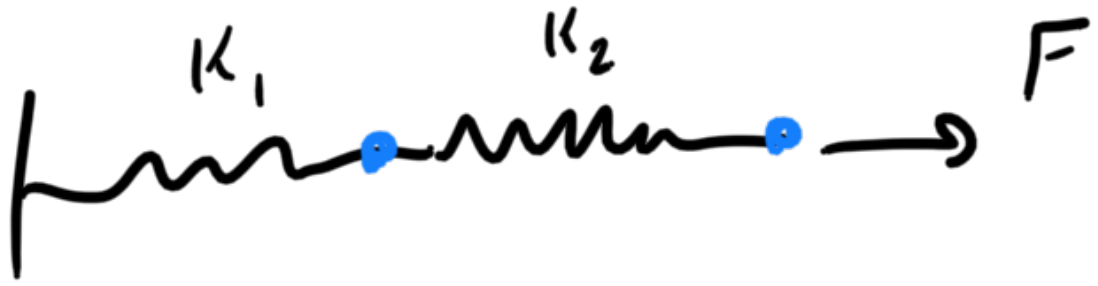
1/17 - Normal program

1/24 - Practice exam

1/31 - Review "

2/7 - Topics by request

2019 B #3



$$\frac{U_1}{U_2} = ?$$

Topic 4 in F=ma Physics

x_1, x_2 = stretch distances

$k_1 x_1 = k_2 x_2$ since forces are equal

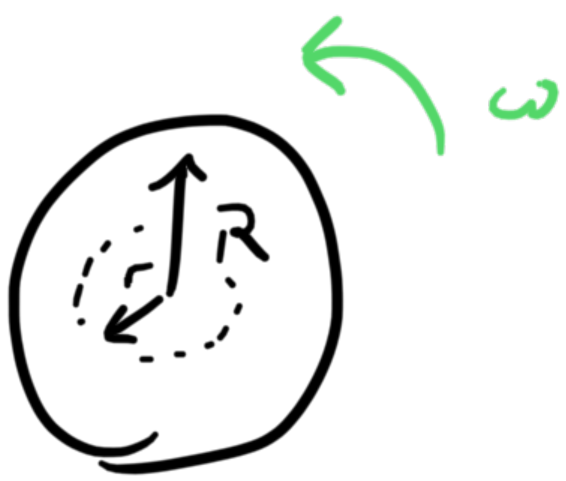
$$U_n = \frac{1}{2} k_n x_n^2 = \frac{1}{2}(k_n x_n)^2 \frac{1}{k_n}$$

$$\frac{U_1}{U_2} = \frac{\cancel{\frac{1}{2}}\cancel{(k_1 x_1)^2}\frac{1}{k_1}}{\cancel{\frac{1}{2}}\cancel{(k_2 x_2)^2}\frac{1}{k_2}} = \frac{k_2}{k_1}$$

C

2019B#6

$\rho(r) \propto r^n \qquad n = ?$



mass of ring $= 2\pi r \lambda$

centripetal force $= 2\pi r^2 \omega^2 \lambda$

force of gravity (inner circle) $= \dfrac{G M_{ring} M}{r^2} = F_g$

$$F_g = \frac{2\pi r \lambda M}{r^2} = 2\pi r^2 \omega^2 \lambda$$

$$\frac{\cancel{2\pi} r \cancel{\lambda} M}{r^2} = \cancel{2\pi} r^2 \omega^2 \cancel{\lambda}$$

$$\frac{M}{r} = \omega^2 r^2$$

$$M = \omega^2 r^3$$

2019B #6

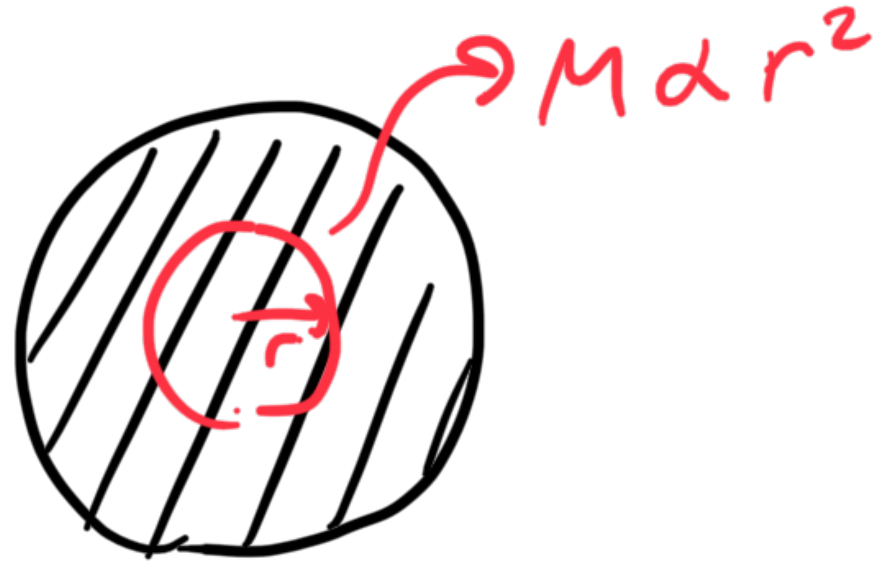
Gauss' Law for gravity

enclosed mass

$$2\pi r \ell g = 4\pi G M$$

λ = length density

$$g = \frac{2GM}{r\ell} = \frac{2G\lambda}{r}$$



$$g = \omega^2 r$$

$$\omega^2 r = \frac{2G\lambda}{r} \Rightarrow \lambda = \frac{\omega^2 r^2}{2G}$$

$$\lambda \propto r^2$$

since cylinder area $\propto r^2$,

$\rho \propto$ constant.

C

2019B #10

$V_{cart} = ?$ when ball is at the bottom of the bowl.

No external horizontal forces!

Conservation of momentum

$$(M_c + m)\, v_0 = (M_c + m)\, v_c + m v_b$$

$$v_c = v_0 - \frac{m}{M_c + m} v_b$$

D

2019B#13

$$H = \frac{1}{2}vt = \frac{v^2}{2g}$$

$$W = v\sin\theta \cdot \frac{2v\cos\theta}{g} = v^2\frac{\sin 2\theta}{g}$$

$H, W \propto v^2$

D

$v = [L]/[T]$

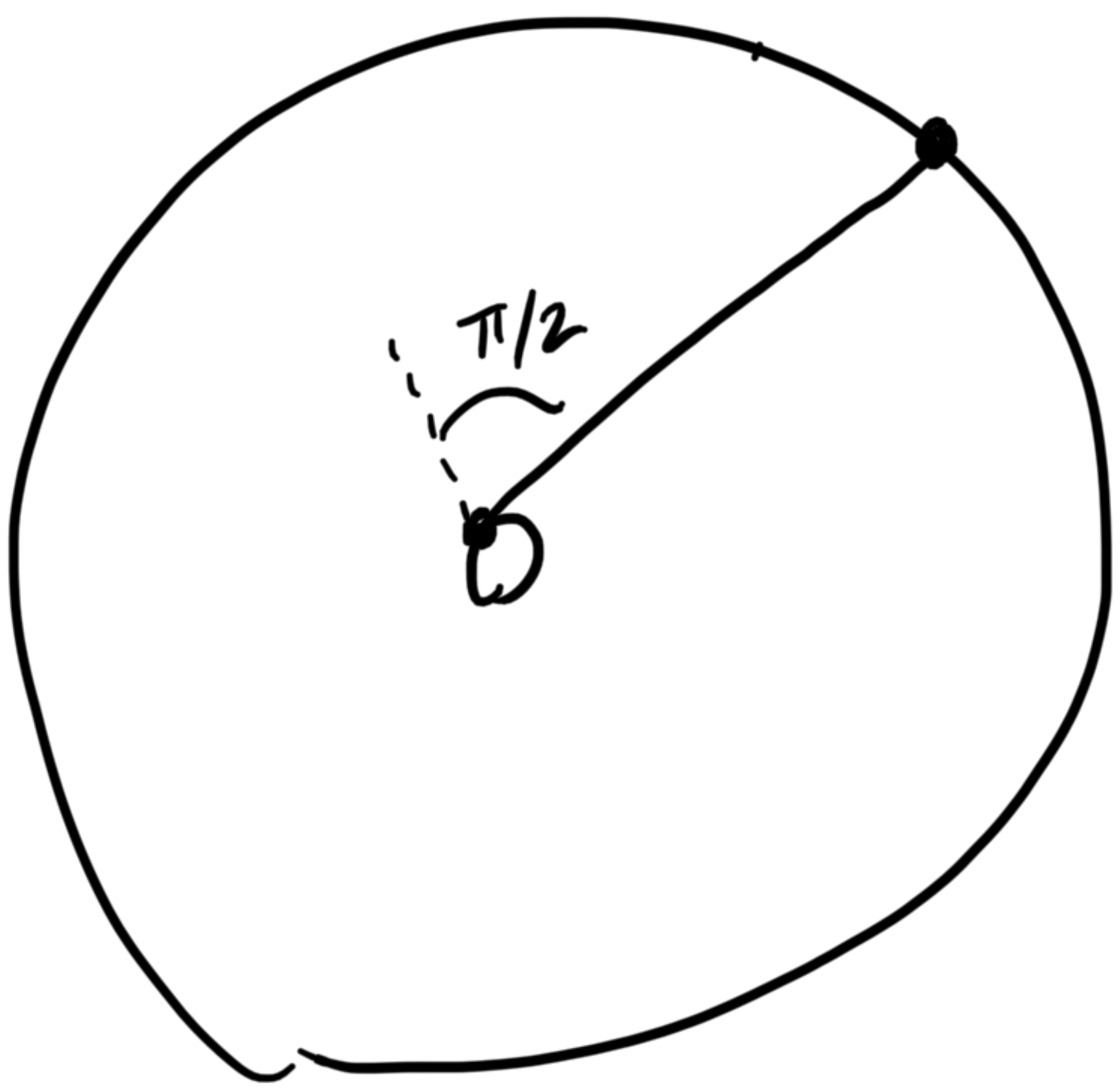
$g = [L]/[T]^2$

$[L] = v^2/g$

all lengths scale with v^2.

D

2019 B #15



tangential tension = air resistance.

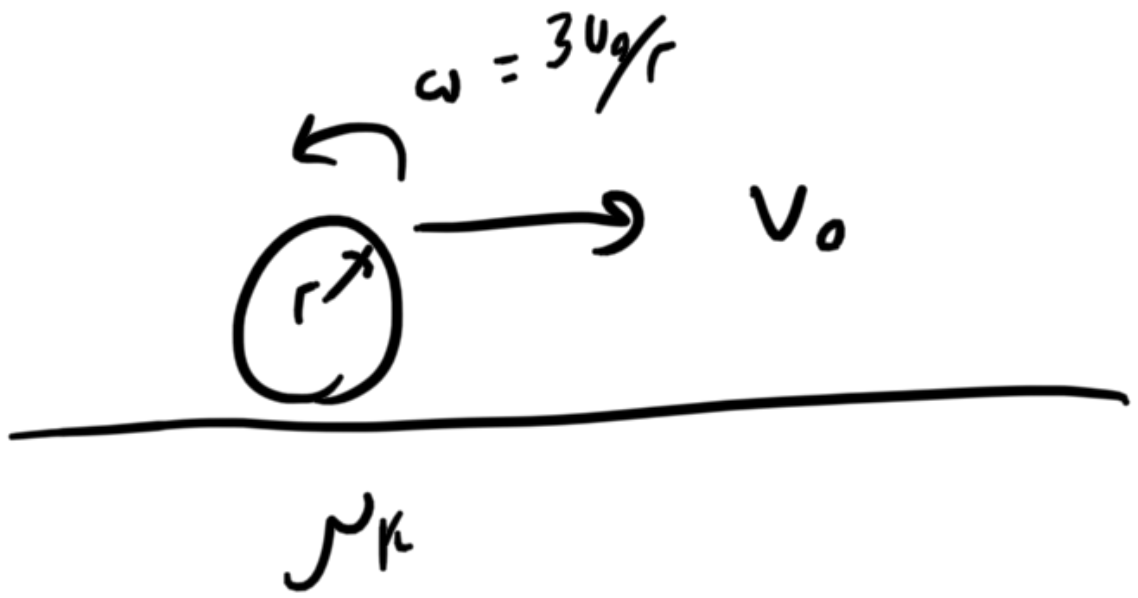
$T = MR\omega^2 = 20\,N$

similar triangles says

$T_{tang} = \frac{r}{R} T = 0.3\,N$

$= F_{ar}$ D

2019B #16



How long does it take for hoop to return to its starting position?

slipping

$v_c(t) = v_0 + at$ $\qquad v_0 = v_0 \qquad \omega_0 = -3v_0/r$

$\omega(t) = \omega_0 + \alpha t$ $\qquad a = -\mu g \qquad \alpha = -\mu g/r$

stops slipping at T s.t.

$v_c(T) = r\omega(T) \Rightarrow T = 2v_0/\mu g$

$v_c(T) = -v_0 \qquad \omega(T) = -v_0/r$

$$x(T) = v_0 T + \tfrac{1}{2}aT^2 = v_0\frac{2v_0}{\mu g} - \frac{1}{2}\mu g\left(\frac{2v_0}{\mu g}\right)^2 = 0$$

thus it has returned to the initial position exactly when it stops slipping.

B

2019B #17

How would #16 change for a disk rather than hoop?

$$\alpha' = 2\mu g/r$$

$$T' = \frac{4v_0}{3\mu g} \Rightarrow v_c(T) = \frac{-v_0}{3} \qquad x(T) = \frac{4v_0^2}{9\mu g}$$

A or D

$$T_{tot} = T' + \frac{x(T)}{|v(T)|} = \frac{4v_0}{3\mu g} + \frac{4v_0}{3\mu g} = \frac{8v_0}{3\mu g} \neq T$$

D