

# Gravitation

## Worksheet -3

1. Why is gravitational potential energy always negative? 1

Ans. Because gravitational force is attractive in nature.

2. At what height above the surface of the earth value of acceleration due to gravity is reduced to one fourth of its value on the surface of the earth? 2

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

$$\frac{g}{4} = g \left( \frac{R}{R+h} \right)^2$$

$$\frac{1}{2} = \frac{R}{R+h}$$

$$R+h = 2R$$

$$h = R$$

3. Name two factors which determine whether a planet has atmosphere or not? 1

Ans. 1. Acceleration due to gravity at the surface of the planet

2. Surface temperature of the planet

4. What is Kepler's law of periods? Show it mathematically? 2

Ans. It states that the square of the period of revolution of a planet around the sun is proportional of a planet to the cube of the semi-major axis of the elliptical orbit.

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

$$T^2 = k R^3$$

5. With two characteristics of gravitational force? 2

- Ans.
- It is a central force
  - It is a conservative force
  - It obeys inverse square law.
  - It is a universal force and is always attractive in nature.

6. Assuming earth to be a uniform sphere finds an expression for density of earth in terms of g and G? 2

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

$$= \frac{G}{R^2} \left( \frac{4}{3} \pi R^3 \rho \right)$$

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

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

7. If radius of earth is 6400km, what will be the weight of 1 quintal body if taken to the height of 1600 km above the sea level? 2

Ans. Value of g at a height is

$$\begin{aligned}
 g' &= g \left( 1 + \frac{h}{R} \right)^{-2} \\
 &= g \left( \frac{R}{h+R} \right)^2 \\
 &= 9.8 \left( \frac{6400}{1600+6400} \right)^2 \\
 &= 9.8 \left( \frac{6400}{8000} \right)^2 \\
 &= 9.8 \left( \frac{4}{5} \right)^2 \\
 &= 6.27 \text{ ms}^{-2}
 \end{aligned}$$

$$W = mg' = 1000 \times 6.27 = 6270 \text{ N}$$

8. A satellite is revolving in a circular path close to a planet of density  $\rho$ . find an expression for its period of revolution? 2

Ans. Derive  $T = \sqrt{\frac{3\pi}{G\rho}}$

9. How far away from the surface of earth does the value of  $g$  is reduced to 4% of its value on the surface of the earth Given radius of earth = 6400km 2

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

$$\frac{4g}{100} = g \left( \frac{R}{h+R} \right)^2$$

$$\frac{2}{10} = \frac{R}{h+R}$$

$$\frac{1}{5} = \frac{R}{h+R}$$

$$h+R = 5R$$

$$h = 4R = 4 \times 6400 = 25600 \text{ km}$$

10. Obtain an expression showing variation of acceleration due to gravity with height? 2

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