0324 phy 240 Wikiquiz Centripetal Acceleration and surface gravity

(1) Version A

$\omega T = 2\pi = .15\,T \rightarrow T = \frac{2\pi}{.15}$

$T = \frac{2\pi}{.15} = \frac{\#sec}{\#rev}$ = period. Here #rev = 8.5

$\#sec = \frac{2\pi}{.15}(8.5) = \frac{2\pi}{.15\ sec^{-1}}(8.5\ rev)$

note units: $\omega = .15\ \frac{rad}{sec} = .15\ s^{-1}$

radian and revolution are dimensionless!

$t = \#sec = \frac{2(8.5)\pi}{.15} = 356\,s\left(\frac{1\,min}{60\,s}\right)$

$t = \boxed{= 5.93\ min}$ checks

t = time for 8.5 revs.

Be sure to invent different symbols for t = time for 8.5 revs and T = time for 1 rev.

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(2) $T = .22\ min$ = period $\quad r = 1.64\ m$ $\quad M = 81.2\ kg$

Want $F = \frac{Mv^2}{r}$

$T = (.22\ min)\left(\frac{60\,sec}{1\,min}\right) = (.22)(60)$ sec

watch units!

use $vT = 2\pi r$ = circumference.

$v = \frac{2\pi r}{T}$

$F = \frac{Mv^2}{r} = \frac{M}{r}\left(\frac{2\pi r}{T}\right)^2 = 4\pi^2\frac{Mr}{T^2}$ – units check

$F = \frac{4\pi^2(81.2)(1.64)}{(.22)^2(60)^2} = \boxed{30.17\ N} \approx 30.2\ N$ checks

(3) Same system as previous.

$F = 30.17 = \mu mg \Rightarrow \mu = \dfrac{30.17}{(81.2)(9.8)}$

$\boxed{\mu = .038}$ ⇝ double check:

$f = \mu mg = ma = \dfrac{mv^2}{r} \Rightarrow \mu = \dfrac{v^2}{rg}$ solve for μ:

$v = \dfrac{2\pi r}{T}$ where $T = (.22)(60)$ sec.

$r = 1.64$ m

$v = \dfrac{(2\pi)(1.64)}{(.22)(60)} = .78$ m/s $= \boxed{.7806 \text{ m/s} = v}$

$\mu = \dfrac{(.7806)^2}{(1.64)(9.8)} = \boxed{.038}$ checks.

(4) $F = mg = G\dfrac{mM}{r^2} \rightarrow g^* m \rightarrow \boxed{g^* = \dfrac{MG}{r^2}}$

$g^* = \text{const}\dfrac{M}{r^2}$ M = mass of planet
r = radius of planet.

$g^* = \dfrac{M}{r^2}(9.8 \text{ m/s}^2)$ M = mass in Earth masses
r = radius in Earth radii

$g^* = \dfrac{2.37}{(1.52)^2}(9.8) = \boxed{10.05 \text{ m/s}^2} \approx 10.1 \text{ m/s}^2$ checks

(5) $g^* = \frac{MG}{r^2}$ ρ = density = $\frac{M}{Vol.}$

$M = \rho \cdot$ volume

Need volume of sphere:

$Vol. = \frac{4\pi}{3} r^3$ but you only need

$Vol = \text{const.}\ r^3$

$M = \text{const}\ \rho r^3$

$g^* = \text{const.}\ \frac{\rho r^3}{r^2} = \text{const} \cdot \rho \cdot r$

$g^* = 9.8 \frac{m}{s^2}$ if $r = 1\ R_\oplus$ ← earth radius

$\rho = 1\ \rho_\oplus$ ← Earthly density.

$g^* = \rho r (9.8)\ m/s^2$

where ρ in units of Earth density

r in units of Earth radius.

$g^* = (2.38)(2.89)(9.8) = \boxed{67.4 \frac{m}{s^2} = g^*}$

Checks.