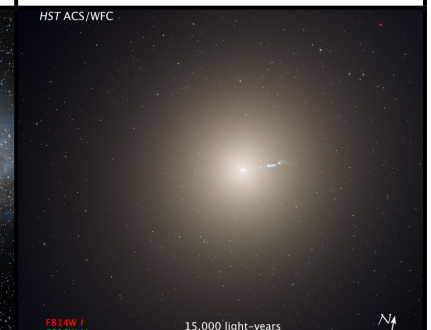
An object hangs motionless from a spring. When the object is pulled down, the sum of the elastic potential energy of the spring and the gravitational potential energy of the object and Earth

A. increases.

B. stays the same.

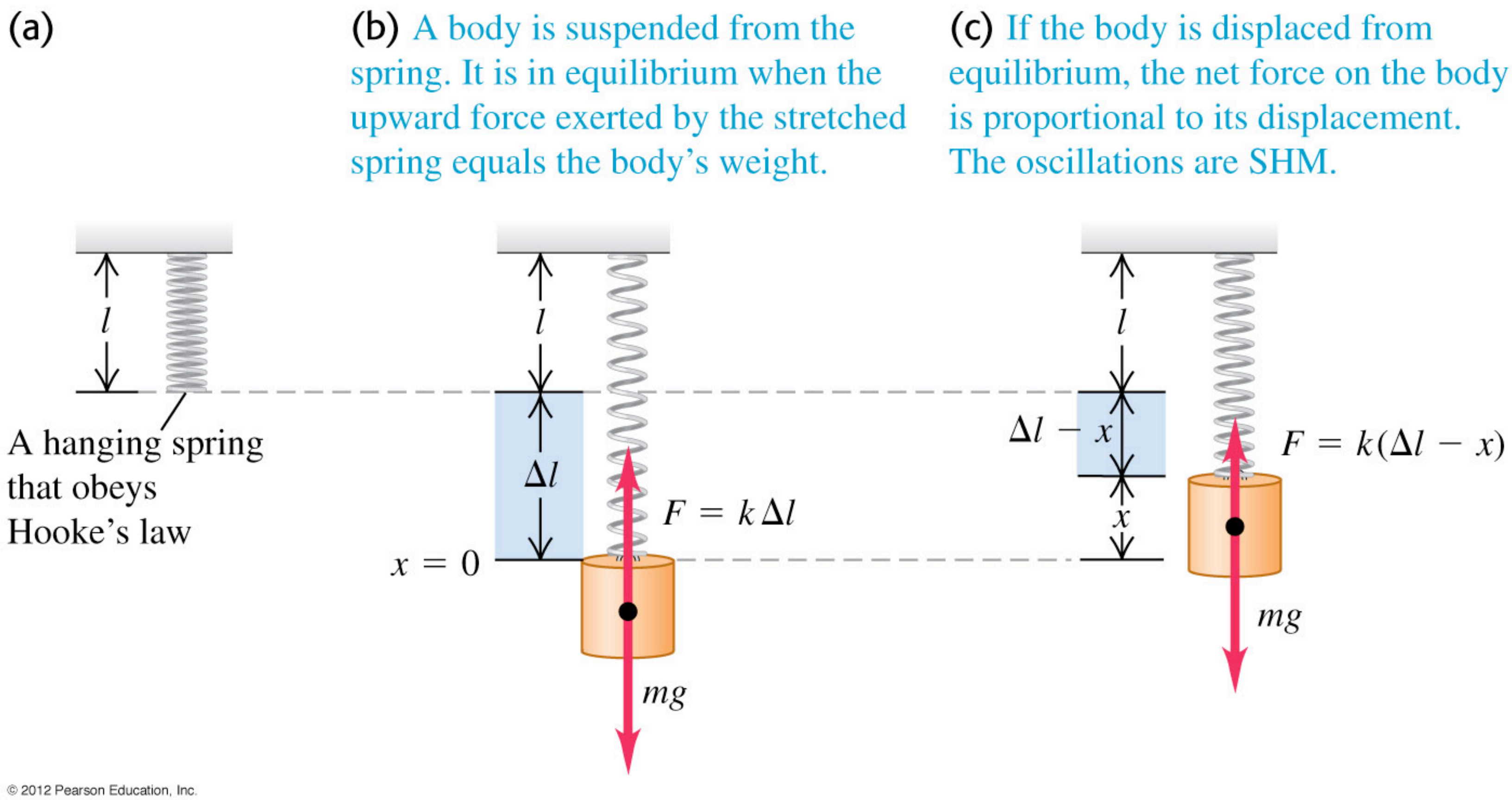
C. decreases.

	Milky Way	Andromeda	M87
Galaxy			
Mass of SMBH	$4\times10^{6}\ M_{\odot}$	$\sim1.5\times10^{8}\ M_{\odot}$	$6.4\times10^{9}\ M_{\odot}$
Schwarzchild radius	1×10^{10} m	$\sim4.4\times10^{11}$ m	1.9×10^{13} m
SMBH density	1×10^{6} kg/m^3	~800 kg /m^3	0.45 kg/m^3

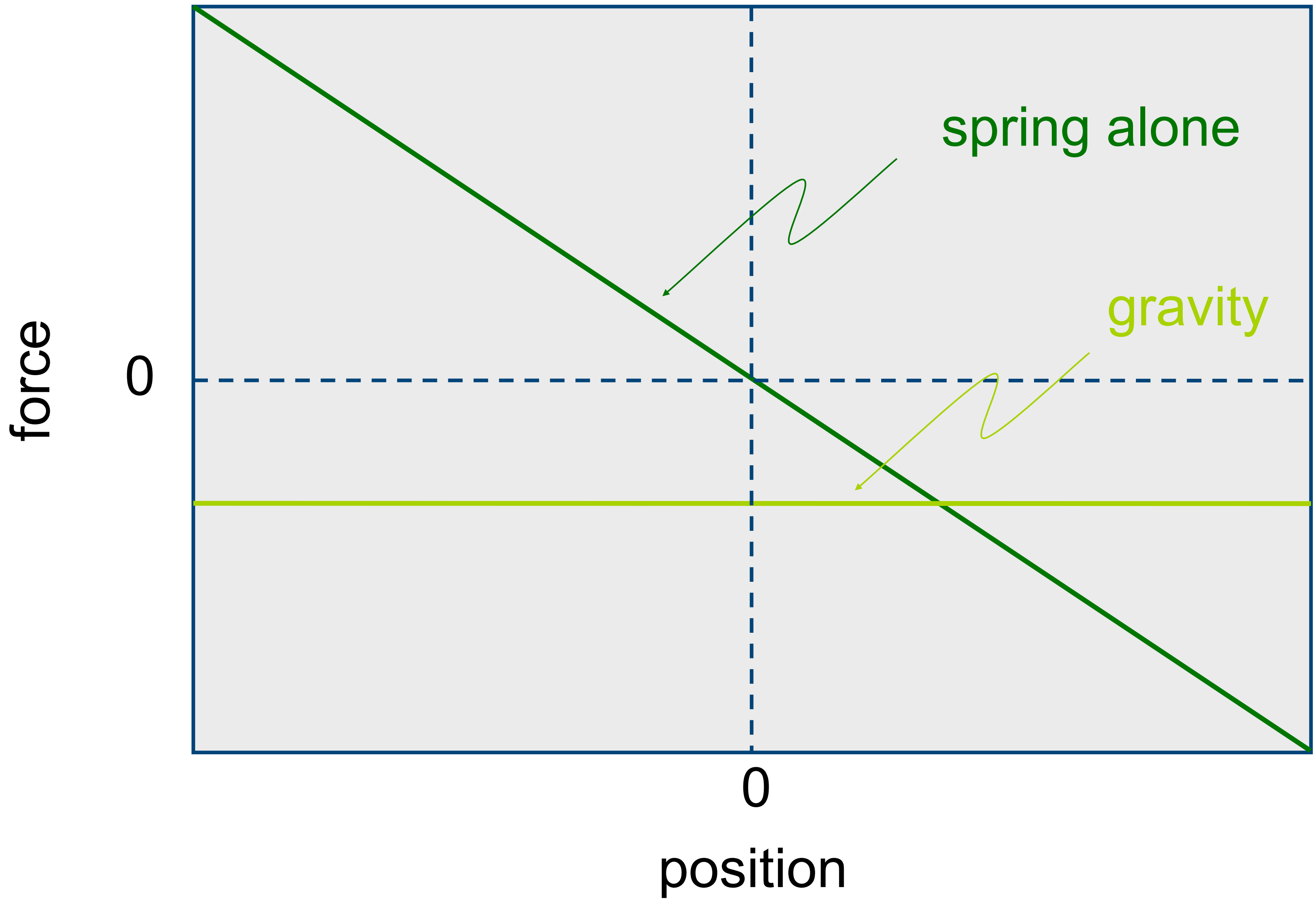
Ch 14.4-6
Pendula

PHYS 1210 -- Prof. Jang-Condell

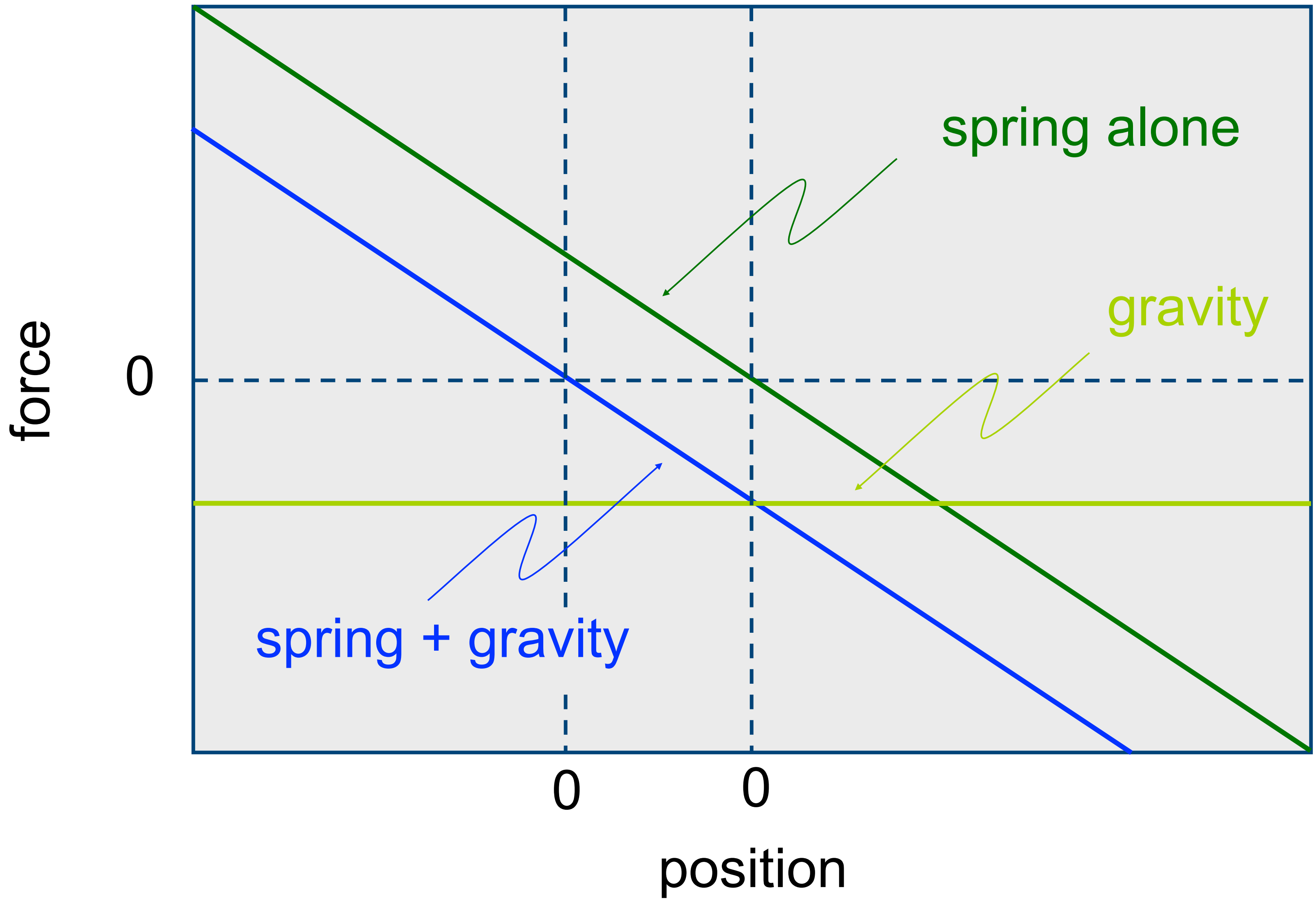
Spring + Gravity



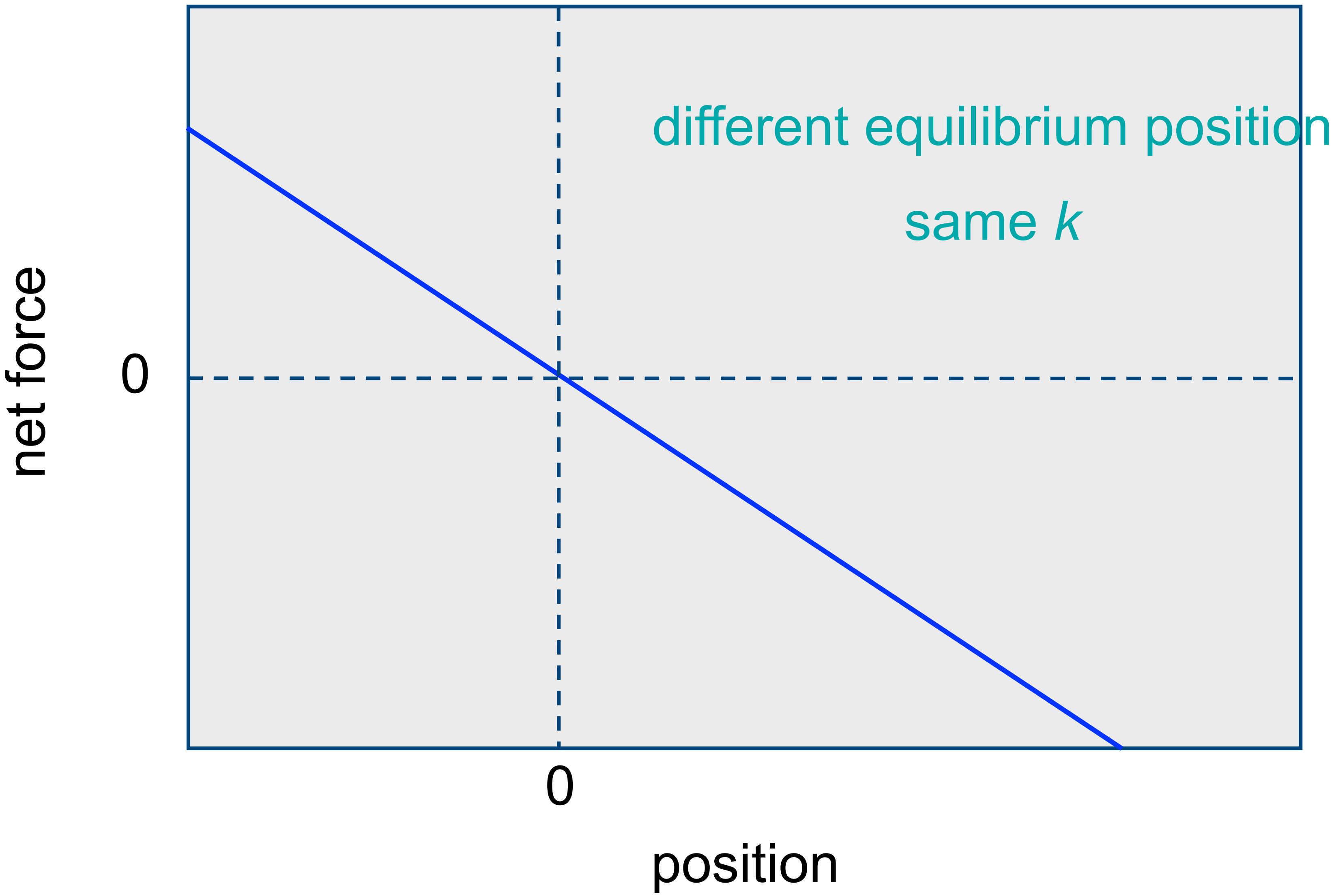
Spring + Gravity



Spring + Gravity



Spring + Gravity



Simple Harmonic Motion

$$x = A\cos(\omega t + \phi) \qquad \text{(displacement in SHM)}$$

$$\omega = \sqrt{\frac{k}{m}}$$

$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$$

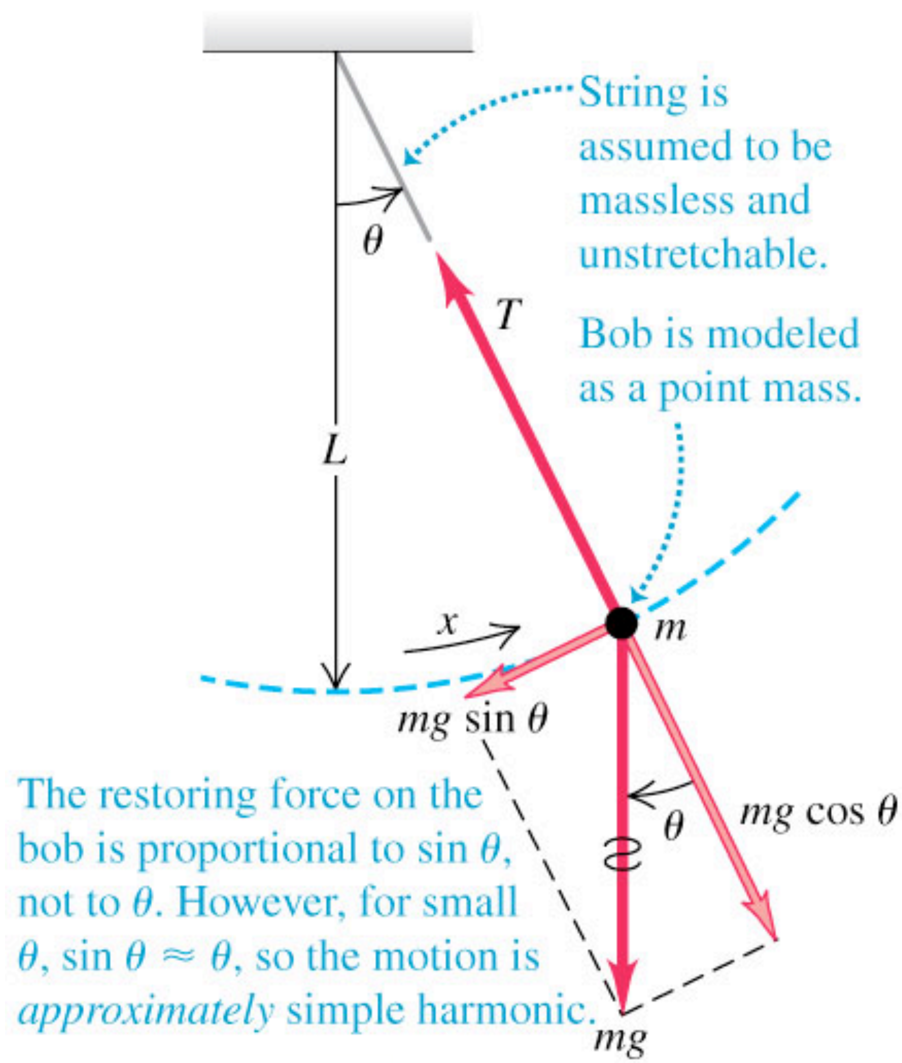
$$T = \frac{1}{f} = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}$$

$$E = \tfrac{1}{2}m{v_x}^2 + \tfrac{1}{2}kx^2 = \tfrac{1}{2}kA^2 = \text{constant}$$

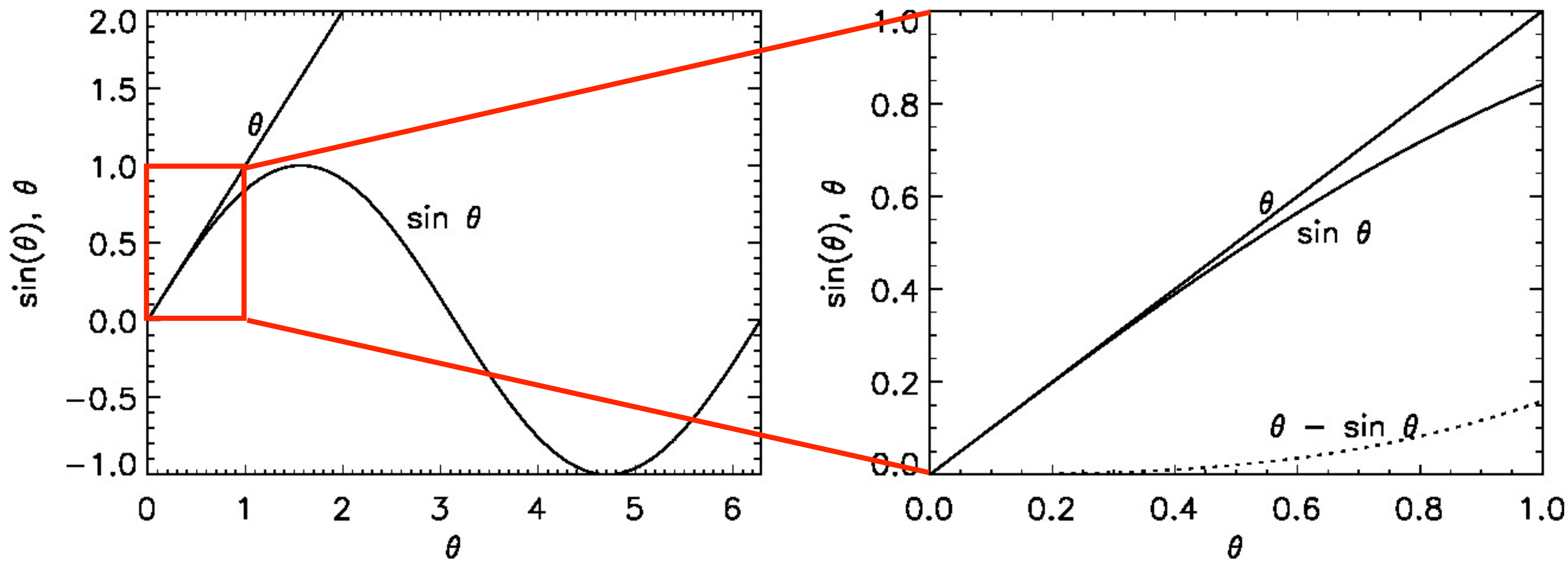
The simple pendulum

- A *simple pendulum* consists of a point mass (the bob) suspended by a massless, unstretchable string.
- If the pendulum swings with a small amplitude θ with the vertical, its motion is simple harmonic. (See Figure 14.21 at the right.)

(b) An idealized simple pendulum



Small angle approximation



$\sin\theta \sim \theta$ for $\theta \ll 1$

Simple Pendulum

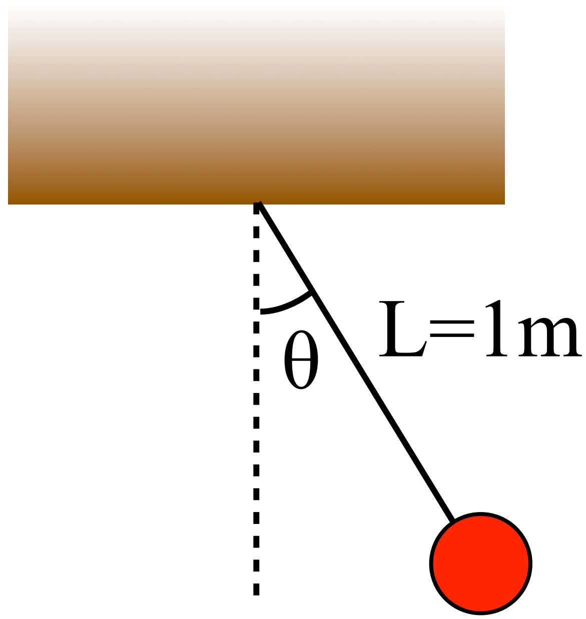
$$x = A\cos(\omega t + \phi) \qquad \text{(displacement in SHM)}$$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{mg/L}{m}} = \sqrt{\frac{g}{L}} \qquad \text{(simple pendulum, small amplitude)} \qquad (14.32)$$

$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \qquad \text{(simple pendulum, small amplitude)} \qquad (14.33)$$

$$T = \frac{2\pi}{\omega} = \frac{1}{f} = 2\pi\sqrt{\frac{L}{g}} \qquad \text{(simple pendulum, small amplitude)} \qquad (14.34)$$

Calculate the period of a simple pendulum with length 1.00 m, and mass M



The period of a 1-m long simple pendulum is almost exactly 2s. For a pendulum of period 1s, how long must it be?

F. 25 cm

G. 50 cm

H. 1 m

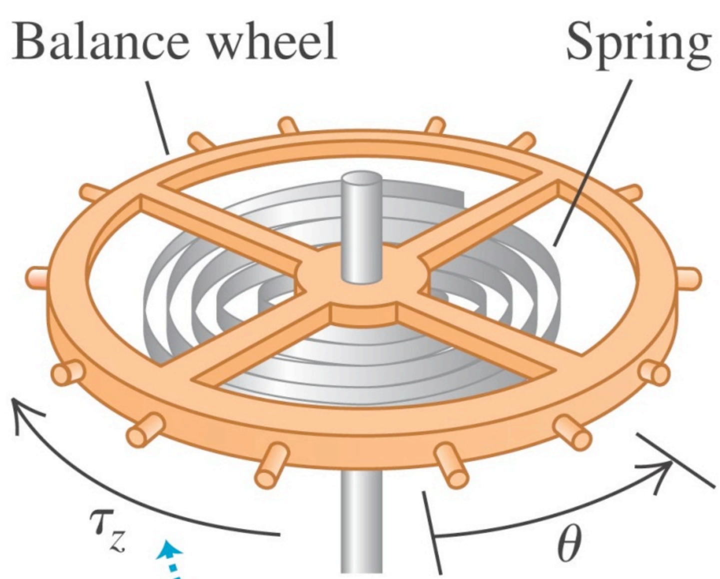
I. 2 m

J. 4 m

Text your answer to 22333.

Angular SHM

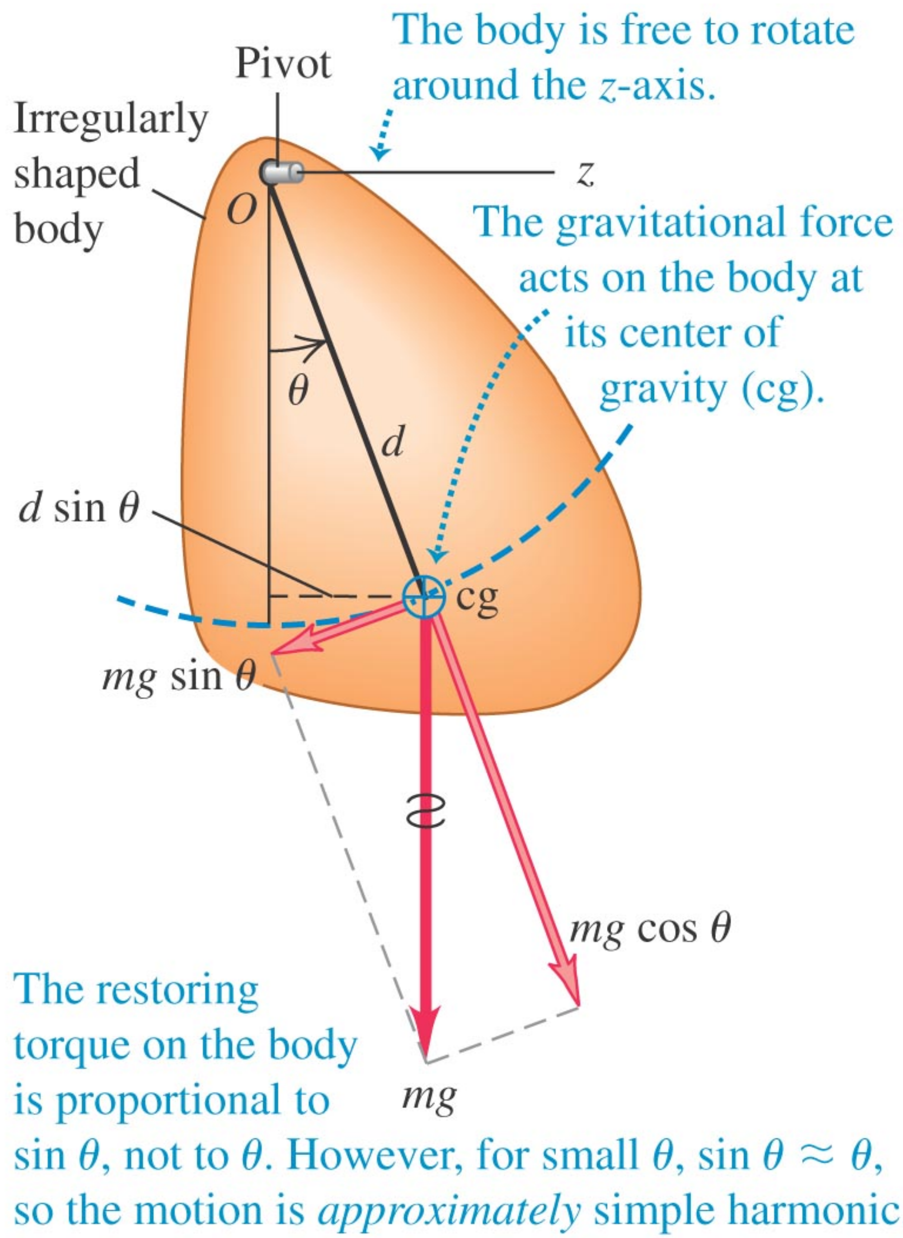
- A coil spring (see Figure 14.19 below) exerts a restoring torque $\tau_z = -\kappa\theta$, where κ is called the *torsion constant* of the spring.
- The result is *angular* simple harmonic motion.



The spring torque τ_z opposes the angular displacement θ.

The physical pendulum

- A *physical pendulum* is any real pendulum that uses an extended body instead of a point-mass bob.
- For small amplitudes, its motion is simple harmonic. (See Figure 14.23 at the right.)



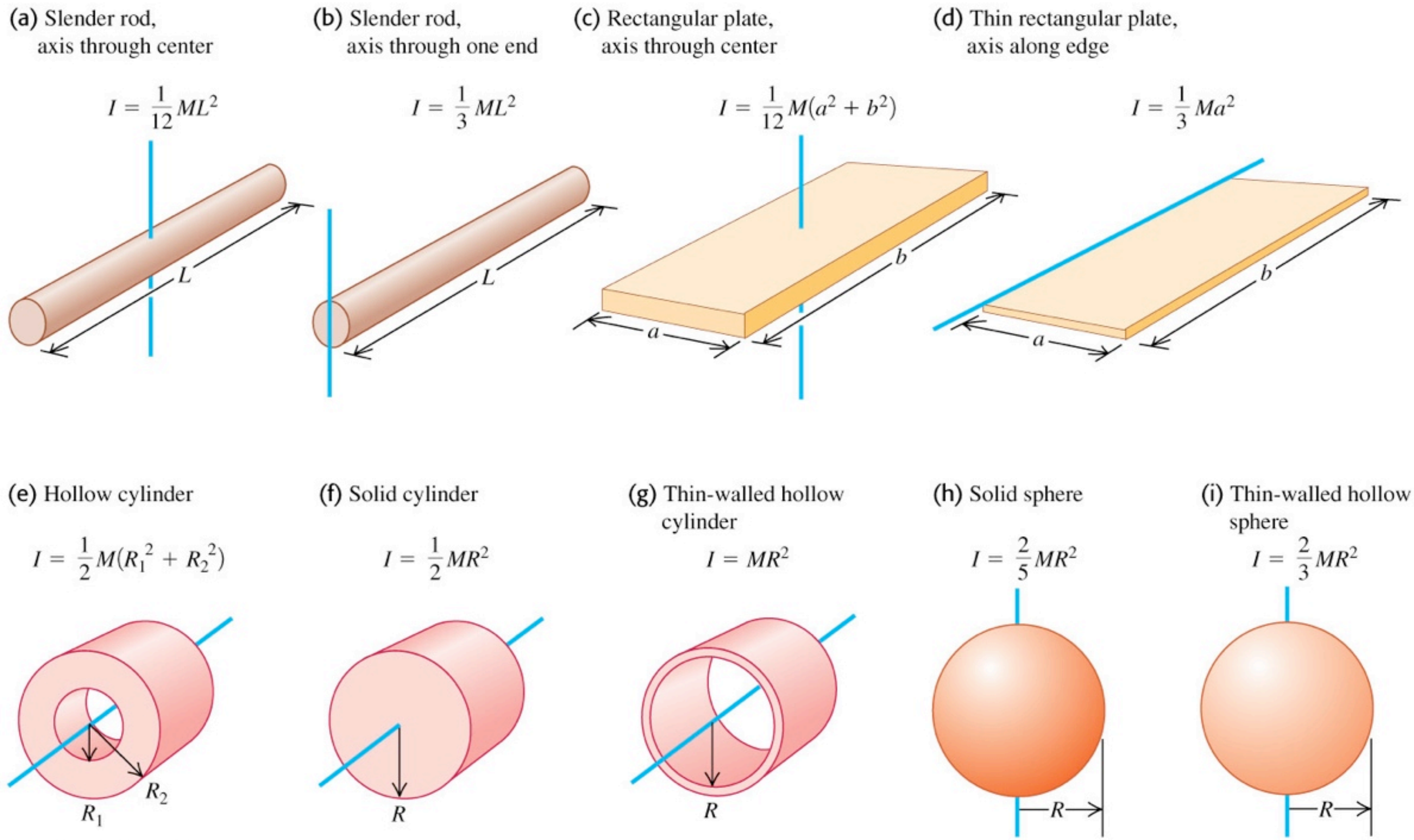
Physical Pendulum

$$\omega = \sqrt{\frac{mgd}{I}} \quad \text{(physical pendulum, small amplitude)} \qquad (14.38)$$

$$T = 2\pi\sqrt{\frac{I}{mgd}} \quad \text{(physical pendulum, small amplitude)} \qquad (14.39)$$

- d = distance between **pivot** and **CoM**
- I = moment of inertia, rotating about **pivot**

Table 9.2 Moments of Inertia of Various Bodies



How does the period of a solid bar compare to a simple pendulum having the same distance to the center of mass?

K. Shorter period

L. Longer period

M. The same period

N. Not enough information

Text your answer to 22333