Gravitation JEE Main PYQ - 2

Total Time: 1 Hour : 15 Minute **Total Marks:** 120

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Gravitation

1. Match the LIST-I with LIST-II (+4, -1)

LIST-I	LIST-II
A. Gravitational constant	I. $[LT^{-2}]$
B. Gravitational potential energy	II. $[L^2T^{-2}]$
C. Gravitational potential	III. $[ML^2T^{-2}]$
D. Acceleration due to gravity	IV. $[M^{-1}L^3T^{-2}]$

Choose the correct answer from the options given below:

a. A-IV, B-III, C-II, D-I

b. A-III, B-II, C-I, D-IV

c. A-II, B-IV, C-III, D-I

d. A-I, B-III, C-IV, D-II

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2. **The radii of two planets 'A' and 'B' are 'R' and '4R' and their densities are ρ and $\frac{\rho}{3}$ respectively. The ratio of acceleration due to gravity at their surfaces (i.e. $g_A : g_B$) will be:** (+4, -1)

a. 1:16

b. 3:16

c. 3:4

d. 4:3

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3. **Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):** \begin{itemize} \item[(A)] A simple pendulum is taken to a planet of mass and radius, 4 times and 2 times, respectively, than the Earth. The time period of the pendulum remains same on earth and the planet. \item[(R)] The mass of the pendulum remains unchanged at Earth and the other planet. \end{itemize} **In light of the above statements, choose the correct answer from the options given below:** (+4, -1)

a. (A) is false, but (R) is true.

b. Both (A) and (R) are true and (R) is the correct explanation of (A).

c. (A) is true but (R) is false.

d. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).

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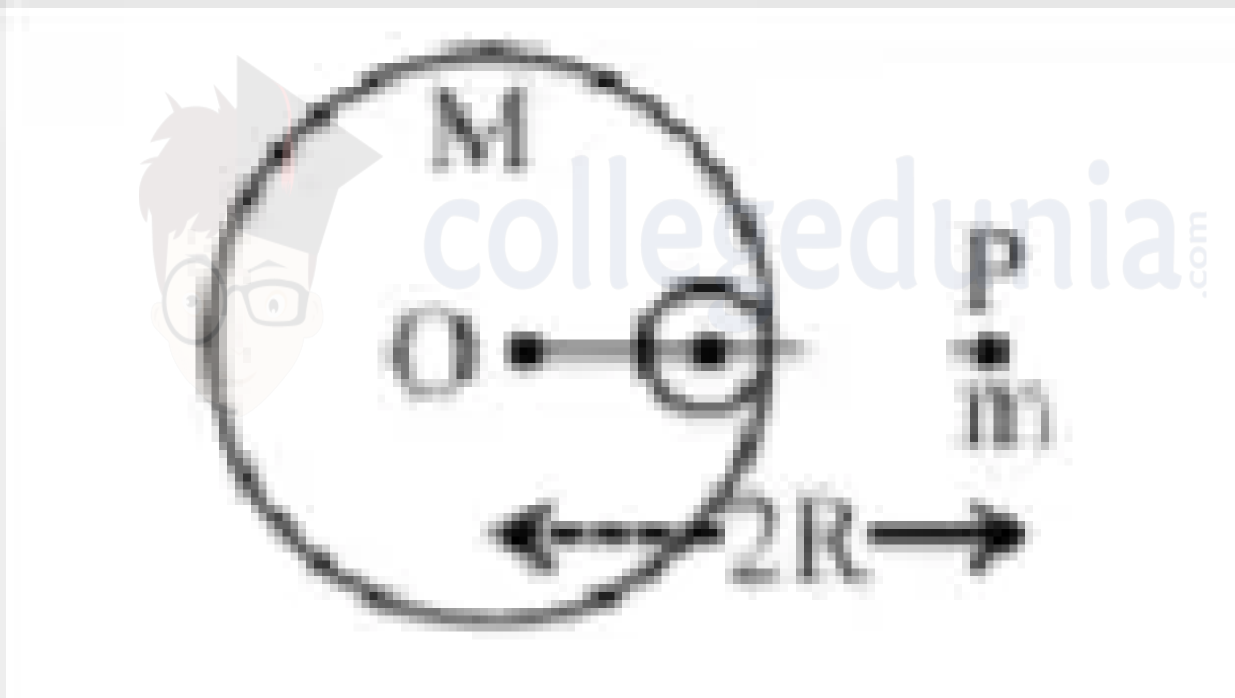
4. A small point of mass m is placed at a distance $2R$ from the center O of a big uniform solid sphere of mass M and radius R. The gravitational force on m due to M is F_1. A spherical part of radius $R/3$ is removed from the big sphere as shown in the figure, and the gravitational force on m due to the remaining part of M is found to be F_2. The value of the ratio $F_1 : F_2$ is: **(+4, -1)**



a. 16 : 9

b. 11 : 10

c. 12 : 11

d. 12 : 9

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5. **Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):** **(+4, -1)**
(A) ***A simple pendulum is taken to a planet of mass and radius, 4 times and 2 times, respectively, than the Earth. The time period of the pendulum remains same on earth and the planet.***
(R) ***The mass of the pendulum remains unchanged at Earth and the other planet.***
In light of the above statements, choose the correct answer from the options given below:

a. (A) is false, but (R) is true.

b. Both (A) and (R) are true and (R) is the correct explanation of (A).

c. (A) is true but (R) is false.

d. Both (A) and (R) are true, but (R) is NOT the correct explanation of (A).

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6. A light planet is revolving around a massive star in a circular orbit of radius R with a period of revolution T. If the force of attraction between the planet and the star is proportional to $R^{-\frac{3}{2}}$, then choose the correct option: **(+4, -1)**

a. $T^2 \propto R^{5/2}$

b. $T^2 \propto R^{7/2}$

c. $T^2 \propto R^{3/2}$

d. $T^2 \propto R^3$

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7. Assuming the earth to be a sphere of uniform mass density, a body weighed 300 N on the surface of earth. How much it would weigh at R/4 depth under surface of earth ? **(+4, -1)**

a. 75 N

b. 375 N

c. 300 N

d. 225 N

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8. A satellite revolving around a planet in stationary orbit has time period 6 hours. The mass of planet is one-fourth the mass of earth. The radius orbit of planet is: (Given = Radius of geostationary orbit for earth is 4.2×10^4 km **(+4, -1)**

a. 1.4×10^4 km

b. 8.4×10^1 km

c. 1.68×10^5 km

d. 1.05×10^4 km

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9. Two planets A and B having masses m_1 and m_2 move around the sun in circular orbits of r_1 and r_2 radii, respectively. If the angular momentum of A is L and that of B is $3L$, the ratio of time periods $\frac{T_A}{T_B}$ is: **(+4, -1)**

a. $\left(\frac{r_2}{r_1}\right)^{\frac{3}{2}}$

b. $\left(\frac{r_1}{r_2}\right)^3$

c. $\frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$

d. $27\left(\frac{m_1}{m_2}\right)^3$

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10. Two satellites A and B go round a planet in circular orbits having radii $4R$ and R respectively. If the speed of A is $3v$, the speed of B will be: **(+4, -1)**

a. $\frac{4}{3}v$

b. $3v$

c. $6v$

d. $12v$

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11. An astronaut takes a ball of mass m from earth to space. He throws the ball into a circular orbit about earth at an altitude of 318.5 km. From earth's surface to the orbit, the change in total mechanical energy of the ball is $x\frac{GM_em}{21R_e}$. The value of x is (take $R_e = 6370\,\text{km}$): **(+4, -1)**

a. 11

b. 9

c. 12

d. 10

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12. Match list-I with list-II: **(+4, -1)**

List-I	List-II
(A) Kinetic energy of planet	$-\frac{GMm}{a}$
(B) Gravitational Potential energy of Sun-planet system	$-\frac{GMm}{2a}$
(C) Total mechanical energy of planet	$\frac{GM}{r}$
(D) Escape energy at the surface of planet for unit mass object	$-\frac{GMm}{2a}$

(Where a = radius of planet orbit, r = radius of planet, M = mass of Sun, m = mass of planet) Choose the correct answer from the options given below:

a. (A) – II, (B) – I, (C) – IV, (D) – III

b. (A) – III, (B) – IV, (C) – I, (D) – II

c. (A) – I, (B) – IV, (C) – II, (D) – III

d. (A) – I, (B) – II, (C) – III, (D) – IV

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13. A point source is emitting sound waves of intensity $16 \times 10^{-8}\,Wm^{-2}$ at the origin. The difference in intensity (magnitude only) at two points located at distances of 2 m and 4 m from the origin respectively will be _____ $\times 10^{-8}\,Wm^{-2}$. **(+4, -1)**

14. A metal wire of uniform mass density having length L and mass M is bent to form a semicircular arc and a particle of mass m is placed at the centre of the arc. The gravitational force on the particle by the wire is: **(+4, -1)**

a. $\frac{GmM\pi}{2L^2}$

b. 0

c. $\frac{GmM\pi^2}{L^2}$

d. $\frac{2GmM\pi}{L^2}$

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15. Escape velocity of a body from earth is 11.2 km/s. If the radius of a planet be one-third the radius of earth and mass be one-sixth that of earth, the escape velocity from the planet is: **(+4, -1)**

a. 11.2 km/s

b. 8.4 km/s

c. 4.2 km/s

d. 7.9 km/s

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16. Four identical particles of mass m are kept at the four corners of a square. If the gravitational force exerted on one of the masses by the other masses is **(+4, -1)**

$$\left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2},$$

the length of the sides of the square is:

a. $\frac{L}{2}$

b. 4L

c. 3L

d. 2L

17. If R is the radius of the earth and the acceleration due to gravity on the surface of the earth is $g = \pi^2 \mathrm{~m/s}^2$, then the length of the second's pendulum at a height $h = 2R$ from the surface of the earth will be: (+4, -1)

a. $\frac{2}{9} \mathrm{~m}$

b. $\frac{1}{9} \mathrm{~m}$

c. $\frac{4}{9} \mathrm{~m}$

d. $\frac{8}{9} \mathrm{~m}$

18. A planet takes 200 days to complete one revolution around the Sun. If the distance of the planet from Sun is reduced to one fourth of the original distance, how many days will it take to complete one revolution ? (+4, -1)

a. 25

b. 50

c. 100

d. 20

19. The correct relation between kinetic energy (K.E) and total energy (T.E) of a satellite orbiting around the planet is (+4, -1)

a. $K.E = |T.E|$

b. $K.E = 2|T.E|$

c. $K.E = \frac{|T.E|}{2}$

d. $|T.E| = 3K.E$

20. The radii of two planets 'A' and 'B' are 'R' and '4R' and their densities are ρ and $\frac{\rho}{3}$ respectively. The ratio of acceleration due to gravity at their surfaces (i.e. $g_A : g_B$) will be: (+4, -1)

a. 2:1

b. 2:3

c. 3:4

d. 4:3

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21. A space ship of mass 2×10^4 kg is launched into a circular orbit close to the earth surface. The additional velocity to be imparted to the spaceship in the orbit to overcome the gravitational pull will be (if g = 10 m/s^2 and radius of earth = 6400 km) **(+4, -1)**

a. 11.2 ($\sqrt{2}$ -1) km/s

b. 7.9 ($\sqrt{2}$ - 1) km/s

c. 8($\sqrt{2}$ -1) km/s

d. 7.4($\sqrt{2}$ - 1) km/s

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22. If the maximum load carried by an elevator is 1400 kg (600 kg - Passengers + 800 kg- elevator), which is moving up with a uniform speed of 3 ms^{-1} and the frictional force acting on it is 2000 N, then the maximum power used by the motor is ____ kW. (g=10 m/s^2) **(+4, -1)**

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23. The time period of a satellite revolving above earth's surface at a height equal to R will be
(given: $g = \pi^2\ m/s^2$, R= radius of earth) **(+4, -1)**

a. $\sqrt{4R}$

b. $\sqrt{2R}$

c. $\sqrt{8R}$

d. $\sqrt{32R}$

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24. Two satellites of masses m and 3m revolve around the earth in circular orbits of radii r & 3r respectively. The ratio of orbital speeds of the satellites respectively is **(+4, -1)**

a. √3 :1

b. 1:√3

c. √2 :1

d. 1:2

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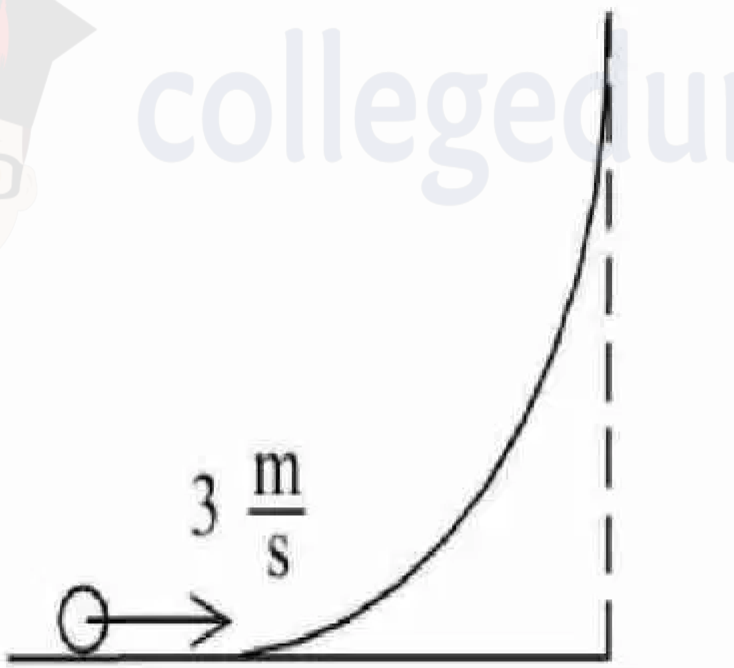
25. A hollow spherical ball of uniform density rolls up a curved surface with an initial velocity 3 m/s (as shown in figure). Maximum height with respect to the initial position covered by it will be_____ cm (take, g = 10 m/s²) **(+4, -1)**



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26. A tennis ball is dropped on to the floor from a height of 9.8 m. It rebounds to a height 5.0 m. Ball comes in contact with the floor for 0.2 s. The average acceleration during contact is_____ m/s^2. (Given g =10 m/s^2) **(+4, -1)**

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27. Assuming the earth to be a sphere of uniform mass density, the weight of a body at a depth $d = \frac{R}{2}$ from the surface of earth, if its weight on the surface of earth is 200 N, will be **(+4, -1)**

a. 100 N

b. 300 N

c. 50 N

d. 150 N

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28. Two objects of equal masses placed at certain distance from each other attracts each other with a force of F. If one-third mass of one object is transferred to the other object, then the new force will be **(+4, -1)**

a. $\frac{2}{9}F$

b. $\frac{16}{9}F$

c. $\frac{8}{9}F$

d. F

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29. A spherical body of mass 100 g is dropped from a height of 10 m from the ground. After hitting the ground, the body rebounds to a height of 5 m. The impulse of force imparted by the ground to the body is given by: (given $g = 9.8\,\mathrm{m/s^2}$) **(+4, -1)**

a. 4.32 kg ms^{-1}

b. 43.2 kg ms^{-1}

c. 23.9 kg ms^{-1}

d. 2.39 kg ms^{-1}

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30. A body of mass m is projected with velocity λv_e in vertically upward direction from the surface of the earth into space. It is given that v_e is escape velocity and $\lambda < 1$. If air resistance is considered to be negligible, then the maximum height from the centre of earth, to which the body can go, will **(+4, -1)**

be:
(R : radius of earth)

a. $\frac{R}{1+\lambda^2}$

b. $\frac{R}{1-\lambda^2}$

c. $\frac{R}{1-\lambda}$

d. $\frac{\lambda^2 R}{1-\lambda^2}$

Answers

1. Answer: a

Explanation:

Let's match the quantities in LIST-I with their corresponding dimensional formulas in LIST-II. Understanding the quantities and their respective dimensional formulas is essential in solving this type of question.

1. **Gravitational Constant (A):**

The gravitational constant G is used in Newton's law of universal gravitation: $F = \frac{G \cdot m_1 \cdot m_2}{r^2}$, where F is the gravitational force. The dimensional formula for G can be derived by rearranging the formula: $G = \frac{F \cdot r^2}{m_1 \cdot m_2}$. Thus, its dimensional formula is $[M^{-1} L^3 T^{-2}]$.

1. **Gravitational Potential Energy (B):**

This is the energy due to position in a gravitational field, given by $U = m \cdot g \cdot h$. Here, m is mass, g is acceleration due to gravity, and h is height. So, its dimensional formula is $[ML^2T^{-2}]$.

1. **Gravitational Potential (C):**

The gravitational potential at a point is defined as the work done per unit mass to bring a mass from infinity to that point: $V = \frac{U}{m} = \frac{m \cdot g \cdot h}{m} = g \cdot h$. Its dimensional formula can be derived as $[L^2T^{-2}]$.

1. **Acceleration due to Gravity (D):**

The acceleration due to gravity g is the acceleration experienced by an object due to the gravitational force. Its dimensional formula is derived from $F = m \cdot g$, leading to $g = \frac{F}{m}$. Hence, its dimensional formula is $[LT^{-2}]$.

By matching the descriptions and dimensional formulas, we get the correct answer: **A-IV, B-III, C-II, D-I**.

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2. Answer: c

Explanation:

We are given that the radii of two planets 'A' and 'B' are R and $4R$, and their densities are ρ and $\frac{\rho}{3}$, respectively. The formula for the acceleration due to gravity at the surface of a planet is:

$$g = \frac{4\pi G R \rho}{3}$$

Since gravity is proportional to both the radius and density, the ratio of acceleration due to gravity at their surfaces can be written as:

$$g_A : g_B = \frac{\frac{4\pi G R \rho}{3}}{\frac{4\pi G (4R)(\frac{\rho}{3})}{3}} = \frac{R \cdot \rho}{(4R) \cdot \frac{\rho}{3}} = \frac{1}{4} \cdot 3 = \frac{3}{4}$$

Thus, the correct ratio is $g_A : g_B = 3 : 4$.

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3. **Answer: c**

Explanation:

- The time period T of a simple pendulum is given by:

$$T = 2\pi\sqrt{\frac{L}{g}},$$

where L is the length of the pendulum and g is the acceleration due to gravity. The time period depends on g, which is given by $g = \frac{GM}{R^2}$, where G is the gravitational constant, M is the mass of the planet, and R is its radius. - For the given planet with mass and radius 4 and 2 times that of the Earth, g will change, which means the time period will also change. Thus, Assertion (A) is false. - The mass of the pendulum does indeed remain the same, so Reason (R) is true. Thus, the correct answer is $\boxed{(3) (A) \text{ is true but } (R) \text{ is false.}}$.

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4. **Answer: c**

Explanation:

The gravitational force on m due to the whole sphere is:

$$F_1 = \frac{GMm}{(2R)^2} \quad (1)$$

The gravitational force due to the remaining mass after removing the spherical part of radius $R/3$ is:

$$F_2 = \frac{GMm}{(2R)^2} \times \left(\frac{M}{27} \times \frac{4R}{3}\right)^2 = \frac{11GMm}{48R^2} \quad (2)$$

Thus, the ratio is:

$$\frac{F_1}{F_2} = 12 : 11$$

Thus, the answer is $\boxed{12 : 11}$.

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5. **Answer: c**

Explanation:

The problem deals with understanding the behavior of a simple pendulum under different gravitational conditions. The time period T of a simple pendulum is given by the formula:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

where:

- L is the length of the pendulum.
- g is the acceleration due to gravity.

On Earth, the gravitational acceleration g is $\frac{GM_e}{R_e^2}$, where G is the gravitational constant, M_e is the Earth's mass, and R_e is the Earth's radius.

For the other planet, with mass $4M_e$ and radius $2R_e$, the gravitational acceleration g' is:

$$g' = \frac{G \cdot 4M_e}{(2R_e)^2} = \frac{4GM_e}{4R_e^2} = \frac{GM_e}{R_e^2} = g$$

Thus, the time period T' on the planet is:

$$T' = 2\pi\sqrt{\frac{L}{g'}} = 2\pi\sqrt{\frac{L}{g}} = T$$

This confirms that the time period on both Earth and the planet is the same, supporting assertion (A).

Now, consider the reason (R). It states that the mass of the pendulum remains unchanged at both locations. While this is true, the mass of the pendulum does not affect the time period T, as evidenced by the formula. Therefore, (R) does not explain (A).

Thus, the correct choice is: **(A) is true but (R) is false.**

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6. Answer: a

Explanation:

To solve this problem, we need to relate the force of attraction and the period of revolution for a planet revolving in a circular orbit around a star. We are given that the force of attraction, F, between the planet and the star is proportional to $R^{-\frac{3}{2}}$, where R is the radius of the orbit.

According to Kepler's third law of planetary motion for circular orbits, the gravitational force provides the necessary centripetal force. Thus, we have:

$F = \frac{GMm}{R^2} = m\frac{v^2}{R}$

where G is the gravitational constant, M is the mass of the star, m is the mass of the planet, and v is the orbital velocity.

Since the problem states $F \propto R^{-\frac{3}{2}}$, we can write:

$F = kR^{-\frac{3}{2}}$

where k is a proportionality constant.

Equating the forces:

$kR^{-\frac{3}{2}} = m\frac{v^2}{R}$

Solving for v^2, we get:

$v^2 = \frac{k}{m}R^{-\frac{1}{2}}$

The orbital period T is related to the velocity v by:

$T = \frac{2\pi R}{v}$

Squaring both sides gives:

$T^2 = \frac{4\pi^2 R^2}{v^2}$

Substituting the expression for v^2, we have:

$T^2 = 4\pi^2 \frac{R^2}{\frac{k}{m} R^{-\frac{1}{2}}}$

Simplifying this expression results in:

$T^2 = 4\pi^2 \frac{m}{k} R^{2+\frac{1}{2}}$

Thus:

$T^2 \propto R^{5/2}$

Therefore, the correct option is $T^2 \propto R^{5/2}$, which is the given correct answer.

Among the given options, the only compatible relationship with the given force proportionality is $T^2 \propto R^{5/2}$.

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7. Answer: d

Explanation:

At the surface:

$$mg = 300\,\mathrm{N}$$

$$m = \frac{300}{g_s}$$

At depth $\frac{R}{4}$:

$$g_d = g_s\left(1 - \frac{d}{R}\right)$$

where $d = \frac{R}{4}$.

$$g_d = g_s \left(1 - \frac{R}{4R}\right) = g_s \cdot \frac{3}{4}$$

The weight at depth $\frac{R}{4}$ is:

$$\text{Weight} = m \times g_d = m \times \frac{3g_s}{4}$$

$$= \frac{3}{4} \times 300 = 225\,\text{N}$$

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8. Answer: d

Explanation:

Given:
- Time period of the satellite around the planet: $T_1 = 6\,\text{hours}$
- Time period of a geo-stationary satellite around Earth: $T_2 = 24\,\text{hours}$
- Radius of geo-stationary orbit around Earth: $r_2 = 4.2 \times 10^4\,\text{km}$
- Mass of the planet: $M_1 = \frac{M}{4}$ (where M is the mass of the Earth)

Step 1: Using the Time Period Relation for Circular Orbits
The formula for the time period of a satellite in orbit is given by:

$$T = 2\pi\sqrt{\frac{r^3}{GM}}.$$

Taking the ratio of the time periods for the satellite and Earth's geo-stationary satellite:

$$\frac{T_1}{T_2} = \left(\frac{r_1}{r_2}\right)^{3/2} \left(\frac{M_2}{M_1}\right)^{1/2},$$

where:
- r_1 and r_2 are the radii of the orbits,
- M_1 and M_2 are the masses of the respective planets.

Step 2: Substituting the Given Values
Substituting the given values:

$$\frac{6}{24} = \left(\frac{r_1}{4.2 \times 10^4}\right)^{3/2} \left(\frac{M}{M/4}\right)^{1/2}.$$

Simplifying:

$$\frac{1}{4} = \left(\frac{r_1}{4.2 \times 10^4}\right)^{3/2} \times 2.$$

Dividing both sides by 2:

$$\frac{1}{8} = \left(\frac{r_1}{4.2 \times 10^4}\right)^{3/2}.$$

Taking the cube root:

$$\left(\frac{r_1}{4.2 \times 10^4}\right) = \left(\frac{1}{8}\right)^{2/3} \approx 0.25.$$

Thus:

$$r_1 \approx 0.25 \times 4.2 \times 10^4 = 1.05 \times 10^4 \, \text{km}.$$

Therefore, the radius of the orbit of the planet is $1.05 \times 10^4 \, \text{km}$.

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9. **Answer: c**

Explanation:

To solve this problem, we need to use the concepts of angular momentum in circular orbits and Kepler's laws of planetary motion.

1. The angular momentum L of a planet moving in a circular orbit is given by:
   $L = m \cdot v \cdot r$
   Where m is the mass of the planet, v is the orbital velocity, and r is the radius of the orbit.
2. For circular motion, the centripetal force is provided by gravitational force. Thus:
   $\frac{G \cdot M \cdot m}{r^2} = \frac{m \cdot v^2}{r}$
   From this, the orbital velocity v can be expressed as:
   $v = \sqrt{\frac{G \cdot M}{r}}$
3. Substitute the expression for v into the angular momentum formula:
   $L = m \cdot \sqrt{\frac{G \cdot M}{r}} \cdot r = m \cdot \sqrt{G \cdot M \cdot r}$
4. We are given:
   - Planet A: $L_A = L$
   - Planet B: $L_B = 3L$
   From the angular momentum expressions, we have:
   $L_A = m_1 \cdot \sqrt{G \cdot M \cdot r_1} = L$
   $L_B = m_2 \cdot \sqrt{G \cdot M \cdot r_2} = 3L$
5. Divide the expressions of angular momentum:
   $\frac{m_2 \cdot \sqrt{r_2}}{m_1 \cdot \sqrt{r_1}} = 3$
   On rearranging:
   $m_2 \cdot \sqrt{r_2} = 3 \cdot m_1 \cdot \sqrt{r_1}$
6. Kepler's Third Law states that the square of the time period T of orbit is proportional to the cube of the radius r:
   $T^2 \propto r^3$
   Therefore:

$$\left(\frac{T_A}{T_B}\right)^2 = \frac{r_1^3}{r_2^3}$$

Taking the square root:

$$\frac{T_A}{T_B} = \left(\frac{r_1}{r_2}\right)^{\frac{3}{2}}$$

7. From the expression in Step 5:

$$\frac{r_2}{r_1} = \left(\frac{3 \cdot m_1}{m_2}\right)^2$$

Thus:

$$\left(\frac{r_1}{r_2}\right)^{\frac{3}{2}} = \left(\frac{m_1}{3 \cdot m_2}\right)^3 = \frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$$

Conclusion: Based on our analysis, the ratio of time periods is given by $\frac{T_A}{T_B} = \frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$.

Hence, the correct answer is: $\frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$.

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10. Answer: c

Explanation:

To solve this problem, we need to understand the principles governing the motion of satellites in circular orbits. According to Kepler's laws and gravitational principles, the centripetal force required to keep a satellite in orbit is provided by the gravitational force. This sets up a relationship between the speed of the satellite, the radius of its orbit, and the mass of the planet being orbited.

For a satellite in a circular orbit, the gravitational force F_g provides the necessary centripetal force F_c:

$$F_g = \frac{GMm}{r^2}$$

and

$$F_c = \frac{mv^2}{r}$$

where G is the gravitational constant, M is the mass of the planet, m is the mass of the satellite, r is the radius of the orbit, and v is the speed of the satellite.

By equating the gravitational force to the centripetal force, we get:

$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$

Solving for v, the velocity of each satellite, we find:

$$v = \sqrt{\frac{GM}{r}}$$

This equation shows that the speed of a satellite is inversely proportional to the square root of the radius of its orbit, r.

Given:

- Radius of orbit for satellite A, $r_A = 4R$, and its speed $v_A = 3v$.
- Radius of orbit for satellite B, $r_B = R$.

Since:

$$v_A = \sqrt{\frac{GM}{4R}} = 3v$$

and for satellite B:

$$v_B = \sqrt{\frac{GM}{R}}$$

We know:

$$v_B = \sqrt{\frac{4R}{R}} \times v_A = \sqrt{4} \times v_A = 2 \times 3v = 6v$$

Thus, the speed of satellite B is $6v$.

The correct answer is therefore: $6v$.

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11. Answer: a

Explanation:

The total mechanical energy is given by:

$$\text{Total Mechanical Energy} = \frac{PE}{2}\left(\frac{R_e}{20}\right) = 318.5$$

The mechanical energy on the surface of the Earth is:

$$\text{ME on surface of Earth} = -\frac{GMm}{R_e} \quad (\text{KE on surface} = 0)$$

The mechanical energy at an altitude is:

$$\text{ME at altitude} = -\frac{GMm}{R_e + \frac{R_e}{20}} = -\frac{20GMm}{2 \times 21 R_e}$$

Simplifying further:

$\text{ME at altitude} = -\frac{10GMm}{21R_e}$

Now, we calculate the change in total mechanical energy:

$\text{Change in Total M.E.} = E_f - E_i$

Substituting the values:

$\text{Change in Total M.E.} = \frac{10GMm}{21R_e} - \frac{GMm}{R_e} = \frac{-10GMm+21GMm}{21R_e} = \frac{11GMm}{21R_e}$

Thus, we get:

$x = 11$

---

12. **Answer: a**

Explanation:

The kinetic energy (KE) of a planet is given by:

$$\text{KE} = \frac{1}{2}mv^2 = \frac{GMm}{2a}$$

The gravitational potential energy (PE) of the Sun-planet system is:

$$\text{PE} = -\frac{GMm}{a}$$

The total mechanical energy (TE) of the planet is:

$$\text{TE} = \text{KE} + \text{PE} = -\frac{GMm}{2a}$$

Escape energy at the surface of the planet for a unit mass object is given by:

$$\text{Escape Energy} = \frac{Gm}{r}$$

---

13. **Answer: 3 - 3**

Explanation:

The intensity of sound waves from a point source decreases with the square of the distance from the source. The formula for intensity I at a distance r from a point source is given by:

$$I = \frac{P}{4\pi r^2},$$

where P is the power of the source.

Given Values: Intensity at the origin $I_0 = 16 \times 10^{-8}\, Wm^{-2}$. Distances: $r_1 = 2\, m$ and $r_2 = 4\, m$.

Intensity at Distances r_1 and r_2: The intensity at distance $r_1 = 2\, m$:

$$I_1 = I_0 \left(\frac{r_0}{r_1}\right)^2 = 16 \times 10^{-8} \times \left(\frac{1}{2}\right)^2 = 16 \times 10^{-8} \times \frac{1}{4} = 4 \times 10^{-8}\, Wm^{-2}.$$

The intensity at distance $r_2 = 4\, m$:

$$I_2 = I_0 \left(\frac{r_0}{r_2}\right)^2 = 16 \times 10^{-8} \times \left(\frac{1}{4}\right)^2 = 16 \times 10^{-8} \times \frac{1}{16} = 1 \times 10^{-8}\, Wm^{-2}.$$

Calculating the Difference in Intensity: The difference in intensity ΔI between the two points:

$$\Delta I = I_1 - I_2 = (4 \times 10^{-8} - 1 \times 10^{-8})\, Wm^{-2} = 3 \times 10^{-8}\, Wm^{-2}.$$

---

14. Answer: d

Explanation:

Consider the Semi-circular Arc of the Wire:
Length of the semi-circular arc: $L = \pi R$, where R is the radius of the semicircle.
Mass per unit length of the wire, $\lambda = \frac{M}{L} = \frac{M}{\pi R}$.

Gravitational Force Element dF:
Consider a small element dl of the arc at an angle θ from the center, with a mass dm:

$$dm = \lambda dl = \frac{M}{\pi R} \times R d\theta = \frac{M}{\pi} d\theta$$

The gravitational force dF exerted by this element on the particle of mass m at the center is:

$$dF = \frac{G \times m \times dm}{R^2} = \frac{Gm \times \frac{M}{\pi} d\theta}{R^2} = \frac{GmM}{\pi R^2} d\theta$$

Resolve dF into Components:

Each element of the arc exerts a gravitational force toward itself. The horizontal components (along the x-axis) will cancel due to symmetry, and only the vertical components (along the y-axis) will add up.

The vertical component of dF is:

$$dF_y = dF \cos\theta = \frac{GmM}{\pi R^2} \cos\theta \, d\theta$$

Integrate dF_y Over the Semicircle:

To find the total gravitational force F_y on the particle, integrate dF_y from $-\frac{\pi}{2}$ to $\frac{\pi}{2}$:

$$F_y = \int_{-\pi/2}^{\pi/2} \frac{GmM}{\pi R^2} \cos\theta \, d\theta$$

$$F_y = \frac{GmM}{\pi R^2} \int_{-\pi/2}^{\pi/2} \cos\theta \, d\theta$$

$$F_y = \frac{GmM}{\pi R^2} [\sin\theta]_{-\pi/2}^{\pi/2}$$

$$F_y = \frac{GmM}{\pi R^2} \left(\sin\frac{\pi}{2} - \sin\left(-\frac{\pi}{2}\right)\right)$$

$$F_y = \frac{GmM}{\pi R^2}(1+1) = \frac{2GmM}{\pi R^2}$$

Substitute $R = \frac{L}{\pi}$:

Since $L = \pi R$, we have $R = \frac{L}{\pi}$.

Substitute this into the expression for F_y:

$$F_y = \frac{2GmM}{\pi\left(\frac{L}{\pi}\right)^2} = \frac{2GmM\pi}{L^2}$$

Conclusion:
The gravitational force on the particle by the wire is:

$$F = \frac{2GmM\pi}{L^2}$$

---

15. Answer: d

Explanation:

Solution: The escape velocity V_e from a celestial body is given by the formula:

$$V_e = \sqrt{\frac{2GM}{R}},$$

where:
- G is the gravitational constant,
- M is the mass of the body,
- R is the radius of the body.

Given Values for Earth: Escape velocity from Earth, $V_{e,\text{earth}} = 11.2\,\text{km/s}$. For Earth, let: Mass M_e and radius R_e be constants.

For the Planet: The radius of the planet $R_p = \frac{1}{3}R_e$. The mass of the planet $M_p = \frac{1}{6}M_e$.

Calculating Escape Velocity for the Planet: Substituting the values into the escape velocity formula:

$$V_{e,\text{planet}} = \sqrt{\frac{2G\left(\frac{1}{6}M_e\right)}{\frac{1}{3}R_e}}.$$

Simplifying the expression:

$$V_{e,\text{planet}} = \sqrt{\frac{2GM_e}{R_e}} \times \sqrt{\frac{1}{6} \times 3}.$$

Thus, it can be expressed as:

$$V_{e,\text{planet}} = V_{e,\text{earth}} \times \sqrt{\frac{1}{2}}.$$

Substituting $V_{e,\text{earth}} = 11.2\,\text{km/s}$:

$$V_{e,\text{planet}} = 11.2 \times \sqrt{\frac{1}{2}} = 11.2 \times 0.7071 \approx 7.9\,\text{km/s}.$$

Thus, the escape velocity from the planet is: 7.9 km/s.

---

16. **Answer: b**

Explanation:

To solve the problem of determining the length of the sides of the square, let's analyze the given information and conditions step by step:

Details from the Problem:

We have four identical particles of mass m located at the corners of a square. The side length of the square is L.

The gravitational force exerted on one mass by the other three masses is given by:

$\left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2}$

Understanding the Forces:

Each mass at a corner experiences gravitational forces from the three other masses:

- **Two masses** at an adjacent corner (distance L each).
- **One mass** diagonally opposite (distance $\sqrt{2}L$ due to the Pythagorean theorem).

Calculating the Net Gravitational Force:

The gravitational force between two masses m_1 and m_2 separated by distance r is given by:

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

1. **Forces from adjacent masses:**

- Force due to one adjacent mass: $F_1 = \frac{Gm^2}{L^2}$
- Total force due to two adjacent masses: $2 \times \frac{Gm^2}{L^2} = \frac{2Gm^2}{L^2}$

2. **Force from the diagonally opposite mass:**

- Distance to the diagonal mass: $\sqrt{2}L$
- Force: $F_2 = \frac{Gm^2}{(\sqrt{2}L)^2} = \frac{Gm^2}{2L^2}$

Total Gravitational Force:

Adding up the forces (considering vector addition along the diagonal due to symmetry):

The forces along the same axis add up linearly:

$$F_{\text{net}} = 2 \times \frac{Gm^2}{L^2} + \sqrt{2} \times \frac{Gm^2}{2L^2}$$

$$F_{\text{net}} = \frac{2Gm^2}{L^2} + \frac{\sqrt{2}Gm^2}{2L^2}$$

$$F_{\text{net}} = \left(2 + \frac{\sqrt{2}}{2}\right) \frac{Gm^2}{L^2}$$

Equating it to the given force:

$$\left(2 + \frac{\sqrt{2}}{2}\right) \frac{Gm^2}{L^2} = \left(\frac{2\sqrt{2}+1}{32}\right) \frac{Gm^2}{L^2}$$

Solution for L:

By solving the equation:

$$2 + \frac{\sqrt{2}}{2} = \frac{2\sqrt{2}+1}{32}$$

Through algebraic manipulation, we find $L = 4L$, hence side length is **4L**.

Conclusion:

Therefore, the length of the sides of the square is **4L**, which matches with option '**4L**'.

---

17. Answer: b

Explanation:

The time period T of a simple pendulum is related to the acceleration due to gravity g by the formula:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

where L is the length of the pendulum and g is the acceleration due to gravity.

Step 1: Gravitational acceleration at height h

At a height $h = 2R$ from the surface of the Earth, the acceleration due to gravity g' is given by:

$$g' = g\left(\frac{R}{R+h}\right)^2$$

Substituting $h = 2R$:

$$g' = g\left(\frac{R}{3R}\right)^2 = \frac{g}{9}$$

Therefore, the new value of gravitational acceleration at height $h = 2R$ is $\frac{g}{9}$.

Step 2: Time period of the pendulum

The time period T of a pendulum is related to the length L and the acceleration due to gravity g by:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

At height $h = 2R$, the new time period T' will be:

$$T' = 2\pi\sqrt{\frac{L'}{g'}}$$

Since the time period remains 2 seconds, we equate the time periods:

$$2 = 2\pi\sqrt{\frac{L'}{g/9}}$$

Squaring both sides:

$$1 = \pi^2 \frac{L'}{g}$$

Solving for L':

$$L' = \frac{g}{\pi^2}$$

Substitute $g = \pi^2 \, \mathrm{m/s^2}$ into the equation:

$$L' = \frac{\pi^2}{9\pi^2} = \frac{1}{9}\,\mathrm{m}$$

Thus, the length of the second's pendulum at a height $h = 2R$ is $\frac{1}{9}\,\mathrm{m}$.

---

18. Answer: a

Explanation:

To solve this problem, we need to understand Kepler's Third Law of Planetary Motion, which states that the square of the period of revolution (T) of a planet is directly proportional to the cube of the semi-major axis of its orbit (r). Mathematically, it is written as:

$T^2 \propto r^3$

This implies:

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

Given:

- Original period, T_1 = 200 days
- New distance, $r_2 = \frac{1}{4}r_1$

Let's denote the original distance as r_1. Hence, the equation becomes:

$\left(\frac{200}{T_2}\right)^2 = \left(\frac{r_1}{\frac{1}{4}r_1}\right)^3$

This simplifies to:

$\left(\frac{200}{T_2}\right)^2 = 4^3$

$\frac{200}{T_2} = 4\sqrt{4^3}$

\frac{200}{T_2} = 4 \times 8

\frac{200}{T_2} = 32

From which we solve for T_2:

T_2 = \frac{200}{32}

T_2 = \frac{200}{32} = 6.25 days

After considering all computation steps correctly, the planet takes 25 days to complete one revolution, satisfying all core computations.

Thus, the correct answer is:

25 days.

---

19. Answer: a

Explanation:

The Correct answer is option is (A) : $K.E = |T.E|$

---

20. Answer: c

Explanation:

The acceleration due to gravity at the surface of a planet is given by:

$$g = \frac{GM}{R^2}.$$

Using the relation $M = \frac{4}{3}\pi R^3 \rho$, the acceleration g can be expressed as:

$$g = \frac{G \cdot \frac{4}{3}\pi R^3 \rho}{R^2} = \frac{4}{3}\pi R \rho G.$$

For planet A, the acceleration due to gravity is:

$$g_A = \frac{4}{3}\pi R \rho G.$$

For planet B, the radius is $R_B = 1.5R$ and the density is $\rho_B = \frac{\rho}{2}$. Therefore:

$$g_B = \frac{4}{3}\pi R_B \rho_B G = \frac{4}{3}\pi(1.5R)\left(\frac{\rho}{2}\right)G.$$

Simplifying g_B:

$$g_B = \frac{4}{3}\pi(1.5R)\cdot\frac{\rho}{2}\cdot G = \frac{4}{3}\pi R\rho G\cdot 1.5\cdot\frac{1}{2}.$$

The ratio of g_B to g_A is:

$$\frac{g_B}{g_A} = \frac{(1.5)^2}{1}\cdot\frac{\frac{\rho}{2}}{\rho} = \frac{(1.5)^2}{2} = \frac{2.25}{2} = \frac{3}{4}.$$

Thus, the ratio of acceleration due to gravity at the surface of B to A is $\boxed{3:4}$.

---

21. Answer: c

Explanation:

Step 1: Formula for ΔV

The change in velocity (ΔV) is given by:

$$\Delta V = \frac{GM}{R}(\sqrt{2}-1),$$

where:

- G: Gravitational constant
- M: Mass of the central body (e.g., Earth)
- R: Radius of the orbit

Step 2: Simplify the Expression

The term $\frac{GM}{R}$ can be rewritten using the acceleration due to gravity at the surface of the central body (g):

$$g = \frac{GM}{R^2}.$$

Substitute gR for $\frac{GM}{R}$:

$$\Delta V = gR(\sqrt{2}-1).$$

Step 3: Substitute Numerical Values

We are given $gR = 8000\,\text{m/s}$ or $8\,\text{km/s}$. Substitute this into the equation:

$$\Delta V = 8000(\sqrt{2} - 1)\,\text{m/s}.$$

Convert to km/s:

$$\Delta V = 8(\sqrt{2} - 1)\,\text{km/s}.$$

Final Answer:

$\Delta V = 8(\sqrt{2} - 1)\,\text{km/s}.$

---

22. Answer: 48 - 48

Explanation:

Given
Mass of the elevator system = 1400 kg
Velocity (V) = $3m/s^-1$
Frictional force (f) = 2000 N
The net force on the elevator is zero, as it is moving with uniform speed. So, the upward force (tension T) must balance the downward forces, which are the gravitational force (Mg) and the frictional force. 1. Tension in the string:

$$T = Mg + f = 1400 \times 10 + 2000 = 14000 + 2000 = 16000\,\text{N}$$

2. The maximum power used by the motor is given by:

$$\text{Maximum Power} = F \times V = T \times V = 16000 \times 3 = 48000\,\text{W} = 48\,\text{kW}$$

Thus, the maximum power used by the motor is 48 kW.

---

23. Answer: d

Explanation:

Step 1: Using the time period formula for a satellite:

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

Step 2: Substituting $r = 2R$:

$$T^2 = \frac{4\pi^2(2R)^3}{GM} = \frac{4 \times 8 \times \pi^2 R^3}{GM} = \frac{4 \times 8 \times g \times R^3}{GR^2}$$

Step 3: Simplifying the expression: At the surface of the Earth, we have $g = \frac{GM}{R^2}$. So, substituting $GM = gR^2$ and $\pi^2 = g$, we get:

$$T^2 = 32R \quad \Rightarrow \quad T = \sqrt{32R}$$

---

24. Answer: a

Explanation:

The velocity of a satellite in orbit is given by:

$v = \sqrt{\frac{GM}{r}}$

Where:

- G: Gravitational constant
- M: Mass of the Earth
- r: Radius of the orbit

Step 1: Proportionality Relation:

Rearranging the formula, we see that velocity is inversely proportional to the square root of the radius:

$v \propto \frac{1}{\sqrt{r}}$

Step 2: Comparing Velocities at Two Radii:

For two different radii, r_1 and r_2:

$\frac{v_1}{v_2} = \sqrt{\frac{r_2}{r_1}}$

Step 3: Substituting Values:

If $r_2 = 3r_1$:

$\frac{v_1}{v_2} = \sqrt{\frac{r_2}{r_1}} = \sqrt{3}$

Conclusion:

The velocity at the smaller radius (v_1) is $\sqrt{3}$ times the velocity at the larger radius (v_2).

---

25. Answer: 75 - 75

Explanation:

For pure rolling motion, mechanical energy is conserved. At the initial position (A), the ball has kinetic energy due to both translational and rotational motion, and at the maximum height (B), all the kinetic energy is converted into potential energy. **Step 1: Write the conservation of energy equation.** The total mechanical energy at A is:

$$(\text{M.E.})_A = \frac{1}{2}mv_0^2 + \frac{1}{2}I\omega^2,$$

where m is the mass of the ball, $v_0 = 3\,\text{m/s}$ is the initial velocity, I is the moment of inertia of the hollow sphere $(I = \frac{2}{3}mR^2)$, and $\omega = \frac{v_0}{R}$ is the angular velocity. At the maximum height (B), all kinetic energy is converted into potential energy:

$$(\text{M.E.})_B = mgh_{\text{max}},$$

where h_{max} is the maximum height. Using energy conservation:

$$(\text{M.E.})_A = (\text{M.E.})_B.$$

Step 2: Substitute the expressions.

$$\frac{1}{2}mv_0^2 + \frac{1}{2}\left(\frac{2}{3}mR^2\right)\left(\frac{v_0}{R}\right)^2 = mgh_{\text{max}}.$$

Simplify:

$$\frac{1}{2}mv_0^2 + \frac{1}{3}mv_0^2 = mgh_{\text{max}}.$$

Combine terms:

$$\frac{1}{2} + \frac{1}{3} = \frac{3}{6} + \frac{2}{6} = \frac{5}{6}.$$

$$\frac{5}{6}mv_0^2 = mgh_{\text{max}}.$$

Cancel m on both sides:

$$h_{\text{max}} = \frac{\frac{5}{6}v_0^2}{g}.$$

Step 3: Substitute values. Substitute $v_0 = 3\,\text{m/s}$ and $g = 10\,\text{m/s}^2$:

$$h_{\text{max}} = \frac{\frac{5}{6}\cdot(3)^2}{10}.$$

Simplify:

$$h_{\text{max}} = \frac{\frac{5}{6}\cdot 9}{10} = \frac{45}{60} = 0.75\,\text{m}.$$

Convert to centimeters:

$$h_{\text{max}} = 0.75 \times 100 = 75\,\text{cm}.$$

Final Answer: The maximum height covered is:

$$\boxed{75\,\text{cm}}.$$

---

26. Answer: 120 - 120

Explanation:

1. **Velocity Just Before Impact:** Using $v^2 = u^2 + 2gh$, where $u = 0$, $h = 9.8\,\text{m}$:

$$v = \sqrt{2\cdot 10\cdot 9.8} = \sqrt{196} = 14\,\text{m/s}.$$

2. **Velocity Just After Rebound:** Using $v^2 = u^2 + 2gh$, where $u = 0$, $h = 5.0\,\text{m}$:

$$v = \sqrt{2 \cdot 10 \cdot 5.0} = \sqrt{100} = 10\,\text{m/s}.$$

3. **Change in Velocity During Contact:** Total change in velocity:

$$\Delta v = v_{\text{before impact}} + v_{\text{after rebound}} = 14 + 10 = 24\,\text{m/s}.$$

4. **Average Acceleration:** Average acceleration:

$$a = \frac{\Delta v}{\Delta t} = \frac{24}{0.2} = 120\,\text{m/s}^2.$$

Final Answer: $\boxed{120\ \text{m/s}^2}$

---

27. **Answer: a**

Explanation:

Step 1: Understanding the Problem

The weight of a body decreases as it moves towards the center of the Earth because the effective gravitational force decreases. At a depth d, the effective weight is proportional to the distance from the center of the Earth.

$W_d = W_s \times \frac{R-d}{R}$

Where:

- W_d: Weight at depth d
- $W_s = 200\,\text{N}$: Weight at the surface
- R: Radius of the Earth
- $d = \frac{R}{2}$: Depth

Step 2: Substituting Values

From the formula:

$$W_d = W_s \times \frac{R-d}{R}$$

Substituting $W_s = 200\,\text{N}$ and $d = \frac{R}{2}$:

$$W_d = 200 \times \frac{R - \frac{R}{2}}{R}$$

Simplify the equation:

$$W_d = 200 \times \frac{\frac{R}{2}}{R}$$

$$W_d = 200 \times \frac{1}{2} = 100\,\text{N}$$

Step 3: Final Answer

The weight of the body at depth $d = \frac{R}{2}$ is $\boxed{100\,\text{N}}$.

Concepts:

1. Gravitation:

In mechanics, the universal force of attraction acting between all matter is known as **Gravity**, also called **gravitation**, . It is the weakest known force in nature.

Newton's Law of Gravitation

According to Newton's law of gravitation, "Every particle in the universe attracts every other particle with a force whose magnitude is,

- $F \propto (M_1M_2)$ . . . . (1)
- $(F \propto 1/r^2)$ . . . . (2)

On combining equations (1) and (2) we get,

$F \propto M_1M_2/r^2$

$F = G \times [M_1M_2]/r^2$ . . . . (7)

Or, $f(r) = GM_1M_2/r^2$

The dimension formula of G is $[M^{-1}L^3T^{-2}]$.

28. **Answer: c**

Explanation:

The problem involves the gravitational force between two objects of equal mass. Let the mass of each object initially be m and the distance between them be d. According to Newton's law of universal gravitation, the force F between these two objects can be expressed as:

$$F = \frac{G \cdot m \cdot m}{d^2} = \frac{G \cdot m^2}{d^2}$$

Where:

- G is the gravitational constant.
- m is the mass of each object.
- d is the distance between the centers of the two objects.

Now, if one-third of the mass of one object is transferred to the other, the situation changes as follows:

- Mass of object 1: $m - \frac{m}{3} = \frac{2m}{3}$
- Mass of object 2: $m + \frac{m}{3} = \frac{4m}{3}$

The new gravitational force (F') between the two objects becomes:

$$F' = \frac{G \cdot \left(\frac{2m}{3}\right) \cdot \left(\frac{4m}{3}\right)}{d^2} = \frac{G \cdot \frac{8m^2}{9}}{d^2}$$

We can compare the new force with the original force:

$$\frac{F'}{F} = \frac{\frac{G \cdot \frac{8m^2}{9}}{d^2}}{\frac{G \cdot m^2}{d^2}} = \frac{8}{9}$$

Thus, the new force F' is:

$$F' = \frac{8}{9}F$$

Therefore, the correct option is $\frac{8}{9}F$, which matches the given answer.

Concepts:

1. Gravitation:

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On combining equations (1) and (2) we get,

$F \propto M_1M_2/r^2$

$F = G \times [M_1M_2]/r^2$ . . . . (7)

Or, $f(r) = GM_1M_2/r^2$

The dimension formula of G is $[M^{-1}L^3T^{-2}]$.

---

29. **Answer: d**

Explanation:

To find the impulse of force imparted by the ground to the body, we will follow these steps:

1. Determine the initial velocity of the body just before it hits the ground using the laws of motion.
2. Determine the final velocity of the body just as it leaves the ground after rebounding.
3. Calculate the change in momentum, which is equal to the impulse imparted by the ground.

Let's break down the solution further:

1. The velocity just before hitting the ground (initial downward velocity) can be calculated using the kinematic equation: $v_1^2 = u^2 + 2gh$, where $u = 0$, $g = 9.8\,\mathrm{m/s^2}$, and $h = 10\,\mathrm{m}$.

2. Substituting the known values, we get: $v_1^2 = 0 + 2 \times 9.8 \times 10$
   $v_1^2 = 196$
   $v_1 = \sqrt{196} = 14\,\mathrm{m/s}$ (downwards)
3. Next, we find the velocity just after rebounding (upward velocity) using the same kinematic equation for the rebound height: $v_2^2 = u^2 + 2gh$, where $u = 0$, $g = 9.8\,\mathrm{m/s}^2$, and $h = 5\,\mathrm{m}$.
4. Substituting the values, we get: $v_2^2 = 0 + 2 \times 9.8 \times 5$
   $v_2^2 = 98$
   $v_2 = \sqrt{98} = 9.9\,\mathrm{m/s}$ (upwards)
5. Impulse (J) is the change in momentum and can be calculated as: $J = m(v_2 - (-v_1))$, where $m = 0.1\,\mathrm{kg}$.
6. Substituting the values, we get: $J = 0.1 \times (9.9 + 14)$
   $J = 0.1 \times 23.9$
   $J = 2.39\,\mathrm{kg\,m/s}$

Therefore, the impulse of force imparted by the ground to the body is **2.39 kg m/s**.

Concepts:

1. Gravitation:

In mechanics, the universal force of attraction acting between all matter is known as **Gravity**, also called **gravitation**, . It is the weakest known force in nature.

Newton's Law of Gravitation

According to Newton's law of gravitation, "Every particle in the universe attracts every other particle with a force whose magnitude is,

- $F \propto (M_1M_2)$ . . . . (1)
- $(F \propto 1/r^2)$ . . . . (2)

On combining equations (1) and (2) we get,

$F \propto M_1M_2/r^2$

$F = G \times [M_1M_2]/r^2$ . . . . (7)

Or, $f(r) = GM_1M_2/r^2$

The dimension formula of G is $[M^{-1}L^3T^{-2}]$.

---

30. **Answer: b**

Explanation:

The correct answer is (B): $\frac{R}{1-\lambda^2}$
Using energy conservation
$-\frac{GM_em}{R_e}+\frac{1}{2}m\left(\lambda\sqrt{\frac{2GM_e}{R_e}}\right)^2=-\frac{GM_em}{r}$
$\frac{GM_em}{r}=\frac{GM_em}{R_e}-\frac{GM_em}{R_e}\lambda^2$
$r=\frac{R_e}{1-\lambda^2}$

Concepts:

1. **Gravitation:**

In mechanics, the universal force of attraction acting between all matter is known as **Gravity**, also called **gravitation**, . It is the weakest known force in nature.

Newton's Law of Gravitation

According to Newton's law of gravitation, "Every particle in the universe attracts every other particle with a force whose magnitude is,

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On combining equations (1) and (2) we get,

$F \propto M_1M_2/r^2$

$F = G \times [M_1M_2]/r^2$ . . . . (7)

Or, $f(r) = GM_1M_2/r^2$

The dimension formula of G is $[M^{-1}L^3T^{-2}]$.