13F

- ① $l = 0.5m$

$$T = 2\pi\sqrt{\frac{0.5}{9.8}} = \boxed{1.419s}$$

- ② $T = 3s$

$$3 = 2\pi\sqrt{\frac{l}{9.8}}$$

$$9 = 4\pi^2\left(\frac{l}{9.8}\right)$$

$$88.2 = 4\pi^2 l$$

$$l = \frac{88.2}{4\pi^2} = \boxed{2.234m.}$$

- ③ $l = 4m$

$$T = 2\pi\sqrt{\frac{4}{9.8}} = \boxed{4.014s}$$

- ④ $T = 5.5\,s$

$$5.5 = 2\pi\sqrt{\frac{l}{9.8}}$$

$$30.25 = 4\pi^2\left(\frac{l}{9.8}\right)$$

$$296.45 = 4\pi^2 l$$

$$l = \frac{296.45}{4\pi^2} = 7.509m$$

$$\approx \boxed{751cm}$$

• ⑤ $2\left(2\pi\sqrt{\frac{l_1}{g}}\right) : 2\pi\sqrt{\frac{l_2}{g}}$

$2\sqrt{l_1} : \sqrt{l_2}$

$4l_1 : l_2 \quad \therefore$ Ans ⇒ $\boxed{4:1}$

• ⑥ $T = 2\pi\sqrt{\frac{l}{g}}$

$T^2 = 4\pi^2\left(\frac{l}{g}\right)$

$gT^2 = 4\pi^2 l$

$l = \frac{gT^2}{4\pi^2}$

$4\left(\frac{gT_1^2}{4\pi^2}\right) : 9\left(\frac{gT_2^2}{4\pi^2}\right)$

$\therefore 4T_1^2 : 9T_2^2$

$2T_1 : 3T_2.$

Ans ⇒ $\boxed{2:3}$

• ⑦. $T^2 \propto \frac{1}{\sqrt{g}}$ (inversely proportional) (kinda!)

∴ if g decreases, T increases.

∴ clock would go <u>slow</u>.

• ⑧. $T = 1s$

$\therefore (60)(60)(24)$

$= \boxed{86400}$ oscillations per day

• (8) contd.

$2\pi\sqrt{\frac{l}{g}} = 1$

old

(*) new

$T = 2\pi\sqrt{\frac{l(1.02)}{g}}$

$= \sqrt{1.02}\left(2\pi\sqrt{\frac{l}{g}}\right)$

$= \sqrt{1.02}$

$= \boxed{1.01\,s}$

Ans: ~~$\frac{86400}{1.01}$~~ $\frac{86400}{1.01} = 85549$ oscillations.

$= \boxed{851}$ fewer

• (9) 30 oscillations/minute

$T = \frac{60}{30} = \underline{2\,s}$.

$T = \frac{60}{31} = \underline{1.935\,s}$

(*) new.

$2 = 2\pi\sqrt{\frac{l}{g}}$.

old.

$1.935 = 2\pi\sqrt{\frac{l(x)}{g}}$.

$1.935 = \sqrt{x}\left(2\pi\sqrt{l/g}\right)$.

$1.935 = \sqrt{x}\,(2)$.

$\sqrt{x} = \frac{1.935}{2} = \frac{30}{31}$.

$x = 0.937$

Ans = $\boxed{6.35\%}$

• (10).

$T_1 = 2\pi\sqrt{\frac{l}{g}}$ $\quad$ $T_2 = 2\pi\sqrt{\frac{2l}{g}}$

$$T_2 = \sqrt{2}\left(2\pi\sqrt{\frac{l}{g}}\right)$$

$$T_2 = \sqrt{2}\, T_1.$$

$$\frac{T_2}{T_1} = \sqrt{2} = 1.414$$

$\approx$ **41% increase**

• (11). earth $\quad$ moon

$T_e = 2\pi\sqrt{\frac{8l}{g}}$ $\quad$ $T_m = 2\pi\sqrt{\frac{3l}{g/6}}$

$$= 2\pi\sqrt{\frac{18l}{g}}$$

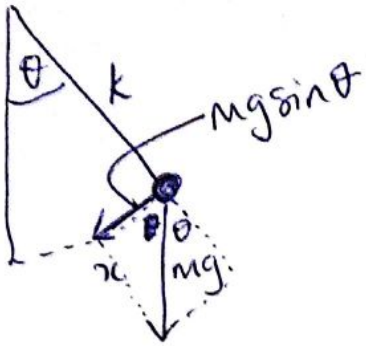
$$= \sqrt{\frac{9}{4}}\left(2\pi\sqrt{\frac{8l}{g}}\right)$$

$$T_m = \frac{3}{2}(T_e)$$

$$\frac{T_m}{T_e} = \frac{3}{2}.$$

$\therefore$ Ans = **3 : 2**

(12) (i) $l = k$



$F = -mg\sin\theta$

but: $\sin\theta \approx \theta$ when θ small.

$\therefore F = -mg\theta$.

also: $x = k\theta$.

$\theta = \frac{x}{k}$.

$\therefore F = -mg\left(\frac{x}{k}\right)$

$ma = -mg\left(\frac{x}{k}\right)$

$$\boxed{a = -\frac{g}{k}x.}$$ $\therefore$ SHM

$\omega^2 = \frac{g}{k}$

$\omega = \sqrt{g/k}$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{g/k}} = \boxed{2\pi\sqrt{\frac{k}{g}}}$

QED

(iii) $T = 2\pi\sqrt{\frac{k}{g}}$

$$T^2 = 4\pi^2\left(\frac{k}{g}\right)$$

$$gT^2 = 4\pi^2 k$$

$$\boxed{g = \frac{4\pi^2 k}{T^2}}$$

(iii) $l = 0.6\,m$

$f = 39/min$

$\therefore T = \frac{60}{39} = \frac{20}{13}\,s$

$$g = \frac{4\pi^2(0.6)}{\left(\frac{20}{13}\right)^2} = \boxed{10.008}\,m/s^2.$$

(iv) error $= 0.208$

$$\therefore Ans = \frac{0.208}{9.8} \times 100 = \boxed{2.12\%}$$

$$\approx \underline{2\%}.$$