

11th Science Lesson 6 Questions in English

6] Gravitation

1. Which of these 17th century theory explained the motion of celestial and terrestrial objects?

- a) Atomic Theory
- b) Theory of Gravitation**
- c) Theory of Relativity
- d) Quantum Theory

Explanation

The 'Theory of Gravitation' was developed by Newton in the late 17th century to explain the motion of celestial objects and terrestrial objects and answer most of the queries raised. In spite of the study of gravitation and its effect on celestial objects, spanning last three centuries, "gravitation" is still one of the active areas of research in physics today.

2. For which of this discovery Albert Einstein was awarded Nobel Prize in 2017?

- a) Gravitational Waves**
- b) Plank's constant
- c) Earth distance from the Sun
- d) Solar system

Explanation

In 2017, the Nobel Prize in Physics was given for the detection of 'Gravitational waves' which was theoretically predicted by Albert Einstein in the year 1915.

3. Who was the first person to explain the geocentric model?

- a) Aristotle
- b) Claudius Ptolemy**
- c) Copernicus
- d) Albert Einstein

Explanation

In the second century, Claudius Ptolemy, a famous Greco-Roman astronomer, developed a theory to explain the motion of celestial objects like the Sun, the Moon, Mars, and Jupiter etc. This theory was called the geocentric model.

4. Choose the correct statements.

- i) The Earth is at the centre of the universe and all celestial objects orbit the earth except the Sun in the geocentric model.

- ii) Ptolemy's model does not match with the naked eye observations of Sky.
 - iii) Ptolemy's model did not explain the motion of Mars and Jupiter effectively.
- a) i only
 - b) ii only
 - c) iii only**
 - d) All the above

Explanation

According to the geocentric model, the Earth is at the centre of the universe and all celestial objects including the Sun, the Moon, and other planets orbit the Earth. Ptolemy's model closely matched with the observations of the sky with our naked eye. But later, astronomers found that even though Ptolemy's model successfully explained the motion of the Sun and the Moon up to a certain level, the motion of Mars and Jupiter could not be explained effectively.

5. In which century Nicholas Copernicus proposed the heliocentric model?

- a) 2nd century
- b) 15th century**
- c) 20th century
- d) 17th century

Explanation

In the 15th century, a Polish astronomer, Nicholas Copernicus (1473-1543) proposed a new model called the 'Heliocentric model'.

6. Which of the following is not correct regarding the heliocentric model?

- a) The Nicholas Copernicus proposed the heliocentric model was an American astronomer.**
- b) The Sun was considered to be at the centre of the solar system.
- c) All the planets orbited the Sun in circular orbits.
- d) Heliocentric model explained the motion of all celestial objects.

Explanation

A Polish astronomer, Nicholas Copernicus (1473-1543) proposed a new model heliocentric model. In the 'Heliocentric model' the Sun was considered to be at the centre of the solar system and all planets including the Earth orbited the Sun in circular orbits. This model successfully explained the motion of all celestial objects.

7. Who discovered that all objects are accelerated towards the Earth?

- a) Tycho
- b) Copernicus

c) Galileo

d) Kepler

Explanation

Around the same time, Galileo, a famous Italian physicist discovered that all objects close to Earth were accelerated towards the Earth at the same rate.

8. Whose observations were used to form the Kepler's law of planetary motion?

a) Tycho Brahe

b) Johannes Kepler

c) Albert Einstein

d) Nicholas Copernicus

Explanation

A noble man called Tycho Brahe (1546-1601) spent his entire lifetime in recording the observations of the stellar and planetary positions with his naked eye. The data that he compiled were analysed later by his assistant Johannes Kepler (1571-1630) and eventually the analysis led to the deduction of the laws of the planetary motion. These laws are termed as 'Kepler's laws of planetary motion'.

9. Which of these statements are not true regarding the Kepler's law of Orbits?

i) All the planets move around the Sun in an elliptical orbit.

ii) The Closest point of approach of the planet to the Sun foci is called as perihelion.

iii) Copernicus and Ptolemy considered the planets orbits to be elliptical around the Sun.

a) i only

b) ii only

c) iii only

d) None of the above

Explanation

Kepler's laws are stated as follows: Law of orbits: Each planet moves around the Sun in an elliptical orbit with the Sun at one of the foci. The closest point of approach of the planet to the Sun 'P' is called perihelion and the farthest point 'A' is called aphelion. The semi-major axis is 'a' and semi-minor axis is 'b'. In fact, both Copernicus and Ptolemy considered planetary orbits to be circular, but Kepler discovered that the actual orbits of the planets are elliptical.

10. Assertion (A): The Planets travel at varying speeds around the Sun to cover equal area in equal intervals of time.

Reasoning(R): The Sun is not at the centre of ellipse so the planets travel faster near the sun and slower when they are farther.

a) Both A and R is True and R is the correct explanation of A.

- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.
- d) Both A and R is False.

Explanation

The radial vector (line joining the Sun to a planet) sweeps equal areas in equal intervals of time. The white shaded portion is the area DA swept in a small interval of time Dt , by a planet around the Sun. Since the Sun is not at the centre of the ellipse, the planets travel faster when they are nearer to the Sun and slower when they are farther from it, to cover equal area in equal intervals of time. Kepler discovered the law of area by carefully noting the variation in the speed of planets.

11. Which of the following statement is not correct regarding the time period of revolution of a planet around the sun?

- a) The square of the revolution time is directly proportional to the cube of semi-major axis of the ellipse.
- b) The Planets revolve around the elliptical orbit of the Sun.
- c) The distance of the planet from the Sun and the time period of revolution vary at the same rate.
- d) The Distance of the planet from the Sun increases and the revolution time period decreases.**

Explanation

The square of the time period of revolution of a planet around the Sun in its elliptical orbit is directly proportional to the cube of the semi-major axis of the ellipse. It can be written as: where, T is the time period of revolution for a planet and a is the semi-major axis. Physically this law implies that as the distance of the planet from the Sun increases, the time period also increases but not at the same rate.

12. State the constant value relating Kepler's third law.

- a) T^5/a^4
- b) T^2/a^3**
- c) T^3/a^5
- d) T^2/a

Explanation

The time period of revolution of planets around the Sun along with their semi-major axes are given. We can realize that T^2/a^3 are nearly a constant endorsing Kepler's third law.

13. Which of the planet takes around 165 years around the Sun?

- a) Mars
- b) Neptune**
- c) Uranus

d) Jupiter

14. Identify the Incorrect Match of the Planet and the revolution time around the sun.

- A. Venus i) 0.615yrs
 B. Jupiter ii) 29.55yrs
 C. Uranus iii) 84yrs
 D. Mars iv) 1.88yrs

- a) i only
 b) ii only
 c) iii only
 d) iv only

Explanation

The time period of revolution of the planets revolving around the Sun and their semi-major axes.

Planet	a ($10^{10}m$)	T (years)	$\frac{T^2}{a^3}$
Mercury	5.79	0.24	2.95
Venus	10.8	0.615	3.00
Earth	15.0	1	2.96
Mars	22.8	1.88	2.98
Jupiter	77.8	11.9	3.01
Saturn	143	29.5	2.98
Uranus	287	84	2.98
Neptune	450	165	2.99

15. Which of these laws endorse the value of the T^2 / a^3 as constant?

- a) Kepler's third law
 b) Newton theory
 c) Gravitational theory
 d) None of the above

Explanation

The time period of revolution of planets around the Sun along with their semi-major axes are given. we can realize that T^2 / a^3 is nearly a constant endorsing Kepler's third law.

16. Which of the following person analysed the Kepler's law?

- a) Galileo
- b) Isaac Newton**
- c) Albert Einstein
- d) Copernicus

Explanation

Even though Kepler's laws were able to explain the planetary motion, they failed to explain the forces responsible for it. It was Isaac Newton who analysed Kepler's laws, Galileo's observations and deduced the law of gravitation.

17. Choose the Incorrect statements.

- i) Newton's law of gravitation states that any particle is attracted by other particle with an attractive force.
 - ii) The strength of the attraction force is directly proportional to the product of the masses.
 - iii) The Square of the distance between the particles is also directly varies proportional to the force of attraction.
- a) i only
 - b) ii only
 - c) iii only**
 - d) None of the above

Explanation

Newton's law of gravitation states that a particle of mass M_1 attracts any other particle of mass M_2 in the universe with an attractive force. The strength of this force of attraction was found to be directly proportional to the product of their masses and is inversely proportional to the square of the distance between them.

18. What is the value of the gravitational constant?

- a) $6.67 \times 10^{-10} \text{ Nm}^2\text{kg}$
- b) $6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$**
- c) $6.67 \times 10^{17} \text{ Nmkg}^{-2}$
- d) $6.67 \times 10^{-15} \text{ Nm}^2\text{kg}^{-2}$

Explanation

G is the Gravitational constant that has the value of $6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$

19. Which of this planet may experience less gravitational force from the sun?

- a) Earth
- b) Jupiter**

- c) Mercury
- d) Mars

Explanation

As the distance between two masses increases, the strength of the force tends to decrease because of inverse dependence on r^2 . Physically it implies that the planet Uranus experiences less gravitational force from the Sun than the Earth since Uranus is at larger distance from the Sun compared to the Earth.

20. Assertion (A): The reaction force is exerted by the Earth on the Sun is directed towards the Earth.
Reasoning(R): The gravitational forces between two particles always constitute an action-reaction pair.

- a) Both A and R is True and R is the correct explanation of A.
- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.
- d) Both A and R is False.

Explanation

The gravitational forces between two particles always constitute an action- reaction pair. It implies that the gravitational force exerted by the Sun on the Earth is always towards the Sun. The reaction-force is exerted by the Earth on the Sun. The direction of this reaction force is towards Earth.

21. Choose the Incorrect statements.

- i) The Earth's angular momentum about the Sun is constant throughout the motion.
 - ii) The torque experienced by the Earth due to gravitational force of the Sun is a constant scalar.
- a) i only
 - b) ii only**
 - c) Both i and ii
 - d) None of the above

Explanation

The torque experienced by the Earth due to the gravitational force of the Sun is given by L is a constant vector. The angular momentum of the Earth about the Sun is constant throughout the motion. It is true for all the planets. In fact, this constancy of angular momentum leads to the Kepler's second law.

22. Which of these assumptions is made to calculate the force between the Sun and the Earth?

- a) Earth and the Sun are point masses.**
- b) The mass of Earth is zero.

- c) Mass of the Sun is infinity.
d) All the above

Explanation

$$\vec{F} = -\frac{GM_1M_2}{r^2}\hat{r}$$

When it is said that Earth orbits around the Sun due to Sun's gravitational force, we assumed Earth and Sun to be point masses. This assumption is a good approximation because the distance between the two bodies is very much larger than their diameters. For some irregular and extended objects separated by a small distance, we cannot directly use the equation. Instead, we have to invoke separate mathematical treatment which will be brought forth in higher classes.

23. State the Newton's equation for the centripetal acceleration towards centre for the circular orbit?

- a) $a = v^3$
b) $a = -v^2 / r$
c) $a = v / r^2$
d) $a = v r$

Explanation

Newton considered the orbits of the planets as circular. For circular orbit of radius r , the centripetal acceleration towards the centre is ,

$$a = -\frac{v^2}{r}$$

Here v is the velocity and r , the distance of the planet from the center of the orbit.

24. Assertion (A): The shape of orbits of the planet around the Sun is elliptical.

Reasoning(R): The Planets orbit is very close to being circular as it has small deviation from the circular shape.

- a) Both A and R is True and R is the correct explanation of A.
b) Both A and R is True but R is not the correct explanation of A.
c) A is True but R is False.
d) Both A and R is False.

Explanation

We assumed that the orbit of the planet to be circular which is not true as the orbit of the planet around the Sun is elliptical. But this circular orbit assumption is justifiable because planet's orbit is very close to being circular and there is only a very small deviation from the circular shape.

25. Who measured the distance between the Earth and the Moon?

- a) **Hipparchrus**
- b) Eratosthenes
- c) Copernicus
- d) Kepler

Explanation

The radius of the Earth was measured by Greek librarian Eratosthenes and distance between the Earth and the Moon was measured by Greek astronomer Hipparchrus 2400 years ago.

26. Assertion (A): The Value of gravitational constant plays an important role in the law of gravitation.

Reasoning(R): The Value of G explains the gravitational force between the Earth and the Sun is so great and between small objects is negligible.

- a) **Both A and R is True and R is the correct explanation of A.**
- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.
- d) Both A and R is False.

Explanation

In the law of gravitation, the value of gravitational constant G plays a very important role. The value of G explains why the gravitational force between the Earth and the Sun is so great while the same force between two small objects (for example between two human beings) is negligible.

27. Who discovered the experimental value of the gravitational constant?

- a) Kepler
- b) **Henry Cavendish**
- c) Copernicus
- d) Isaac Newton

Explanation

In the year 1798, Henry Cavendish experimentally determined the value of gravitational constant 'G' by using a torsion balance. He calculated the value of 'G' to be equal to $6.75 \times 10^{-11} \text{Nm}^2 \text{kg}^{-2}$.

28. What is the exact accepted value of the gravitational constant?

- a) $66.672 \times 10^{-11} \text{Nmkg}^{-2}$
- b) **$6.67259 \times 10^{-11} \text{Nm}^2\text{kg}^{-2}$**
- c) 6.67259×10^5
- d) $12.663 \times 10^{-11} \text{Nm}^2\text{kg}^{-2}$.

Explanation

Using modern techniques a more accurate value of G could be measured. The currently accepted value of G is $6.67259 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$.

29. Based on which property the forces are classified?

a) Type of interaction

- b) Movement of object
- c) Type of objects
- d) Number of forces involved

Explanation

Force is basically due to the interaction between two particles. Depending upon the type of interaction we can have two kinds of forces: Contact forces and Non-contact forces.

30. Assertion (A): Contact forces are applied to object in physical contact with the other object.

Reasoning(R): The movement of the object is caused by the physical force exerted through the contact.

a) Both A and R is True and R is the correct explanation of A.

- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.
- d) Both A and R is False.

Explanation

Contact forces are the forces applied where one object is in physical contact with the other. The movement of the object is caused by the physical force exerted through the contact between the object and the agent which exerts force.

31. Assertion (A): The magnitude of E decreases as the distance increases.

Reasoning(R): The strength of gravitational field decreases as we move away from the mass.

a) Both A and R is True and R is the correct explanation of A.

- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.
- d) Both A and R is False.

Explanation

The strength of the gravitational field decreases as we move away from the mass M as depicted. The magnitude of \vec{E} decreases as the distance r increases.

32. Which of this physical quantity carries energy and momentum in space?

- a) Field
- b) Space
- c) Charge
- d) Quantum

Explanation

The “field” concept was introduced as a mathematical tool to calculate gravitational interaction. Later it was found that field is a real physical quantity and it carries energy and momentum in space. The concept of field is inevitable in understanding the behaviour of charges.

33. Which of the following has the unit Newton per kilogram?

- a) Gravity
- b) Gravitational field**
- c) Gravitational intensity
- d) Gravity constant

Explanation

The unit of gravitational field is Newton per kilogram (N/kg) or $m\ s^{-2}$.

34. Choose the correct statements.

- i) The superposition principle of gravitational fields involves the vector sum of the entire gravitational field due to individual masses.
- ii) The total gravitational field at a point is irrespective of all the individual masses.

- a) i only**
- b) ii only
- c) Both i and ii
- d) Neither i nor ii

Explanation

Consider ‘n’ particles of masses m_1, m_2, \dots, m_n distributed in space at position r_1, r_2, \dots, r_n with respect to point P. The total gravitational field at a point P due to all the masses is given by the vector sum of the gravitational field due to the individual masses. This principle is known as superposition of gravitational fields.

35. Assertion (A): The gravitational potential energy is always a negative value.

Reasoning(R): The system does the work when two masses come together from infinity.

- a) Both A and R is True and R is the correct explanation of A.**
- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.

d) Both A and R is False.

Explanation

The gravitational potential energy U_r - is always negative because when two masses come together slowly from infinity, work is done by the system.

36. Choose the correct statements.

- i) The unit of gravitational potential energy is Joule / s which are a vector quantity.
- ii) The gravitational potential energy depends on the masses and the distance between the masses.

a) i only

b) ii only

c) Both i and ii

d) Neither i nor ii

Explanation

The unit of gravitational potential energy U_r - is Joule and it is a scalar quantity. The gravitational potential energy depends upon the two masses and the distance between them.

37. State the gravitational potential energy of a system with two masses m_1 and m_2 and the distance between that is r .

a) $-G m_1 m_2 / r$

b) $G m_1 m_2 + r$

c) $G m_1 m_2 r$

d) $G m_1 m_2 / r^2$

Explanation

We can define gravitational potential energy of a system of two masses m_1 and m_2 separated by a distance r as the amount of work done to take the mass m_2 from a distance r to infinity assuming m_1 to be fixed in its position and is written as,

$$U(r) = -\frac{Gm_1m_2}{r}$$

38. Which of the following value is responsible for the gravitational field?

a) Number of source

b) Forces

c) Source mass

d) Distance between the objects

Explanation

The gravitational field \vec{E} depends only on the source mass which creates the field. It is a vector quantity. We can also define a scalar quantity called "gravitational potential" which depends only on the source mass.

39. What is the unit of the gravitational potential?

- a) J s
- b) J kg⁻¹**
- c) J / s
- d) J

Explanation

The gravitational potential at distance r is equivalent to gravitational potential energy per unit mass at the same distance r . It is a scalar quantity and its unit is J kg⁻¹.

40. Choose the Incorrect statements.

- i) The Gravitational field and gravitational force are vector quantities.
 - ii) The gravitational potential and gravitational potential energy are scalar quantities.
 - iii) The Vector quantities are used for easy analyses of the motion of particles.
- a) i only
 - b) ii only
 - c) iii only**
 - d) None of the above

Explanation

Gravitational field and gravitational force are vector quantities whereas the gravitational potential and gravitational potential energy are scalar quantities. The motion of particles can be easily analysed using scalar quantities than vector quantities.

41. Assertion (A): The gravitation pull produces a constant acceleration in all the bodies near the Earth's surface.

Reasoning(R): Newton's second law states that an object is accelerated only under the action of a force.

- a) Both A and R is True and R is the correct explanation of A.**
- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.
- d) Both A and R is False.

Explanation

When objects fall on the Earth, the acceleration of the object is towards the Earth. From Newton's second law, an object is accelerated only under the action of a force. In the case of Earth, this force is the gravitational pull of Earth. This force produces a constant acceleration near the Earth's surface in all bodies, irrespective of their masses.

42. Which of this value does not depend on the gravitational force exerted by earth near its surface?

- a) Mass of the Earth
- b) Radius of the Earth
- c) Distance between the object and the Earth**
- d) Mass of the object

Explanation

The gravitational force exerted by Earth on the mass m near the surface of the Earth is given by,

$$F = -\frac{GM_E m}{R_E^2}$$

M_E - mass of the Earth, m -mass of the object, R_E - radius of the Earth.

43. What is the magnitude of the earth's gravity?

- a) $G M_e / R_e^2$**
- b) $G M_e^3 / R_e^3$
- c) $G M_e^2 / R_e$
- d) $G M_e / R_e$

Explanation

The acceleration experienced by the object near the surface of the Earth due to its gravity is called acceleration due to gravity. It is denoted by the symbol g . The magnitude of acceleration due to gravity is g ,

$$|g| = \frac{GM_e}{R_e^2}$$

44. Which of this factor does not depend on the mass of an object?

- a) Acceleration due to gravity**
- b) Kinetic energy
- c) Frictional forces
- d) All the above

Explanation

It is to be noted that the acceleration experienced by any object is independent of its mass. The value of g depends only on the mass and radius of the Earth. In fact Galileo arrived at the same conclusion 400 years ago that all objects fall towards the Earth with the same acceleration through various quantitative experiments.

45. What is the value of the acceleration due to gravity near Earth equator?

- a) 19.8 m s
- b) 12.8 ms⁻²
- c) 9.8 m s⁻²**
- d) 6.6 m

Explanation

The acceleration due to gravity g is found to be 9.8 m s⁻² on the surface of the Earth near the equator.

46. Choose the correct statements.

- i) The Earth's centrifugal force depends on the revolution time.
 - ii) The objects on earth's surface experiences only the centrifugal force of earth's spinning.
 - iii) The centrifugal force on objects on the surface of the Earth depends on the latitude of the object.
- a) i only
 - b) ii only
 - c) iii only**
 - d) All the above

Explanation

Whenever we analyse the motion of objects in rotating frames we must take into account the centrifugal force. Even though we treat the Earth as an inertial frame, it is not exactly correct because the Earth spins about its own axis. So when an object is on the surface of the Earth, it experiences a centrifugal force that depends on the latitude of the object on Earth. If the Earth were not spinning, the force on the object would have been mg . However, the object experiences an additional centrifugal force due to spinning of the Earth.

47. Which of this value is represented by the symbol λ in the centrifugal force of an object?

- a) Wavelength
- b) Latitude**
- c) Mass
- d) Length

Explanation

This centrifugal force is given by $m\omega^2 R'$. $R' = R \cos \lambda$ where λ is the latitude. The component of centrifugal acceleration experienced by the object in the direction opposite to g .

48. At which of the following places the acceleration due to gravity is minimum?

- a) North Pole
- b) Earth's atmosphere
- c) South Pole
- d) Equator**

Explanation

$$g' = g - \omega^2 R \cos^2 \lambda$$

From the above equation of we can infer that at equator, $\lambda = 0$; $g' = g - \omega^2 R$. The acceleration due to gravity is minimum. At poles $\lambda = 90$; $g' = g$, it is maximum. At the equator, g' is minimum.

49. Which of the following is mainly found in earth's atmosphere?

- a) Oxygen**
- b) Hydrogen
- c) Helium
- d) Argon

Explanation

Hydrogen and helium are the most abundant elements in the universe but Earth's atmosphere consists mainly of nitrogen and oxygen.

50. Which of these molecules easily escape from the earth surface?

- a) Nitrogen
- b) Hydrogen**
- c) Helium
- d) Carbon dioxide

Explanation

Lighter molecules such as hydrogen and helium have enough speed to escape from the Earth unlike the heavier ones such as nitrogen and oxygen. The average speed of hydrogen and helium atoms compared with the escape speed of the Earth is presented in the kinetic theory of gases.

51. What is the value of the distance covered by the satellite during one rotation in the orbit?

- a) $R_E h$
- b) $2\pi R_E h$**

- c) $2\pi R$
d) $2R_E$

Explanation

Time period of the satellite: The distance covered by the satellite during one rotation in its orbit is equal to $2\pi R_E$ and time taken for it is the time period, T . Then Speed v Distance travelled Time taken

$$\text{Speed } v = \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{2\pi(R_E + h)}{T}$$

52. What is the value of the total energy of a satellite orbiting the earth?

- a) Kinetic energy of the Satellite
b) Gravitational potential energy
c) Earth's Magnetic energy

d) Both a and b

Explanation

The total energy of a satellite orbiting the Earth at a distance h from the surface of Earth is calculated as follows; the total energy of the satellite is the sum of its kinetic energy and the gravitational potential energy.

53. In which of this condition a satellite is free from the Earth's gravity?

- a) h approaches ∞**
b) h approaches 0
c) h is maximum
d) None of the above

Explanation

The total energy of the satellite orbiting the Earth at a height of h is,

$$E = -\frac{GM_s M_E}{2(R_E + h)}$$

The negative sign in the total energy implies that the satellite is bound to the Earth and it cannot escape from the Earth. As h approaches ∞ , the total energy tends to zero. Its physical meaning is that the satellite is completely free from the influence of Earth's gravity and is not bound to Earth at large distances.

54. What is the value of h for the geo-stationary satellite?

- a) 24 km
- b) 86400 km
- c) 36000 km**
- d) 100000 km

Explanation

Kepler's third law is used to find the radius of the orbit.

$$T^2 = \frac{4\pi^2}{GM_E} (R_E + h)^3$$

$$(R_E + h)^3 = \frac{GM_E T^2}{4\pi^2}$$

$$R_E + h = \left(\frac{GM_E T^2}{4\pi^2} \right)^{1/3}$$

Substituting for the time period (24 hrs = 86400 seconds), mass, and radius of the Earth, h turns out to be 36,000 km. Such satellites are called "geo-stationary satellites", since they appear to be stationary when seen from Earth.

55. Which of the following statements are not true regarding the Polar satellites?

- a) The polar satellites orbits earth from South Pole to North Pole.**
- b) The time period of a polar satellite is about 100 minutes.
- c) The Polar satellites cover different small strips of earth area in each revolution.
- d) Polar satellites cover only a small strip of area from pole to pole during one revolution.

Explanation

Earth orbits the Earth from north to south direction. This type of satellite that orbits Earth from North Pole to South Pole is called a polar satellite. The time period of a polar satellite is nearly 100 minutes and the satellite completes many revolutions in a day. A Polar satellite covers a small strip of area from pole to pole during one revolution. In the next revolution it covers a different strip of area since the Earth would have moved by a small angle. In this way polar satellites cover the entire surface area of the Earth.

56. Choose the correct statements.

- i) All the objects anywhere in the solar system experience the gravitational force.
 - ii) The Earth gravitational force acts downwards towards the centre of the earth.
 - iii) There are number of forces acting on us when we stand on the floor in earth surface.
- a) i only
 - b) ii only**

- c) iii only
- d) All the above

Explanation

Objects on Earth experience the gravitational force of Earth. The gravitational force acting on an object of mass m is mg . This force always acts downwards towards the centre of the Earth. When we stand on the floor, there are two forces acting on us. One is the gravitational force, acting downwards and the other is the normal force exerted by the floor upwards on us to keep us at rest.

57. Assertion (A): The weight of an object is defined as the upward force with magnitude W is equal to the force.

Reasoning(R): Weight of an object is the upward force applied to hold it at rest or at constant velocity relative to earth.

- a) Both A and R is True and R is the correct explanation of A.
- b) Both A and R is True but R is not the correct explanation of A.
- c) A is False but R is True.**
- d) Both A and R is False.

Explanation

The weight of an object W is defined as the downward force whose magnitude W is equal to that of upward force that must be applied to the object to hold it at rest or at constant velocity relative to the earth.

58. In which of this direction normal object weight is directed?

- a) Upward force
- b) Linear force
- c) Gravitational force**
- d) Momentum

Explanation

The direction of weight is in the direction of gravitational force. So the magnitude of weight of an object is denoted as, $W=N=mg$

59. Choose the Incorrect statements.

- i) A man standing in an elevator experiences two kinds of forces.
 - ii) Gravitational force on the man in an elevator is acting downwards to the ground.
 - iii) The Normal force exerted by the floor also acts downwards to the man in an elevator.
- a) i only
 - b) ii only

c) iii only

d) None of the above

Explanation

When a man is standing in the elevator, there are two forces acting on him.

1. Gravitational force which acts downward. If we take the vertical direction as positive y direction, the gravitational force acting on the man is

$$\vec{F}_G = -mg\hat{j}$$

2. The normal force exerted by floor on the man which acts vertically upward,

$$\vec{N} = N\hat{j}$$

60. Assertion (A): The Astronauts in the satellites do not experience any gravitational force due to the distance from the earth.

Reasoning(R): The Satellites orbit very close to Earth experience only gravitational force.

a) Both A and R is True and R is the correct explanation of A.

b) Both A and R is True but R is not the correct explanation of A.

c) A is True but R is False.

d) Both A and R is False.

Explanation

There is a wrong notion that the astronauts in satellites experience no gravitational force because they are far away from the Earth. Actually the Earth satellites that orbit very close to Earth experience only gravitational force. The astronauts inside the satellite also experience the same gravitational force. Because of this, they cannot exert any force on the floor of the satellite. Thus, the floor of the satellite also cannot exert any normal force on the astronaut. Therefore, the astronauts inside a satellite are in the state of weightlessness. Not only the astronauts, but all the objects in the satellite will be in the state of weightlessness which is similar to that of a free fall.

61. Towards which of this direction the planets move in the retrograde motion?

a) West

b) North

c) East

d) South

Explanation

When the motion of the planets are observed in the night sky by naked eyes over a period of a few months, it can be seen that the planets move eastwards and reverse their motion for a while and return to eastward motion again. This is called “retrograde motion” of planets.

62. From which month the Mars changes its direction from retrograde motion?

- a) July
- b) October**
- c) September
- d) June

Explanation

Careful observation for a period of a year clearly shows that Mars initially moves eastwards (February to June), then reverses its path and moves backwards (July, August, September). It changes its direction of motion once again and continues its forward motion (October onwards).

63. Which of the following concept was introduced by Ptolemy to explain the retrograde motion of the planets?

- a) Gravitational constant
- b) Eclipse
- c) Geo-stationary
- d) Epicycle**

Explanation

To explain this retrograde motion, Ptolemy introduced the concept of “epicycle” in his geocentric model. According to this theory, while the planet orbited the Earth, it also underwent another circular motion termed as “epicycle”.

64. Choose the incorrect statements.

- i) The retrograde motion of the planets is a combination of epicycle and circular motion around the Earth.
 - ii) The Earth centric idea was introduced by Aristotle.
 - iii) Ptolemy’s model was very simple as every planet undergoes the retrograde motion.
- a) i only
 - b) ii only
 - c) iii only**
 - d) None of the above

Explanation

A combination of epicycle and circular motion around the Earth gave rise to retrograde motion of the planets with respect to Earth. Essentially Ptolemy retained the Earth centric idea of Aristotle and added the epicycle motion to it. Ptolemy's model became more and more complex as every planet was found to undergo retrograde motion.

65. Which of these is the centre of the solar system according to the heliocentric model of Copernicus?

- a) Earth
- b) Sun**
- c) Mars
- d) Jupiter

Explanation

In the 15th century, the Polish astronomer Copernicus proposed the heliocentric model to explain this problem in a simpler manner. According to this model, the Sun is at the centre of the solar system and all planets orbited the Sun. The retrograde motion of planets with respect to Earth is because of the relative motion of the planet with respect to Earth.

66. Choose the correct statements.

- i) Copernicus explained the retrograde motion of the Mars and Earth only.
 - ii) The Mars orbits around the Sun faster than the Earth.
 - iii) Mars appears to move backwards from July to October because of the relative motion of the Earth and Mars.
- a) i only
 - b) ii only
 - c) iii only**
 - d) All the above

Explanation

The Earth orbits around the Sun faster than Mars. Because of the relative motion between Mars and Earth, Mars appears to move backwards from July to October. In the same way the retrograde motion of all other planets was explained successfully by the Copernicus model.

67. What is the advantage of the heliocentric model?

- a) Simple model**
- b) Accurate results
- c) Explained all the forces involved
- d) All the above

Explanation

It was because of its simplicity, the heliocentric model slowly replaced the geocentric model. Historically, if any natural phenomenon has one or more explanations, the simplest one is usually accepted.

68. Which of the following statement is not true?

- a) Kepler relied on Tycho Brahe's astronomical observations for his laws.
- b) Kepler's third law related the distances of a planet from the Sun to its revolution period.
- c) The distance of the planet from the Sun is calculated in terms of the distance between Earth and the Sun.
- d) The Astronomers used complex algorithms and calculations to calculate the distance of a planet from the Sun.**

Explanation

When Kepler derived his three laws, he strongly relied on Tycho Brahe's astronomical observation. In his third law, he formulated the relation between the distances of a planet from the Sun to the time period of revolution of the planet. Astronomers cleverly used geometry and trigonometry to calculate the distance of a planet from the Sun in terms of the distance between Earth and Sun.

69. What is the distance between the Earth and the Sun?

- a) One Astronomical Unit**
- b) One Light year
- c) One Parsec
- d) One Solar Mass

Explanation

When Venus is at maximum elongation (i.e., 46 degree) with respect to Earth, Venus makes 90 degree to Sun. This allows us to find the distance between Venus and Sun. The distance between Earth and Sun is taken as one Astronomical unit (1 AU).

70. Which of the following planets have the highest value of the semi major axis of the orbit from the Sun?

- a) Mars
- b) Earth
- c) Jupiter**
- d) Venus

71. Identify the Incorrect Match.

PLANETS TIME PERIOD

- A. Saturn i) 4332.62

- B. Mercury ii) 87.77
 C. Venus iii) 224.70
 D. Mars iv) 686.98

a) i only

b) ii only

c) iii only

d) iv only

Explanation

The distances of planets from the Sun are given in the table below.

Planet	semi major axis of the orbit(a)	Period T (days)	a^3/T^2
Mercury	0.389 AU	87.77	7.64
Venus	0.724 AU	224.70	7.52
Earth	1.000 AU	365.25	7.50
Mars	1.524 AU	686.98	7.50
Jupiter	5.200 AU	4332.62	7.49
Saturn	9.510 AU	10,759.20	7.40

72. Which of these values denotes the difference in sun ray shadow due to the curvature of the Earth?

- a) 7.5 degree
b) 1/ 8 radian
 c) 0.75 degree
 d) 1/ 18 radian

Explanation

During noon time of summer solstice the Sun's rays cast no shadow in the city Syne which was located 500 miles away from Alexandria. At the same day and same time he found that in Alexandria the Sun's rays made 7.2 degree with local vertical. This difference of 7.2 degree was due to the curvature of the Earth. The angle 7.2 degree is equivalent to 1/8radian. So $\theta = 1/8 \text{ rad}$;

73. In which colour the moon will appear inside the umbra shadow?

- a) Yellow
 b) Blue

- c) Red
- d) Black

Explanation

When the Moon is inside the umbra shadow, it appears red in colour. As soon as the Moon exits from the umbra shadow, it appears in crescent shape.

74. Assertion (A): During the lunar eclipse the orbits of the Moon and Earth lie on the same plane on full moon day.

Reasoning(R): The Solar eclipse is observed during the new moon day.

- a) **Both A and R is True and R is the correct explanation of A.**
- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.
- d) Both A and R is False.

Explanation

If the orbits of the Moon and Earth lie on the same plane, during full Moon of every month, we can observe lunar eclipse. If this is so during new Moon we can observe solar eclipse.

75. Why Solar and Lunar eclipse occur only during certain periods of the year?

- a) The earth revolution on its own axis.
- b) **The Orbit of Moon is tilted for 5° with respect to the Earth's orbit.**
- c) The Gravitation field of the Earth and Moon are different.
- d) Planets have different rotation period with respect to Earth.

Explanation

Moon's orbit is tilted 5° with respect to Earth's orbit. Due to this 5° tilt, only during certain periods of the year, the Sun, Earth and Moon align in straight line leading to either lunar eclipse or solar eclipse depending on the alignment.

76. Assertion (A): The Northern and the Southern part of the Earth experiences seasonal changes depending on the distance from the Sun.

Reasoning(R): The seasons in the Earth arise due to the rotation of the Earth around the Sun with 23.5° tilt.

- a) **Both A and R is True and R is the correct explanation of A.**
- b) Both A and R is True but R is not the correct explanation of A.
- c) A is True but R is False.
- d) Both A and R is False.

Explanation

The seasons in the Earth arise due to the rotation of Earth around the Sun with 23.5° tilt. Due to this 23.5° tilt, when the northern part of Earth is farther to the Sun, the southern part is nearer to the Sun. So when it is summer in the northern hemisphere, the southern hemisphere experiences winter.

77. Which of these can be explained by the spinning motion of Earth?

- a) Sun light radiation
- b) Solar eclipse
- c) Position of Stars**
- d) Planets movement

Explanation

The Earth's spinning motion can be proved by observing a star's position over a night. Due to Earth's spinning motion, the stars in the sky appear to move in circular motion about the pole star.

78. Name the pole star of the Earth.

- a) Polaris**
- b) Alpha Pictoris
- c) Delta Doradus
- d) Draconis

Explanation

Pole star is a star located exactly above the Earth's axis of rotation hence it appears to be stationary. The Star Polaris is our pole star.

79. Choose the incorrect statements.

- i) The Electromagnetic spectrum was discovered at the end of the 19th century.
 - ii) Newton's law of gravitation was able to explain the entire phenomenon related to gravity.
 - iii) Albert Einstein's General relativity theory was the most successful theory in the 20th century.
- a) i only
 - b) ii only**
 - c) iii only
 - d) None of the above

Explanation

After the discovery of the electromagnetic spectrum at the end of the 19th century, our understanding of the universe increased enormously. Because of this development in the late 19th century it was found that Newton's law of gravitation could not explain certain phenomena and showed some discrepancies. Albert Einstein formulated his 'General theory of relativity' which was one of the most successful theories of 20th century in the field of gravitation.

80. For which of the following theories Subramanian Chandrasekhar was awarded Nobel Prize in the year 1983?

- a) **Black hole theory**
- b) Gravitational theory
- c) Big Bang theory
- d) Quantum field theory

Explanation

Subramanian Chandrasekhar formulated the theory of black holes and explained the life of stars. These studies brought him the Nobel Prize in the year 1983. Another very notable Indian astrophysicist Meghnad Saha discovered the ionization formula which was useful in classifying stars. This formula is now known as "Saha ionization formula".

81. Choose the correct statements.

- i) Amal Kumar Raychaudhuri solved an equation, Raychaudhuri equation in the field of gravitation.
 - ii) The Astrophysicist Jayant V Narlikar wrote books on astronomy and astrophysics.
- a) i only
 - b) ii only
 - c) **Both i and ii**
 - d) Neither i nor ii

Explanation

In the field of gravitation Amal Kumar Raychaudhuri solved an equation now known as "Raychaudhuri equation" which was a very important contribution. Another notable Indian Astrophysicist Jayant V Narlikar made pioneering contribution in the field of astrophysics and has written interesting books on astronomy and astrophysics.

82. Who founded the Inter University Centre for Astronomy and Astrophysics, India?

- a) Homi Jahangir Bhabha
- b) **J.V. Narlikar**
- c) Jagadish Chandra Bose
- d) C.V. Raman

Explanation

IUCAA (Inter University Centre for Astronomy and Astrophysics) is one of the important Indian research institutes where active research in astrophysics and gravitation are conducted. The institute was founded by Prof. J.V. Narlikar. Students are encouraged to read more about the recent developments in these fields.