

freely falling object on earth due to force and gravity is called acceleration due to gravity. It is denoted by the letter 'g'.

Question 3. Write down three points of difference between mass and weight.

Ans. Three differences between mass and weight are as follows :

Mass	Weight
1. Mass of an object is the quantity of matter contained in it.	1. Weight of an object is the force of attraction of the earth on the object.
2. Mass is a scalar quantity and it does not vary from place to place.	2. Weight is a vector quantity and it varies from place to place.
3. Dimension of mass is M and its unit is kg.	3. Dimension of weight is MLT^{-2} and its unit is N.

Question 4. Explain why the masses of two objects will be the same when measured by a balance on the earth and the moon.

Ans. Every object is made of matter. The quantity of matter contained in the object is its mass. Mass is measured by balance in units of kilogram (kg). Mass is a physical quantity that does not change from place to place on the surface of the earth or above the earth. The mass of an astronaut of 75 kg will remain 75 kg on the moon or the orbit of earth. The quantity of matter with which the astronaut is made of does not change with the change of place and thus his mass remains the same at all places.

Question 5. Why there is a difference in the weight of the same object when measured at the polar region and in the equatorial region.

Ans. The earth is not perfectly round in shape. So the distances from the centre of the earth to all places on the surface are not the same. The radius of the earth at the equatorial region is the largest and this is why the value of g is the least at the equator which means that the weight of an object is the least at the equator. Exactly the opposite thing happens in case of polar regions where the radius of the earth is least, the value is maximum meaning that the weight of the same object is maximum.



MCQs with Answers

1. What is the unit of weight?
 A gram B kilogram
 C quintal D newton

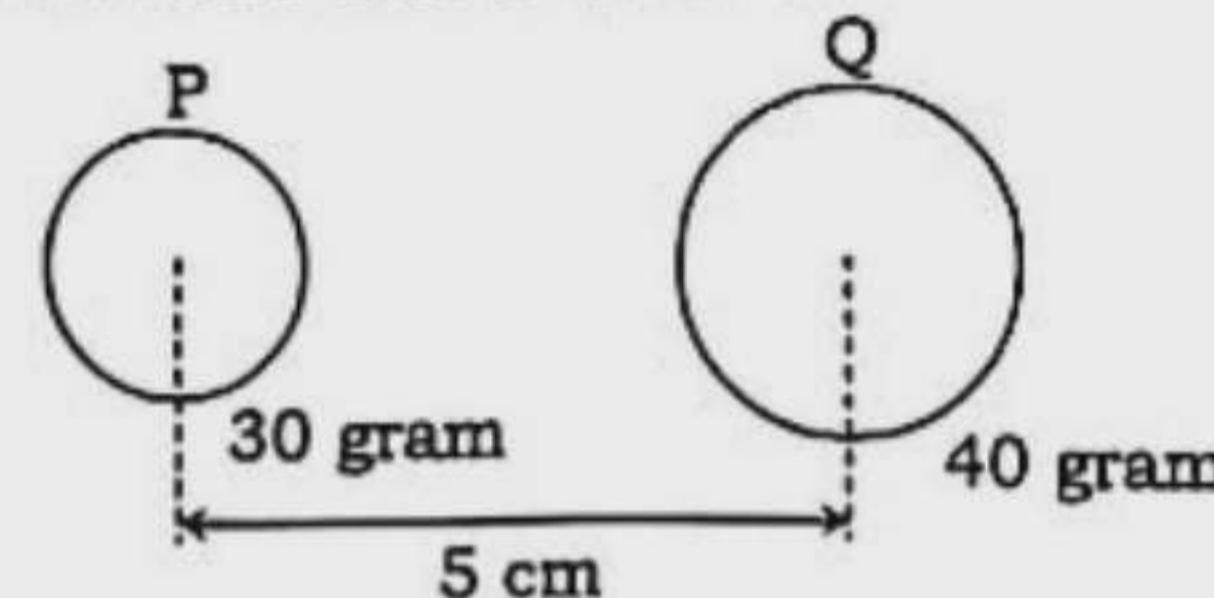
► **Explanation :** Gram → Unit of mass in CGS system.
 Kilogram → MKS system or international unit of mass is kg.
 Quintal → 100 kg is 1 quintal.
 Newton → Unit of force and weight.

2. Which of the following comments is correct with reference to the mass of an object?

- (A) The mass of an object changes with the change in its location.
- (B) The attractive force on an object due to the earth is nothing but mass.
- (C) The net amount of material in an object is its mass.
- (D) The unit of mass is newton.

► **Explanation :** Mass is the total amount of matter in an object. The mass of an object does not change due to changes in its position, shape and state of motion. The international unit of mass is kg (kilogram). On the other hand, the force of gravity of the earth on an object is the weight of the object.

- From the figure given below, give answer to questions no. 3 and 4.



3. The attractive force between P and Q depends on —.

- i. the masses of the object.
- ii. the distance between the objects.
- iii. the nature of the medium.

Which one is correct?

- (A) i & ii (B) i & iii (C) ii & iii (D) i, ii & iii
- **Explanation :** Every particle in this universe attracts each other towards itself.

According to the law of gravity, $F = G \frac{m_1 m_2}{d^2}$

According to the law of gravity, the value of this force of attraction between two particles depends on their mass and the distance between them. It does not depend on their shape, nature or the nature of the medium.

Therefore, the force of attraction between P and Q will support the above law of gravity.

4. If the product of the masses of the two objects becomes 3600 gram^2 , what will be the change in the force of attraction between them?

- (A) Will be half (B) Will be double
- (C) Will be three times (D) Will be four times

► **Explanation :** According to the law of gravity, we get, $F = G \frac{m_1 m_2}{d^2}$

From the said law, we see that the force of attraction is proportional to the product of the masses of the two particles and proportional to the square of the distance between them. That is, if the product of the masses is

doubled, the force will be doubled, if the product of the masses is tripled, the force will be tripled. And if the distance between them is doubled, the force will be one-fourth, if the distance is tripled, the force will be one-ninth (one-ninth).

Now, the product of the masses of the stimulus P and Q = $30 \text{ gram}^2 \times 40 \text{ gram}^2 = 1200 \text{ gram}^2$. Therefore, if the product of the masses is tripled, the force will also be tripled. So, if the product of mass is tripled, $3600 \text{ gram}^2 = 1200 \text{ gram}^2 \times 3$, the force will also be tripled.

Creative Questions with Answers

- Ques. 01** Nuha let a stone of mass 50 gram and a piece of paper to fall from the fifth floor of their building at the same time. Her brother standing on the ground observes that stone reached the ground earlier than the piece of paper.
- What is gravity? 1
 - What is meant by acceleration due to gravity? 2
 - Find the weight of the stone. 3
 - Explain why the stone reached the ground earlier than the paper. 4

Answer to Question No. 01 :

- a The attraction between the earth and any body in the universe is called gravity.
- b Newton's second law of motion reveals that an object gets acceleration when a force acts on it. In this way, acceleration of an object is produced due to the force of gravity as well. This acceleration is called acceleration of gravity. In other words, the rate of increase of velocity of a freely falling object on earth due to force and gravity is called acceleration due to gravity. It is denoted by the letter 'g'.

- c We know, $W = m \times g$
(W = weight, m = mass, g = acceleration due to gravity, a constant. Its value on earth surface is 9.8 meter/sec^2)

$$\text{Given, } m = 50 \text{ gm.} = \frac{50}{1000} \text{ kg} = \frac{1}{20} \text{ kg.}$$

$$\text{So, } W = \frac{1}{20} \text{ kg} \times 9.8 \text{ m/s}^2 = 0.05 \text{ kg} \times 9.8 \text{ m/s}^2 = 0.49 \text{ N}$$

The stone's weight is 0.49N.

- d A sheet/piece of paper is much lighter than a 50 gm stone. This is why, the stone has to exert much lower friction of air than the piece of paper does. Again, the piece of paper exerts much more upward air-pressure than the stone does. The piece of paper needs longer time to touch the ground as it has to undergo the resistance of air much more

than the tiny stone does. If there exist no such resistance, both the stone and the piece of paper would fall down at the same moment. Isaac Newton proved it with an experiment commonly known as the experiment of guinea and feather.

Ques. 02 A body of mass 120 kg is carried to the moon by a rocket. It is observed that, though the mass of the object did not change, its weight changed.

- What is mass? 1
- What is the difference between mass and weight? 2
- Find the weight of the object on the moon. 3
- Will there be any change of weight of the object on the moon? Explain. 4

Answer to Question No. 02 :

- a The quantity of matter contained in an object is called its mass.
- b Mass of an object is the quantity of matter contained in it but its weight means the attraction force of the earth on it. Mass is a scalar quantity while weight is a vector quantity. Weight varies from place to place but mass does not do.
- c Weight depends on acceleration due to gravity (g). The higher the position of an object, the higher is its weight loss. It is because the higher is the distance of an object from the earth-surface, the lower is the magnitude of 'g'.

We know, an object of one kilogram weighs 1.6 Newton in the moon.

So an object of 120 kg will weigh 120×1.6 Newton = 192 Newton in the moon.

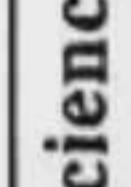
- d Since mass is a constant quantity, weight depends not on mass but on acceleration due to gravity (g). Factors causing change in acceleration due to gravity also causes change in weight. The higher the position of an object, the higher will be its weight loss.

The given object has a mass of 120 kg.

Its weight on the earth surface is $120 \text{ kg} \times 9.8 \text{ m/s}^2 = 1176 \text{ Newton}$.

We know, an object of one kg. weighs 1.6 Newton in the moon.

So, the given object of mass 120 kg will have a weight of 192 Newton (120×1.6 Newton) in the moon. That is, the object loses a weight of 984 Newton because of the fact that acceleration due to gravity in the moon is roughly one-sixth times of that on earth ($1 \text{ kg} \times 9.8 \text{ m/s}^2 \div 1.6 \text{ N} = 9.8 \text{ N} \div 1.6 \text{ N} = 6.125 \text{ N}$).



**Multiple Choice Q/A****Designed as per topic****Lesson 1 : Gravitation** ► Textbook Page 66

1. Which one of the following is an example of gravitation? (Comprehension)
 - (A) attraction force between a chair and a table
 - (B) attraction force between a river and the moon
 - (C) attraction force between the sun and the uranus
 - (D) all the above
2. Which one of the following is a constant? (Knowledge)
 - (A) m (B) F (C) M (D) W
3. If the distance between two objects is increased four times, how would the attraction force between them be? (Comprehension) [D.B.-'19]
 - (A) $\frac{1}{4}$ (B) $\frac{1}{16}$
 - (C) 4 times (D) 16 times
4. In the Newton's law of gravitation— (Application) [JB '19]
 - i. every particle in the universe attracts each other
 - ii. the force of attraction is proportional to the product of their masses
 - iii. the force of attraction is proportional to the square of the distance between them

Which one is correct?

 - (A) i & ii (B) i & iii (C) ii & iii (D) i, ii & iii
5. Two objects of 25 kg and 30 kg mass are 10m far from each other. How is the force of attraction between these two objects? (Comprehension) [CB '19]
 - (A) 0.55 G Newton (B) 5.50 G Newton
 - (C) 7.50 G Newton (D) 75.00 G Newton
6. Which is Newton's law of gravitation? (Knowledge) [DJB '18]
 - (A) $F = G \frac{Mm}{d^2}$ (B) $F = G \frac{m_1 m_2}{d^2}$
 - (C) $g = \frac{GM}{d^2}$ (D) $mg = \frac{GMm}{d^2}$

Lesson 2-3 : Gravity and the acceleration due to gravity ► Textbook Page 67

7. What is the value of 'g' in polar regions? (Higher Ability)
 - (A) 9.812 m/s² (B) 9.823 m/s²
 - (C) 9.832 m/s² (D) 9.821 m/s²
8. Where the magnitude of 'g' is the least? (Comprehension)
 - (A) in the equinox (B) in the equator
 - (C) in the north pole (D) in the south pole

9. The value of acceleration due to gravity 'g' is higher in— (Knowledge) [JB '19]
 - (A) equator region (B) polar region
 - (C) at the center of the earth (D) at moon
10. What is the value of the acceleration due to gravity at the center of the earth? (Higher Ability) [SB '18]
 - (A) 9.78 m/s² (B) 9.8 m/s²
 - (C) 9.83 m/s² (D) 0 m/s²

Lesson 4: Mass and weight

► Textbook Page 68
11. Where will an object have maximum weight? (Knowledge)

- (A) in any pole (B) in any mine
- (C) on any hill top (D) in any valley
- 12. In which country will an object have the least weight? (Knowledge)
 - (A) Finland (B) Ireland
 - (C) Netherland (D) Poland

(Netherland lies below the sea level. Almost the whole country is surrounded with thick walls.)
- 13. In which country will the weight of an object be maximum? (Knowledge)
 - (A) Iceland (B) Swaziland
 - (C) Thailand (D) Tunisia

[Iceland is a polar country]

14. In which country will the weight of an object be the least? (Knowledge)
 - (A) New Zealand (B) Finland
 - (C) China (D) Congo

[Congo lies in the equinox / tropic of cancer]

15. Where is the weight of an object the highest? (Application) [D.B.-'19]
 - (A) At the centre of the earth
 - (B) At the polar region
 - (C) At the equator
 - (D) At the surface of the earth

16. What is the international unit of mass? (Knowledge) [JB '19; MB '19]
 - (A) Centigram (B) kg
 - (C) Quintal (D) Gram

Lesson 5 : The relation between mass and weight ► Textbook Page 69

17. Features of weight—. (Higher Ability)
 - i. vector quantity
 - ii. centripetal
 - iii. the product of mass and acceleration due to gravity

Which one is correct?

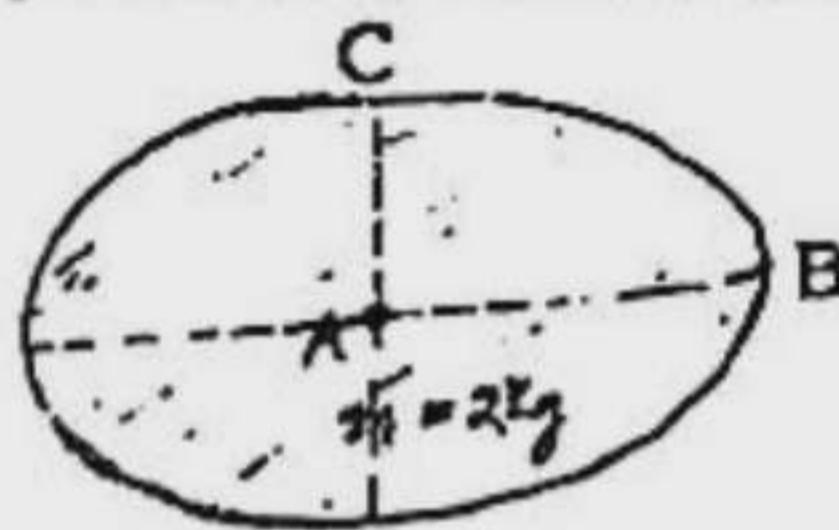
 - (A) i & ii (B) i & iii (C) ii & iii (D) i, ii & iii

- Look at the stem carefully and answer the questions No. 18 and 19 :
Moni is playing cricket at the roof of a building. Suddenly, the bat of mass 2000 gram is falling down from his hand. [JB '19]

18. What is the weight of Moni's bat? (Knowledge)
 @ 19.6 Newton @ 20.41 Newton
 @ 196 Newton @ 19600 Newton
19. The above phenomenon occurred— (Application)
 i. due to acceleration due to gravity
 ii. due to gravitational force
 iii. due to the attraction of earth
 Which one is correct?
 @ i & ii @ i & iii @ ii & iii @ i, ii & iii
20. A body of mass is 30 kg in Dhaka, How much weight in Newton of the body? (Higher Ability)
 [CtgB '19]
 @ 48.9 @ 293.4
 @ 294.0 @ 294.9

21. The weight of a body on moon is 20 Newton. What is the weight of that body on earth? (Higher Ability)
 [SB '19]
 @ 3.33 Newton @ 2.04 Newton
 @ 120 Newton @ 196 Newton

■ On the basis of the stem, answer the questions No. 22 and 23 :



[MB '19]

22. What will be the weight of the object M in the position B? (Knowledge)
 @ 4.89 Newton @ 4.91 Newton
 @ 19.56 Newton @ 19.66 Newton

23. The reason behind the difference in the object M in position B and C— (Application)
 i. acceleration due to gravity
 ii. shape of the earth
 iii. mass of the object
 Which one is correct?

- @ i & ii @ i & iii
 @ ii & iii @ i, ii & iii

24. What is the weight of an object of 10 Kg mass on Earth? (Knowledge) [DB '18]
 @ 19.8 Newton @ 49 Newton

- @ 98 Newton @ 196 Newton
 ■ Answer the questions No. 25 and 26 form the following information :

Mass of two bodies are 50kg and 60kg respectively. [CB '18]

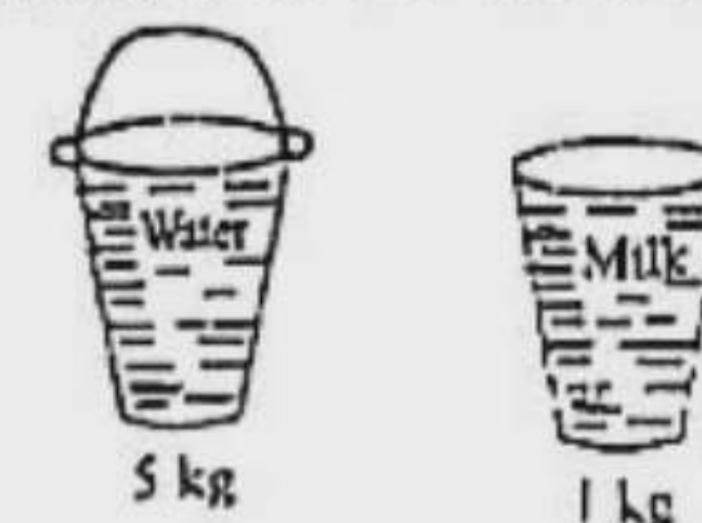
25. How many weight difference of the two bodies? (Higher Ability)
 @ 1278 newton @ 588 newton
 @ 490 newton @ 98 newton

26. If the multiplication of masses of two bodies is 12000 kg then how much time the attraction force? (Comprehension)

@ 4 @ 8

@ 12 @ 16

- Look at the picture and answer the questions number 27 and 28 :



[BB '18]

27. What is the weight of the water mentioned in the picture? (Knowledge)

@ 49 newton @ 39 newton

@ 9.8 newton @ 1.96 newton

28. What is the difference of weight between water and milk mentioned in the stem in polar region? (Higher Ability)

@ 39.07 newton @ 39.17 newton

@ 39.20 newton @ 39.32 newton

- The light of the paragraph below answer the questions No. 29 and 30 :

Science teacher said, "The earth is not round. For this the acceleration due to gravity is different at different places on the earth and he taught mass and weight." [DjB '18]

29. The relation between mass and weight —. (Application)

i. are fully different quantity

ii. mass and weight are measured by spring scale

iii. unit of mass is kg and unit of weight is newton

Which one of the following is correct?

@ i & ii @ i & ii

@ ii & iii @ i, ii & iii

30. How much velocity increases freely falling body near the surface of the earth at every second? (Higher Ability)

@ 9.78 m/sec² @ 9.79 m/sec²

@ 9.80 m/sec² @ 9.83 m/sec²

Lesson 6 : The acceleration due to gravity and the weight of an object are different at different places on the earth

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31. What is the value of 'g' in the zones of tropic of cancer? (Application)

@ 9.86605 m/s² @ 9.86065 m/s²

@ 9.85660 m/s² @ 9.80665 m/s²

32. What is the mass of an object having a weight of 980 Newton on the earth surface? (Comprehension)

@ 98 kg @ 100 kg @ 980 kg @ 10 kg

33. An object starts losing its weight along with —.
(Application)
- staying around the equinox
 - staying around the equator
 - moving up to upper
- Which one is correct?
- a** @ i & ii **b** ii & iii **c** i & iii **d** i, ii & iii
34. Causes of weight difference in the earth —.
(Comprehension)
- Distance between the earth and the moon is not uniform
 - Different radii at different places of the earth
 - Diurnal rotation of the earth
- Which one is correct?
- b** @ i & ii **c** ii & iii **d** i & iii **e** i, ii & iii
35. How much weight of a 1 kg mass object at the equinoctial point? (Knowledge) [RB '19]
- a** @ 9.78 N **b** 9.79 N
- a** @ 9.80 N **b** 9.83 N
36. Where the value of 'g' is maximum? (Application) [SB '19]
- a** @ At polar region **b** At the equator
- a** @ At the equinocial point **b** At the center of the earth
37. Where the value of 'g' is zero? (Knowledge) [BB '19]
- a** @ At polar region **b** At the equator
- a** @ On earth surface **b** At the center of the earth
38. The values of 'g' is greater in—(Application) [DJB '19]
- a** @ Pole region **b** Equatorial region
- a** @ Tropical region **b** Center of the Earth
39. What is the magnitude of 'g' at the centre of the earth? (Knowledge) [CtgB '18]
- a** @ 9.83 ms^{-2} **b** 9.78 ms^{-2}
- a** @ 9.8 ms^{-2} **b** 0 ms^{-2}
- Lesson 7 - 8 : The variation of weight in a lift and in space: Weightlessness
- Textbook Page 71
40. What will be the weight of an object having a mass of 10 kg in either pole? (Higher Ability)
- b** @ 983 N **b** 98.3 N **c** 9.83 N **d** 9.38 N

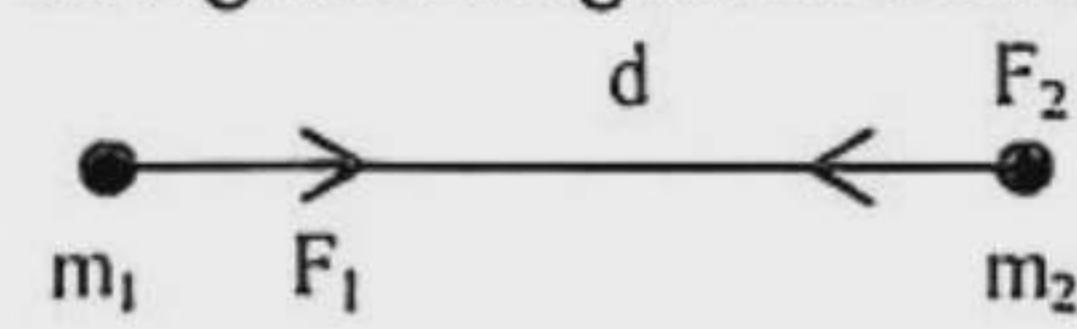
41. What will be the weight of an object having a mass of 100 kg in equinoctial regions?
(Comprehension)
- a** @ 9.78 N **b** 9.87 N
- c** @ 978 N **d** 987 N
42. What will be the weight of an object having a mass of 100 kg in equatorial regions?
(Application)
- a** @ 9.79 N **b** 9.97 N
- d** @ 997 N **c** 979 N
43. The value of the weight of an object—
(Comprehension) [CtgB '19]
- depend on the mass
 - difference in different places
 - is maximum in pole region
- Which one is correct?
- d** @ i & ii **c** ii & iii **b** i & iii **a** i, ii & iii
44. What is the mass of an astronaut in the Moon when the mass of this astronaut is 70 kg on Earth? (Knowledge) [Din.B.-'19]
- a** @ 11.67 kg **b** 70 kg
- b** @ 420 kg **c** 686 kg
45. How many satellites Saturn has? (Comprehension) [DJB '19]
- a** @ 62 **b** 34
- a** @ 27 **c** 13
46. If the lift goes down freely then our acceleration would be in comparative to the lift—.
(Higher Ability) [BB '18]
- a** @ limitless **b** zero
- b** @ 9.5 m/sec^2 **c** 9.8 m/sec^2
47. How much velocity increases freely falling body near the surface of the earth at every second?
- a** @ 9.78 m/sec^2 **b** 9.79 m/sec^2
- c** @ 9.80 m/sec^2 **d** 9.83 m/sec^2
48. What is the value of "g" at the surface of the earth for a freely falling body? (Comprehension) [DB '17]
- a** @ 9.73 m/sec^2 **b** 9.67 m/sec^2
- d** @ 9.97 m/sec^2 **c** 9.8 m/sec^2

**Short Q/A****Designed as per topic**

- Lesson 1 : Gravitation ► Textbook Page 66
- Question 1. What is gravitational force? Explain.
- Ans. The force by which every particle in the universe attracts each other is called gravitational force. The magnitude of this attractive force between two particles depends on the mass of the particles and the distance between them. It does not depend on their shape, nature, or the nature of the medium. For example, the attractive force between the Earth and the Moon is gravitational force.

Question 2. Explain Newton's law of gravitation.

Ans. Answer: Every particle in the universe attracts each other. The magnitude of this attractive force is proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them. This force acts along the straight line connecting the two particles.



[m_1 and m_2 are attracting each other with forces F_1 and F_2 , and the distance between them is d .]

According to the law of gravitation,

$$F_1 = F_2 = F \propto \frac{m_1 m_2}{d^2}$$

$$F = \frac{G m_1 m_2}{d^2} \quad [\text{Here } G \text{ is a constant of proportionality.}]$$

Question 3. What factors does gravitational force depend on?

Ans. Gravitational force depends on the following factors :

1. Mass of the particles
2. Distance between the particles

Question 4. Why is the gravitational constant called universal?

Ans. The value of the gravitational constant is the same everywhere in the universe. That's why it's called universal. The value of the gravitational constant G remains the same on the Moon and even on Mars. It does not depend on location.

Question 5. If the distance between two objects is tripled, what will be the gravitational force?

$$\text{Ans. We know, } F \propto \frac{1}{d^2}$$

If the distance between two objects is tripled, the gravitational force will be $\frac{1}{9}$ th of the original force.

Question 6. Why does the gravitational force increase when the mass of two objects increases?

Ans. The attraction force between any two objects in the universe is gravitational force. According to Newton's law, gravitational force is proportional to the product of the masses. When the mass increases, the force also increases. Therefore, the gravitational force increases when the mass of two objects increases.

 **Lesson 2-3 : Gravity and the acceleration due to gravity** → Textbook Page 67

Question 7. What is meant by weightlessness?

Ans. The attraction force of the Earth on an object is its weight. Just as the Earth attracts an object, the object also attracts the Earth. An object feels weight when it exerts a force on the Earth and the Earth exerts an equal and opposite reaction force on it. If the reaction force on the object is zero, the object will experience weightlessness.

Question 8. Why does a cricket ball thrown upwards come back down?

Ans. A cricket ball thrown upwards comes back down to the Earth's surface. This is because the Earth attracts the cricket ball with gravitational force, causing it to come back down. Also, the mass of the Earth is much greater than the mass of the cricket ball, so the Earth's attraction force is also much greater.

Question 9. What is meant by acceleration due to gravity?

Ans. We know that when a force is applied to an object, its velocity changes. The rate of change of velocity with respect to time is called acceleration. Gravitational force also causes acceleration in objects. Therefore, the rate at which the velocity of a freely falling object increases under the influence of gravitational force is called acceleration due to gravity.

Question 10. Why is acceleration due to gravity object-independent?

$$\text{Ans. We know, } g = \frac{GM}{d^2}$$

Acceleration due to gravity or g does not depend on the mass of the object. That's why it's object-independent.

Question 11. Why does the value of g vary at different locations on Earth?

Ans. The value of acceleration due to gravity g depends on the distance d of the object from the center of the Earth. The value of d varies at different locations on Earth. That's why the value of g also varies at different locations on Earth.

Question 12. Why is the value of g greater at the poles of the Earth?

Ans. The value of acceleration due to gravity g depends on the radius of the Earth, R . The Earth is not perfectly spherical; it is slightly flattened at the poles. The distance R from the center of the Earth is the smallest at the poles, which is why the value of acceleration due to gravity is greater there.

Question 13. Why does the value of acceleration due to gravity decrease from the poles to the equator?

Ans. The Earth is not perfectly spherical; it is slightly flattened at the poles. Therefore, the radius is smallest at the poles. But as we move from the poles towards the equator, the radius increases. Acceleration due to gravity depends on the radius of the Earth. That's why the value of acceleration due to gravity decreases as we move from the poles to the equator.

 **Lesson 4: Mass and weight** → Textbook Page 68

Question 14. Explain the concept of mass.

Ans. Every object is made up of matter. Mass is the amount of matter in an object. The mass of an object does not change with changes in its location, shape, or motion. The mass of an object depends on the number and type of atoms and molecules that make up the object. The international unit of mass is kilogram or kg.



Question 15. What is weight? Explain.

Ans. The force with which the Earth attracts an object is called the weight of that object. If only gravitational force is acting on an object, and the acceleration due to gravity at a location on Earth is g , and the mass of the object is m , then the weight of the object at that location will be $W = mg$.

Question 16. If the mass of a person on the Earth's surface is 60 kg, what will be his weight?

Ans. We know,

$$W = mg = 60 \times 9.8 = 588 \text{ N.}$$

Therefore, the person's weight will be 588 N.

Question 17. Write two differences between mass and weight.

Ans. Two differences between mass and weight are listed below :

Mass	Weight
1. Mass is the amount of matter in an object.	1. The force with which the Earth attracts an object is called the weight of that object.
2. Mass does not change with changes in the object's location.	2. Weight depends on acceleration due to gravity, so it changes with changes in location.

Lesson 5 : The relation between mass and weight

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Question 18. Why does the mass of an object remain unchanged on the Moon?

Ans. The amount of matter in an object is its mass. Mass is a constant quantity that does not change with the change in the object's location on the Earth's surface or above it. That's why the mass of an object remains unchanged on the Moon.

Question 19. Why is weight not a fundamental property of an object?

Ans. A fundamental property of an object is one that always remains unchanged, such as mass. Weight varies from place to place and is always changing. That's why weight is not a fundamental property of an object.

Question 20. Why does the weight of an object decrease when we climb a mountain?

Ans. The weight of an object depends on acceleration due to gravity g . The factors that cause changes in g also cause changes in the weight of an object. When we climb a mountain, the distance d between the object and the center of the Earth increases, resulting in a decrease in the value of g . That's why the weight of an object decreases when we climb a mountain.

Question 21. Why is the weight of an object zero at the center of the Earth?

Ans. The weight of an object depends on acceleration due to gravity. Acceleration due to gravity depends on the radius of the Earth. The radius is zero at the center of the Earth, so the acceleration due to gravity is also zero. That's why the weight of an object is zero at the center of the Earth.

Question 22. What does $W = 9.8 \text{ N}$ mean?

Ans. $W = 9.8 \text{ N}$ of an object means that the Earth attracts the object towards its center with a force of 9.8 N.

Lesson 6: The acceleration due to gravity and the weight of an object are different at different places on the earth

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Question 23. What are the reasons for the change in weight of an object?

Ans. The reasons for the change in weight of an object are as follows :

1. Shape of the Earth
2. Diurnal motion of the Earth
3. Angular distance from the pole
4. Higher altitude above the Earth's surface
5. Location inside the Earth

Question 24. Why is the weight of an object less in a mine?

Ans. As we go deeper inside the Earth, the value of acceleration due to gravity decreases. As a result, the weight of an object also decreases as we go deeper inside the Earth. That's why the weight of an object is less in a mine.

Lesson 7 - 8 : The variation of weight in a lift and in space: Weightlessness

► Textbook Page 71

Question 25. What will be the weight of a person inside a stationary lift?

Ans. A person inside a stationary lift exerts a force on the floor of the lift equal to their actual weight. The floor of the lift also exerts an equal and opposite reaction force on the person. Therefore, the person's weight inside the lift will be equal to their actual weight.

Question 26. Why does a person feel heavier in an upward accelerating lift?

Ans. When an upward accelerating lift moves upwards, an additional upward force (greater than the combined weight of the lift and the person) is applied to the lift. In this case, the acceleration becomes $(g + a)$. As a result, the floor of the lift exerts a greater force on the person than their actual weight. That's why the person feels heavier.

Question 27. Why do astronauts feel weightless in space?

Ans. Astronauts orbit the Earth in a spacecraft at a certain altitude in a circular path. The weight of the spacecraft and the astronaut are responsible for this circular motion, and both the spacecraft and the astronaut move with the same acceleration. Therefore, the acceleration of the astronaut relative to the walls of the spacecraft is zero, and the astronaut does not exert any force on the walls or floor of the spacecraft. As a result, they do not feel any reaction force against their weight and experience weightlessness.

Question 28. Why does a rider feel weightless in a freely falling lift?

Ans. A freely falling lift does not exert any force on the rider inside it. As a result, the rider feels weightless.

Question 29. What kind of weight will a rider feel when a lift is moving at a constant velocity?

Ans. A rider in a lift moving upwards or downwards at a constant velocity also moves with the same constant velocity. As a result, only their actual weight (gravitational force) acts on them. The rider exerts a force on the lift equal to their actual weight, and the floor of the lift exerts an equal reaction force on the rider. Therefore, the rider's perceived weight is equal to their actual weight.

Question 30. Why does a rider feel less weight in a downward accelerating lift?

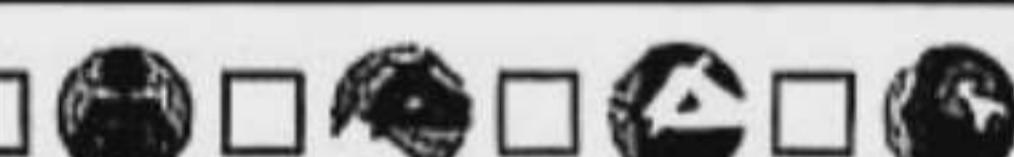
Ans. When a downward accelerating lift moves downwards, the tension applied through the lift's cables is reduced from the total weight of the lift and the rider. The rider moving downwards with the lift experiences a force from the lift's floor that is less than their actual weight. As a result, the rider feels less weight than their actual weight.



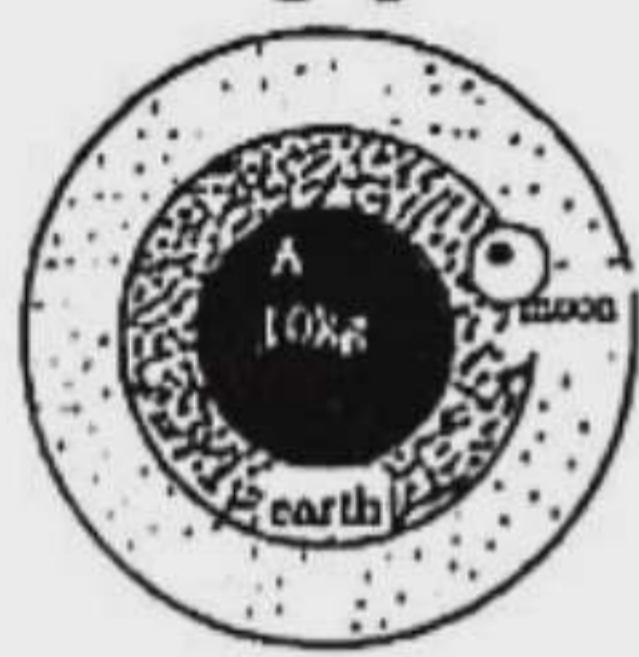
Creative Q/A



Designed as per learning outcomes



Ques. 01 Look at the picture below and answer to the following questions.



- What form of attraction force is in action between the earth and the moon? 1
- How is 'F' related to 'd'? 2
- Suppose, object A is taken to the moon. Find A's weight there. 3
- Analyse the changes in mass and weight of the object A if it is taken to the different regions in the earth. 4

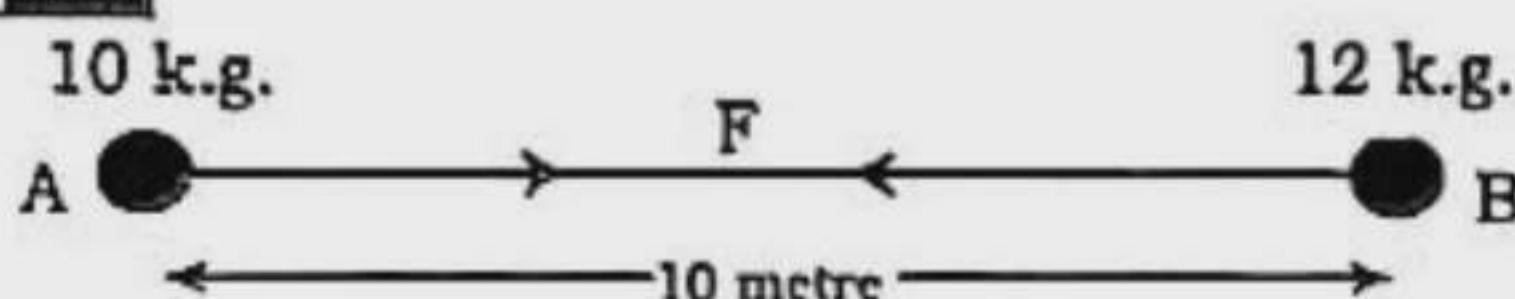
c Object A has a mass of 10 kg. So, its weight is $10 \text{ kg} \times 9.8 \text{ m/s}^2 = 98 \text{ Newton}$. But the object will not weigh 98 Newton when it will measured in the moon. We know, an object having a mass of 10 kg. weigh 1.6 Newton in the moon. So object 'A' will weight $10 \times 1.6 \text{ Newton} = 16 \text{ Newton}$ in the moon. That is, the weight of the same object is more than 6 times larger (6.125) than it weighs in the earth.

d If object 'A' is taken to the different regions of the earth, there will be no change in its mass. It is weight which will change from region to region. If the object is taken to the polar region, it will gain maximum weight because the radius of the earth is the least in the polar region. On the contrary, the object will be of minimum weight in the equatorial region where the radius of the earth is the largest. If it is taken to the mountain top, its weight will decrease. The same thing will happen if it is taken to the depth of a mine. If the object is taken to the centre of the earth, its weight will simply be zero because of the zero value of 'g' (acceleration due to gravity).

Answer to Question No. 01 :

- The attraction force between the earth and the moon is called gravity.
- 'F' is inversely related to the square of 'd'. F stands for quantity and 'd' for distance between two objects. If the objects have masses m_1 and m_2 , the magnitude of F will be $G \frac{m_1 m_2}{d^2}$ where 'G' is the gravitational constant.



Ques. 02

- a. What is the attraction force between A and B called? 1
- b. $F = G \frac{m_1 m_2}{d^2}$ What does the equation mean? 2
- c. Determine the magnitude of F in case of the stem. 3
- d. If masses of A and B are lowered to halves and distance between A and B is raised to double, the magnitude of F will be 16 times lower. 4

Answer to Question No. 02 :

a The attraction force between A and B is called gravitational force.

b $F = G \frac{m_1 m_2}{d^2}$. The equation means that the magnitude of the attraction force between two objects at a certain distance depends on the product of the masses of the objects divided by the square of the distance between them while G is the gravitational (also universal) constant.

c $F = G \frac{m_1 m_2}{d^2}$.

Here, $G = 6.673 \times 10^{-11} \text{ Nm}^2 \text{kg}^{-2}$ (universal value)

$$m_1 = 10 \text{ kg}$$

$$m_2 = 12 \text{ kg}$$

$$d = 10 \text{ metre}$$

$$\therefore F = 6.673 \times 10^{-11} \text{ Nm}^2 \text{kg}^{-2} \frac{10 \text{ kg} \times 12 \text{ kg}}{(10 \text{ m})^2}$$

$$= 6.673 \times 10^{-11} \text{ Nm}^2 \text{kg}^{-2} \frac{120 \text{ kg}^2}{100 \text{ m}^2}$$

$$= 6.673 \times 10^{-11} \text{ Nm}^2 \text{kg}^{-2} \frac{6 \text{ kg}^2}{5 \text{ m}^2}$$

$$= \frac{6.673 \times 10^{-11} \text{ N} \times 6 \text{ kg}^2}{5 \text{ m}^2}$$

$$= \frac{6}{5} \times 6.673 \times 10^{-11} \text{ N}$$

$$= 1.2 \times 6.673 \times 10^{-11} \text{ N}$$

$$\therefore F = 8.0076 \times 10^{-11} \text{ N} \quad (\text{Eq. 1})$$

d If mass of A is lowered to half, it becomes $\frac{10}{2} \text{ kg} = 5 \text{ kg}$

If mass of B is lowered to half, it becomes $\frac{12}{2} \text{ kg} = 6 \text{ kg}$

If distance between A and B is raised to double, it (d) becomes $10 \text{ m} \times 2 = 20 \text{ m}$.

$$\text{So, } F = 6.673 \times 10^{-11} \text{ Nm}^2 \text{kg}^{-2} \frac{5 \text{ kg} \times 6 \text{ kg}}{(20 \text{ m})^2}$$

$$= 6.673 \times 10^{-11} \text{ Nm}^2 \text{kg}^{-2} \frac{30 \text{ kg}^2}{400 \text{ m}^2}$$

$$= \frac{30}{400} \times 6.673 \times 10^{-11} \text{ N}$$

$$= \frac{3}{40} \times 6.673 \times 10^{-11} \text{ N}$$

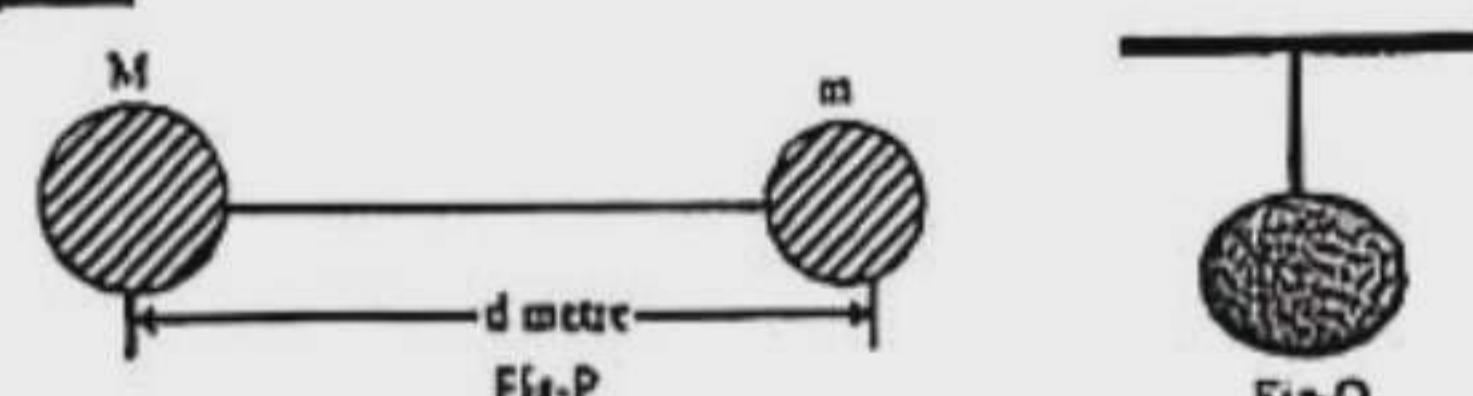
$$= 0.075 \times 6.673 \times 10^{-11} \text{ N}$$

$$\therefore F = 0.5004 \times 10^{-11} \text{ N} \quad (\text{Eq. 2})$$

Let us divide the right side of Eq. 2 by that of Eq. 1,

$$\frac{0.5004 \times 10^{-11} \text{ N}}{8.0076 \times 10^{-11} \text{ N}} = \frac{0.5004}{8.0076} = \frac{1}{16}$$

Evidently, the magnitude of F is 16 times lower.

Ques. 03

- a. What is called mass? 1
- b. Why the weight of an object is more in polar region? 2
- c. In the fig-'P' if the value of 'd' decreases half, what will be the change of force? 3
- d. In fig 'Q' if the hanging body is fall down what type of variation of weight of the body—Analyze logically. 4

• Rajshahi Board 2019

Answer to Question No. 03 :

a The quantity of matter contained in an object is called its mass.

b The force by which the earth attracts an object to its center is called its weight. The weight of an object depends on the value of acceleration due to gravity that is 'g'. The value of 'g' is different at different regions of the earth and its value is maximum in polar region. That's why the weight of an object is more in polar region.

c We know that the force F between two bodies with mass m_1 and m_2 and distance between them d is—
 $F = G \frac{m_1 m_2}{d^2}$, where G is gravitational constant.

Here,

$$m_1 = M \text{ kg}$$

$$m_2 = m \text{ kg}$$

$$d = d \text{ meter.}$$

Now if the value of d decreases half, then $d = \frac{d}{2}$ meter.

And the force between them will be –

$$F = G \frac{Mm}{\left(\frac{d}{2}\right)^2} = G \frac{Mm}{\frac{d^2}{4}} \\ = 4 \cdot \frac{Mm}{d^2} \text{ Newton}$$

So, in the fig- 'P', if the value of 'd' decreases half, then the force will increases 4 times.

a The force by which the earth attracts an object to its center is called its weight. If the mass of an object is m and the acceleration due to gravity at a place is g , the weight of an object is $w = mg$.

Now, according to the stem, in hanging condition the weight of the body is $w = mg$. In this case there is a gravitational force on it. But the weight of an object is not a fundamental parameter. When the body is fall down there will be no gravitational force on it. Therefore the value of acceleration due to gravity will be zero. So, the weight of the object will be $w = m(0) = 0$

So, if the hanging body is fall down the weight of the body will be zero.

Ques. 04 Mr. 'X' of 735 Newton weight suddenly fall down front the one-storeyed building. He goes to the doctor for treatment. To move up-down needs lift to the chamber. He feels heavy when goes up by lift.

- a. What is acceleration due to gravity? 1
- b. Why the value of 'g' is different, in equator region and polar region? 2
- c. Calculate the mass of Mr. 'X'. 3
- d. Analyse the reasons of the two occurrence of the stem. 4

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Answer to Question No. 04 :

a The rate of change of velocity of a body due to the influence of the force of gravity on that body is called acceleration due to gravity.

b Variation of the acceleration due to gravity: If the distance of the body at the surface of the earth measured from the centre of the earth that is the radius of the earth R ,

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

Since the earth is not a perfect sphere, R is not really constant. So the value of g is not equal everywhere at the surface of the earth. As we move from the pole to the equator, the value of R increases and the value of g decreases. At the

equator the value of g is minimum. It is 9.78 meter/sec². The value of g in the polar region is 9.832 meter/sec² at the surface of the earth.

c The quantity of matter contained in an object is called its mass. On the other hand, the force of attraction on a body by the earth towards its centre is called the weight of the body. If the mass of an object is m and the acceleration due to gravity at a place is g , the weight of an object is $w = mg$. Now, according to the stem, weight of Mr. 'X', $w = 735$ Newton. Acceleration due to gravity $g = 9.8 \text{ ms}^{-2}$.

$$\text{So, the mass of Mr. 'X' } m = \frac{W}{g} \\ = \frac{735 \text{ Newton}}{9.8 \text{ ms}^{-2}} \\ = 75 \text{ kg.}$$

So, the mass of Mr. 'X' is 75 kg.

d The two occurrence of the stem are falling down of Mr. 'X' from the one storied building and feeling heavy when goes up by lift. The reasons of the two occurrence are given below –

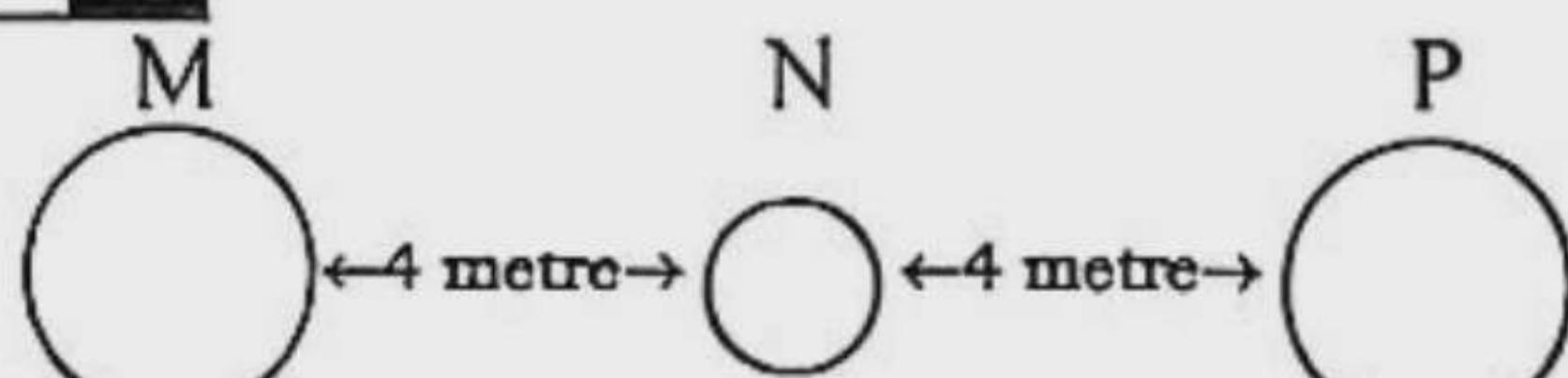
Occurrence - 1 : Mr. 'X' fall down from the one-storied building due to gravity. The accelerating force due to the earth on any object near to it is called gravity.

Occurrence - 2 : The value of g at a particular point on the surface of the earth is fixed and therefore the weight of a person at that point is also definite. But even then a person there may feel a change of his weight and even feel weightlessness under special conditions.

To understand the change of weight and weightlessness in a lift, we have to introduce the idea of inertial frame of reference and the concept of apparent weight. When a system of reference moves with constant velocity, it is called an inertial system. Thus an inertial system has no acceleration; Newton's laws are applicable only in inertial systems. In an accelerated frame, the apparent weight of a body differs from the true weight. Whenever a frame of reference is accelerated, an inertial force arises from which we can find the apparent weight. If the frame like our lift has an acceleration a , an inertial (fictions) force arises given by $-ma$, in a direction opposite to the acceleration of the frame of reference. By applying newton's law of motion $F + (-m g) = ma$ Or, $F = m(g + a)$.

Acceleration a is positive when lift is accelerated upwards and the felt weight of the person in the lift is greater than the real weight.



Ques. 05

40 kilogram 30 kilogram 35 Kilogram

- What is gravity? 1
- During travel to the space, why does an astronaut thinks himself to be weightless? 2
- Calculate the weight of the object 'N' in polar region. 3
- Which of the attraction forces between M and N and N and P is greater? Analyze mathematically. 4

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Answer to Question No. 05 :

a The attraction between the earth and any body in the universe is called gravity.

b The value of g at a particular point on the surface of the earth is fixed and therefore the weight of a person at that point is also definite. But A person can feel weightlessness under special conditions. Where there is no contact force, A person feels weightless.

Thats why an astronaut thinks himself to be weightless during travel to the space.

c According to the stem, mass of 'N' object is 30 kilogram. We know that, weight of an object $w = mg$. Here, mass $m = 30 \text{ kg}$. Acceleration due to gravity, ' g ' in polar region $= 9.83 \text{ ms}^{-2}$. So, the weight of the object 'N' in polar region
 $= 30 \text{ kg} \times 9.83 \text{ ms}^{-2}$
 $= 294.9 \text{ newton}$.

d According to the law of gravitation, if two objects of masses m_1 and m_2 are separated from each other by a distance d and the attraction force between them is F , then—

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

So, in case of object M and N, attraction force between them—

$$F_1 = G \frac{40 \times 30}{(4)^2 m^2} \quad [\text{mass of } M = 40 \text{ kg}]$$

$$\text{, , , } N = 30 \text{ kg}$$

Distance between them $= 4\text{m}$

$$= 75 \text{ G Nm}^2 \text{kg}^{-2}$$

Again, in case of object N and P, attraction force between them—

$$F_2 = G \frac{30 \times 35}{(2x)^2} \text{Nm}^2 \text{kg}^{-1} \quad [\text{mass of } N = 30 \text{ kg}]$$

$$\text{mass of } P = 35 \text{ kg.}$$

Distance between them $= 2\text{m}$]

So, attraction force between N and P is greater than that of M and N.

Ques. 06

Ohi and Itmam are standing in the playground. The distance between them is 40 meter. The masses of them are 35 kg and 40 kg respectively.

- What is mass? 1
- All the gravity is gravitation, but all the gravitation is not gravity.—Explain. 2
- Determine die weight of itmam on moon. 3
- What will be the change of the attraction force between Ohi and itmam, if the distance between them is reduced. The new distance between them is 20 meter. Analyze it mathematically. 4

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Answer to Question No. 06 :

a The quantity of matter contained in an object is called its mass.

b All objects in the universe attract one another. This attractive force is called gravitation. If one of the objects is the earth and the attraction on the object is due to the earth, it is called gravity. That means if attraction involves any two objects in the universe, we call it gravitation. Gravity is a kind of gravitation because in this case attraction occurs between an object and earth. But if one object between them is not earth, the attraction force will not be graving rather it will be gravitation. That's why all the gravity is gravitation, but all the gravitation is not gravity.

c The force by which the earth attracts an object to its center is called its weight. If the mass of an object is m and the acceleration due to gravity at a place is g , the weight of an object is $w = mg$.

Now, according to the stem,

The mass of Itman $m = 40 \text{ kg}$. On the moon, acceleration due to gravity

$$= \frac{1}{6} \times \text{acceleration due to gravity on earth surface}$$

$$= \frac{1}{6} \times 9.8 \text{ ms}^{-2}$$

$$= 1.633$$

[∴ Acceleration due to gravity on earth surface is 9.8 ms^{-2}]

So, the weight of Itmam

$$\text{On the moon } = 40 \times 1.633$$

$$= 65.32 \text{ newton.}$$

d According to the law of gravitation, if two objects of masses m_1 and m_2 are separated from each other by a distance d and the attraction force between them is F , then—

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

$$= 6.6732 \times 10^{-11} \frac{m_1 m_2}{d^2} \text{Nm}^2 \text{kg}^{-2}$$

From the stem, mass of Ohi $m_1 = 35 \text{ kg}$
mass of Itman $m_2 = 40 \text{ kg}$.

Distance between them $d = 40 \text{ meter}$.

$$\begin{aligned} \therefore F &= 6.673 \times 10^{-11} \times \frac{35 \times 40}{(40)^2} \text{ N} \\ &= 6.673 \times 10^{-11} \times \frac{35}{40} \text{ N} \\ &= 6.673 \times 10^{-11} \times \frac{7}{8} \text{ N} \dots\dots (\text{i}) \end{aligned}$$

If the distance between them, is reduced to 20 meter, then the attraction force between them—

$$\begin{aligned} F &= 6.673 \times 10^{-11} \frac{35 \times 40}{20 \times 20} \\ &= 6.673 \times 10^{-11} \frac{35}{10} \\ &= 6.673 \times 10^{-11} \times \frac{7}{2} \text{ N} \dots\dots (\text{ii}) \end{aligned}$$

Let us divide equation (ii) by equation (i)

$$\begin{aligned} \frac{6.673 \times 10^{-11} \times 7}{2} &\div \frac{6.673 \times 10^{-11} \times 7}{8} \\ \frac{6.673 \times 10^{-11} \times 7}{2} &\times \frac{8}{6.673 \times 10^{-11} \times 7} \\ &= \frac{8}{2} = 4. \end{aligned}$$

So, if the distance between Ohi and Itman is reduced to 20 meter, the attraction force will increase four times.

Ques. 07 Class Eighth student Mamun raised a lot of questions with a sugar sack of mass 90 kg. in the future, he wants to be a NASA scientist.

- What is acceleration due to gravity? 1
- Why the weight of a body is different in different places on the Earth? Explain. 2
- Determine the weight of fee body in the Moon according to the stem. 3
- What kind of changes will take place if the object of the stem is taken to the North pole? Explain mathematically. 4

• Dinajpur Board 2019

Answer to Question No. 07 :

a The increase in velocity per second of an object falling freely due to force of gravity is called acceleration due to gravity.

b The weight of an object is different at different locations on the earth because of the shape of the earth and its different locations. The weight of an object depends on the value of acceleration due to gravity that is ' g '. The value of ' g ' is different at different regions of the earth. That's why the weight of an object in different places of the earth is different.

c Mass of sugar sac, $m = 90 \text{ kg}$.
Acceleration due to gravity, $g = 9.8 \text{ ms}^{-2}$
 \therefore Weight of sugar sac on the earth = mg
= $90\text{kg} \times 9.8\text{ms}^{-2}$
= 882N

Again, we know that, the weight of a body on the moon = $\frac{1}{6} \times$ the weight of the body on the earth.

$$\begin{aligned} \therefore \text{Weight of sugar sac on the moon} &= \frac{1}{6} \times 882 \text{ N} \\ &= 147 \text{ N}. \end{aligned}$$

d Acceleration due to gravity depends on the radius of earth. Since the earth is not a perfect sphere, radius of earth (R) is really constant. So the value not ' g ' is not constant at the surface of the earth. If we move from equator to polar regions, the radius of the earth decreases. As a result, the value of ' g ' increases. The value of g in the polar region is 9.832 ms^{-2} . The weight of sugar will increase to $90 \text{ kg} \times 9.832\text{ms}^{-2} = 884.88 \text{ N}$.

- Ques. 08** A material of 100 kg mass posses 9.8 meter/sec^2 acceleration due of gravity. The material is taken to the moon and its weight changes.
- What is gravitation? 1
 - Why does a fish under clear water seem nearer? 2
 - Determine the weight on earth of the thing mentioned in the stem. 3
 - Why does the weight of the thing mentioned in the stem vary on the moon? Analyze. 4

• Dhaka Board 2018

Answer to Question No. 08 :

a The force by which all objects in the universe attract one another is called gravitation.

b When we see a fish in water, it is found to stay at a place which is a bit upwards compared to its actual position. This happens due to refraction of light. In that case, light is refracted while coming from the denser medium and enters in our eyes. Every part of the emerged fish is raised upwards. As a result the fish appears lifted upwards or closer.

c We know that weight of a body is the force acting on the body by the Earth towards its centre. The weight of a body can be symbolically expressed as—

$w = mg$, where m = mass and g = acceleration due to gravity.
Here, mass of the material = 100 kg Acceleration due to gravity $g = 9.8 \text{ ms}^{-2}$

\therefore Weight of the material = $100 \times 9.8\text{N} = 980\text{N}$
So, the weight of the material is 980N on earth.

d Since mass is a constant quantity, weight depends not on mass but on acceleration due to gravity (g).



Answer to Question No. 10 :

a Weight is the force of attraction on a body by the earth towards its centre is called the weight of the body.

b Variation of the acceleration due to gravity:

If the distance of the body at the surface of the earth measured from the centre of the earth that is the radius of the earth R ,

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

Since the earth is not a perfect sphere, R is not really constant. So the value of g is not equal everywhere at the surface of the earth. As we move from the pole to the equator, the value of R increases and the value of g decreases. At the equator the value of g is minimum. It is 9.78 m/s^2 . The value of g in the polar region is 9.832 m/s^2 at the surface of the earth.

c The acceleration of free fall on the moon is $\frac{1}{6}$ of acceleration due gravity (g).

Here, mass (m_1) = 50 kg

\therefore Weight on the moon (w) = ?

We know,

$$\begin{aligned} W &= m_1 g_1 \\ &= m_1 \frac{1}{6} \times g = \frac{1}{6} m_1 g = \frac{1}{6} \times 50 \times 9.8 \\ &= 81.67 \text{ N} \end{aligned}$$

The weight on the moon of the body (m_1) is 81.67 N .

d In the stem, it is given that, mass $m_1 = 50 \text{ kg}$

mass $m_2 = 30 \text{ kg}$

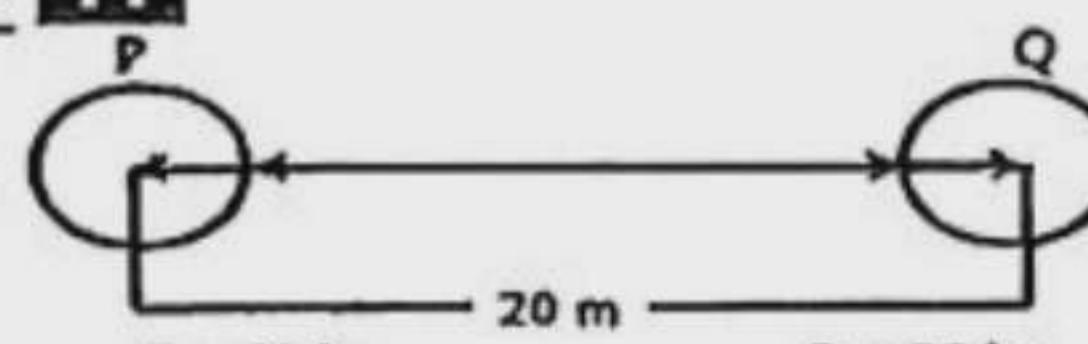
distance between the mass (d) = 5 m

$$\begin{aligned} \text{The force of attraction (F)} &= \frac{GM_1 m_2}{d^2} \\ &= \frac{50 \times 30}{(5)^2} = 60 \text{ G} \end{aligned}$$

Again if the distance between the mass becomes 10 m , the force of attraction (F_1).

$$\begin{aligned} F_1 &= G \frac{m_1 m_2}{d_1^2} \\ &= G \cdot \frac{50 \times 30}{(10)^2} = 15 \text{ G} \\ \therefore \frac{F}{F_1} &= \frac{60 \text{ G}}{15 \text{ G}} = 4 \\ \Rightarrow F &= 4 \cdot F_1 \\ \therefore F_1 &= \frac{1}{4} F \end{aligned}$$

When distance becomes 10 m , then attraction force becomes $\frac{1}{4}$ of attraction force of the stem.

Ques. 11

P = 20 kg Q = 30 kg

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

- What is gravitation? 1
- "The weight of an object is different for the shape of the earth"— Explain it. 2
- Find the weight of the "P" object. 3
- What type of changes of force is occurred with respect to the previous force if the mass of the "P" and "Q" object are half and the distance in between them is doubled? Analyze it mathematically. 4

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Answer to Question No. 11 :

a The attractive force that exists between any two particles in the universe is called gravitational force.

b The weight of an object is different at different locations on the earth because of the shape of the earth and its different locations. The weight of an object depends on the value of acceleration due to gravity, that is ' g '. The value of ' g ' is different at different regions of the earth. That's why the weight of an object in different places of the earth is different.

c The object P has mass (m) = 20 kg
Acceleration due to gravity $g = 9.80 \text{ ms}^{-2}$
Weight (W) = ?

We know that,

$$\begin{aligned} W &= mg \\ &= 20 \times 9.80 \text{ N} \\ &= 196 \text{ N} \end{aligned}$$

The weight of the body is 196 N .

d Force between the objects P and Q is F .

$$\begin{aligned} \therefore F &= G \frac{m_P \cdot m_Q}{d^2} \\ &= 6.673 \times 10^{-11} \times \frac{20 \times 30}{(20)^2} \\ &= 1.00 \times 10^{-10} \text{ N}. \end{aligned}$$

Here,
 $m_P = 20 \text{ kg}$
 $m_Q = 30 \text{ kg}$
 $G = 6.673 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$
 $d = 20 \text{ m}$

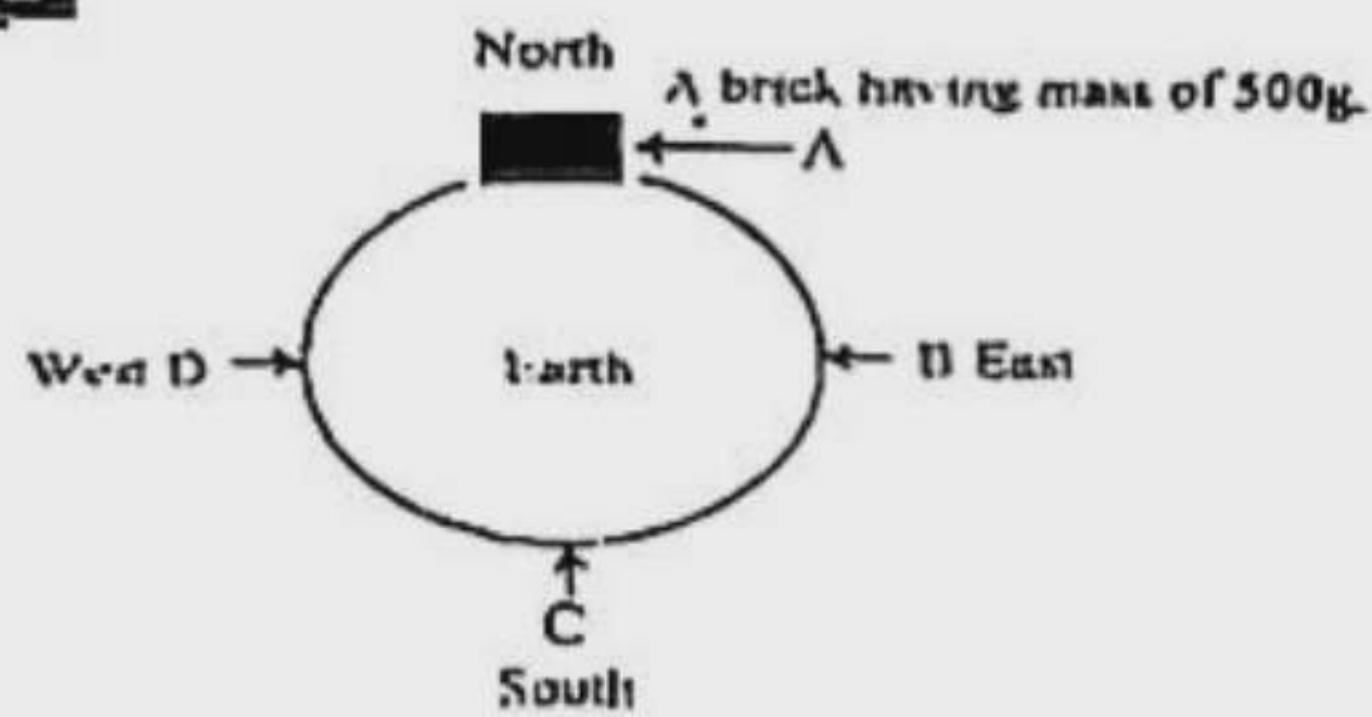
Again, if the mass of P and Q become half and distance between them is doubled then, force between them,

$$\begin{aligned} \therefore F &= G \frac{m_1 \cdot m_2}{d_1^2} \\ &= 6.673 \times 10^{-11} \times \frac{10 \times 15}{(40)^2} \\ &= 6.256 \times 10^{-12} \text{ N} \end{aligned}$$

Here,
 $m_1 = \frac{m_P}{2} = \frac{20}{2} = 10 \text{ kg}$
 $m_2 = \frac{m_Q}{2} = \frac{30}{2} = 15 \text{ kg}$
 $d_1 = 2d = 2 \times 20 = 40 \text{ m}$
 $G = 6.673 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$

The force will be decreased. The change of force will be $(1.00 \times 10^{-10} - 6.256 \times 10^{-12}) = 9.374 \times 10^{-11} \text{ N}$.



Ques. 12

- What is called gravitation? 1
- What is weightlessness? Explain. 2
- Determine the weight of the brick located in D. 3
- Analyze the cause of variation of weight of the brick in location B and C. 4

• Barishal Board 2017

Answer to Question No. 12 :

- a** The force by which all objects in the universe attract one another is called gravitation.
- b** The value of g at a particular point on the surface of the earth is fixed and therefore the weight of a person at that point is also definite. But even then a person there may feel a change of his weight and even feel weightlessness under special conditions. Where there is no gravitational force, the weight of an object must be zero.
A person can feel weightlessness in the lift.

- c** In the stem, the Earth is shown in which A is north pole, C is south pole, B is east and D is west. So, B and D is the equator region. A brick is shown in the stem which mass is 500 g.

The force by which the earth attracts an object to its center is called its weight. If the mass of an object is m and the acceleration due to gravity at a place is g , the weight of the object $w = mg$.
So, the weight of an object depends on the value of g in that place.

The value of g in the equator is least with a value of 9.78 ms^{-2} .

∴ The weight of the brick located in D is 500 g or,
 $\frac{1}{2} \text{ kg} \times 9.78 \text{ ms}^{-2} = 4.89 \text{ N}$.

- d** The weight of an object at a location depends on a distance if the point of measurement from the center of the earth. If the distance is increased, the force of gravity due to earth at that point decreases. As a result, the weight of an object there decreases. At the surface of the earth the weight of mass 1 kilogram is 9.8 N. But at a distant point from the earth, its weight decreases with the increase of distance.

The weight of an object vary slightly also at different positions on the surface of the earth. One reason for this is that, the earth is not a perfect sphere and the acceleration due to gravity is not same at all the points on the earth's surface.

However, this variation is so small that it can be detected only by using a very sensitive weighing machine. We neglect this variation in most of our calculation. An object will weigh maximum at the two poles. At these places one kilogram will weigh 9.83 N. At the equator, this weight will be least with a value of 9.78 Newton. At the equinoctial point, the weight is 9.79 N.

In the stem, B is equator of earth and C is south pole. The value of g is different in equator and polar region. This is the reason of variation of weight of the brick in location B and C.

Ques. 13 Tamal is a student of class eight.

There are many questions arise in his mind about the packet of sugar of 90 Kg. In future he wants to be a scientist of NASA.

- What is outer space? 1
- What is meant by Galaxy? 2
- Determine the weight of the substance of the above stem in moon. 3
- What type of change will occur of the weight of the substance of the above stem, if it carry to north pole? Explain with mathematical logic. 4

• Dhaka Board 2016

Answer to Question No. 13 :

- a** The outer space is the vast extension of space in which all objects of the sky including the planets, stars and galaxies have their existence.

- b** Galaxy is a large group of comets and stars. Our earth exists in the galaxy of Milky-way. There are crores of galaxies in the universe where crores of stars exists. The galaxies move in groups in outer space.

- c** We know the weight of a body of man m gm is $W = mg$ newton, where m in kg and g in m/sec^2 . Here $m = 90 \text{ kg}$ and $g = 9.8 \text{ m/sec}^2$.

$$\begin{aligned}\therefore W &= 90 \times 9.8 \text{ N} \\ &= 882 \text{ N}\end{aligned}$$

That is, the weight of the body is 882 Newton on the earth. We also know that the weight of a body in the moon is one-sixth of the weight of the same on the earth.

∴ The weight of the moon in the earth = $\frac{882}{6}$ newton or 147 newton.

- d** It is known that the weight of a body is the highest at the two poles and it is the least at the equinoctial points. This happens because of the fact that the weight of a body on the earth depends on the acceleration due to gravity (g) on the earth. Again ' g ' depends on the distance of a place/ point

on the earth from the centre of the earth. The pole is the nearest of any other point on the earth. So, the value of 'g' is maximum at the pole implies weight of a body is maximum at the pole. Conversely, the distance of the equinoctial points from the centre of the earth is maximum and as such the value of 'g' is the least at equinoctial points implies the weight of a body at equinoctial points is the least. Finally, it can be said that weight, $w = mg$.

Since m is fixed, $w \propto g$.

Again $g \propto \frac{1}{d}$, the distance of any point on the earth from the centre.

$$\therefore w \propto \frac{1}{d} \quad \text{(i)}$$

Since d is least at the pole, w is greater at the pole from (i). Since d is maximum at the equinoctial point, w is the least at the equinoctial points from (i).



Knowledge & Comprehension-based Q/A



Designed as per topic



Preparatory Knowledge-based Q/A

Question 1. How can you formulate gravitational force?

Ans. We can formulate gravitational force, F as under :

$$F = G \frac{m_1 m_2}{d^2}, \text{ where } G \text{ is gravitational constant } m_1$$

and m_2 are masses of any two universal bodies and d is the distance between them.

Question 2. What is the relation between force of gravity and acceleration due to gravity?

Ans. The relation between force of gravity (F) and acceleration due to gravity (g) is :

$F = mg$, where m denotes the mass of an object near the earth.

Question 3. Who put forward the law of gravitation?

Ans. World famous mathematician, Newton put forward the law of gravitation.

Question 4. What is mass of a body?

Ans. Mass of a body is the quantity of matter possesses by the body.

Question 5. What is weight of a body?

Ans. The force of gravity on a body is the weight of the body.

Question 6. What does 1kg weighs at the surface of the earth?

Ans. 9.8 N.

Question 7. What is the weight of a body of mass of 1kg at the equator?

Ans. 9.79 N.

Question 8. What is the weight of the body of mass 1kg at the surface of the moon?

Ans. 1.6 N.

Question 9. Where is the value of 'g' largest?

Ans. At the pole, the value of 'g' is the largest.

Question 10. Where is the value of 'g' lowest?

Ans. The value of 'g' is lowest at the equator.

Question 11. What is the weight of a body at the centre of the earth?

Ans. At the centre of the earth, the weight of a body is 0 (zero).

Preparatory Comprehension-based Q/A



Science

Question 1. Why will the weight of a object at the centre of the earth be zero?

Ans. The weight of an object depends on the value of 'g'. Again, the value of 'g' is the highest at the surface of the earth and it decreases gradually at places above the earth surface as well as below the earth surface. The magnitude of 'g' is zero at the centre of the earth. So, the weight of an object is zero at the centre of the earth.

Question 2. Why is the weight of an object at the surface of the moon one—sixth of that of the earth?

Ans. The value of 'g', acceleration due to gravity due to gravitational force at the surface of the moon is $\frac{1}{6}$.

compared to that at the surface of the earth. So, the weight of an object on the moon becomes one-sixth of its weight on the earth.

Question 3. When will the magnitude of gravitational force and the universal constant be equal?

Ans. We know that the gravitational force (F) between two universal bodies (m_1 and m_2) is : $F = G \frac{m_1 m_2}{d^2}$,

where d is the distance between the two bodies. From the above formula, it will be evident that the magnitude of F will be equal to the magnitude of G if and only if $m_1 = m_2 =$ an unit mass and $d =$ an unit distance of the same system of measurement of unit.

Question 4. Why does the passenger of a lift feel himself lighter when the lift goes downwards?

Explain. [Dinajpur Board 2017]

Ans. In an accelerated frame, the apparent weight of a body differs from the true weight. Whenever a frame of reference is accelerated, an inertial force arises from which we can find the apparent weight. If the frame like our lift has an acceleration a , an inertial (fictitious) force arises given by $-ma$, in a direction opposite to the acceleration of the frame of reference. By applying Newton's law of motion $F + (-mg) = ma$ Or, $F = m(g + a)$. If the lift is given additional acceleration downwards, the apparent weight felt is less than the real weight mg . If the lift has a free fall then $a = -g$, and $F = 0$. Therefore the apparent weight is zero and the mass in the lift will feel weightlessness.

Question 5. Why are orange fallen from the tree on the earth? [Chattogram Board 2018]

Ans. Each particle in the universe attracts every other particle with a force which is proportional to the product of their masses and inversely proportional to the square of the distance between them.

Force between orange and earth is more than the force between orange and other object in the universe is large. This is why an orange falls from a tree on the earth.

Question 6. Why the weight of an object is more in polar region? [Chattogram Board 2019]

Ans. The force by which the earth attracts an object to its center is called its weight. The weight of an object depends on the value of acceleration due to gravity that is ' g '. The value of ' g ' is different at different regions of the earth and its values is maximum in polar region. That's why the weight of an object is more in polar region.

Question 7. Why everybody is falling downward?

[Barishal Board 2019]

Ans. Everybody in the universe attracts other body and it is called gravitation. Again attractive force between earth and other body is called gravity. Earth pulls everybody to its centre. For this reason, everybody is falling downward.



Super Suggestions



Super Suggestions with 100% preparatory questions selected by the Master Trainer Panel

Dear learners, important multiple choice, short, creative, knowledge & comprehension-based questions of this chapter selected by Master Trainer Panel for Half-Yearly and Annual Exams are presented below. Learn the answers to the mentioned questions well to ensure 100% preparation.

Question Pattern	7*	5*
MCQs with Answers	Learn each MCQs in this chapter thoroughly.	
Short Q/A	1, 2, 4, 7, 9, 14, 15, 17, 24, 27, 31	3, 9, 11, 12, 18, 21, 23
Creative Q/A	2, 3, 4, 6, 8, 9	1, 5, 7, 10, 12
Knowledge-based Q/A	1, 4, 6, 9, 12	2, 3, 5, 7, 10
Comprehension-based Q/A	1, 2, 4	3, 5, 6

Exclusive Tips ► Master the solutions to all the activities in this chapter along with exercise and other Q/A to develop the creative thinking and assess your talent:



Assessment & Evaluation



A question bank presented in the form
of a class test to assess the preparation

Class Test

Time : 3 hours

Science

Class : Eight

Full marks : 100

Multiple Choice Questions (Each question carries 1 mark)

$1 \times 30 = 30$

[N.B. : Answer all the questions. Each question carries one mark. Block fully, with a ball-point pen, the circle of the letter that stands for the correct/best answer in the "Answer Sheet" for Multiple Choice Question Type Examination.]

1. Which one of the following is a constant?
Ⓐ m Ⓑ F Ⓒ M Ⓓ W
2. What is the value of 'g' in polar regions?
Ⓐ 9.812 m/s² Ⓑ 9.823 m/s²
Ⓒ 9.832 m/s² Ⓓ 9.821 m/s²
3. Where the magnitude of 'g' is the least?
Ⓐ in the equinox Ⓑ in the equator
Ⓒ in the north pole Ⓓ in the south pole
4. The value of acceleration due to gravity 'g' is higher in—
Ⓐ equator region Ⓑ polar region
Ⓒ at the center of the earth Ⓓ at moon
5. What is the value of the acceleration due to gravity at the center of the earth?
Ⓐ 9.78 m/s² Ⓑ 9.8 m/s² Ⓒ 9.83 m/s² Ⓓ 0 m/s²
6. Where will an object have maximum weight?
Ⓐ in any pole Ⓑ in any mine
Ⓒ on any hill top Ⓓ in any valley
7. In which country will the weight of an object be maximum?
Ⓐ Iceland Ⓑ Swaziland Ⓒ Thailand Ⓓ Tunisia
8. What is the international unit of mass?
Ⓐ Centigram Ⓑ kg Ⓒ Quintal Ⓓ Gram
- Look at the stem carefully and answer the questions No. 9 and 10 :
Moni is playing cricket at the roof of a building. Suddenly, the bat of mass 2000 gram is falling down from his hand.
9. What is the weight of Moni's bat?
Ⓐ 19.6 Newton Ⓑ 20.41 Newton
Ⓒ 196 Newton Ⓓ 19600 Newton
10. The above phenomenon occurred—
i. due to acceleration due to gravity
ii. due to gravitational force
iii. due to the attraction of earth
Which one is correct?
Ⓐ i & ii Ⓑ i & iii Ⓒ ii & iii Ⓓ i, ii & iii
11. What is the value of 'g' in the zones of tropic of cancer?
Ⓐ 9.86605 m/s² Ⓑ 9.86065 m/s²
Ⓒ 9.85660 m/s² Ⓓ 9.80665 m/s²
12. What is the mass of an object having a weight of 980 Newton on the earth surface?
Ⓐ 98 kg Ⓑ 100 kg Ⓒ 980 kg Ⓓ 10 kg
- Answer the questions No. 13 and 14 form the following information :
Mass of two bodies are 50kg and 60kg respectively.
13. How many weight difference of the two bodies?
Ⓐ 1278 newton Ⓑ 588 newton
Ⓒ 490 newton Ⓓ 98 newton
14. If the multiplication of masses of two bodies is 12000 kg then how much time the attraction force?
Ⓐ 4 Ⓑ 8 Ⓒ 12 Ⓓ 16

15. How much weight of a 1 kg mass object at the equinoctial point?
Ⓐ 9.78 N Ⓑ 9.79 N Ⓒ 9.80 N Ⓓ 9.83 N
16. How many satellites Saturn has?
Ⓐ 62 Ⓑ 34 Ⓒ 27 Ⓓ 13
17. How much velocity increases freely falling body near the surface of the earth at every second?
Ⓐ 9.78 m/sec² Ⓑ 9.79 m/sec²
Ⓒ 9.80 m/sec² Ⓓ 9.83 m/sec²
18. What will be the weight of an object having a mass of 10 kg in either pole?
Ⓐ 983 N Ⓑ 98.3 N Ⓒ 9.83 N Ⓓ 9.38 N
19. What will be the weight of an object having a mass of 100 kg in equatorial regions?
Ⓐ 9.79 N Ⓑ 9.97 N Ⓒ 997 N Ⓓ 979 N
20. The value of the weight of an object—
i. depend on the mass
ii. difference in different places
iii. is maximum in pole region
Which one is correct?
Ⓐ i & ii Ⓑ i & iii Ⓒ ii & iii Ⓓ i, ii & iii
21. Where the value of 'g' is maximum?
Ⓐ At polar region Ⓑ At the equator
Ⓒ At the equinoctial point Ⓓ At the center of the earth
22. Where the value of 'g' is zero?
Ⓐ At polar region Ⓑ At the equator
Ⓒ On earth surface Ⓓ At the center of the earth
23. The values of 'g' is greater in—
Ⓐ Pole region Ⓑ Equatorial region
Ⓒ Tropical region Ⓓ Center of the Earth
24. What is the magnitude of 'g' at the centre of the earth?
Ⓐ 9.83 ms⁻² Ⓑ 9.78 ms⁻² Ⓒ 9.8 ms⁻² Ⓓ 0 ms⁻²
25. What is the value of "g" at the surface of the earth for a freely falling body?
Ⓐ 9.73 m/sec² Ⓑ 9.67 m/sec²
Ⓒ 9.97 m/sec² Ⓓ 9.8 m/sec²
26. An object starts losing its weight along with—
i. staying around the equinox
ii. staying around the equator
iii. moving up to upper
Which one is correct?
Ⓐ i & ii Ⓑ ii & iii Ⓒ i & iii Ⓓ i, ii & iii
27. What is the weight of an object of 10 Kg mass on earth?
Ⓐ 19.8 Newton Ⓑ 49 Newton
Ⓒ 98 Newton Ⓓ 196 Newton
28. A body of mass is 30 kg in Dhaka, How much weight in Newton of the body?
Ⓐ 48.9 Ⓑ 293.4 Ⓒ 294.0 Ⓓ 294.9
29. In which country will the weight of an object be the least?
Ⓐ New Zealand Ⓑ Finland Ⓒ China Ⓓ Congo
30. In which country will an object have the least weight?
Ⓐ Finland Ⓑ Ireland Ⓒ Netherlands Ⓓ Poland

Answer Sheet ▶ Multiple Choice Questions

1	Ⓐ	2	Ⓑ	3	Ⓐ	4	Ⓑ	5	Ⓐ	6	Ⓐ	7	Ⓐ	8	Ⓑ	9	Ⓐ	10	Ⓐ	11	Ⓐ	12	Ⓑ	13	Ⓐ	14	Ⓐ	15	Ⓐ
16	Ⓐ	17	Ⓒ	18	Ⓑ	19	Ⓓ	20	Ⓐ	21	Ⓐ	22	Ⓓ	23	Ⓐ	24	Ⓐ	25	Ⓓ	26	Ⓐ	27	Ⓒ	28	Ⓒ	29	Ⓓ	30	Ⓒ



Short-Answer Question (Each question carries 2 marks)

Answer any 10 of the following questions :

$$2 \times 10 = 20$$

1. What is gravitational force? Explain.
 2. Explain Newton's law of gravitation.
 3. Why is the gravitational constant called universal?
 4. What is meant by weightlessness?
 5. Why does a cricket ball thrown upwards come back down?
 6. What is meant by acceleration due to gravity?
 7. Why is the value of g greater at the poles of the Earth?
 8. Explain the concept of mass.
 9. What is weight? Explain.

- If the mass of a person on the Earth's surface is 60 kg, what will be his weight?
 - Why does the mass of an object remain unchanged on the Moon?
 - Why is weight not a fundamental property of an object?
 - What does $W = 9.8 \text{ N}$ mean?
 - Why is the weight of an object less in a mine?
 - Why do astronauts feel weightless in space?

Creative Question (Each question carries 10 marks)

Answer any 5 of the following questions :

$$10 \times 5 = 50$$

1.

a. What is the attraction force between A and B called? 1

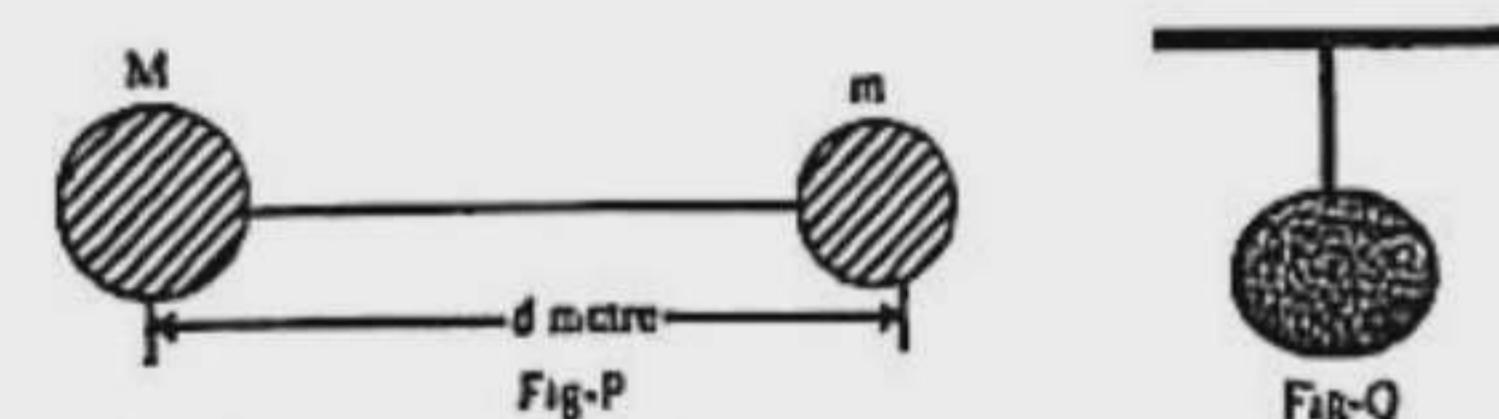
b. $F = G \frac{m_1 m_2}{d^2}$ What does the equation mean? 2

c. Determine the magnitude of F in case of the stem. 3

d. If masses of A and B are lowered to halves and distance between A and B is raised to double, the magnitude of F will be 16 times lower. 4

5. Class Eighth student Mamun raised a lot of questions with a sugar sack of mass 90 kg. in the future, he wants to be a NASA scientist.

 - a. What is acceleration due to gravity? 1
 - b. Why the weight of a body is different in different places on the Earth? Explain. 2
 - c. Determine the weight of fee body in the Moon according to the stem. 3
 - d. What kind of changes will take place if the object of the stem is taken to the North pole? Explain mathematically. 1



- a. What is called mass? 1

b. Why the weight of an object is more in polar region? 2

c. In the fig-'P' if the value of 'd' decreases half, what will be the change of force? 3

d. In fig 'Q' if the hanging body is fall down what type of variation of weight of the body—Analyze logically. 4

3. Mr. 'X' of 735 Newton weight suddenly fall down front the one-storeyed building. He goes to the doctor for treatment, To move up-down needs lift to the chamber. He feels heavy when goes up by lift.

a. What is acceleration due to gravity? 1

b. Why the value of 'g' is different, in equator region and polar region? 2

c. Calculate the mass of Mr. 'X'. 3

d. Analyse the reasons of the two occurrence of the stem. 4

4. Ohi and Itmam are standing in the playground. The distance between them is 40 meter. The masses of them are 35 kg and 40 kg respectively.

a. What is mass? 1

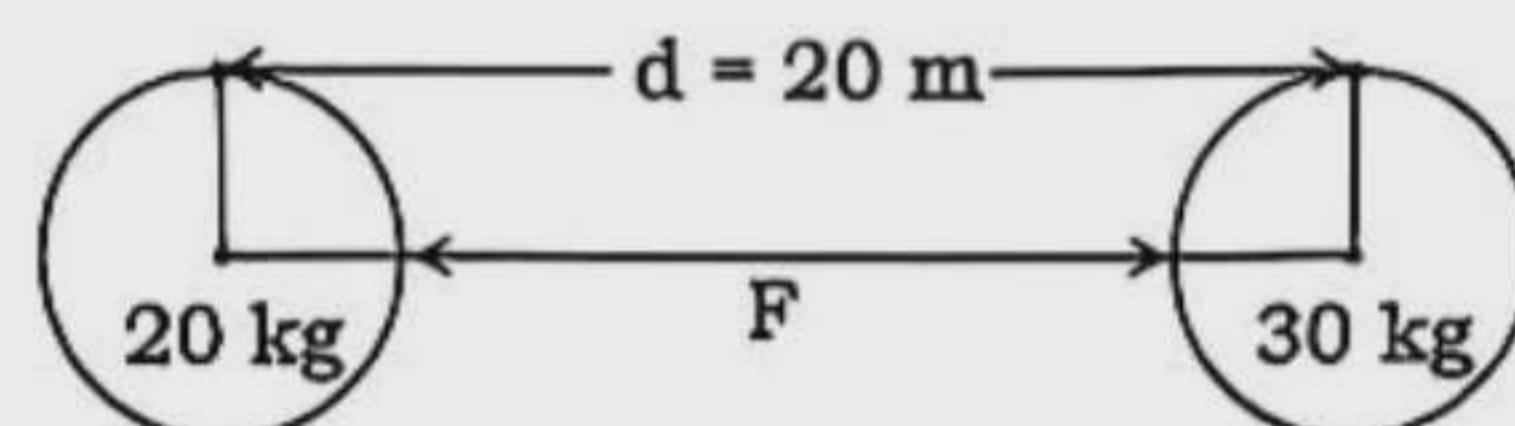
b. All the gravity is gravitation, but all the gravitation is not gravity.—Explain. 2

c. Determine die weight of Itmam on moon. 3

d. What will be the change of the attraction force between Ohi and Itmam, if the distance between them is reduced. The new distance between them is 20 meter. Analyze it mathematically. 4

6. A material of 100 kg mass posses 9.8 meter/sec^2 acceleration due of gravity. The material is taken to the moon and its weight changes.

 - What is gravitation? 1
 - Why does a fish under clear water seene nearer? 2
 - Determine the weight on earth of the thing mentioned in the stem. 3
 - Why does the weight of the thing mentioned in the stem vary on the moon? Analyze. 4



- | A substance | B substance |
|---|-------------|
| a. What is mass? | 1 |
| b. What do you mean by the value of the gravitation acceleration due to gravity is 9.83 meter/second ² ? | 2 |
| c. Determine weight of 'A' in equilateral area. | 3 |
| d. If the distance between A and B is doubled what will be the change attraction force? Analyze mathematically. | 4 |

8. Taimal is a student of class eight. There are many questions arise in his mind about the packet of sugar of 90 Kg. In future he wants to be a scientist of NASA.

 - a. What is outer space? 1
 - b. What is meant by Galaxy? 2
 - c. Determine the weight of the substance of the above stem in moon. 3
 - d. What type of change will occur of the weight of the substance of the above stem, if it carry to north pole? Explain with mathematical logic. 4

Answering Reference ► Short-Answer Questions

- 1 ► See this Chapter, Ques. 01 | 5 ► See this Chapter, Ques. 08 | 9 ► See this Chapter, Ques. 15 | 13 ► See this Chapter, Ques. 22
2 ► See this Chapter, Ques. 02 | 6 ► See this Chapter, Ques. 09 | 10 ► See this Chapter, Ques. 16 | 14 ► See this Chapter, Ques. 24
3 ► See this Chapter, Ques. 04 | 7 ► See this Chapter, Ques. 12 | 11 ► See this Chapter, Ques. 18 | 15 ► See this Chapter, Ques. 27
4 ► See this Chapter, Ques. 07 | 8 ► See this Chapter, Ques. 14 | 12 ► See this Chapter, Ques. 19

Answering Reference ► Creative Questions

- 1 ► See this Chapter, Ques. 02 | 3 ► See this Chapter, Ques. 04 | 5 ► See this Chapter, Ques. 07 | 7 ► See this Chapter, Ques. 09
2 ► See this Chapter, Ques. 03 | 4 ► See this Chapter, Ques. 06 | 6 ► See this Chapter, Ques. 08 | 8 ► See this Chapter, Ques. 13