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UTS FFKG

1. Gravity

a. The body weight is 10 times higher than on Earth

i) ~~$M_e = M_p$~~

~~radius of earth~~ ~~radius of new planet~~

$r_e = r_p$

r_e: radius of earth, r_p: radius of new planet

since $F_p = 10 F_e$, where $F = \frac{G M_1 M_2}{r^2}$

$$F_p = \frac{G M . m_p}{r_p^2}$$

$$F_e = \frac{G M . M_e}{r_e^2} \rightarrow F_p = 10 F_e \rightarrow \frac{\cancel{G} \cancel{M} . M_p}{r_p^2} = \frac{10 . \cancel{G} . \cancel{M} . M_e}{r_e^2}$$

where $r_e = r_p \rightarrow \frac{M_p}{\cancel{r_e^2}} = \frac{10 . M_e}{\cancel{r_e^2}}$

$$\frac{M_p}{M_e} = 10$$

∴ The ratio of new planet mass compare to earth mass is 10:1 or 10 times earth mass

ii) $M_e = M_p$

M_e: mass of earth, M_p: mass of new planet

$F_p = 10 F_e$ and $F = \frac{G . M_1 . M_2}{r^2}$

so, $F_p = \frac{G . M . M_p}{r_p^2}$ and $F_e = \frac{G . M . M_e}{r_e^2}$

$$\Rightarrow F_p = 10 F_e$$

$$\Rightarrow \frac{\cancel{G} . \cancel{M} . M_p}{r_p^2} = \frac{10 \cancel{G} . \cancel{M} . M_e}{r_e^2}$$

where $M_p = M_e \Rightarrow \frac{\cancel{M_p}}{r_p^2} = \frac{10 \cancel{M_e}}{r_e^2} \Rightarrow \frac{r_p}{r_e} = \frac{1}{\sqrt{10}}$

∴ the ratio of new planet radius is $1 : \sqrt{10}$ or $\frac{1}{\sqrt{10}}$

iii) Answer :

If we know ~~…~~ nothing about its size and mass of new planet, we can just know about comparing ~~the~~ by the formula of gravitational force. Thus where

$F_p = \frac{G\,M.M_p}{r_p^2}$ and $F_e = \frac{G.M.M_e}{r_e^2}$ where m is the observer mass. Thus the comparison will be

$$F_p = 10\,F_e$$

$$\frac{\cancel{G}\cancel{M}.M_p}{r_p^2} = \frac{10.\cancel{G}.\cancel{M}.M_e}{r_e^2}$$

$$\frac{M_p}{r_p^2} = \frac{10.M_e}{r_e^2}$$

So, we just have that information about the new planet mass and size compare to earth

2. Underwater oscillation

a) Find spring displacement

$\Sigma F = 0$

$k \cdot x_{dis} = m \cdot g$

$k \cdot x_{dis} = \rho_m \cdot V \cdot g$

$\cancel{x_0 = x_{dis} - x_{eq}}$

So the displacement will be $x_{dis} = \dfrac{\rho_m V \cdot g}{k}$

$\cancel{x_{dis} = \dfrac{\rho_m V g}{k} + x_{eq}}$

b. $\ddot{x} + \omega^2 x = C$

where $x = A \cos(\omega t + \phi_0)$

$\ddot{x} = -\omega^2 A \cos(\omega t + \phi_0)$

so, $\ddot{x} + \omega^2 x = C$

$-\omega^2 A \cos(\omega t + \phi_0) + \omega^2 A \cos(\omega t + \phi_0) = C$

$0 = C$

and $\omega = 2\pi f = \sqrt{\dfrac{k}{m}}$

$\omega = \sqrt{\dfrac{k}{V \cdot \rho_m}}$

C. Frequency and period.

$\omega = 2\pi f = \sqrt{\dfrac{k}{V \cdot \rho_m}}$

$f = \dfrac{1}{2\pi}\sqrt{\dfrac{k}{V \cdot \rho_m}}$ $\quad T = 2\pi\sqrt{\dfrac{V \cdot \rho_m}{k}}$

d. $x(t) = A + B \sin(\omega t + \phi)$

B is the Amplitude so, $B = x_0$

A is the vertical shift. so, $A = x_{eq}$

$\omega = 2\pi f = \sqrt{\dfrac{k}{V \cdot \rho_m}}$

we also can calculate ϕ by

$x_{eq} - x_0 = x_{dis}$

$x_{eq} = x_{dis} + x_0$

$= \dfrac{\rho_m V \cdot g}{k} + x_0$

$\cancel{\phi = \cos^{-1}\left(\dfrac{\rho_m V g}{k} + x_0\right)}$

$\phi = \cos^{-1}\left(\dfrac{x_0}{\dfrac{\rho_m \cdot V \cdot g}{k} + x_0}\right)$

f.) Presense of gravity

answer:

Yes, it effect the period and amplitude because the spring constant k is calculated by $k = \frac{\rho_m . V . g}{x_{dis}}$.

3) a. the depth

~~do~~ The percentage of volume submerge is $V_{depth}\% = \left(1 - \frac{\rho_m}{\rho_F}\right) . 100\%$ where 1 represent the full volume.

Since the area is ~~const~~ constant. $V = A.h$. the depth is equal to

$V_{depth} = A.d \quad = V . V_{depth}\% \quad = A.h.\left(1 - \frac{\rho_m}{\rho_F}\right)$

~~$V = V_{depth} \rho_m$~~

$$V_{depth} = A.h\left(1 - \frac{\rho_m}{\rho_F}\right)$$

$$A.d = \cancel{A}.h\left(1 - \frac{\rho_m}{\rho_F}\right)$$

$$d = h\left(1 - \frac{\rho_m}{\rho_F}\right).$$

b. The submerge volume is $V_d = A.d$.

the newton 2nd law $\rightarrow f = m a$. since $a = g$

$F = m.g$ or $F = W$ and $F = \rho . g . V$

$\rho_F . g . V_d = m g$

$\rho_F . A.d = m$.

The restoring force is equal to $= -A y \rho_F g$. Where y is the displacement

~~do~~: $F = m.a$

$a = \frac{F}{m} = \frac{-\cancel{A}y.\cancel{\rho_F}.g}{\cancel{A}.d.\cancel{\rho_F}} = \frac{-g.y}{d}$. So, $a = \frac{-g.y}{d} \Leftrightarrow \frac{y}{a} = \frac{-d}{g}$

Thus, $T = 2\pi\sqrt{\frac{d}{g}}$.

So, the cube will follow the simple harmonic motion c.) Period of oscilation

→ From the answer b, we know that $T = 2\pi\sqrt{\frac{d}{g}}$.

where $d = h\left(1 - \frac{\rho_m}{\rho_F}\right)$.

So. the period is $T = 2\pi\sqrt{\frac{h.\left(1-\frac{\rho_m}{\rho_F}\right)}{g}}$

4. Pitot tube

a). Find P_s.