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PHYSICS

BOOKS - FULL MARKS PHYSICS (TAMIL ENGLISH)

GRAVITATION

In Textual Solved Examples

1. Consider two point masses m_1 and m_2 which are separated by a distance of 10 metre

as shown in the following figure. Calculate the force of attraction between them and draw the directions of forces on each of them. Take $m_1 = 1\text{kg} \quad \text{and } m_2 = 2\,\text{kg}$

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2. Moon and an apple are accelerated by the same gravitational force due to Earth. Compare the acceleration of the two.

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3. Two particles of masses m_1 arem_2 placed along the x and y axes respectively at a distance from the origin. Calculate the gravitational field at a point P shown in figure below.

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4. Match the columns

1.	J.J. Thomson	(a)	Atomic model for hydrogen atom
2.	Rutherford	(b)	Theoretical atom model
3.	Geiger and Marsden	(c)	Nucleus
4.	Neils Bohr	(d)	Scattering of alpha particles

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5. Water falls from the top of a hill to the ground. Why?

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6. Consider four masses m_1, m_2, m_3 and m_4 arranged on the circumference of a circle as shown in figure below: Calculate:

(a) The gravitational potential energy of the system of 4 masses shown in figure.

(b) The gravitational potential at the point O due to all the 4 masses.

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7. Calculate the value of g in the following two cases:

(a) If a mango of mass $\frac{1}{2}$ kg falls from a tree from a height of 15 metres, what is the acceleration due to gravity when it beigns to fall?

(b) Consider a satellite orbiting the Earth in a circular orbit of radius 1600 km above the surface of the Earth. What is the acceleration experienced by the satellite due to Earth's gravitational force?

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8. Find out the value of g in your school laboratory?

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9. Moon is the natural satellite of Earth a f it takes 37 days to go once around its orbit. Calculate the distance of the Moon from the surface of the Earth assuming the orbit of the Moon as circular.

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10. Calculate the energy of the (i) Moon orbiting the Earth and (ii) Earth orbiting the Sun.

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Textual Evaluation Solved I Multiple Choice Questions

1. The linear momentum and position vector of the planet is perpendicular to each other at

A. perihelion and aphelion

B. at all points

C. only at parihelion

D. no point

Answer:

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2. If the masses of the Earth and Sun suddenly double, the gravitational force between them will

A. remain the same

B. increase 2 times

C. increase 4 times

D. decrease 2 times

Answer:

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3. A planet moving along an elliptical orbit is closest to the Sun at distance r_1 and farthest away at a distance of r_2. If v_1 and v_2 are linear speeds at these points respectively. Then the ratio $\frac{v_1}{v_2}$ is

A. $\frac{r_2}{r_1}$

B. $\left(\frac{r_2}{r_1}\right)^2$

C. $\frac{r_1}{r_2}$

D. $\left(\frac{r_1}{r_2}\right)^2$

Answer:

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4. The time period of a satellite orbiting Earth in a circular orbit is independent of

A. Radius of the orbit

B. The mass of the satellite

C. Both the mass and radius of the orbit

D. Neither the mass nor the radius of its orbit

Answer:

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5. If the distance between the Earth and Sun were to be doubled from its present value, the number of days in a year would be

A. 64.5

B. 1032

C. 182.5

D. 730

Answer:

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6. According to Kepler's second law, the radial vector to a planet from the Sun sweeps out equal areas in equal intervals of time. This law is a consequence of:

A. conservation of linear momentum

B. conservation of angular momentum

C. conservation of energy

D. conservation of kinetic energy

Answer:

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7. The gravitational potential energy of the Moon with respect to Earth is:

A. always positive

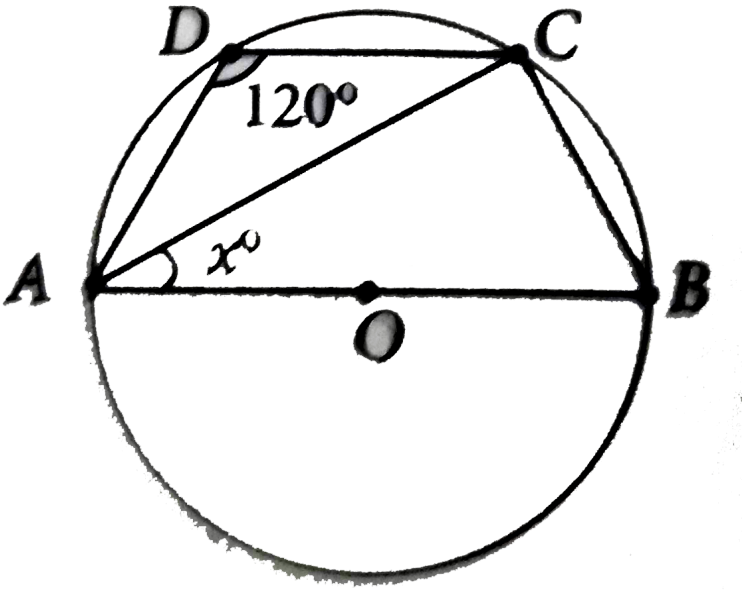
B. always negative

C. can be positive or negative

D. always zero.

Answer:

8. Find the value of x in the given figure.



A. $K_A < K_B < K_C$

B. $K_B < K_A < K_C$

C. $K_A < K_B < K_C$

D. $K_B > K_A > K_C$

Answer:

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9. The work done by the Sun's gravitational force on the Earth is

A. always zero

B. always positive

C. can be positive or negative

D. always negative

Answer:

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10. If the mass and radius of the Earth are both doubled, then the accelration due to gravity g

A. remains same

B. $\frac{g}{2}$

C. $2g$

D. $4g$

Answer:

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11. The magnitude of the Sun's gravitational field as experienced by Earth is:

A. same over the year

B. decreases in the month of January and increases in the month of July

C. decreases in the month of July and increases in the month of January

D. increases during day time and decreases during night time.

Answer:

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12. If a person moves from Chennai to Trichy, his weight:

A. increases

B. decreases

C. remains same

D. increases and then decreases

Answer:

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13. An object of mass 10 kg is hanging on a spring scale which is attached to the roof of a lift. If the lift is in free fall, the reading in the spring scale is

A. 98 N

B. zero

C. 49 N

D. 9.8 N

Answer:

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14. If the accelaration due to gravity becomes 4 times its original value, then escape speed

A. remains same

B. 2 times of original value

C. becomes halved

D. 4 times of original value

Answer:

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15. The kinetic energy of the satellite orbiting around the Earth is

A. equal to potential energy

B. less than potential energy

C. greater than kinetic energy

D. zero

Answer:

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Textual Evaluation Solved Ii Short Answer Questions

1. State Kepler's three laws.

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2. State Newtons Universal law of gravitaion.

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3. Will the angular momentum of a planet be conserved? Justify your answer.

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4. Define the gravitational field. Give its unit.

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5. What is meant by superposition of gravitational field?

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6. Define gravitational potential energy.

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7. Is potential energy the property of a single object? Justify.

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8. Define gravitational potential.

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9. What is the difference between gravitational potential and gravitational potential energy?

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10. What is meant by escape speed in the case of the Earth?

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11. Why is the energy of a satellite negative?

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12. What are geostationary and polar satellites?

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13. Define weight.

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14. Why is there no lunar eclipse and solar eclipse every month?

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15. How will you prove that Earth itself is spinning?

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Textual Evaluation Solved Iii Long Answer Questions

1. Discuss the important features of the law of gravitation

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2. Explain how Newton derived his law of gravitation from Kepler's third law.

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3. Explain how Newton verified his law of gravitation.

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4. Derive the expression for gravitational potential energy.

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5. Prove that at points near the surface of the Earth, the gravitational potential energy of the object is U = mgh.

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6. Explain in detail the idea of weightlessness using lift as an example.

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7. Derive an expression for escape speed.

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8. Explain the variation of 'g' with latitude.

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9. Explain the variation of g with altitude from the Earth's surface.

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10. Explain the variation of g with depth from the Earth's surface.

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11. Derive the time period of satellite orbiting the Earth.

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12. Derive an expression for energy of satellite.

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13. What are geostationary and polar satellites?

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14. Explain how geocentric theory is required by helliocentric theory using the idea of

retrograde motion of planets.

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15. Explain in detail the Eratosthenes method of finding the radius of Earth.

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16. Describe the measurement of Earth's shadow (umbra) radius during total lunar eclipse.

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O

1. In the following what are the quantities which that are conserved?

A. Linear momentum of planet

B. Angular momentum of planet

C. Total energy of planet

D. Potential energy of planet

Answer:

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2. The work done by sun on Earth at any finite interval of time is

A. positive, negative or zero

B. Strictly positive

C. Strictly negative

D. It is always zero

Answer:

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Textual Evaluation Solved Iv Conceptual Questions

1. The work done by Sun on Earth in one year will be:

A. Zero

B. None zero

C. positive

D. negative

Answer:

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2. If a comet suddenly hits the moon and imparts energy which is more than the toatl energy of the moon, what will happen?

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3. If the Earth's pull on the Moon suddenly disappears, what will happen to the Moon?

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4. If the Earth has no tilt what happens to the seasons of the Earth?

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5. A student was asked a question 'why are there summer and winter for us? He replied as 'since Earth is orbiting in an elliptical orbit, when the Earth is very faraway from the Sun (aphelion) there will be winter, when the Earth is nearer to the Sun (perihelion) there will be winter}. Is this answer correct? If not, what is the correct explanation for the occurrence of summer and winter?

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6. The following photographs are taken from the recent lunar eclipse which occurred on January 31, 2018. Is it possible to prove that Earth is a sphere from these photographs?

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Textual Evaluation Solved V Numerical Problems

1. An unknown planet orbits the sun with distance twice the semi major axis distance of the Earth's orbit. It the Earths time period is

T_1 , what is the time period of this period is planet?

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2. Assume that you are in another solar system and provided with the set of data given below consisting of the planets' semi major axes and time periods. Can you infer the relation connecting semi major axis and time period?

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3. If the masses and mutual distance between the two objects are doubled, what is the change in the gravitational force between them?

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4. Two bodies of masses m and 4m are placed at a distance r. Calculate the gravitational potential at a point on the joining them where the gravitational field is zero.

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5. If the ratio of the orbital distance of the two planets $\frac{d_1}{d_2} = 2$, what is the ratio of gravitational field experienced by these two planets?

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6. The Moon Io orbits jupiter once in 1.769 days. The orbital radius of the Moon Io is 421700 Km. Caculate the mass of jupiter?

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7. If the angular momentum of a planet is given by $.\overrightarrow{L} = 5t^2\hat{i} - 6t\hat{j} + 3\hat{k}$. What is the torque experienced by the planet? Will the torque be in the same direction as that of the angular momentum?

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8. Four particles, each of mass M and equidistant from each other, move along a circle of radius R under the action of their mutual gravitational attraction. Calculate the speed of each particle

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9. Suppose unknowingly you wrote the universal gravitational constant value as $G = 6.67 \times 10^{11}$ Instead of the correct value

$G = 6.67 \times 10^{-11}$, what is the acceleration due to this new acceleration due to gravity, what will be your weight W'?

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10. Calculate, the gravitational field at point O due to three massesm_1, m_2 and m_3 whose positions are given by the following figure. If the masses m_1 and m_2 are equal what is the change in gravitational field at the point O?

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11. What is the gravitational potential energy of the Earth and sun ? The Earth to sun distance is arouund 150 million Km . The mass of the Earth is 5.9×10^{24}kg and the mass of the sun is 1.9×10^{30} kg.

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12. Earth revolves around the sun at 30 kms^{-1} calculated the kinetic energy of the Earth.What is the total energy of the Earth in

that case? Is the total energy positive?Give reasons.(Potential energy of earth = -49.84×10^{32})

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13. An object is thrown from Earth is such a way that it reaches a point at infinity with non-zero kinetic energy $\left[K.E(r=\infty)=\frac{1}{2}MV_{\infty}^{0}\right]$, with what velocity should the object be thrown from Earth?

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14. Suppose we go 200 km above and below the surface of the Earth, what are the g values at these two points? In which case, is the value of g small?

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15. Calculated the change in g value in your district of Tamil nadu. (Hint : Get the latitude of your district of Tamil nadu from the

Google). What is the difference in g values at Chennair and Kanyakumari?

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Additional Questions Solved I Choose The Correct Answer From The Following

1. According to Kepler's planet move in

A. Circular orbits around the Sun

B. Elliptical orbits around the Sun with Sun at exact centre

C. Straight lines with constant velocity

D. Elliptical orbits around the Sun with Sun at one of its foci.

Answer: D

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2. Kepler's second law regarding constancy of aerial velocity of a planet is consequence of the law of conservation of .....

A. energy

B. angular momentum

C. linear momentum

D. None of these

Answer: B

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3. Accorrding to Kepler, the period of revolution of a planet (T) and its mean distance from the Sun ® related by the equation.

A. T^3a^3 = constant

B. T^2a^{-3}=constant

C. Ta^3=constant

D. T^2a=constant

Answer: B

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4. The period of Moon's rotation around the Earth is nearly 29 days.If Moon's mass were 2 fold its present value and all other things remained unchanged the period of Moon's rotation would be nearly .....days.

A. $29\sqrt{2}$

B. $\frac{29}{\sqrt{2}}$

C. 29×2

D. 29

Answer: D

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5. The period of revolution of planet A around the Sun is 8 times that of B. The distance of A from the Sun is how many times greater than that of B from the Sun.

A. 2

B. 3

C. 4

D. 5

Answer: C

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6. The radius of orbit of a planet is two times that of Earth. The time period of planet is ..... . years.

A. 4.2

B. 2.8

C. 5.6

D. 8.4

Answer: B

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7. A Geo-stationary satellite bits around the earth in a circular of radius 36, 000 km then what will be the time period of a spy satellite orbiting a few hundred km above the earth's surface $(R_{\text{earth}} = 6400km)$

A. (a) $\frac{1}{2}$

B. (b) 1

C. (c) 2

D. (d) 4

Answer: C

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8. What does not change in the field of central force?

A. Potential energy

B. kinetic energy

C. linear momentum

D. Angular momentum

Answer: D

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9. A satellite which is geostationary in a particular orbit is taken to another orbit. Its distance from the center of earth in new orbit

is two times of the earlier orbit. The time period in second orbit is..... hours.

A. 4.8

B. $48\sqrt{2}$

C. 24

D. $24\sqrt{2}$

Answer: B

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10. If Earth be at one fourth its present distance from the Sun, how many days will there be in a year?

A. half the present year

B. one-eight the present year

C. one-fourth the present year

D. one-sixth the present year

Answer: B

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11. The Earth E moves in an elliptical orbit with the Sun S at one of the foci as shown in figure. Its speed of motion will be maximum at a point .....

A. C

B. A

C. B

D. D

Answer: A

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12. Rockets are launched in eastward direction to take advantage of..... .

A. the clear sky on eastern side

B. Earth's rotation

C. the thinner atmosphere on this side

D. Earth's tilt

Answer: B

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13. Two sphere of mass M_1 are M_2 situated in air and the gravitational force between them is F. The space around the masses is now filled with liquid of specific gravity 3. The gravitational force will now be..... . .

A. F

B. 3F

C. $\frac{F}{3}$

D. $\frac{F}{9}$

Answer: A

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14. Which of the following statement about the gravitational constant is true?

A. It is a force

B. It has same value in all system of unit

C. It has not unit

D. It does not depend on the nature of the medium in which the bodies are kept.

Answer: A

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15. Energy required to move a body of mass 'M' from an orbit of radius 2R to 3R is..... .

A. $\frac{GM}{12R}$

B. $\frac{GMm}{3R^2}$

C. $\frac{GMm}{8R}$

D. $\frac{GMm}{6R}$

Answer: D

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16. The mass of the earth is 6×10^{24} kg and that of the Moon is 7.4×10^{22} kg. The constant of gravitation G is $6.67 \times 10^{-11} \mathrm{Nm}^2 \mathrm{kg}^{-2}$ The potential energy of the system is -7.79×10^{28}

J The mean distance between the Earth and Moon is..... metre.

A. 3.80×10^8

B. 3.37×10^8

C. $7. .60 \times 10^8$

D. 1.90×10^2

Answer: A

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17. What is the intensity of gravitational field at the center of spherical shell?

A. $\frac{Gm}{r^2}$

B. g

C. zero

D. None of these

Answer: C

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18. A body of mass m is taken from the Earth's surface to a height equal to the radius R of the earth. If g is the acceleration to gravity at the surface of the Earth, then find the change in the potential energy of the body.....

A. $\frac{1}{4}mgR$

B. $\frac{1}{2}$mgR

C. mgR

D. 2mgR

Answer: B

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19. A satellite is orbiting around the Earth in a circular orbit with velocity v. If m is the mass of the satellite, its total energy is ....

A. mv^2

B. $\frac{1}{2}mv^2$

C. $-\frac{1}{2}mv^2$

D. $\frac{3}{4}mv^2$

Answer: C

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20. Escape velocity of a body of 1 kg. On a planet is 100 ms^{-1}. Gravitational potential energy of the body at the planet is .....

A. -5000 J

B. $-1000J$

C. $-2400J$

D. 4000 J

Answer: A

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21. A particle falls towards earth from infinity. It's velocity reaching the Earth would be .....

A. infinity

B. $\sqrt{2gR}$

C. $2\sqrt{gR}$

D. zero

Answer: B

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22. An artificial satellite is revolving round the Earth in a circular orbit, its velocity is half the eacape velocity. Its height from the Earth surface is..... km.

A. 6400

B. 12800

C. 3200

D. 1600

Answer: A

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23. The escape velocity of a body on the surface of the Earth is 11.2km/s If the mass of the Earth is increase to twice its present value and the radius of the earth becomes half, the escape velocity becomes $= \ldots\ldots \mathrm{kms}^{-1}$

A. 5.6

B. 22.4

C. 7.6

D. 8.6

Answer: C

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24. The velocity with which a projectile must be fired so that it escapes Earth's gravitational does not depend on..... .

A. Mass of Earth

B. Radius of the projectile's orbit

C. Mass of the projectile

D. Gravitational constant

Answer: C

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25. The escape velocity for a body projected vertically upwards from the surface of Earth is $11 \mathrm{kms}^{-1}$ If the body is projected at an angle

of45° with verical, the escape velocity will be .....

A. $\frac{11}{\sqrt{2}}$

B. $11\sqrt{2}$

C. 22

D. 11

Answer: D

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26. Two satellites of masses m_1 and $m_2(m_1 > m_2)$ are moving around the earth in orbits of radii r_1 and $r_2(r_1 > r_2)$. Which one of the following statements about their velocities is correct?

A. $v_1 = v_2$

B. $v_1 < v_2$

C. $v_1 > v_2$

D. $\frac{v_1}{r_1} = \frac{v_2}{r_2}$

Answer: B

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27. As astronaut orbiting the earth in a circular orbit 120 km above the surface of Earth, gently drops a spoon out of space-ship. The spoon will. . . ..

A. fall vertically down to the Earth

B. move towards the moon

C. will move along with space-ship

D. will move in an irregular way then fall down to Earth

Answer:

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28. A satellite revolves around the Earth in an elliptical orbit. Its speed.

A. is the same at all point in the orbit

B. is greatest when it is closest to the Earth

C. is greatest when it is farthest to the Earth

D. goes on increasing or decreasing continuously depending upon the mass of the satellite.

Answer:

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29. A satellite is moving around the Earth with speed v in a circular orbit of radius r. If the orbit radius is decreased by 1% its speed will ..... .

A. increase by 1%

B. increase by 0.5%

C. decrease by 1%

D. decrease by 0.5%

Answer:

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30. Orbital velocity of earth satellite does not depend on:

A. mass of Earth

B. mass of satellite

C. radius of Earth

D. acceleration doe to gravity

Answer:

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31. The orbital speed of Jupiter is.....

A. greater than the orbital speed of Earth

B. less then the orbital speed of Earth

C. zero

D. equal to the orbital speed of Earth

Answer:

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32. As we go from the equator to the poles, the value of g ..... .

A. remains constant

B. decreases

C. increases

D. decreases upto latitude of 45°

Answer:

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33. The value of g on the Earth surface is $980 \mathrm{cm} / \mathrm{sec}^2$ Its value at a height of 64 km from the Earth surface is $\ldots\ldots\ldots\ldots \mathrm{cms}^{-2}$

A. 960.4

B. 961.4

C. 962.4

D. 963.4

Answer:

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34. The Moon's radius is $\frac{1}{4}$ that of earth and its mass is $\frac{1}{80}$ times that of the Earth. If g represents the acceleration due to gravity on the surface of Earth, that on the surface of the Moon is .....

A. $\frac{g}{4}$

B. $\frac{g}{5}$

C. $\frac{g}{6}$

D. $\frac{g}{7}$

Answer:

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35. If the density of small planet is that of the same as that of the earth while the radius of the planet is 0.2 times that of the Earth, the gravitational acceleration on the surface for the planet is..... .

A. $0.2g$

B. $0.4g$

C. $2g$

D. $4g$

Answer:

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36. Assuming Earth to be a sphere of a uniform density, what is value of gravitational acceleration in mine 100 km below the Earth surface = ... ms^{-2}

A. 9.66

B. 7.64

C. 5.00

D. 3.1

Answer:

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37. The radii of two planets are respectively R_1 and R_2 and their densities are respectively ρ_1 and ρ_2. The ratio of the

accelerations due to gravity (g_1/g_2) at their surfaces is:

A. $g_1 : g_2 = \frac{\rho_1}{R_1^2} : \frac{\rho_2}{R_2^2}$

B. $g_1, g_2 = R_1 R_2, \rho_1 \rho_2$

C. $g_1, g_2 = R_1 \rho_2 : R_2 \rho_1$

D. $g_1 : g_2 = R_1 \rho : R_2 \rho_2$

Answer:

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38. The acceleration due to gravity near the surface of a planet of radius R and density d is proportional to:

A. $\frac{d}{R^2}$

B. dR^2

C. dR

D. $\frac{d}{R}$

Answer:

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39. The acceleration of a body due to the attraction of the Earth (radius R) at a distance 2R from the surface of the Earth is .....

A. $\frac{g}{9}$

B. $\frac{g}{3}$

C. $\frac{g}{4}$

D. 9

Answer:

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40. If density of Earth increased 4 times and its radius become half of then our weight will be..... .

A. four times its present value

B. doubled

C. remains same

D. halved

Answer:

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41. The radius of the Earth is 6400 km and g = 10 in order that a body of 5 kg weights zero at the equator, the angular speed of the Earth is ..... rad

A. $\frac{1}{80}$

B. $\frac{1}{400}$

C. $\frac{1}{800}$

D. $\frac{1}{600}$

Answer:

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42. Weight of a body is maximum at.....

A. Moon

B. poles of Earth

C. equator of Earth

D. center of Earth

Answer:

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43. The weight of an astronaut, in an artificial satellite revolving around the Earth is:

A. zero

B. equal to that on the Earth

C. more than that on Earth

D. less than that on Earth

Answer:

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Additional Questions Solved 2 Marks Questions

1. Distinguish between the terms gravitation and gravity.

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2. Why is G called the universal gravitational constant?

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3. What is meant by the term free fall?

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4. What is meant by acceleration due to gravity? Is is a scalar or a vector?

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5. What do you mean by weight of a body? Is it a scalar or vector?

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6. Define orbital velocity.

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7. Give some uses of geostationary satellites.

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8. Give the uses of polar satellites.

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Additional Questions Solved Numerical Problems

1. A geo-stationary satellite is orbiting the Earth of a height of 6R above the surface of Earth R being the radius of the Earth calculate the time period of another satellite at a height of 2.5R from the surface of Earth.

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2. The time period of a satellite of Earth is 5 hours. If the separation between the Earth and the satellite is increased to four times the previous value, the new time period will become.

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3. The figure shows elliptical orbit of a planet 'M' about the Sun 'S', the shaded area SCD is twice the shaded area SAB. If t_1 is the time for

the planet to move from C and D and t_2 is the time to move from A to B then.

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4. A satellite moves in a circle around the Earth, the radius of this circle is equal to one half of the radius of the Moon's orbit. The satellite completes one revolution in ..... lunar month.

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5. Two identical solid copper sphere of radius R are placed in contact with each other. The gravitational force between them is proportional to.

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6. Two satellite A and B of the same mass are revolving around the Earth in circular orbits such that the distance of B from the centre of the Earth is thrice as compared to the

distance of A from the centre. What will be the ratio of centripetal force on B to that on A.

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7. An infinite number of bodies, each of mass 2 kg, are situated on at distance 1m, 2m, 4m, 8m from the origin. What will be the resultant gravitational potential due to this system at the origin.

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8. A body of mass 'm' kg starts falling from a point 2R above the Earth's surface. What is its K.E. When it has fallen to a point 'R' above the Earth's surface.

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9. A particle of mass 10g is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to done against the gravitational force between them to take the particle is away from the sphere.

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10. The mass of a space ship is 1000 kg. It is to be launched from Earth's surface out into free space the value of g and R (radius of Earth) are $10ms^2$ and 6400 km respectively. The required energy for this work will be.

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11. If the mean radius of the Earth is R, its angular velocity is ω and the acceleration due to gravity at the surface of the Earth is g, then what will be the cube of the radius of the orbit of a geostationary satellite.

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12. The escape velocity of a body from Earth's surface isv_e. What will be the escape velocity

of the same body from a height equal to 7R from Earth's surface.

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13. If R is the radius of the Earth and g is the acceleration due to gravity on the Earth's surface. Find the mean density of the Earth.

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14. If the mass of Earth is 80 times of that of a planet and 'g' diameter is double that of planet and 'g' on the Earth is $9.8ms^{-2}$ Calculate te value of on that planet?

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15. At what distance from the centre of Earth, the value acceleration due to gravity 'g' will be half that of the surface?

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16. A body weight 700 g on the surface of Earth. How much it weight on the surface of planet whose mass is $\frac{1}{7}$ and radius is half that of the Earth.

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17. An object weight 72 N the Earth. What its weight at a height $\frac{R}{2}$ from Earth.

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18. A body weight 500 N on the surface of the Earth. How much would it weight half way below the surface of Earth.

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