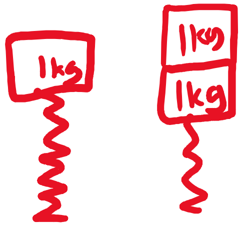
A 1 kg mass sits on a spring with k=1000N/m. If we add another 1kg mass on top, the amount by which the equilibrium position changes is:

A) 1cm
B) 2cm
C) 10cm
D) 1m
E) It can’t be determined without knowing the unstretched length of the spring.



A 1 kg mass sits on a spring with k=1000N/m. If we add another 1kg mass on top, the amount by which the equilibrium position changes is about:

A) 1cm
B) 2cm
C) 10cm
D) 1m
E) It can't be determined without knowing the unstretched length of the spring.

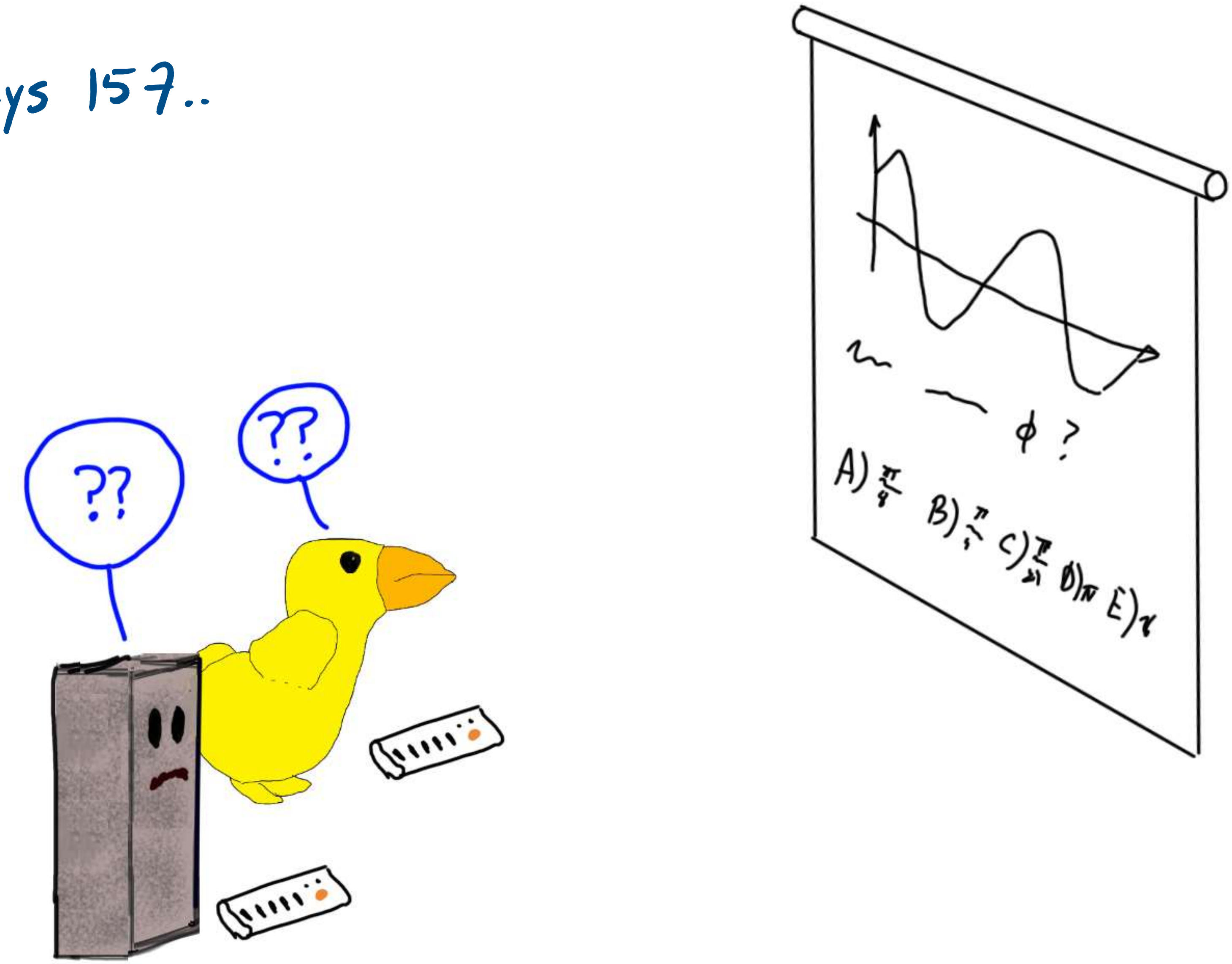
At equilibrium, compression of the spring is determined by $F_{NET} = 0$

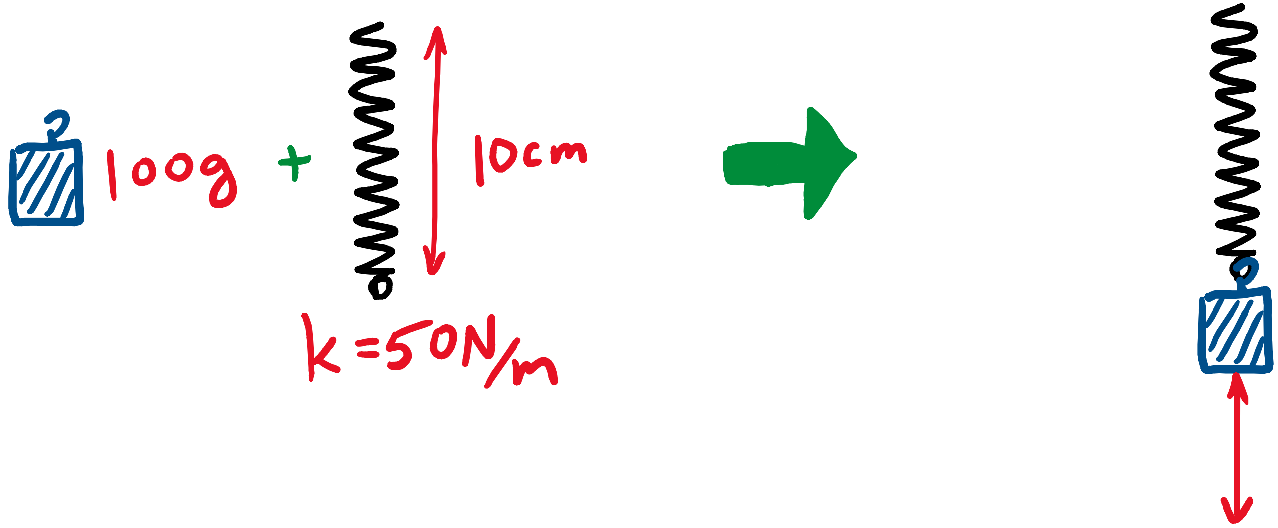
$mg = kx$

With different masses, $\overset{1kg}{m_1} g = kx_1$, and $\overset{2kg}{m_2} g = kx_2$, so when we add the extra mass, $\Delta m \cdot g = k \cdot \Delta x$. Thus: $\Delta x = \frac{\Delta m g}{k}$

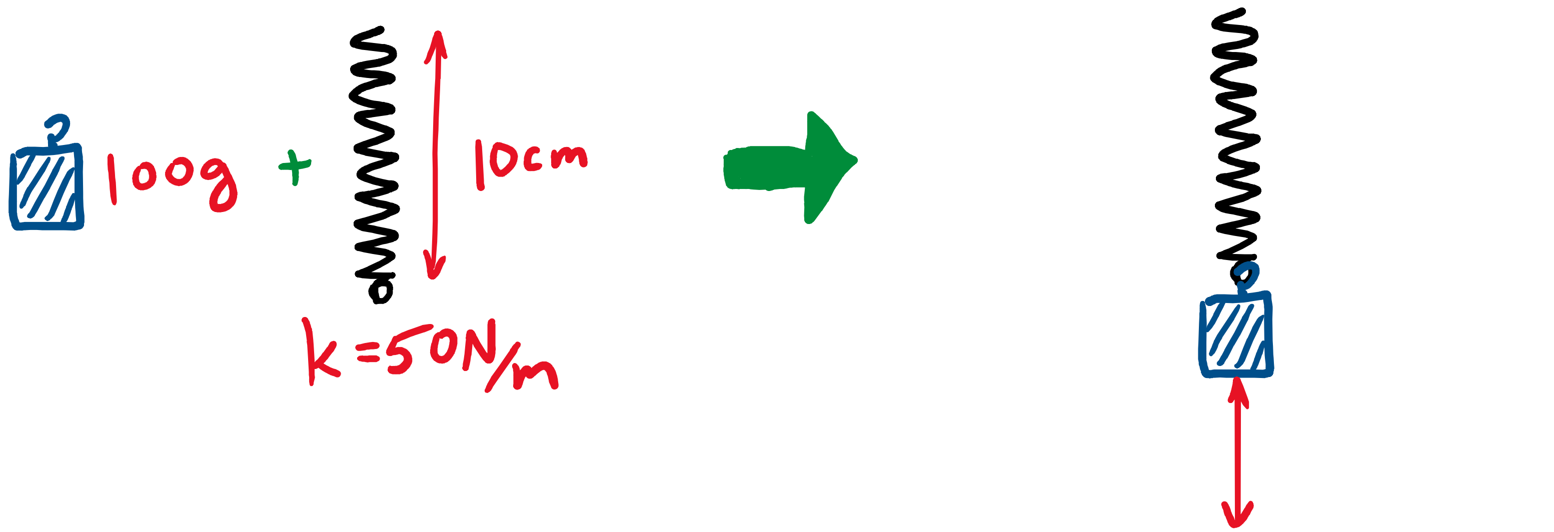
$= 1cm$

Last time in Phys 157..



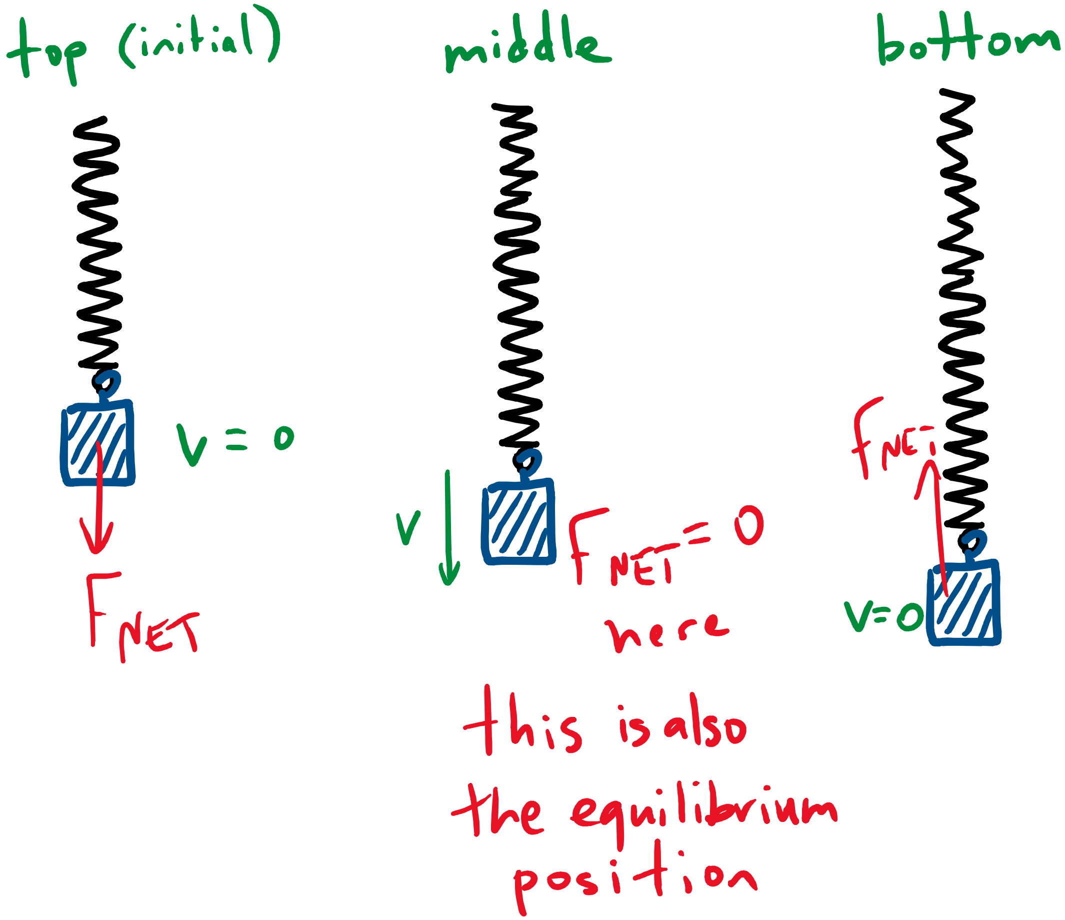


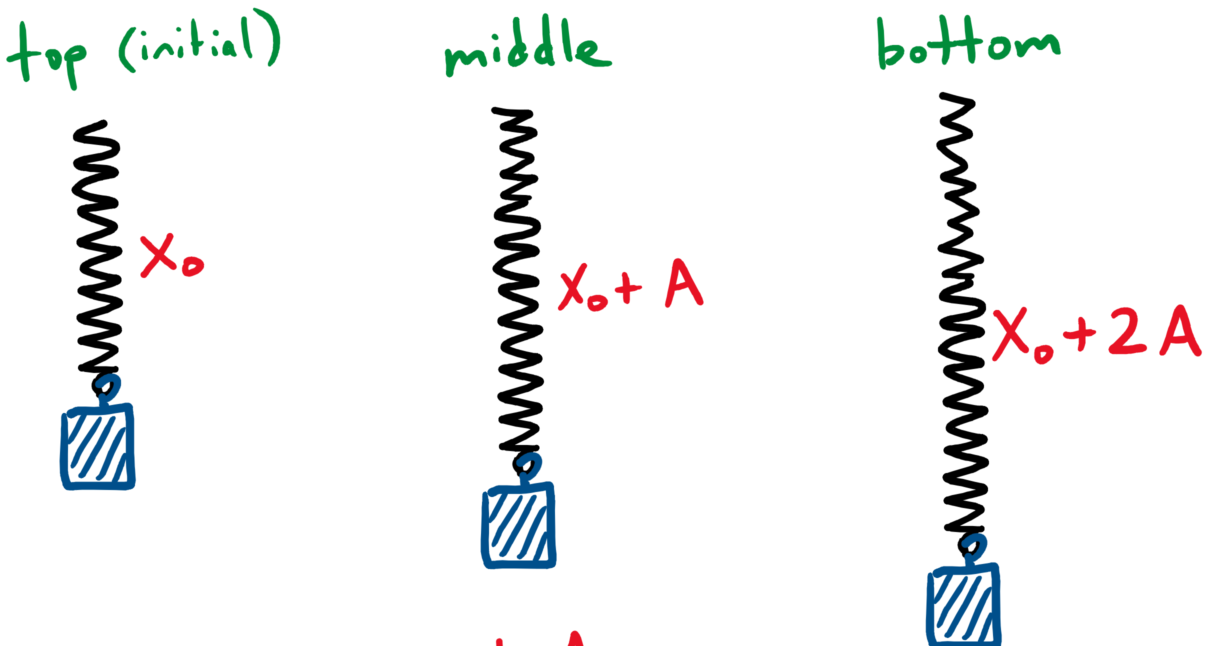
Discussion question: A 10cm long spring has a spring constant of 20 N/m. If we attach a 100g weight to the spring and release it, what will be the amplitude of the resulting oscillation?



Discussion question: A 10cm long spring has a spring constant of 20 N/m. If we attach a 100g weight to the spring and release it, what will be the amplitude of the resulting oscillation?

A) 1cm B) 2cm C) 3cm D) 4cm E) 5cm


top (initial)
v = 0
F NET
middle
v
F NET = 0
here
this is also
the equilibrium
position
bottom
F NET
V=0



Middle position is equilibrium position,
so $F_{NET} = mg - kA = 0$ here.

$$A = \frac{mg}{k} = \frac{1\,N}{50\,N/m} = 2\,cm$$

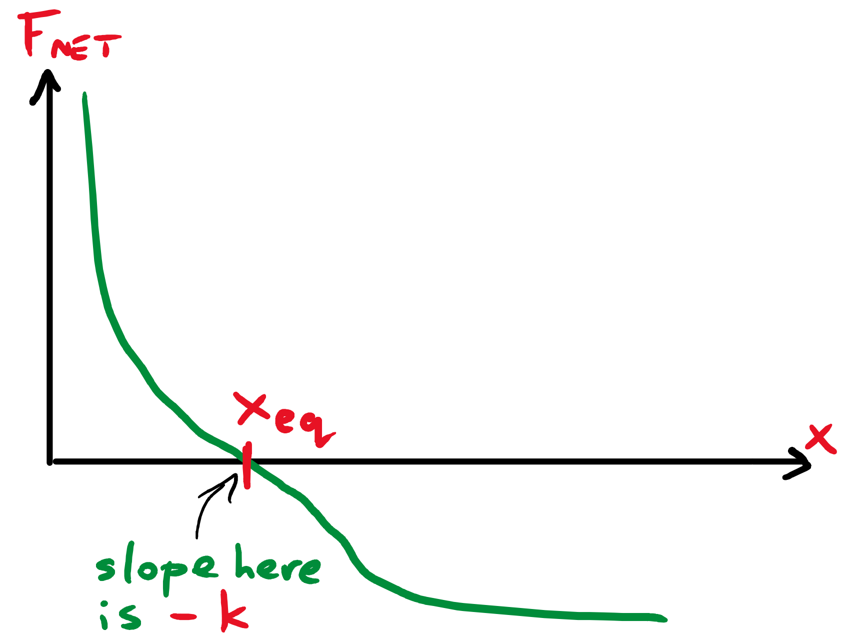
How to find ω in examples:

1. Find F_{NET} as a function of position x

2. Find equilibrium value x_{eq} by solving $F_{NET}(x_{eq}) = 0$.

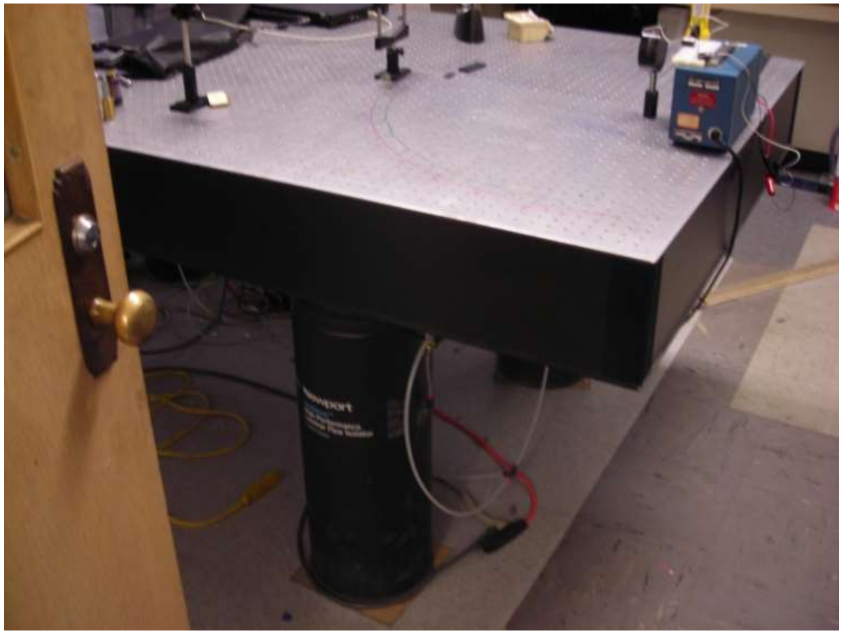
3. $-k$ is $F_{NET}'(x_{eq})$, the slope at x_{eq}.

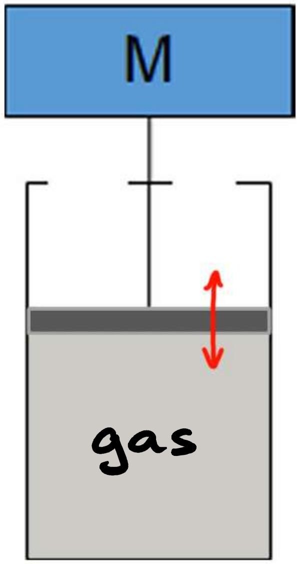
4. Then $\omega = \sqrt{\frac{k}{m}}$



Example: air leg

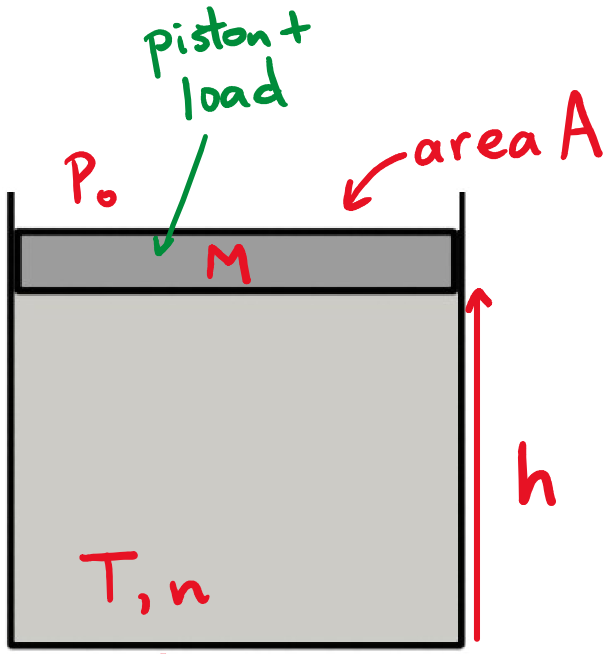
- used to isolate sensitive equipment from vibration.





assume: any motion of piston is slow
so compression/expansion is isothermal

Example: air leg



$P_0 = 100\,\text{kPa}$

$M = 200\,\text{kg}$

$g \approx 10\,\text{m/s}^2$

$A = 0.03\,\text{m}^2$

$T = 300\,\text{K}$

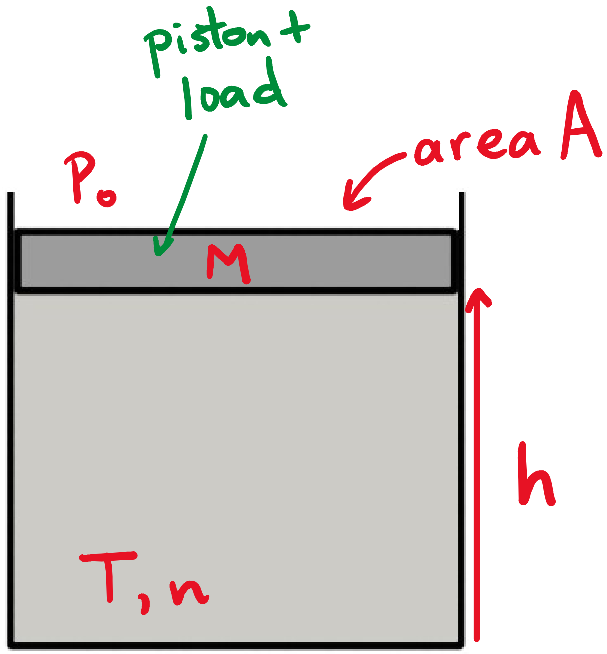
$n \cdot R = 5\,\text{J/K}$

a) Draw a free body diagram for the object of mass M showing the vertical forces.

b) Calculate the magnitude of the net upwards force on the object as a function of the height h of the piston.

Your answer should be a function of h

Example: air leg



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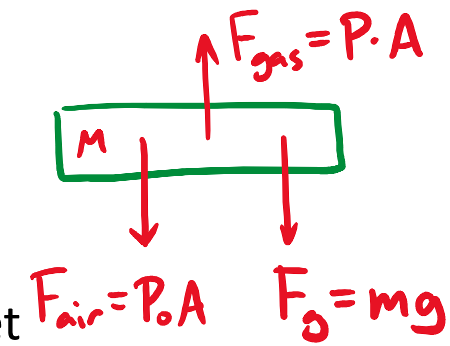


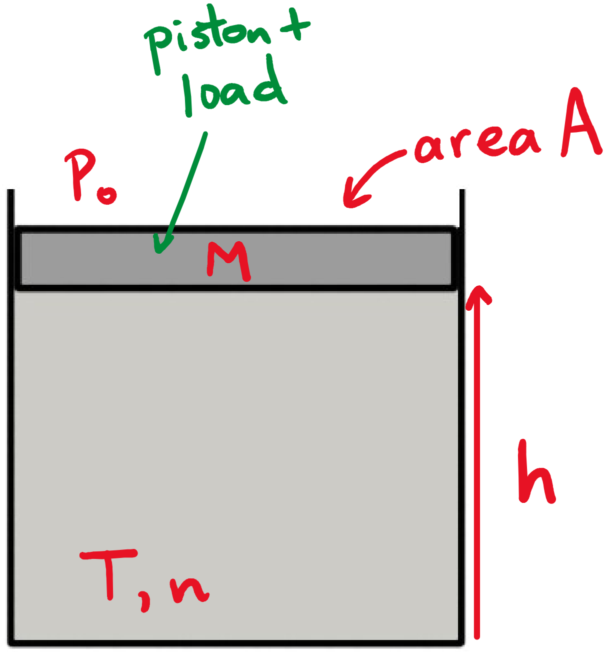
b) Calculate the magnitude of the net upwards force on the object as a function of the height h of the piston.

$$\text{Have: } P = \frac{nRT}{V} = \frac{nRT}{A \cdot h}$$

$$\text{so } F_{gas} = PA = \frac{nRT}{h}$$

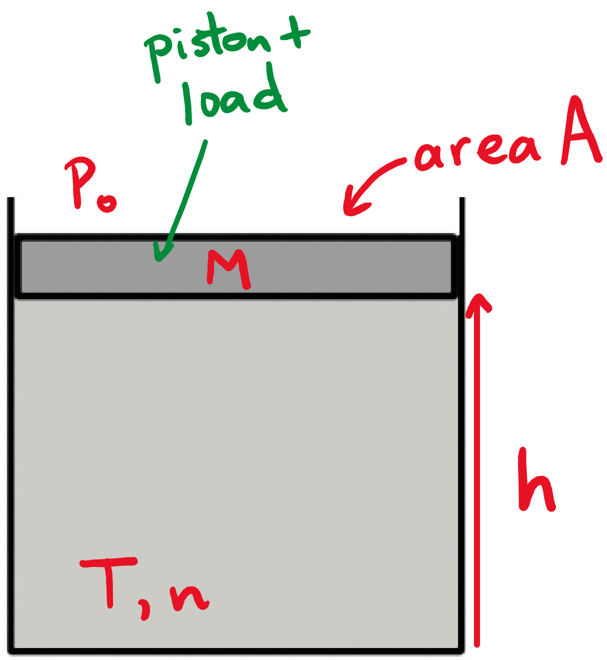
$$F_{NET}^{up} = \frac{nRT}{h} - P_0 A - mg = \frac{1500\,J}{h} - 5000\,N$$

Example: air leg



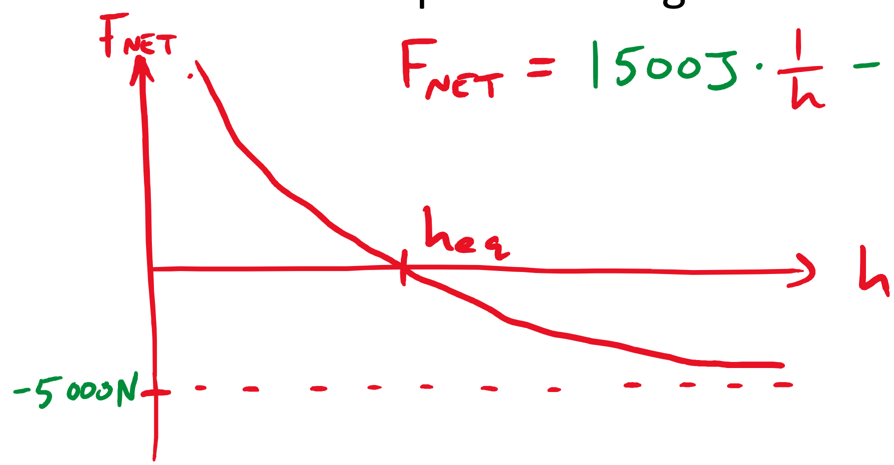
c) Graph this upward force as a function of h, for positive values of h up to the height of the object.

Example: air leg

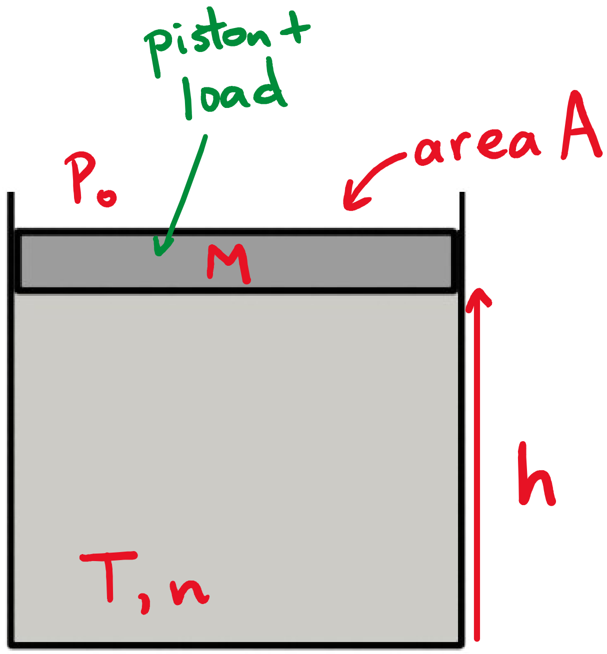


c) Graph this upward force as a function of h, for positive values of h up to the height of the object.

$$F_{NET} = 1500J \cdot \frac{1}{h} - 5000N$$



Example: air leg



d) What is the equilibrium height of the piston?

e) What is the oscillation frequency f?