink water inside an artificial ~~satlit~~ satellite in the space.

q. A parachutist can land safely after jumping out from a flying aeroplane.

⇒ When a parachutist jumps out from a flying plane with a parachute, the resistance given by air to the parachute will be considerably high because of its large size. During the fall downward force and upthrust will be equal. As a result velocity of falling parachute will be low and balanced. Thus parachutist can land safely.

Q. An astronaut can feel weightlessness in an artificial satellite but not on the moon.

→ An astronaut feels weightlessness in an artificial satellite because the satellite and the astronaut are both falling freely around the earth. Since they fall together, astronaut doesn't feel any force but on moon moon has its gravity so, we have some weight on moon.

7.

i→ Galileo's free fall experiment

ii→ Second figure shows correct phenomenon. This is because Galileo proved that all objects fall at the same rate under gravity regardless of their masses.

iii. The conclusion is that all objects fall at same accelration due to gravity and rate of fall doesn't depend on their masses.

b. Yes, there is difference between gravitational force when the earth moves from position A to position B.

This is because gravitational force is inversely proportional to the square of distance between them two objects

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

- At position A Earth is farther from sun
- At position B Earth is closer from sun

So, more Gravitational force at point B than A.