PHYSICS

BOOKS - SURA PHYSICS (TAMIL ENGLISH)

GRAVITATION

Exercise 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 perihelion

D. no point

Answer: A

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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: C

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 $\dfrac{v_1}{v_2}$ is

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

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

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

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

Answer: B

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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: B

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: B

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: B

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: B

8. 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: C

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

    A. remain same

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

    C. $2g$

    D. $4g$

Answer: B

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

A. same over the year

B. decrease in the month of January and increase

in the month of July

C. decrease in the month of July and increase in

the month of January

D. increase during day time and decreases during

night time

Answer: C

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

    A. increases

    B. decreases

    C. remains same

    D. increases and then decreases

Answer: B

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12. 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: B

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

    A. remain same

    B. 2 times of original value

    C. become halved

    D. greater than kinetic energy

Answer: B

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14. 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: B

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Exercise 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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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.

4. Derive the expression for gravitational potential energy.

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

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.

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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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Exercise Conceptual Questions

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 a planet

Answer: B::D

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

A. Zero

B. non-zero

C. positive

D. negative

Answer: A

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3. 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: D

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

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

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7. 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 far away 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?

8. 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?

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' sami major axes and time periods. Can you infer the relation connecting semi major axis and

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.

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

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?

7. If the angular momentum of a planet is given by .

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

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

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'?

10. Calculated the gravitational field at point O due to three masses m_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 $= -49.84 \times 10^{32}$)

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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?

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?

1. 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. linear momentum

B. angular momentum

C. energy

D. Newton's law of gravitation

Answer: B

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2. A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius 4R. The ratio of their respective periods is

   A. $4:1$

   B. $1:8$

   C. $8:1$

   D. $1:4$

Answer: B

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3. Two particles of equal mass m go round a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is

A. $\dfrac{1}{2R}\sqrt{\dfrac{1}{GM}}$

B. $\sqrt{\dfrac{GM}{2R}}$

C. $\dfrac{1}{2}\sqrt{\dfrac{GM}{R}}$

D. $\sqrt{\dfrac{4GM}{R}}$

Answer: C

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4. A body projected electrically from the earth reaches a height equal to earth's radius before retruning to the earth. The power exerted by the gravitational force is greatest

    A. at the highest position of the body

    B. at the instant just before the body hits the

       earth

    C. it remains constant all through

    D. at the instant just after the body is projected

Answer: B

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5. A rocket is fired from the earth. The body is projected the distance between the earth of the moon is r & the mass of the earth is 81 times the mass of the moon. The gravitational force on the rocket will be zero, when its from the moon is

A. $\dfrac{r}{5}$

B. $\dfrac{r}{10}$

C. $\dfrac{r}{15}$

D. $\dfrac{r}{20}$

Answer: A

6. A body of mass 500g is town upwards with a velocity $20ms^{-1}$ and reaches back to the surface of a planet after 20s. Then the weight of the body on that planet is

A. 2 N

B. 4 N

C. 5 N

D. 1 N

Answer: D

7. A body of mass m falls from earth's surface at a height equal to twice the radius (R) each. Then the change in P.E. of body will be

A. $2mgR$

B. $\dfrac{2}{3}mgR$

C. $3mgR$

D. $\dfrac{1}{3}mgR$

Answer: B

8. Three bodies of each of mass 2kg are situated on x-axis at distance 1m, 2m , 4m from origin. The resolving gravitational potential due to the system at the origin will be

A. $2G$

B. $\dfrac{8}{3}G$

C. $\dfrac{4}{3}G$

D. $\dfrac{7}{2}G$

Answer: D

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

A.

B.

C.

D.

Answer: C

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10. If the acceleration due to gravity at the surface of the earth is g, the work done is slowly lifting a body

of mass in from the earth's surface to a height R equal to the radius of the earth is

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

B. $2mgR$

C. mgR

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

Answer: A

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11. Let V & E be gravitational potential & gravitational field at a distance r from the centre of a uniform

solid sphere, consider the 2 statements

(A) the plot of V against r is discontinuous

(B) the plot of E against r is discontinuous

A. both A & B correct

B. A is correct but B is wrong

C. B is correct but A is wrong

D. both A & B wrong

Answer: D

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12. Two spherical balls of mass 10 hg are placed 10 cm apart. Find gravitational force of attraction between them

A. the earth does not arrtact the object in a satellite

B. the normal force by chair on the person balance the earth attraction

C. the normal force is zero

D. the person in sattelite is not accelartaed

Answer: C

13. A body is suspended from a spring balance kept in a satellite the reading of the balance is W_1 when the satellite goes in an orbit of radius R and is W_2 when it goes in an orbit of radius 2R

A. $W_1 = W_2$

B. $W_1 < W_2$

C. $W_1 > W_2$

D. $W_1 \neq W_2$

Answer: A

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14. A particle is kept at rest at a distance R (earth's radius) above the earth's surface, the minimum speed with which it should projected so that it does not return is

A. $\sqrt{\dfrac{GM}{4R}}$

B. $\sqrt{\dfrac{GM}{2R}}$

C. $\sqrt{\dfrac{GM}{R}}$

D. $\sqrt{\dfrac{2GM}{R}}$

Answer: C

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15. A satellite is orbiting the earth close to its surface. A particle is to be projected from the satellite to just escape from the earth the escape speed from the earth is V_e its speed with respect to the satellite

    A. will be less than V_e

    B. will be more than V_e

    C. will be equal to V_e

    D. will depend on direction of projection

Answer: D

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16. Which of following quantities remain constant in a planetary motion (consider elliptical orbits) as seen from the sun?

A. speed

B. angular momentum

C. kinetic energy

D. angular speed

Answer: B

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1. The gravitational force is a _____ force.

    A. mere

    B. vast

    C. central

    D. rare

Answer: C

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2. The acceleration due to earth's gravity decreases as _____ increases.

A. altitude

B. latitude

C. depth

D. sea level

Answer: A

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3. The energy of the satellite is _____.

A. positive

B. negative

C. partly negative

D. Partly positve

Answer: B

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4. The gravitational potential energy is a _____ quantity.

A. scalar

B. real

C. Vector

D. dimensionless

Answer: A

5. The gravitational field intensity (E) due to a mass 'm' at a point which is at a distance 'r' from mass is given by _____.

A. $\dfrac{Gm}{r}$

B. $+\dfrac{Gm}{r^2}$

C. $-\dfrac{Gm}{r^2}\hat{r}$

D. $-\dfrac{Gm}{r}$

Answer: C

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6. The escape speed is _____ of mass of the object.

A. dependent

B. independent

C. change

D. linear

Answer: B

7. _____ proposed heliocentric theory.

A. Nicolaus Copernics

B. Ptolemy

C. Kepler

D. Galileol

Answer: A

8. Due to rotation of the earth, the acceleration due to gravity is maxium at _____.

A. equator

B. poles

C. above sea level

D. below sea level

Answer: B

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9. _____experimentally determined the value of gravitational constant 'G' using a torsion balance.

A. Henry cavendish

B. Newton

C. Kepler

D. Galileo

Answer: A

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Additional Questions Choose The Odd One Out

1. Choose the odd one out:

A. Galileo

B. Newton

C. Kepler

D. Plato

Answer: D

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2. Choose the odd one out:

A. Satellite

B. Planets

C. Moon

D. Free fall

Answer: D

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3. Choose the odd one out:

A. Gravitational field

B. Gravitational Potential Energy

C. Elastic Potential Energy

D. Gravitational potential

Answer: C

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Additional Questions Choose The Correct Pair

1. Choose the correct pair :

(a) Energy of satetllite   —   Positive

(b) Gravitational field   —   Positive

(c) Escape speed   —   Positive

(d) Gravitational of force   —   Positive

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1. Choose the Incorrect Pair :

(a)	Kepler	—	Law of period
(b)	Galileo	—	Motion on Inclined plane
(c)	Newton	—	Calculus
(d)	Ptolemy	—	Helicocentric theory

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2. Choose the Incorrect Pair :

(a)   Escape speed   — $\sqrt{2gr}$

(b)   Gravitational Potential energy   — $\left(\frac{Gm}{r}\right)$

(c)   Gravitational Potential   — $\left(-\frac{Gm}{r^2}\right)\hat{r}$

(d)   Frictional force   — $\left(-\frac{Gm_1m_2}{r}\right)$

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Additional Questions Assertion Reason

1. In damped oscilation the directions of the restoring force and the resistive force

    A. are the same

B. are opposite

C. maybe same or opposite

D. no relation

Answer: C

2. Assertion: Gravitational potential is a scalar quantity and its unit is J/kg.

Reason: From this expression, $g' = g\left|1 - \dfrac{d}{R_e}\right|$ it is explained that as we go deep into the earth, gravity

decreases. i.e. As d increases, g' decreases. At the centre of earth. g' = 0.

A. Assertion and Reason are correct and Reason is the correct explanation of Assertion

B. Assertion and Reason are true but Reason is the false explanation of the Assertion

C. Assertion is true but Reason is false

D. Assertion is false but Reason is true

Answer: B

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1. (I)Gravitational force is attractive.

(II) Gravitational potential energy is a Scalar quantity?

Which one is correct statement?

A. I only

B. II only

C. both are correct

D. None

Answer: A

2. (I) Copernicous and Kepler measured the distance between a planet and the sun using simple Geometry and Trignometry.

(II) Eratosthenes measured radius of the Jupiter.

Which one is correct statement?

A. I only

B. II only

C. both are correct

D. None

Answer: A

3. (I) Gravitational force is a central force.

(II) Energy of the satellite is negative sometimes.

Which one of Incorrect?

    A. I only

    B. II only

    C. both are correct

    D. None

Answer: B

4. (I) Kepler's law is not derived from Newton's law of gravitation.

(II) Motion of planets is explained by copernicus.

Which one is correct statement?

    A. I only

    B. II only

    C. both are correct

    D. None

Answer: D

5. (I) Copernicus model explained regrograde motion.

(II) Ptolemy also explained retrograde motion before

Copernicus explained.

Which one is Incorrect?

    A. I only

    B. II only

    C. both are correct

    D. None

Answer: B

Very Short Answer Questions 2 Marks

1. If the force of gravity acts on all bodies in proportion to their masses, why does heavy body not all faster than a light body?

2. According to Newton's law of gravitation, the apple and the earth experience equal and opposite forces due to gravitation. But it is the apple falls towards the earth and not vice-versa. Why?

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3. Why does a tennis ball bounce higher on hills than on plains?

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4. What is the effect of rotation of the earth on the acceleration due to gravity?

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5. Explain why high & low tide are formed on seas.

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6. A satellite does not need any fuel to aide around the earth. Why?

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7. By which law is the Kepler's law of areas identical? Is this Kepler's law kinematic?

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8. Tides arise in the ocean. Give reason.

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9. Assume that the law of gravitiontion changes from inverse square to inverse cube. Does the angular momentum of a planet about the sun will remain constant?

10. Out of aphelion and perihelion where is the speed of the earth more any why?

11. If the K.E. of a satellite revolving around the earth in any orbit is doubled then what will happen to satellite?

12. Does the change in gravitational potential energy of a body between to given points depend upon the nature of path followed why?

13. A comet orbits the sun is highly elliptical orbit. Does a comet has a constant.

(i) Linear speed

14. A comet orbits the sun is highly elliptical orbit.

Does a comet has a constant.

(i) angular momentum

15. A comet orbits the sun is highly elliptical orbit.

Does a comet has a constant.

kinetic energy

16. State the theory of geocentric model of solar system? And by whom this was proposed.

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17. State the theory proposed by Copernicus?

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18. What did Galileo discover regarding gravitation?

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19. What does the law of period of Kepler's law imply?

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20. The gravitational force is always attractive in nature. Why?

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21. Why does the gravitational potential energy U(r) is always negative?

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22. What is 'retrograde motion' of planets?

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23. Find the distance between Venus and Sun.

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Short Answer Questions

1. Why the gravitational force between the Earth and the sun is so great while the same force between two small objects is negligible?

2. according to kinetic theory of gases, at absolute zero of temperature

    A. Water freezes

    B. liquid helium freezes

    C. motion of molecule stops

    D. liquid hydrogen feezes

Answer: c

3. Obtain an expression for Gravitational field intensity measured with an object of unit mass.

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4. State the important points to be remembered in gravitational field.

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5. When does the work done to be negative and positive?

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6. Determine gravitational potential from gravitational potential energy.

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7. Find the expression of the orbital speed of satellite revolving around the earth.

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8. Why do we have seasons on Earth?

Long Answer Questions

1. Explain the freely falling apple on Earth using the concept of gravitational potential V(r)?

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2. Derive the Relation between g and G .

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1. A geostationary satellite is orbiting the earth at a height of 5R above the surface of the earth, R being the radius of the earth. Find the time period of another satellite at a height of 2R from the surface of the earth.

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2. What will be the potential energy of a body of mass 67 kg at a distance of 6.6×10^{10} m from the centre of the earth? Find gravitational potential at

the earth? Find gravitational potential at this distance?

3. Two heavy spheres, each of mass 100kg and radius 0.8 m are placed 1m about on a table What is the gravitational force and potential at the mid point of the line joining the centres of the spheres ?

4. Find the period of oscillation of a simple pendulum of length L suspended from the roof of a vehicle

which moves without friction down an inclined plane of inclination α.

5. Imagine a light planet revolving around a massive star in a circular orbit of radius r with a period of revolution T. If the gravitaional force of attraction between planet and the star is proportional to $r^{-3/2}$, find the relation between $T \& r$.

6. The time period of a satellite of the earth is 5h. If the separation between the earth and the satellite is increased to 4 times the previous value, then what will be the new time period of the satellite acceleration to Kepler's law of period.

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Creative Questions Hots

1. A mass M is broken into two parts, m & (M-m). How is m related to M so that the gravitational force between two parts is maximum?

2. Draw graphs showing the variation of acceleration due to gravity with (i) height above the earth's surface.

3. Draw graphs showing the variation of acceleration due to gravity with (i) height above the earth's surface.

4. Suppose the gravititional force varies inversely as the nth power of distance then, find the expression for the time period of a planet in a circular orbit of radius r around the sun.

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5. A simple pendulum has a time peirod T_1 when on the earth's surface & T_2 when taken to a height & above the earth's surface, where R is the radius of the earth. What is the value of T_2/T_1?

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6. 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 $(R_{\text{earth}} = 6400km)$

7. The mass and diameter of a planet are twice those of the earth. What will be the time period of that pendulum on this planet which is a seconds pendulum on the earth.

8. An artificial satellite is moving in a circular or bit around the earth with a speed equal to half the magnitude of escape velocity from the earth (i) determine the height of the satellite above the earth's surface.

9. An artificial satellite is moving in a circular or bit around the earth with a speed equal to half the magnitude of escape velocity from the earth (ii) If the satellite is stopped suddenly in its orbit or allowed to fall freely on the earth, find the speed with which it

hits the surface of the earth take $g = 9.8 ms^{-2}$, radius of the earth = 6400 km.

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10. A particle is projected upward from the surface of the earth (radius) with a K.E. Equal to half the minimum value needed for it to escape. To which height, does it rise above the surface of earth?

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Value Based Questions

1. Jagaseesh was rotating a stone tied to an elastic rubber band. As time passes he kept on increasing its speed of rotation. As the speed increased, the length (i.e. radius) of the band was also increasing. His father Mr. Sridhar watched this and called Jagadeesh. When Jagadeesh came near by his father rotating the stone tied to the elastic band, he asked how this happened?

(i) State Keper's III law and give an expression.

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2. Jagaseesh was rotating a stone tied to an elastic rubber band. As time passes he kept on increasing its

speed of rotation. As the speed increased, the length (i.e. radius) of the band was also increasing. His father Mr. Sridhar watched this and called Jagadeesh. When Jagadeesh came near by his father rotating the stone tied to the elastic band, he asked how this happened?

(ii) What are Apogee and Perigee?

3. Following gases are kept at the same temperature. Which gas possesses maximum r.m.s. speed?

A. o

B. N

C. H

D. CO2

Answer: c

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4. Average kinetic energy of molecules is

A. Directly proportional to square root of
temperature

B. Directly proportional to absolute temperature

C. Independent of absolute temperature

D. Inversely proportional to absolute temperature

Answer: b

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