SAMPLE CONTENT

SSC 1343 MCQs

SCIENCE and TECHNOLOGY

PART 1 & 2

CHAPTERWISE & SUBTOPICWISE

THE PERFECT **CONCEPT BUILDER & CONFIDENCE BOOSTER** FOR YOUR EXAM

STD. X

(ENG. & SEMI ENG. MEDIUM)

Target Publications® Pvt. Ltd.

Based on the **Latest Textbook** prescribed by the Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04

Science and Technology MCQs

Chapterwise & Subtopicwise

(Part - 1 & 2)

STD. X

Salient Features

- Subtopic wise segregation of MCQs for efficient practice
- '1343' MCQs including Questions from previous years board papers
- Quick Review of each chapter to facilitate quick revision
- Topic Test along with solutions at the end of every chapter for self-evaluation
- Answers are provided to all the questions and Solutions are provided for difficult questions
- Important inclusions: Connections and Caution
- R symbol represents Topics/Subtopics/Questions that are part of the reduced syllabus 2021-22.

Please scan the adjacent QR code to see the reduced syllabus of Science and Technology (Part 1& 2) for year 2021 - 22.

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PREFACE

Target's **"Std. X: Science and Technology MCQs"** is a complete, thorough, critically analysed and extensively drafted book to offer students practice of Multiple Choice Questions (MCQs) *with answers*.

The book contains MCQs based on all the textual chapters of Science and Technology (Part 1 & 2). The aim of this book is to provide conceptual preparedness to the students by giving them ample practice of MCQs. It also gives them a hang of competitive examinations which are mostly MCQ-based. Complete coverage of topics in this book ensures strong foundation of the subject. MCQs which are part of reduced syllabus are marked as Ⓡ to keep students focused on the preparation of topics/subtopics listed for the examination to be held in year 2021-22.The **Subtopic-wise** segregation of each chapter of this book helps the students to practice questions smoothly and as per their own pace.

Each chapter begins with a **Synopsis** which acts as a revision tool for the students in efficient form of pointers, tables, charts etc. followed by **Quick Review** of the chapter.

Section of **'Multiple Choice Questions'** consists of specially created and compiled MCQs as well as textual MCQs and the MCQs appeared in previous board examination. The section is intended to fulfill following objectives – to help students revise concepts as well as to prepare them for solving complex questions which require strenuous effort and understanding of multiple-concepts. The assortment of MCQs is a beautiful blend of straight forward, average and higher order thinking questions.

To aid students, Solutions are provided for difficult questions. '**Caution**' is added to make students watchful against commonly made mistakes. Also, '**Connections**' are furnished to enable students perceive the interlinking of concepts covered in different chapters and preparing them for possible coalition questions.

Topic Test along with solutions at the end of the chapter allows students to gauge their grasp of chapter.

We hope that the book builds up necessary knowledge and skillset in the students and boost their confidence required to succeed in the examination.

\- Publisher
Edition: First

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

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A book affects eternity; one can never tell where its influence stops.

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Note: *Textual exercise questions are represented by * mark.*
Questions belonging to the reduced syllabus for year 2021-22 are represented with Ⓡ *mark.*

1 Gravitation

Synopsis

1.1 Gravitation

Gravitation is a natural phenomenon by which all things with mass or energy; including planets, stars, galaxies, etc. are attracted to one another.

1.2 Circular motion and centripetal force

Centripetal force:
The force acting on any object moving in a circle and directed towards the centre of the circle is called as centripetal force.
Example: The planets revolve around the Sun due to the centripetal force exerted on them by the Sun. The direction of the force is towards the centre of the Sun.

1.3 Kepler's laws

Kepler noticed that the motion of planets follows certain laws. He stated three laws describing planetary motion. These are known as Kepler's laws and are given as:

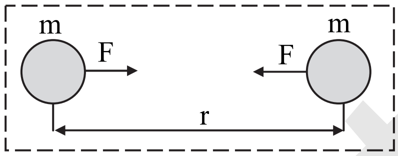
i. **Kepler's first law:** The orbit of a planet is an ellipse with the Sun at one of the foci.
ii. **Kepler's second law:** The line joining the planet and the Sun sweeps equal areas in equal intervals of time.
iii. **Kepler's third law:** The square of orbital period of revolution of a planet around the Sun is directly proportional to the cube of the mean distance of the planet from the Sun.
Mathematically it means, $T^2 \propto r^3$

$\therefore \quad \frac{T^2}{r^3}$ = constant (K)

1.4 Newton's universal law of gravitation

i. With the help of Kepler's third law, Newton concluded that the centripetal force acting on the planet must be inversely proportional to the square of the distance between the planet and the Sun and hence, formulated theory of gravitation.
ii. According to this theory, every object in the Universe attracts every other object with a definite force. This force is directly proportional to the product of the masses of the two objects and is inversely proportional to the square of the distance between them.
iii. Mathematically, the gravitational force between any two objects is given by, $F = \frac{Gm_1m_2}{r^2}$

Where,
G = universal gravitational constant
m_1 and m_2 = mass of the two objects
r = distance between the two objects.



CAUTION

Direction of gravitational force for the two spherical bodies, is always along the line joining the centres of the two bodies and the distance between the centres is taken as r as shown in the figure above.
Whereas, for non-spherical or irregular shaped bodies, the direction of force is along the line joining their centres of mass and r is taken to be the distance between the two centres of mass.

Gravitational constant (G):

i. The gravitational force acting between unit masses kept at a unit distance away from each other equals gravitational constant (G).
ii. The SI value of $G = 6.67 \times 10^{-11}$ Nm^2/kg^2.

Earth' gravitational force:

i. The earth attracts every object near it towards itself because of the gravitational force.
ii. As the centre of mass of the earth is situated at its centre, the gravitational force on any object due to the earth is always directed towards the centre of the earth.
iii. It is due to this force; an object falls vertically downwards on the earth and the moon and the satellites revolve around the earth.

1.5 Acceleration due to the gravitational force of the Earth

i. The acceleration produced in a body under the influence of the gravitational force of earth alone is called acceleration due to gravity (g).
ii. The direction of the acceleration due to gravity is towards the centre of the earth i.e., vertically downwards.
iii. Factors upon which value of g depend are:
a. **Shape of earth:** The radius of the earth at the poles is less than that at the equator. Hence, the value of 'g' is highest at the poles (9.832 m/s^2) and decreases slowly with decreasing latitude. It is the lowest at the equator (9.78 m/s^2).

b. **Height from the surface of the earth:** value of 'g' decreases with increase in height.

c. **Depth:** The value of g is maximum on the surface of the earth. As depth of an object increases, the value of 'g' decreases. At the centre of the earth, the value of 'g' becomes zero.

CAUTION

G being universal gravitational constant has fixed value and does not vary from place to place. Whereas, g being acceleration due to gravity, its value varies from place to place, planet to planet.

Mass and Weight:

	Mass	Weight
i.	Mass is the quantity of matter contained in an object.	Weight is the force with which the earth attracts an object.
ii.	Mass remains same everywhere.	Weight of a body keeps on changing from place to place.
iii.	Mass is measured in kilogram (kg).	Weight is measured in newton (N).
iv.	Mass is a scalar quantity.	Weight is a vector quantity.
v.	Mass of an object can never be zero.	Weight of an object becomes zero at the centre of the earth.

1.6 Free fall

i. The motion of any object under the influence of the force of gravity alone is called as free fall.

ii. During free fall on the earth, the frictional force due to air opposes the motion of the object and a buoyant force also acts on the object. Hence, true free fall is possible only in vacuum.

iii. For a freely falling object, the velocity on reaching the earth and the time taken for it can be calculated by using Newton's equations of motion.

iv. As, the moon and the artificial satellites are moving only under the influence of the gravitational field of the earth, they are in free fall.

v. The free fall leads to weightlessness of space travellers as well as object in the spacecraft.

Gravitational potential energy:

i. Gravitational potential energy is energy an object possesses because of its position in a gravitational field.

ii. This energy is relative and increases as with increase in height from the surface of the earth.

iii. For an object of mass m,

Position	Gravitational Potential energy
on ground	0
at height h from surface	$mgh = \dfrac{-GMm}{R+h}$
at height h from surface	0

1.7 Escape velocity

i. The minimum velocity with which a body should be projected from the surface of a planet or moon, so that it escapes from the gravitational influence of the planet or moon is called as escape velocity.

ii. The escape velocity is different for different planets.

Formulae

1. **Kepler's third law:**

i. $T^2 \propto r^3$

Where,
T = the period of revolution of a body,
r = the radius of orbit in which the body is revolving.

ii. $\left(\dfrac{T_1}{T_2}\right)^2 = \left(\dfrac{r_1}{r_2}\right)^3$

Where T_1, T_2 and r_1, r_2 are periodic times and mean radii of the orbits of two planets around the Sun respectively.

2. **Gravitational force between two bodies:**

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

Where, m_1 and m_2 = masses of two bodies,
r = distance of separation between them,
G = universal gravitational constant

3. **Universal gravitational constant:** $G = \dfrac{Fr^2}{m_1m_2}$

4. **Acceleration due to gravity:**

On the earth surface, $g = \dfrac{GM}{R^2}$

Where, M = mass of the earth,
R = radius of the earth.

5. **Weight of an object of mass m,** W = mg

6. **Kinematical equations of motion:**

i. $v = u + at$

ii. $s = ut + \dfrac{1}{2}at^2$

iii. $v^2 = u^2 + 2as$

For a freely falling body:

i. $v = gt$

ii. $h = \dfrac{1}{2}gt^2$

iii. $v^2 = 2gh$

For a body thrown upwards:

i. $u = -gt$

(negative sign indicates velocity is decreasing)

ii. $h = ut - \frac{1}{2}gt^2$

iii. $u^2 = 2gh$

Where, u = initial velocity,

v = final velocity,

g = acceleration due to gravity,

h = distance of the body from the surface of the earth

7. Potential energy of a body:

i. On the earth's surface, $P.E. = \frac{-GMm}{R}$

ii. At a height h from surface of earth,

$$P.E. = \frac{-GMm}{R+h}$$

where, m = mass of the body.

8. Escape velocity of a body (On the surface of the earth):

$$v_{esc} = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$$

Values to remember

1. **Gravitational constant (G)** = 6.7×10^{-11} Nm^2/kg^2
2. **Standard value of acceleration due to gravity (g)** = 9.8 m/s^2
3. **Mass of the earth** = 6×10^{24} kg
4. **Radius of the earth** = 6.4×10^6 m

Classification of physical quantities

Scalar Quantities	Vector Quantities
Universal gravitational constant (G), period of revolution (T), mass, gravitational potential energy.	Gravitational force, centripetal force, velocity, gravitational acceleration (g), weight.

QUICK REVIEW

Kepler's laws of planetary motion

Law of orbit
- Planets orbit is an ellipse with Sun at one of the foci.

Law of areas
- Line joining planet and Sun sweeps equal areas in equal time interval

Law of period
- Square of orbital revolution of planet around Sun is directly proportional to cube of mean distance of the planet from sun.
- $T^2 \propto R^3$

helped in formulating

Newton's law of Gravitation

Formulates

Gravitational force
- $F = G\frac{Mm}{r^2}$

To escape its influence

Escape velocity
- $v_{esc} = \sqrt{\frac{2GM}{R}} = \sqrt{2gR}$

Gives rise to

Gravitational acceleration
- $g = \frac{GM}{r^2}$

Varies

Due to shape of the earth
- Value of 'g' is highest at poles and lowest at equator.

With height
- Value of 'g' decreases with increase in height

With depth
- Value of 'g' decreases with increase in depth

Gives rise to

Weight
- $W = mg$

MULTIPLE CHOICE QUESTIONS

1.1 Gravitation

1. A _______ is necessary to change the speed as well as the direction of motion of an object.
   (A) force (B) inertia
   (C) momentum (D) motion

1.2 Circular motion and centripetal force

1. Force which is directed towards the centre of the circle is _______.
   (A) centrifugal force
   (B) gravitational force
   (C) centripetal force
   (D) circular force

2. A boy is whirling a stone tied to a string in a horizontal circular path. If the string breaks, the stone
   (A) will move along a straight line towards the centre of the circular path.
   (B) will move along a straight line perpendicular to the circular path away from the boy.
   (C) will move along a straight line tangential to the circular path.
   (D) will continue to move in circular path.

3. In which of the following cases centripetal force is not experienced?
   (A) Moon revolving around the earth
   (B) A vehicle taking a sharp turn
   (C) Stone tied to a string and rotating in a circular path
   (D) Spacecraft getting launched from the earth's surface

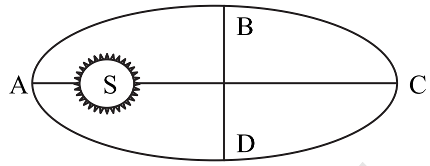
4. What would happen to the moon if the earth stops exerting force of attraction on it?
   (A) The moon will collide on the earth.
   (B) The moon will keep orbiting the earth.
   (C) The moon will go away from the earth.
   (D) The moon will travel in a straight line which is tangent to its orbit.

1.3 Kepler's laws

1. The orbit of a planet is an _______ with the Sun at _______.
   (A) circular, the centre
   (B) hyperbolic, the centre
   (C) parabolic, one of the foci
   (D) ellipse, one of the foci

2. Which of the following laws states that areal velocity of the planet remains constant?
   (A) Newton's law of gravitation.
   (B) Kepler's first law.
   (C) Kepler's second law.
   (D) Kepler's third law.

3. The earth rotates about the Sun in an elliptical orbit. At which point will its velocity be maximum?



   (A) At A (B) At B
   (C) At C (D) At D

4. The square of orbital period of revolution of a planet around the Sun is directly proportional to the _____ of the mean distance of the planet from the Sun.
   (A) square root (B) cube root
   (C) square (D) cube

5. According to Kepler, the period of revolution of a planet (T) and its mean distance from the Sun (r) are related by the equation
   (A) T^3r^3 = constant. (B) T^2r^{-3} = constant.
   (C) Tr^3 = constant. (D) T^2r = constant.

6. The earth revolves round the Sun in one year. If the distance between them becomes double, the new period of revolution will be
   (A) 1/2 year (B) $2\sqrt{2}$ years
   (C) 4 years (D) 8 years

1.4 Newton's universal law of gravitation

1. Law of gravitation gives the gravitational force between _______.
   (A) the earth and a point mass only
   (B) the earth and Sun only
   (C) any two bodies having some mass
   (D) two charged bodies only

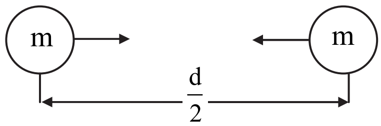
2. The gravitational force between two bodies is directly proportional to the product of the masses of those bodies and is _______ of the distance between them.
   (A) inversely proportional to the square
   (B) directly proportional to the square
   (C) inversely proportional to the cube
   (D) inversely proportional to the square root

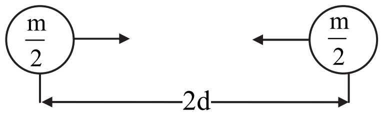
3. An apple falls from a tree because of gravitational attraction between the earth and apple. If F_1 is the magnitude of force exerted by the earth on the apple and F_2 is the magnitude of force exerted by apple on earth, then
   (A) F_1 is very much greater than F_2.
   (B) F_2 is very much greater than F_1.
   (C) F_1 is slightly greater than F_2.
   (D) F_1 and F_2 are equal.

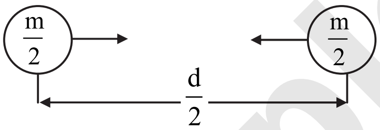
4. The force of attraction between two-unit point masses separated by a unit distance equals
(A) gravitational potential.
(B) acceleration due to gravity.
(C) gravitational field.
(D) universal gravitational constant.

5. If mass of one of two objects is doubled then the gravitational force acting between the two is _______.
(A) doubled (B) four times
(C) eight times (D) halved

6. When distance between two objects is decreased by d times, the gravitational force between them increases 4 times. The value of d is _______.
(A) 2 (B) 3 (C) 4 (D) 8

7. For two balls of equal masses as shown in the figure, the magnitude of gravitational force between them is F.
In which of the conditions shown in the options below, the gravitational force remains same i.e., F?
(A)


(B)


(C)


(D)


8. The _______ force is much weaker than other forces in nature.
(A) gravitational (B) electromagnetic
(C) nuclear force (D) inter molecular

9. Which of the following is NOT a characteristic of gravitational force?
(A) Gravitational force is always attractive.
(B) Gravitational force has a small range.
(C) Gravitational force does not depend upon intervening medium.
(D) Gravitational force is a weak force.

10. Though the gravitational force is much weaker than other forces in nature but it controls the Universe because of the _______
(A) large distances between the planets, stars and other constituents of the Universe.
(B) high value of G.
(C) huge masses of planets, stars and other constituents of the Universe.
(D) (A) and (C)

11. The tidal waves in the sea are primarily due to gravitational effect of
(A) earth on the sea.
(B) Sun on the earth.
(C) earth on the moon.
(D) moon on the earth.

12. The point inside or outside an object at which the total mass of the object can be assumed to be concentrated is termed as _______.
(A) centre of gravity (B) focus
(C) centre of balance (D) centre of mass

13. Which of the following statement is incorrect in case of centre of mass?
(A) All the mass of the object is assumed to be concentrated at the centre of mass.
(B) The centre of mass of any object is always inside that object.
(C) The centre of mass of a spherical object having uniform density is at its geometrical centre.
(D) The centre of mass of any object having uniform density is at its centroid.

14. For bodies which are not spherical or having an irregular shape, the direction of the force is along the line joining their _______.
(A) centre of masses (B) centres
(C) nearest edges (D) both (A) and (B)

15. In SI units, the value of G is equal to the ________ between two masses of 1 kg kept 1 m apart.
(A) Kepler's constant
(B) gravitational force
(C) acceleration due to gravity
(D) repulsive force

16. Which of the following is the S.I. unit of universal gravitational constant?
(A) Nm/kg^2 (B) Nm^2/kg
(C) Nm/kg (D) Nm^2/kg^2

17. The value of universal gravitational constant (G) in SI unit is _______
(A) $6.673 \times 10^{-11}\ Nm^2/kg^2$
(B) $6.673 \times 10^{11}\ Nm/kg$
(C) $9.673 \times 10^{-11}\ Nm/kg$
(D) $9.673 \times 10^{-11}\ Nm^2/kg^2$

18. Which of the following statements about the gravitational constant is true?
(A) It is a force.
(B) It depends on the distance between two objects.
(C) It depends on the value of the masses.
(D) It does not depend on the nature of the medium in which the bodies are kept.

19. Uniform circular motion is possible only _______
(A) when the body is constantly acted upon by a force directed towards the centre of the circle.
(B) when the body is constantly acted upon by a force perpendicular to the centre of the circle.
(C) when the body is not acted upon by any force.
(D) when the body is constantly acted upon by any uniform force.

20. According to Newton's_____ law of motion, a force acting on a body results in its acceleration.
(A) first (B) second
(C) third (D) zeroth

1.5 Acceleration due to the gravitational force of the Earth

1. The direction of the acceleration due to gravity of any object is always _______.
(A) vertically upwards
(B) away from the centre
(C) vertically downwards
(D) both (B) and (C)

2. A spherical planet far out in space has a mass M_o and diameter D_o. A particle of mass m falling freely near the surface of this planet will experience acceleration due to gravity equal to
(A) GM_o/D_0^2 (B) $4mGM_o/D_0^2$
(C) $4GM_o/D_0^2$ (D) GmM_o/D_0^2

3. The mass and diameter of a planet have twice the value of the corresponding parameters of earth. Acceleration due to gravity on the surface of the planet is
(A) 9.8 m/s^2 (B) 4.9 m/s^2
(C) 980 m/s^2 (D) 19.6 m/s^2

4. The value of acceleration due to gravity
(A) is same at the equator and poles.
(B) is least at the poles.
(C) is least at the equator.
(D) is maximum at the centre of the earth.

5. For an object at infinite distance from the earth, the value of acceleration due to gravity (g) is
(A) maximum (B) 9.8 m/s^2
(C) 9.73 m/s^2 (D) zero

6. Value of acceleration due to gravity (g) ________ as we go deep inside the earth.
(A) decreases initially and later increases
(B) increases initially and later decreases
(C) decreases
(D) increases

7. According to Newton's first law of motion, higher the mass _______ is the inertia.
(A) lower (B) higher
(C) zero (D) double

8. When an object is taken from earth to the moon,
(A) its weight increases.
(B) its mass decreases.
(C) its weight remains unchanged.
(D) its mass remains unchanged.

9. If the gravitational attraction of the earth suddenly disappears, then,
(A) weight of the body will become zero but the mass will remain unchanged.
(B) weight of the body will remain unchanged but the mass will become zero.
(C) both mass as well as weight will be zero.
(D) neither mass nor weight will be zero.

10. Where will it be profitable to purchase 1 kilogram sugar?
(A) At poles (B) At equator
(C) At 45° latitude (D) At 40° latitude

11 On the________, value of acceleration due to gravity is 1/6 times that on the surface of the earth.
(A) planet Mercury
(B) Sun
(C) moon
(D) Mars

12. The value of g on moon is $1/6^{th}$ of its value on the earth. If a person weighs 14 N on the moon's surface, then the weight of the person on earth's surface is
(A) 96 N (B) 84 N
(C) 62 N (D) 54 N

13. If earth's satellite is moved from one stable orbit to a farther stable orbit, then which of the following quantities increase?
(A) Potential energy.
(B) Gravitational acceleration.
(C) Gravitational force.
(D) All of the above.

14. What is the gravitational potential energy of an object located 20,000 m above the earth's surface?
(A) $U = -GMm/(20 \text{ km} + R_E)$
(B) $U = -GMm/(20{,}000 \text{ km} + R_E)$
(C) $U = -GMm/R_E$
(D) $U = -GMm/(R_E - 20 \text{ km})$

1.6 Free fall

1. Acceleration of an object thrown upwards is always taken _______ as it moves against the force of gravity.
(A) negative (B) positive
(C) zero (D) infinite

2. Medium in which true free fall is possible is ______.
   (A) vacuum (B) water
   (C) fluid (D) moist air

R 3. When a feather and a heavy stone are dropped from a same height at the same time in vacuum,
   (A) they both will reach the earth at the same time
   (B) the feather will reach the earth first
   (C) the stone will reach the earth first
   (D) it cannot be predicted as the given data is insufficient

4. Which of the following is an example of free fall?
   (A) A spacecraft with propulsion off
   (B) Flying in an aircraft
   (C) Descending to the earth using parachute
   (D) Standing on the ground

5. A ball of mass 2 kg is released from a height of 180 m and falls freely to the ground. Assuming that the value of g is 10 m/s^2, the time taken by the ball to reach the ground is ________.
   (A) 5 s (B) 6 s
   (C) 2 s (D) 4 s

1.7 Escape velocity

1. Escape velocity of a satellite depends on the
   (A) mass of the satellite
   (B) radius of the orbit of the satellite
   (C) mass of the planet
   (D) all of the above.

2. The minimum velocity of the spacecraft to escape from earth's gravitational force must be _______. **[Dec 2020]**
   (A) 112 km/s (B) 11.2 km/s
   (C) 1.12 km/s (D) 0.112 km/s

3. Escape velocity on a planet is v_e. If radius of the planet remains same and mass becomes 4 times, the escape velocity becomes
   (A) 4 v_e (B) 2 v_e
   (C) v_e (D) $\frac{1}{2}v_e$

ANSWERS TO MCQs

1.1 Gravitation

1. (A)

1.2 Circular motion and centripetal force

1. (C) 2. (C) 3. (D) 4. (D)

1.3 Kepler's laws

1. (D) 2. (C) 3. (A) 4. (D) 5. (B) 6. (B)

1.4 Newton's universal law of gravitation

1. (C) 2. (A) 3. (D) 4. (D) 5. (A) 6. (A) 7. (C) 8. (A) 9. (B) 10. (C)
11. (D) 12. (D) 13. (B) 14. (A) 15. (B) 16. (D) 17. (A) 18. (D) 19. (A) 20. (B)

1.5 Acceleration due to the gravitational force of the Earth

1. (C) 2. (C) 3. (B) 4. (C) 5. (D) 6. (C) 7. (B) 8. (D) 9. (A) 10. (B)
11. (C) 12. (B) 13. (A) 14. (A)

1.6 Free fall

1. (A) 2. (A) 3. (A) 4. (A) 5. (B)

1.7 Escape velocity

1. (C) 2. (B) 3. (B)

SOLUTIONS TO MCQs

1.2 Circular motion and centripetal force

3. Spacecraft does not experience a centripetal force while getting launched from the surface of the earth while other objects mentioned experience centripetal force.

1.3 Kepler's laws

3. From Kepler's second law of planetary motion, the velocity of a planet is maximum when its distance from Sun is the least.

5. $\frac{T^2}{r^3}$ = constant

∴ T^2r^{-3} = constant

6. $r_2 = 2r_1$

∴ $\frac{T_2}{T_1} = \left(\frac{r_2}{r_1}\right)^{3/2} = (2)^{3/2} = 2\sqrt{2}$

∴ $T_2 = 2\sqrt{2}$ years ….(As, T_1= 1 year)

1.4 Newton's universal law of gravitation

5. F ∝ mass of object
Hence, as mass increases by 2 times, force increases by 2 times.

6. $F \propto \frac{1}{(\text{distance})^2} \Rightarrow (\text{distance}) \propto \frac{1}{\sqrt{F}}$
Hence, as force increases by 4 times, distance decreases by 2 times.

7. $F' = \frac{G(m/2)(m/2)}{(d/2)^2} = \frac{Gmm}{d^2} = F$

16. $F = G\frac{m_1m_2}{r^2} \Rightarrow G = \frac{Fr^2}{m_1m_2}$

∴ S.I. unit of G is $\frac{Nm^2}{kg^2}$

18. Gravitational constant 'G' is independent of the medium intervening the two masses interacting gravitationally.

1.5 Acceleration due to the gravitational force of the Earth

2. Acceleration due to gravity,
$g = \frac{GM_O}{r_O^2} = \frac{GM_O}{(D_O/2)^2} = \frac{4GM_O}{D_O^2}$

3. Acceleration due to gravity for the given planet,
$g_p = \frac{GM_p}{R_p^2}$
$= \frac{G(2M)}{(2R)^2} = \frac{2GM}{4R^2} = \frac{g}{2}$ ….($\because g = \frac{GM}{R^2}$)

∴ $g_p = \frac{9.8}{2} = 4.9$ m/s^2

10. The weight of an object is defined as the force with which the earth attracts the object. It is given as, W = F = mg.
The weight of an object depends on the mass of the object and the value of acceleration due to gravity. On the surface of the earth, the value of g is highest at the poles and decreases slowly with decreasing latitude becoming lowest at the equator. Hence, a 1 kg of sugar would weigh more at the poles and less at equator.

12. Let weight on the moon and earth be respectively W′ and W
$\frac{W'}{W} = \frac{mg_{moon}}{mg_{earth}}$
$\Rightarrow W = W' \times \frac{g_{earth}}{g_{moon}} = W' \times 6$
….(Given: $g_{moon} = \frac{g_{earth}}{6}$)

∴ W = 14 × 6 = 84 N

14. At a height h from surface of earth,
P.E., $U = \frac{-GMm}{R+h}$
For h = 20,000 m = 20 km,
∴ $U = \frac{GMm}{R+20}$

1.6 Free fall

3. **CAUTION**

When we drop a feather and a heavy stone at the same time from a height, they do not reach the earth at the same time because the feather experiences a buoyant force and a frictional force due to air and floats. As a result, it reaches the ground slowly, later than the heavy stone.
But in vacuum, due to free fall two objects, irrespective of their masses or any other properties, when dropped from the same height and falling freely both will reach the earth at the same time.

4. Spacecraft with propulsion off experiences a free fall while others are not examples of free fall.

5. Newton's second equation of motion is given as,
$s = ut + \frac{1}{2}at^2$

∴ $180 = 0 \times t + \frac{1}{2} \times 10 \times t^2 = 5t^2$

∴ $t^2 = \frac{180}{5} = 36$

∴ t = 6 s

1.7 Escape velocity

3. $v_e = \sqrt{\frac{2GM}{R}}$

∴ $v_e \propto \sqrt{M}$ if R = constant

∴ If the mass of the planet becomes four times then escape velocity will become 2 times.

TOPIC TEST

Total Marks: 15

1. For free fall, the initial velocity of the object is always taken as _______ and acceleration, a = g. **[1]**
   (A) negative (B) positive (C) zero (D) infinite

2. Choose the correct option. **[1]**

If $F = \frac{Gm_1m_2}{d^2}$ then $F' =$ ☐

   (A) 3F (B) 9F (C) F/3 (D) F/9

3. The value of acceleration due to gravity is maximum at ________. **[1]**
   (A) the centre of the earth (B) the pole of the earth
   (C) the equator of the earth (D) anywhere on the surface of the earth

4. Which of the following quantities is a variable? **[1]**
   (A) Mass of an object (B) Acceleration due to gravity of the object
   (C) Universal gravitation constant (G) (D) None of the above.

5. The value of g on moon is $1/6^{th}$ of its value on the earth. If a person weighs 36 N on the moon's surface, then the weight of the person on earth's surface is **[1]**
   (A) 216 N (B) 84 N (C) 6 N (D) 36 N

6. For an object placed at height h from the surface of two planets, its magnitude of gravitational potential energy will be **[1]**
   (A) greater on heavier planet. (B) greater on planet with larger radius.
   (C) same of both the planets. (D) non-zero only if planets have atmosphere.

7. A ball of mass 2 kg is released from a height of 540 m and falls freely to the ground. Assuming that the value of g is 10 m/s^2, the time taken by the ball to reach the ground is ________. **[1]**
   (A) $10\sqrt{3}$ s (B) 6.5 s (C) $6\sqrt{3}$ s (D) 2.4 s

8. Which of the following laws states that planet revolve around the Sun in an elliptical orbit? **[1]**
   (A) Newton's law of gravitation. (B) Kepler's first law.
   (C) Kepler's second law. (D) Kepler's third law.

9. CGS unit of weight is _______. **[1]**
   (A) erg (B) gram (C) joule (D) dyne

10. According to Newton's law of gravitation, for two objects kept at a distance d from each other, if the distance between the objects is halved, then the force between the two objects _______. **[1]**
    (A) increases by a factor of 4 (B) decreases by a factor of 4
    (C) decreases by a factor of 2 (D) increases by a factor of 2

11. Initial velocity required to attain by any object to get rid of the gravitational force of the planet is _______. **[1]**
    (A) escape velocity (B) critical velocity
    (C) free fall velocity (D) tangential velocity

12. The C.G.S. unit of universal gravitational constant is **[1]**
    (A) dyne cm^2/g^2 (B) dyne g^2/cm^2 (C) $dyne^2$ cm/g (D) g^2/ dyne cm^2

13. If a body of mass 10 kg is taken to the centre of the earth, its weight will be **[1]**
    (A) zero (B) infinity (C) 98 N (D) 980 N

14. Two satellites A and B are rotating in same orbit. The ratio of their escape velocities, if radius and mass of A is twice to B, is **[1]**
    (A) 1 : 1 (B) 1 : 2 (C) 1 : 3 (D) 1 : 4

15. If a body is taken from the surface of earth to moon, then its weight will **[1]**
(A) first decrease then increase. (B) first increase then decrease.
(C) continuously increase. (D) continuously decrease.

ANSWERS

1.	(C)	2.	(D)	3.	(B)	4.	(B)	5.	(A)	6.	(A)	7.	(C)	8.	(B)	9.	(D)	10.	(A)
11.	(A)	12.	(A)	13.	(A)	14.	(A)	15.	(A)										

SOLUTIONS

2.
$$F' = \frac{Gm_1 m_2}{(3d)^2} = \frac{Gm_1 m_2}{9d^2} = \frac{F}{9}$$

4. Acceleration due to gravity of any object varies while mass of the object and gravitation constant remains unchanged anywhere in the universe

5. Let weight on the moon and earth be respectively W′ and W
$$\frac{W'}{W} = \frac{mg_{moon}}{mg_{earth}} \Rightarrow W = W' \times \frac{g_{earth}}{g_{moon}} = W' \times 6 \quad \text{....(Given: } g_{moon} = \frac{g_{earth}}{6})$$
∴ $W = 36 \times 6 = 216$ N

6. $P.E = \frac{-GM_{planet} m}{(R_{planet} + h)}$

$\Rightarrow$ P.E $\propto$ mass of planet

$\propto \frac{1}{\text{Radius of planet}}$

Hence, object will possess greater magnitude of potential energy on the planet with higher mass, i.e., heavier planet.

7. Newton's second equation of motion is given as,

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

∴ $540 = 0 \times t + \frac{1}{2} \times 10 \times t^2 = 5t^2$

∴ $t^2 = \frac{540}{5} = 108$

∴ $t = 6\sqrt{3}$ s

10. $F \propto \frac{1}{(\text{distance})^2}$

Hence, as distance decreases by $\frac{1}{2}$ times, force increases by 4 times.

13. At the centre of earth $g' = 0$;
Weight = $mg' = 10 \times 0 = 0$

14. $v_e = \sqrt{\frac{2GM}{r}}$

Thus, escape velocity is independent of mass of satellite and depends on the radius of orbit.
Hence, they have equal escape velocities.

15. As the body moves away from surface of the earth, its weight decreases due to decrease in gravitational acceleration of the earth. But as it enters gravitational field of moon, its weight starts increasing due to increase in gravitational acceleration of moon.

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