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Effect of gravity by the rotation of earth and the object have different weight in velocity and rest the object have different weight in different direction

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Abstract :-According to Newton's gravitational law each body attract another body which is called gravitational force. Because the earth rotating with the same velocity on its Axis. So the earth create a centripetal force at each body. the body create a circle by the rotation of earth. The gravitational force attract the body and the centripetal force repulsed the body.

Let the mass of earth **Me ,** rotating velocity **Ve** and the mass of body **m.** Centripetal force **Fc** and gravitational force **Fg** then

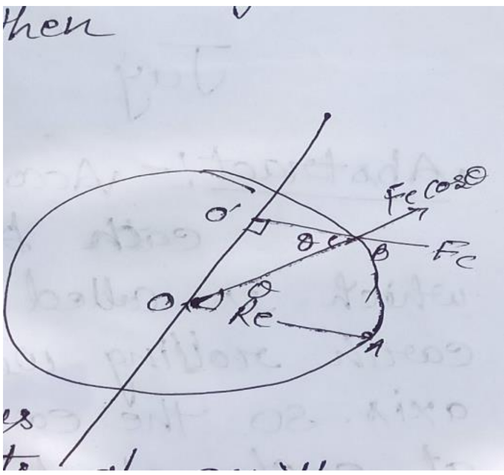
$$mg' = F_g - F_c$$

$$mg' = \frac{GM_e m}{R_e^2} - \frac{mV_e^2}{R_e}$$

Key words:- *Newton's gravitational law and centripetal force*

I. Introduction:-

Let the mass of earth is **Me** and radius **Re.** The mass of body is m when the body is at A point.then



$$mg' = F_g - F_c$$

$$mg' = \frac{GM_e m}{R_e^2} - \frac{mV_e^2}{R_e}$$

Where, Ve is the velocity of earth at A point which is the maximum velocity. Because at point A the radius of earth is greater than all points of Earth.

$$mg' = \frac{GM_e m}{R_e^2} - \frac{mV_e^2}{R_e}$$

- $g' = \frac{GM_e}{R_e^2} - \frac{V_e^2}{R_e}$

Hance, the weight of body and the value of g depends on the rotating velocity of Earth. When Ve maximum then the weight of body is minimum

When the body is at B point. Then the body create a circle of radius O'B. Centripetal force acting in O'B direction and gravitational force acting in OB direction.

Let. $\angle O'BO = \theta$ $then$ $\angle AOB = \theta$

Centripetal force in O'B direction is Fc. Then centripetal force in OB direction is $F_c Cos\theta$.

Let the velocity of body at B point is Ve'. Then

OB=Re

In ΔOO'B

$$Cos\theta = \frac{O'B}{R_e}$$

$$O'B = R_e Cos\theta$$

Then centripetal force in O'B d

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$F_c = \frac{mV_e'^2}{R_e Cos\theta} \; Or \; \frac{m\omega^2(R_e Cos\theta)^2}{R_e Cos\theta} \; Or \; m\omega^2 R_e Cos\theta$

Centripetal force in OB direction.

$$F_c Cos\theta = \frac{mV_e'^2}{R_e Cos\theta} Cos\theta = \frac{mV_e'^2}{R_e}$$

$$= m\omega^2 R_e Cos^2\theta$$

Then the weight of body

$$mg' = \frac{GM_e m}{R_e^2} - \frac{mV_e^2}{R_e^2}$$

$$g' = g - \omega^2 R_e Cos^2\theta$$

At $\theta = 0$

$$g' = g - \omega^2 R_e$$

At $\theta = 0$

The body has minimum weight

At $\theta = 90°$

$$g' = g$$

At $\theta = 90°$

The body has maximum weight

Let a body of mass m is in rest state from the distance of h with the Earth. Let at Earth gravitational acceleration is

g_e and g_h at height . Where height has taken at $\theta = 0$

Where the rotation velocity of body is V_e then at Earth

$$mg_e = \frac{GM_e m}{R_e^2} - \frac{mV_e^2}{R_e^2} R_e$$

$$= \frac{GM_e m - mV_e^2 R_e}{R_e^2} \qquad ---------1$$

The weight of body at h distance. Because the body is in rest state.

$$mg_h = \frac{GM_e m}{(R_e+h)^2} \qquad ---------2$$

Divide equation 2 by 1

$$\frac{mg_h}{mg_e} = \frac{GM_e m}{(R_e+h)^2} \times \frac{R_e^2}{GM_e m - mV_e^2 R_e}$$

$$\frac{g_h}{g_e} = \frac{GM_e R_e^2}{(R_e+h)^2(GM_e - V_e^2 R_e)} \qquad --------3$$

It has cleared by equation 3, the weight of body which is in rest state at h distance depend at the rotational velocity of earth. when V_e is increasing then g_h. is increasing.

When the body is near the earth

Put h=0 in equation 3

$$\frac{g_h}{g_e} = \frac{GM_e R_e^2}{R_e^2(GM_e - V_e^2 R_e)}$$

On putting all values .

we get

$$\frac{g_h}{g_e} = 1.0034$$

Hance the weight of body which is in rest near the earth has some large weight comparison to the body which is at earth surface.

Let the velocity of the body at h distance is V_o. the body is orbit the earth with the direction of rotating Earth.

The weight at earth surface

$$mg_e = \frac{GM_e m}{R_e^2} - \frac{mV_e^2}{R_e^2} . R_e$$

$$mg_e = \frac{m(GM_e - V_e^2 R_e)}{R_e^2} \qquad --------1$$

The weight at h distance

$$mg_h = \frac{GM_e m}{(R_e+h)^2} - \frac{mV_o^2}{(R_e+h)^2}(R_e + h)$$

$$mg_h = \frac{m[GM_e - V_o^2(R_e+h)]}{(R_e+h)^2} \qquad ------2$$

Divide equation 2 by 1

$$\frac{g_h}{g_e} = \frac{[GM_e - V_o^2(R_e+h)]R_e^2}{(GM_e - V_e^2 R_e)(R_e+h)^2} \qquad ------3$$

At h distance the body has zero weight for a certain velocity.

By equation 3, put g_h=0

$$\frac{0}{g_e} = \frac{[GM_e - V_o^2(R_e + h)]R_e^2}{(GM_e - V_e^2 R_e)(R_e + h)^2}$$

$$g_e[GM_e - V_o^2(R_e + h)]R_e^2 = 0$$

$$GM_e - V_o^2(R_e + h) = 0$$

$$V_o^2(R_e + h) = GM_e$$

$$V_o^2 = \frac{GM_e}{R_e + h}$$

The velocity at h height, on which the body has same weight which is on the earth surface.

$$g_h = g_e$$

$$\frac{g_h}{g_e} = 1$$

By equation 3

$$\frac{1}{1} = \frac{[GM_e - V_o^2(R_e + h)]R_e^2}{(GM_e - V_e^2 R_e)(R_e + h)^2}$$

$$[GM_e - V_o^2(R_e + h)]R_e^2 = (GM_e - V_e^2 R_e)(R_e + h)^2$$

Let $R_e + h = r$

$$R_e^2 GM_e - V_o^2 r R_e^2 = GM_e r^2 - V_e^2 R_e r^2$$

$$GM_e R_e^2 - GM_e r^2 + V_e^2 R_e r^2 = V_o^2 r R_e^2$$

$$V_o^2 = \frac{GM_e R_e^2 - GM_e r^2 + V_e^2 R_e r^2}{r R_e^2}$$

$$V_o^2 = \frac{GM_e}{r} - \frac{GM_e r}{R_e^2} + \frac{V_e^2 r}{R_e}$$

Put $r = R_e + h$

$$V_o^2 = \frac{GM_e}{R_e + h} - \frac{GM_e(R_e + h)}{R_e^2} + \frac{V_e^2(R_e + h)}{R_e}$$

Put h=0, hence and earth surface

$$V_o^2 = \frac{GM_e}{R_e} - \frac{GM_e R_e}{R_e^2} + \frac{V_e^2 R_e}{R_e}$$

$$V_o^2 = V_e^2$$

$$V_o = V_e$$

By equation 3 we will get the weight of body which is in velocity. The weights of the body in velocity and rest state are differents . Let the velocity of body is V_o

At Earth surface

$$\frac{g_v}{g_e} = \frac{[GM_e - V_o^2(R_e + h)]R_e^2}{(GM_e - V_e^2 R_e)(R_e + h)}$$

At h=0

$$\frac{g_v}{g_e} = \frac{(GM_e - V_o^2 R_e)R_e^2}{(GM_e - V_e^2 R_e)R_e^2}$$

$$\frac{g_v}{g_e} = \frac{GM_e - V_o^2 R_e}{GM_e - V_e^2 R_e}$$

Where g_v is the gravitational acceleration for dynamic body. And V_o=V_e+V_b

When the body is dynamic in the Earth's rotating direction. Then

$$\frac{g_v}{g_e} = \frac{GM_e - (V_e + V_b)^2 R_e}{GM_e - V_e^2 R_e}$$

Hence, when the velocity of body is increasing then the weight of body is decreasing

When the body is dynamic in opposite direction. Then

$$\frac{g_v}{g_e} = \frac{[GM_e - (V_e - V_b)^2 R_e]}{GM_e - V_e^2 R_e}$$

Hence the body has large weight in opposite direction.