**INDIAN SCHOOL AL WADI AL KABIR**

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| **Class: XI** | **Department: SCIENCE 2020 – 21**<br>**SUBJECT :PHYSICS** | **Date of submission:**<br>**22/10/2020** |
| **Worksheet No: 08** | **CHAPTER: GRAVITATION** | **Note:**<br>**A4 FILE FORMAT** |
| **Name of the student:** | **Class & Sec:** | **Roll No:** |

## OBJECTIVE TYPE QUESTIONS

1. **What is the increase in the potential energy of the body with mass m if the body is taken at the height h which is equal to the radius of the earth?**

   (a) $\frac{GMm}{R}$

   (b) $\frac{1}{2}\frac{GMm}{R}$

   (c) $\frac{2}{}\frac{GMm}{R}$

   (d) $\frac{1}{4}\frac{GMm}{R}$

   **Answer:** (b)

2. **Consider a body of mass m which needs to be moved from an orbit of radius 2R to 3R. What is the energy required?**

   (a) $\frac{GMm}{12R^2}$

   (b) $\frac{GMm}{6R}$

   (c) $\frac{GMm}{8R}$

   (d) $\frac{GMm}{3R^2}$

**Answer:** (b)

3. **Does escape velocity of a body depend on its mass?**

   A: No

B: YES
Ans. A

4. **If a stone is brought back to earth from moon then its**
   A: mass will be changed
   B: mass and weight will be changed
   C: Weight never be changed
   D: mass remain constant but weight will be changed
   Ans. D
5. **Gravitational potential is –**
   A: proportional to distance
   B: inversely proportional to distance
   C: proportional to the square of the distance
   D: inversely proportional to the square of the distance.
   Ans. B
6. **If we double the distance between two objects, gravitational force will be**
   A: double
   B: half
   C: one fourth
   D: 4 times greater
   Ans. C

**7. What happens to the gravitational potential at the centre of the uniform spherical shell which shrinks gradually?**

(a) Remains constant

(b) Decreases

(c) Increases

(d) Oscillates

**Answer:** (b) Decreases

**8. What is the relation between the escape velocity and orbital velocity of a satellite, if the satellite is close to the earth's surface?**

(A) ve =$\sqrt{2v_0}$
(B) ve = $\sqrt{2}v_0$

(C) v0 = $\sqrt{2v_e}$
(D) $v_0 = v_e$.

Ans.B

9. **What is the unit of Universal Gravitational Constant in SI unit?**

A: N-m-Kg
B: N/m-Kg
C: N-$m^2$/$Kg^2$
D: N/$m^2$-$Kg^2$
Ans. C - N-$m^2$/$kg^2$.

10. **What would be the height of an artificial satellite so that it can be observed at same position with respect to earth?**

A: 36000 km above the earth surface
B: 40000 km above the earth surface
C: 26000 km above the earth surface
D: 63000 km above the earth surface
A **satellite** in **such** an orbit **is** at an **altitude** of approximately 35,786 km (22,236 mi) above mean sea level. It maintains the **same position** relative to the **Earth's** surface

## VERY SHORT ANSWER QUESTIONS ( BASIC LEVEL)

11. Can gravitational potential have positive value?

Yes, the positive or negative value of potential depends on the reference point chosen.

For e.g., if the surface of the earth is taken as the reference point for gravitational potential, then the gravitational potential above the surface of the earth is positive.

12. An elephant and an ant are to be projected out of the gravitational pull of the earth. Do we need different velocities to achieve so?
( Ans. No. Escape velocity of any body from the surface of a planet does not depend on the mass of the body but depends on the mass and radius of the planet)
13. Why G is called universal gravitation constant? (as it is a constant everywhere in the universe)
14. What is the weight of the body at the centre of the earth? (zero)

- 15. Give two uses of a geostationary satellite
- **Used** as weather **satellites** to predict weather of **the satellite**.
- Communication **satellites**. Eg. Dish antennas of TV.

- Military purposes. Activities of other countries can be scanned using these **satellites**.
- GPS. Global Positioning System.

**SHORT ANSWER QUESTIONS - (INTERMEDIATE LEVEL)**:

16. The radius of the Earth is reduced by 1%, mass remains the same. Find the percentage changes in escape velocity.

Ans. $v_e = \sqrt{2gR}$

$$R' = R - 1\%\ of\ R$$

$R' = R\left(1 - \frac{1}{100}\right)$ $= R' = 0.99R$

% decrease in escape velocity = $\frac{v_e - Ve'}{v_e} \times 100$

$= \frac{\sqrt{2gR} - \sqrt{2g}Rx\sqrt{0{\cdot}99}}{\sqrt{2gR}} x\ 100 = \left(1 - \sqrt{0 \cdot 99}\right) x\ 100$ =1%)

17. What are geostationary satellite? What are the conditions necessary for a satellite to be geostationary?

1. it should rotate **about** the axis of rotation of earth with absolutely **zero inclination** and in the **same sense** as rotation of earth (west to east).
2. The period of revolution of satellite must be identical with the **period** of rotation of earth about its axis (**23hrs 56mins**).
3. The satellite must revolve in **earth's equatorial plane** about the axis of rotation of earth the trajectory of satellite must be **circular**.

18. Define escape velocity. Derive an expression for the escape velocity of a body from the surface of Earth.

19. The artificial satellites does not have any fuel, but even then, it remains orbiting around the earth. Why? Explain.

A **Satellite** is a Projectile

Once launched into **orbit**, the only force governing the motion of a **satellite** is the force of gravity. Newton was the first to theorize that a projectile launched with sufficient speed would actually **orbit** the **earth**.

20. Gravitational force between two bodies is 1 N. If the distance between them is made twice, what will be the force?
21. Define gravitational potential at a point. Is it scalar or vector quantity?

(ii) Obtain an expression for gravitational potential at a point due to earth.

## ADVANCED LEVEL QUESTIONS

22. Calculate the escape velocity on the surface of the earth if the radius of the earth = 6400km, G = 6.67 x 10-11 $Nm^2/kg^2$ and density of the earth is 5500kg/$m^3$.

Ans.

$$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2GVd}{R}} = \sqrt{\frac{2G\frac{4}{3}\pi R^3 d}{R}}$$

$$V_e = \sqrt{\frac{8}{3}\pi G R^2 d} = 2R\sqrt{\frac{2\pi G d}{3}}$$

$$V_e = 2\times 6.4\times 10^6 \sqrt{\frac{2\times 3.14\times 6.67\times 10^{-11}\times 5500}{3}}$$

$$V_e = 2\times 6.4\times 10^6 \sqrt{\frac{2\times 3.14\times 6.67\times 550\times 10^{-10}}{3}}$$

$$V_e = 2\times 6.4\times 10^6 \sqrt{\frac{2\times 3.14\times 6.67\times 550}{3}}\times 10^{-5}$$

$$V_e = 2\times 6.4\times 10\sqrt{\frac{2\times 3.14\times 6.67\times 550}{3}} = 11.2\times 10^3 \text{ m/s}$$

$$V_e = 11.2 \text{ km/s}$$

23.i. State Newton's law of gravitation.

ii) What is the force exerted by Big Ben on the Empire State building? Assume that Big Ben has a mass of $10^8$ kilograms and the Empire State building $10^9$ kilograms. The distance between them is about 5000 - kilometres and Big Ben is due east of the Empire State building.

Ans.

$$F = \frac{GM_{ben}M_{empire}}{r^2} = \frac{6.67 \times 10^{-11} \times 10^9 \times 10^8}{(5000000)^2} = 2.67\times10^{-7}N$$

24. On a planet, whose size is the same and mass three times as that of the earth, find the amount of work done to lift 5kg mass vertically upwards through 10m on the planet.
(The value of g on the surface of the earth is 9.8m/s$^2$)
(Ans:1470J) (mgh)

25. (a) Derive an expression for the total energy of a satellite revolving around the surface of the earth.
(b) Calculate the energy required to move a satellite of mass $10^3$ kg from a circular orbit of radius 2R to that of radius 3R. Given mass of the earth, M = 6 x $10^4$ kg and radius of the earth R = 6.4 x $10^6$ m.
( Ans. Total energy of the satellite = E = P.E + K.E

$$= -\frac{GMm}{r} + \frac{1}{2}mv^2$$

$$= -\frac{GMm}{r} + \frac{1}{2}m \cdot \frac{GM}{r} = \frac{-GMm}{r}$$

$$W = E_f - E_i = \frac{-GMm}{2\times3\pi} + \frac{Gm_m}{2\times2R} = \frac{GMm}{12R}$$

$$= 5.02 \text{ x } 10^9 \text{ J}$$

26. What is orbital velocity of a satellite? Derive an expression to find the orbital velocity of a satellite, when it is at a height of 'h' from the surface of Earth. Also derive the expression to find the total energy possessed by this satellite.

27. The mass of the moon is $\frac{1}{80}th$ of the earth and the diameter of the moon is $\frac{1}{4}^{th}$ that of the earth. Given that the escape velocity from the earth's surface is **11**.2 km/s. Find the escape velocity from the surface of the moon.

Ans.

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

For Moon $V_{eM} = \sqrt{\frac{2GM_M}{R_M}}$ ..... (1)

For Earth $V_{eE} = \sqrt{\frac{2GM_E}{R_E}}$ ..... (2)

Dividing equation (1) by (2) we have

$$\frac{V_{eM}}{V_{eR}} = \sqrt{\frac{M_M}{R_M} \times \frac{R_E}{M_E}} = \sqrt{\frac{M_M}{M_E} \times \frac{R_E}{R_M}}$$

$$V_{eM} == \sqrt{\frac{\frac{1}{80} M_E}{M_E} \times \frac{R_E}{\frac{1}{4} R_E}} \times 11.2$$

$$V_{eM} == \sqrt{\frac{4}{80}} \times 11.2 = 2.504 \text{ km/s}$$

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