Superman

Batman

Bus jump

Space Odyssey

A fall of 100 m

Superman

Batman

Bus jump

Space Odyssey

A fall of 100 m

44 m/s

Superman

Batman

Bus jump

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

Superman

Batman

Bus jump

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2

Superman

Batman

Bus jump

Space Odyssey

A fall of 100 m

Superman

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

Batman

Bus jump

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

Bus jump

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

Bus jump

50 foot gap

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

Bus jump

50 foot gap

70 mph

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

Bus jump

50 foot gap

70 mph

2^o incline (generous)

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

Bus jump

50 foot gap

70 mph

2^o incline (generous)

22 feet

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

25 m/s

Bus jump

50 foot gap

70 mph

2^o incline (generous)

22 feet

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

25 m/s

0.1 s

Bus jump

50 foot gap

70 mph

2^o incline (generous)

22 feet

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

25 m/s

0.1 s

140 kg

Bus jump

50 foot gap

70 mph

2^o incline (generous)

22 feet

Space Odyssey

A fall of 100 m

44 m/s

Stops over 5 m

193.6 m/s^2 (20 g's)

13,000 N

Superman

Batman

25 m/s

0.1 s

140 kg

35,000 N

Bus jump

50 foot gap

70 mph

2^o incline (generous)

22 feet

Space Odyssey

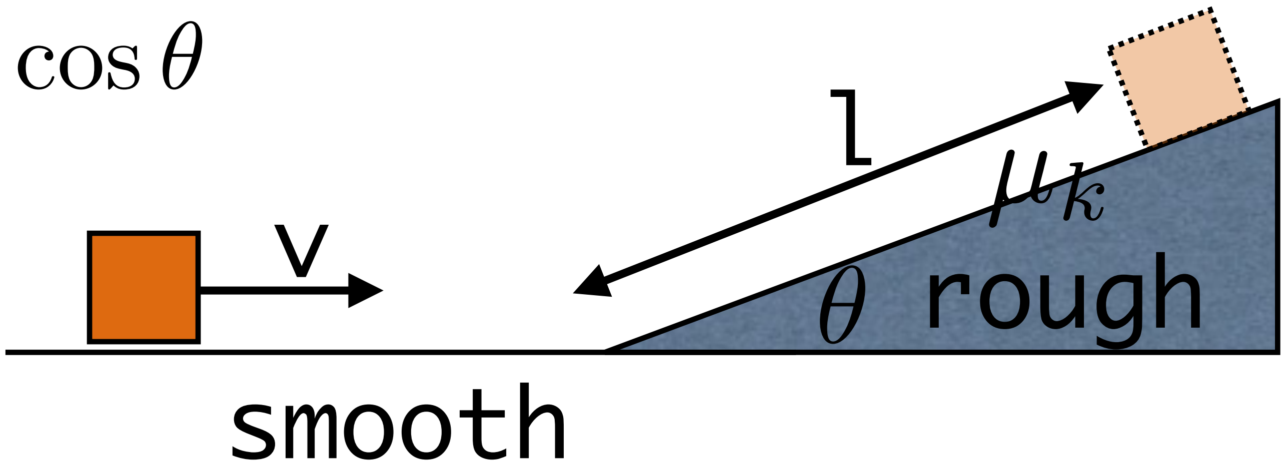
Question #11

Can you determine how far up the incline the box will travel?

A $\frac{1}{2}mv^2 = mgl\cos\theta + \mu_k mg\sin\theta l$

B $\frac{1}{2}mv^2 = mgl\sin\theta + \mu_k mg\sin\theta l$

C $\frac{1}{2}mv^2 = mgl\sin\theta + \mu_k mg\cos\theta$

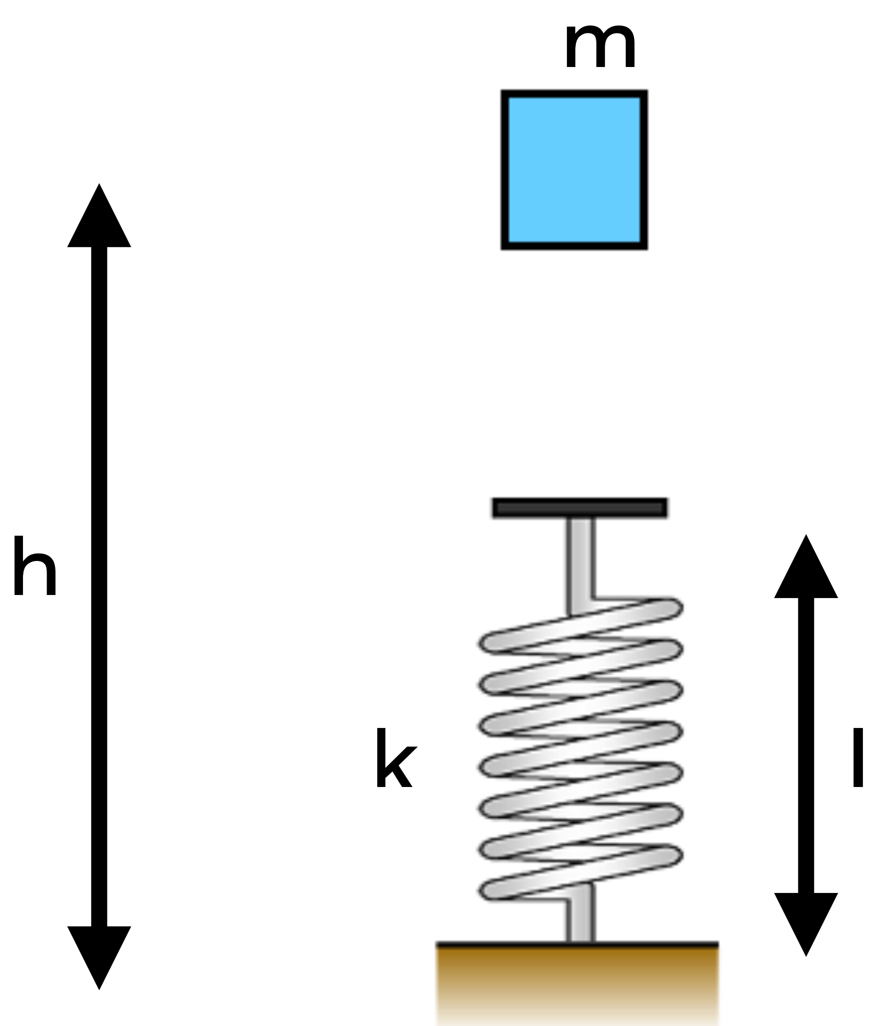


D $\frac{1}{2}mv^2 = mgl\sin\theta + \mu_k mg\cos\theta l$

$$U_i + K_i + W_{\text{ext}} = U_f + K_f + \Delta E_{\text{th}}$$

Spring potential energy **Question #12**

By how much does the spring compress?



B $$mgh = \frac{1}{2}kx^2$$

C $$mgh = \frac{1}{2}kx^2 + \frac{1}{2}mv^2$$

D $$mgh = \frac{1}{2}kx^2 + mgl$$

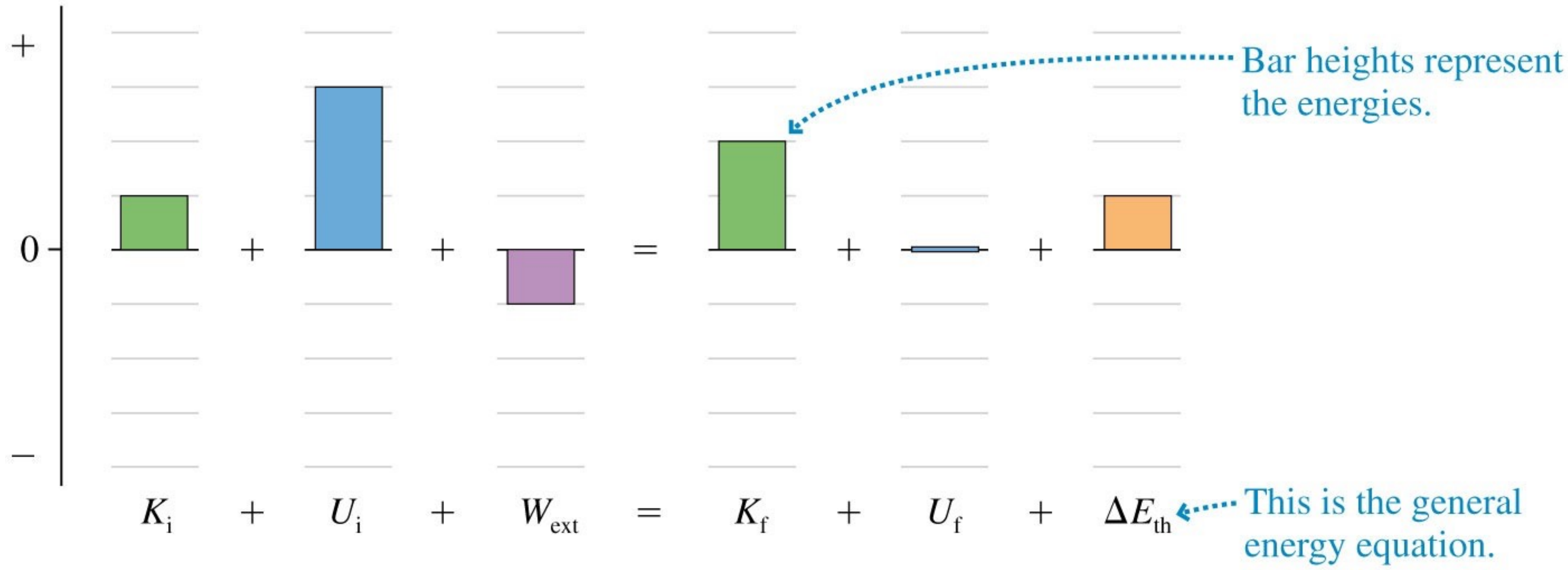
E $$mgh = \frac{1}{2}kx^2 + mg(l - x)$$

$$U_i + K_i + W_{\text{ext}} = U_f + K_f + \Delta E_{\text{th}}$$

Energy bar charts

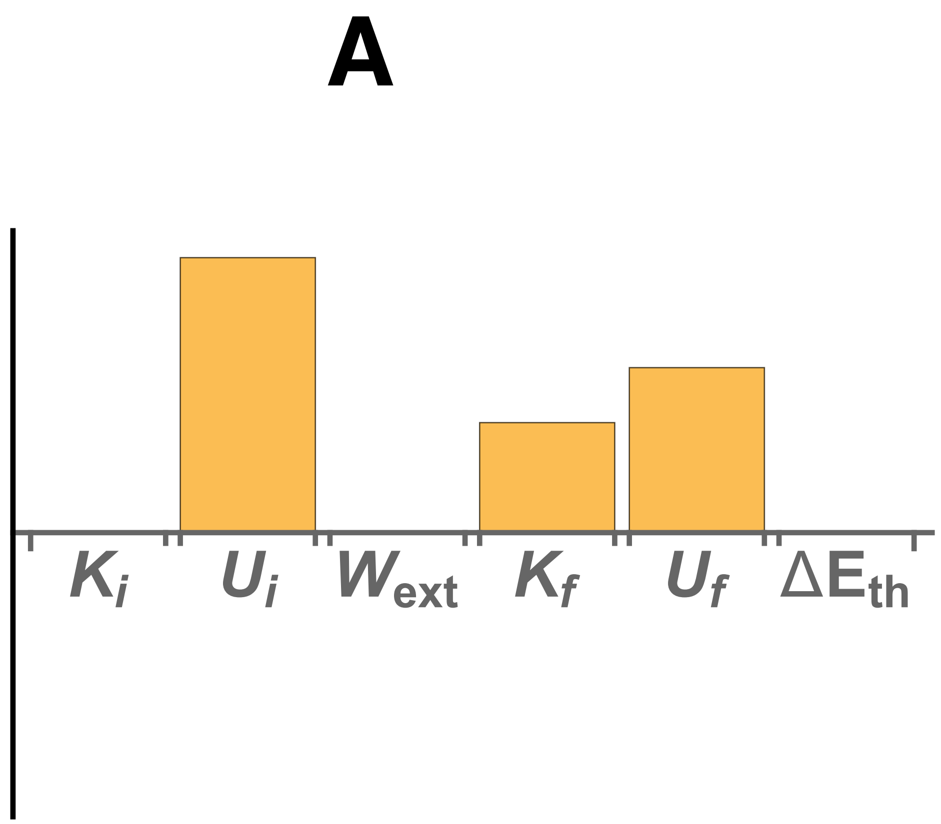
$$U_i + K_i + W_{\text{ext}} = U_f + K_f + \Delta E_{\text{th}}$$

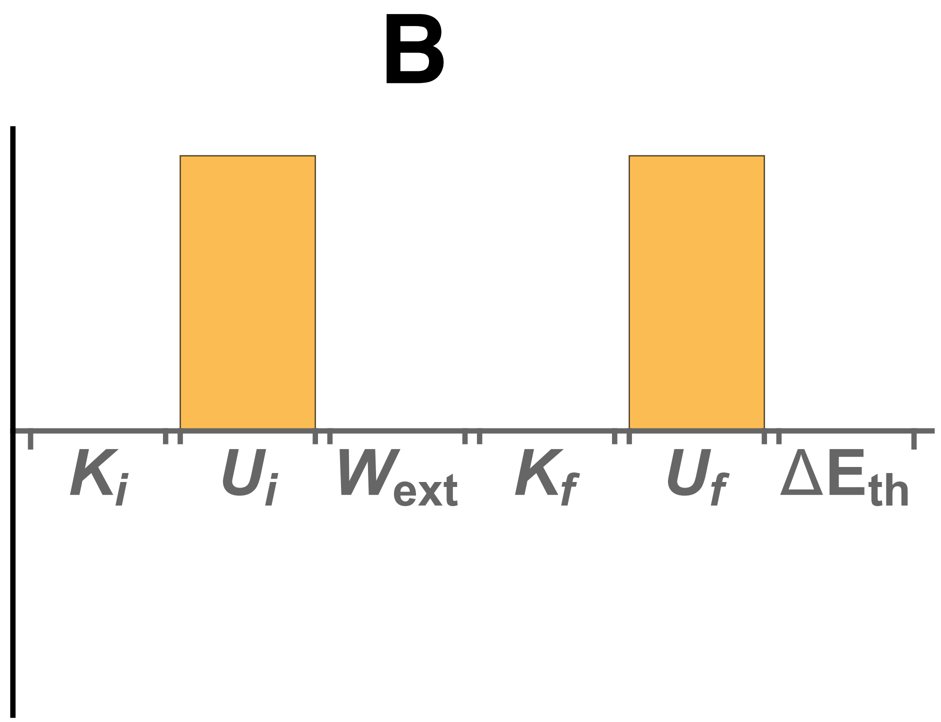
Graphical representation of conservation of energy

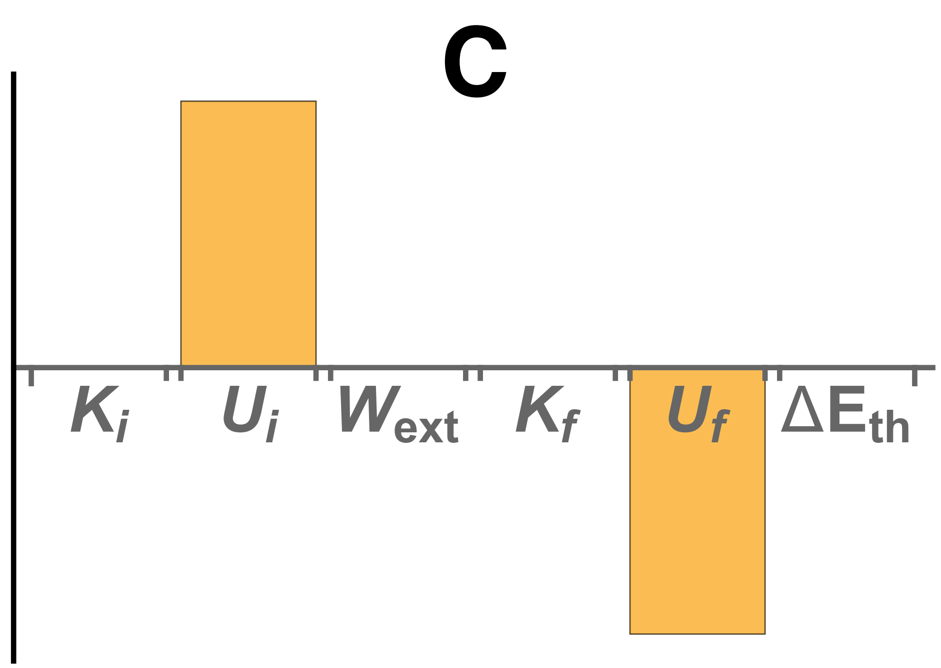


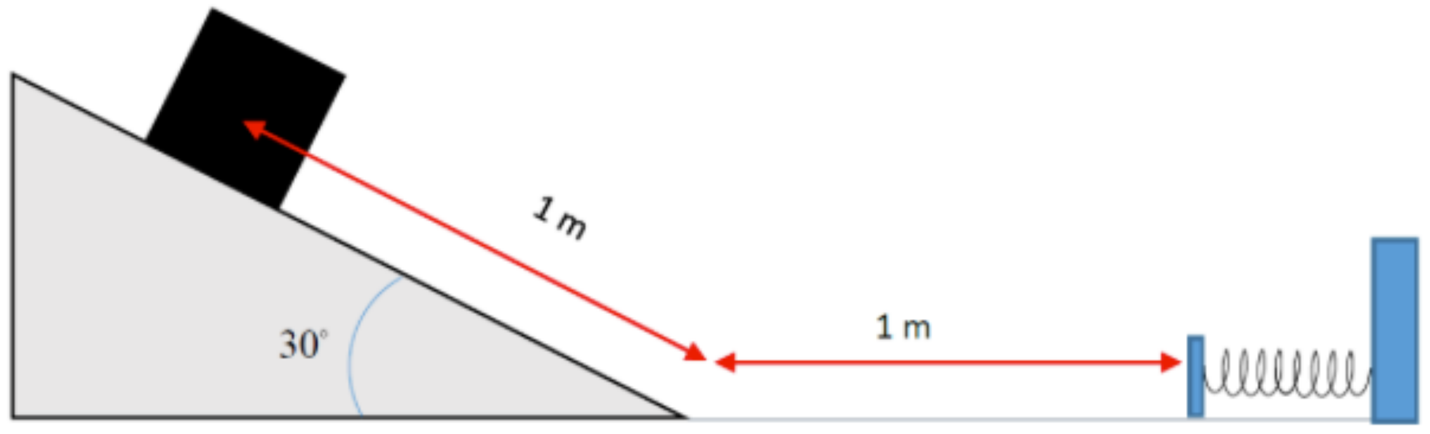
Energy Bar Charts

Question #13





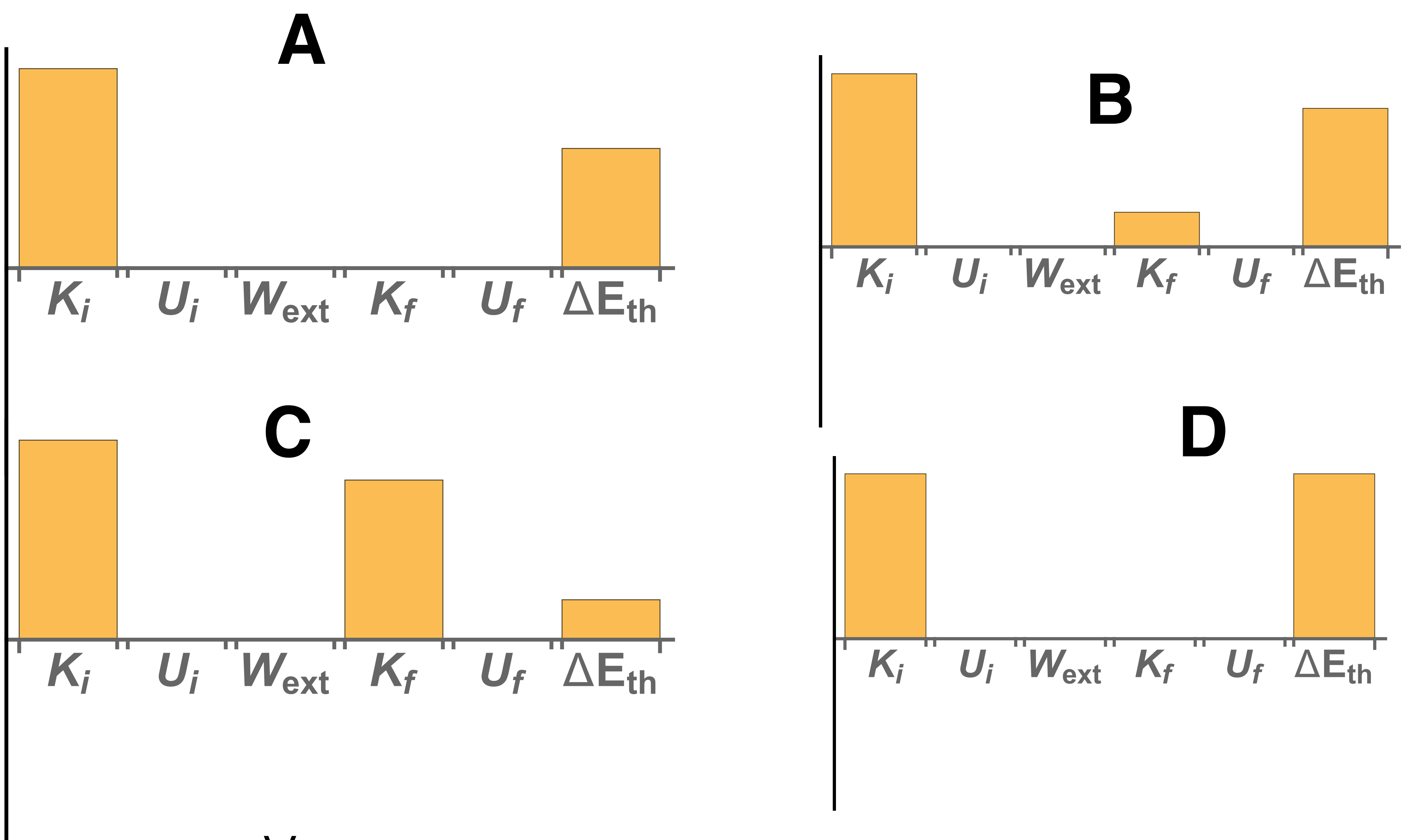


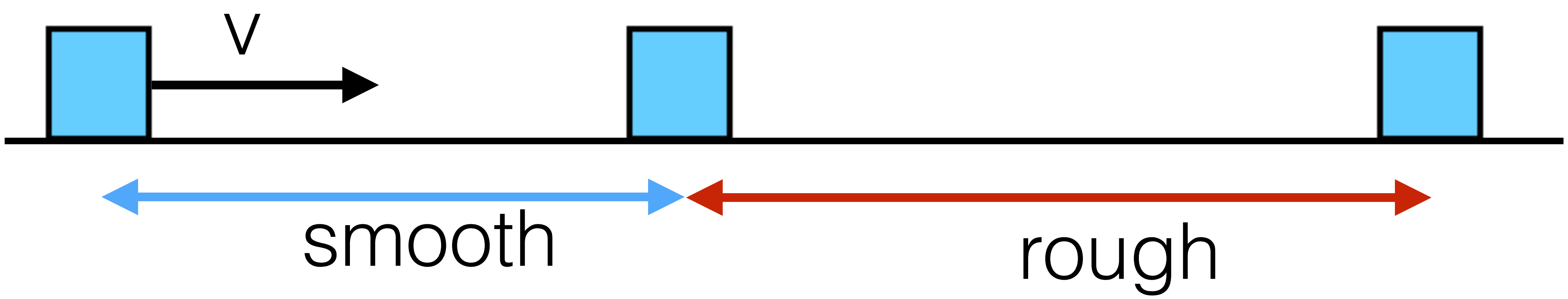


Energy Bar Charts

Question #14

How far does the box slide before coming to rest?



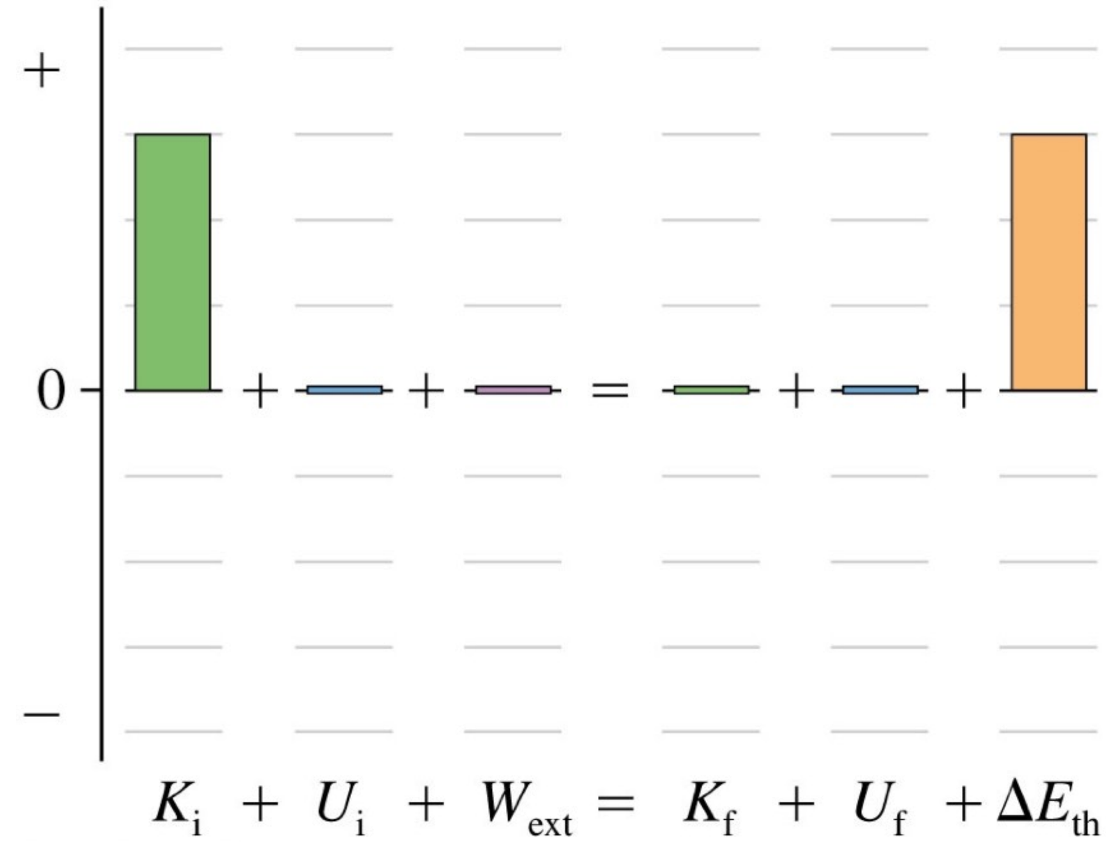


Try a few

A speeding car skids to a halt.

Try a few

A speeding car skids to a halt.

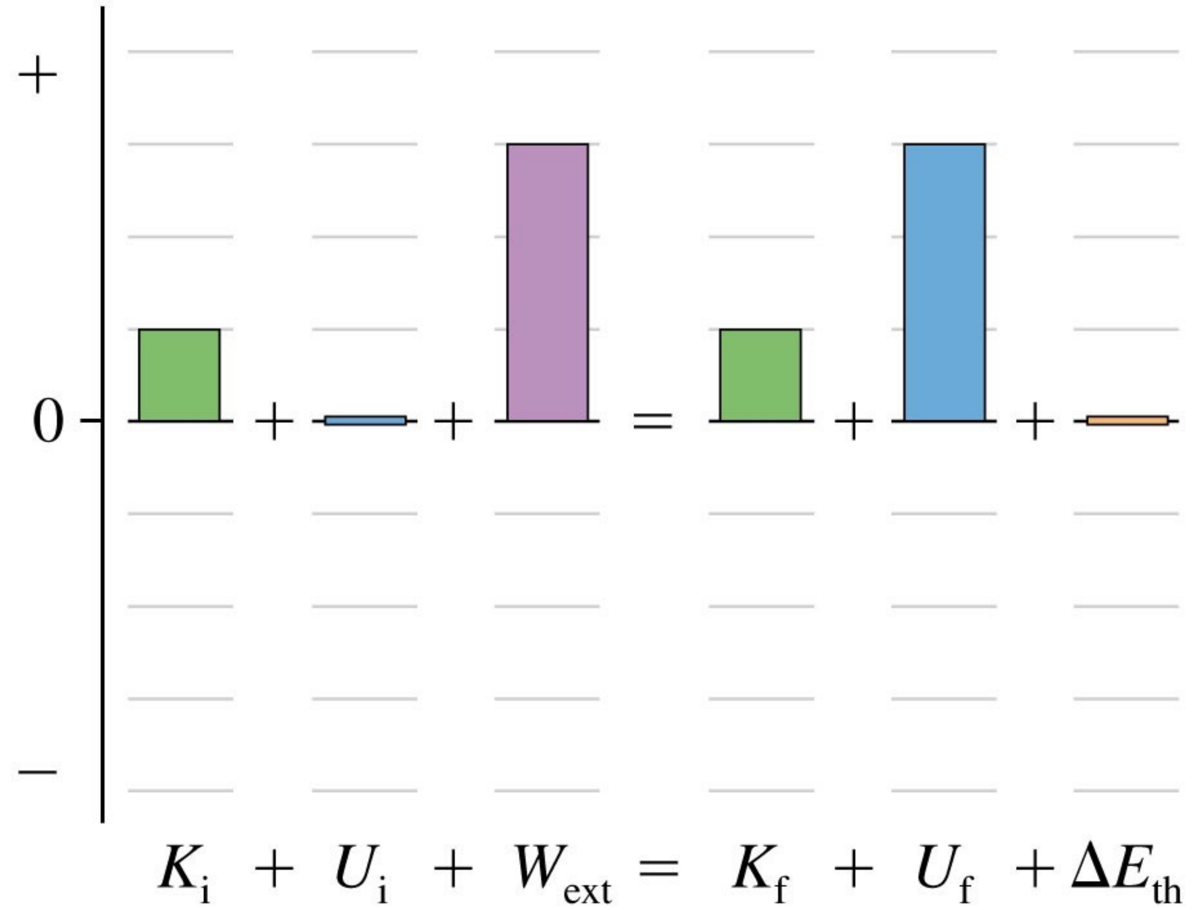


Try a few

A rope lifts a box at constant speed

Try a few

A rope lifts a box at constant speed

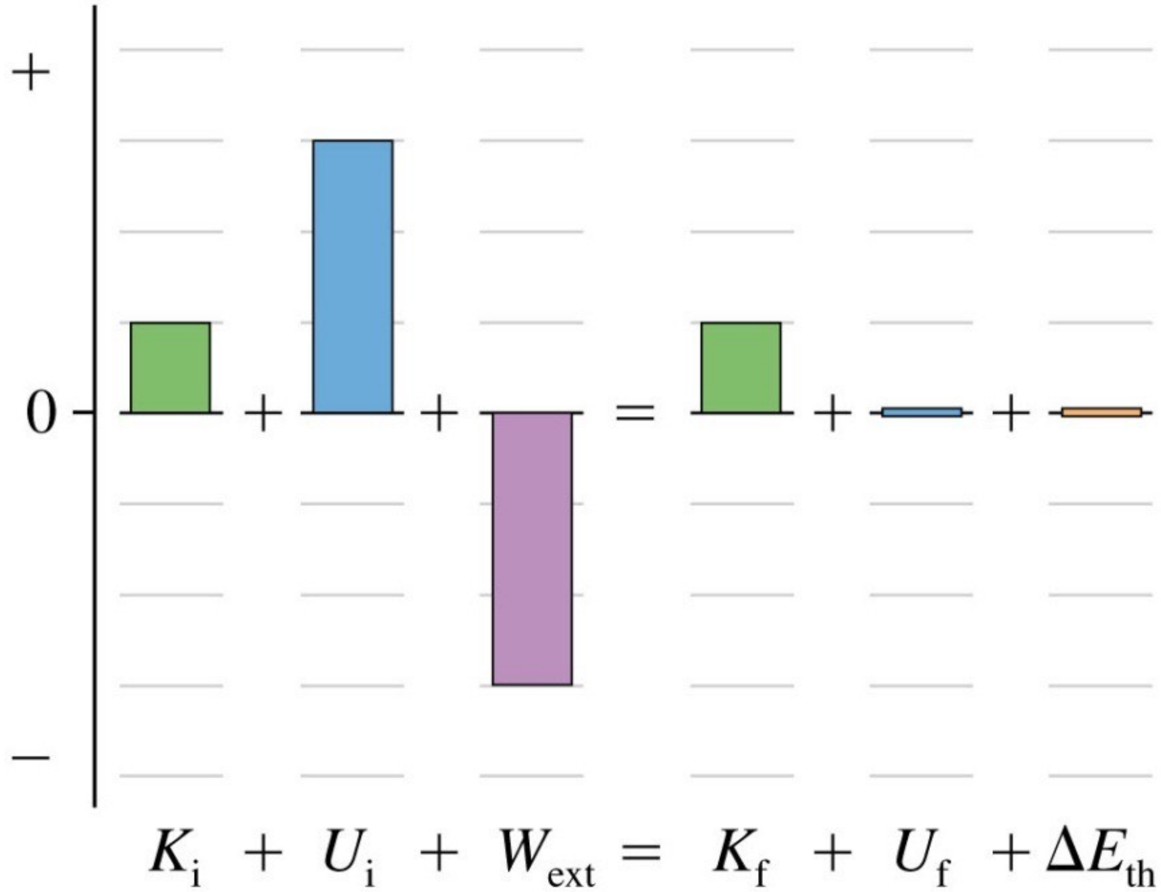


Try a few

The box falls at steady speed as the rope spins a generator and causes a lightbulb to glow.

Try a few

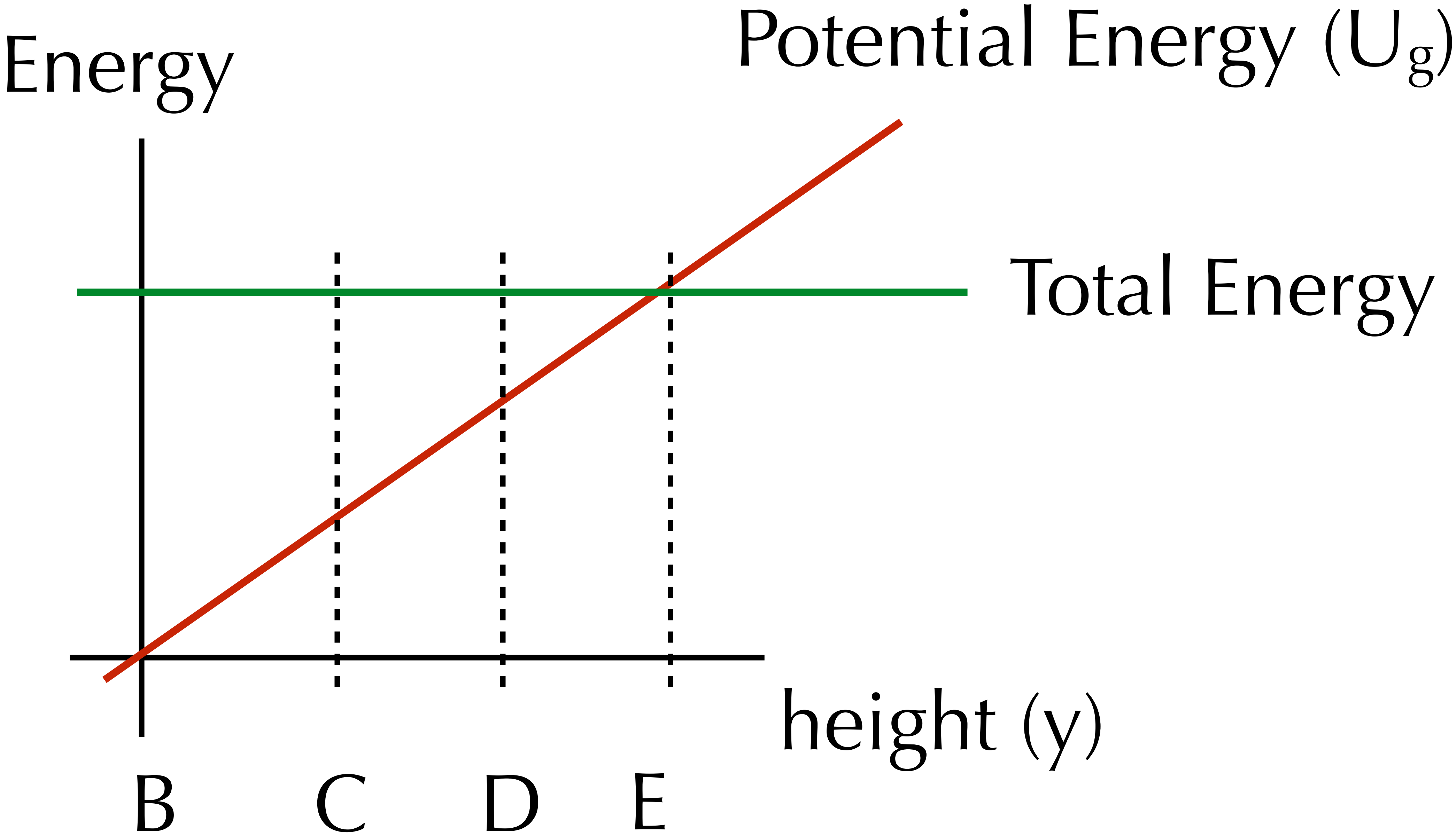
The box falls at steady speed as the rope spins a generator and causes a lightbulb to glow.



Energy diagram for ball thrown upward

Question #12

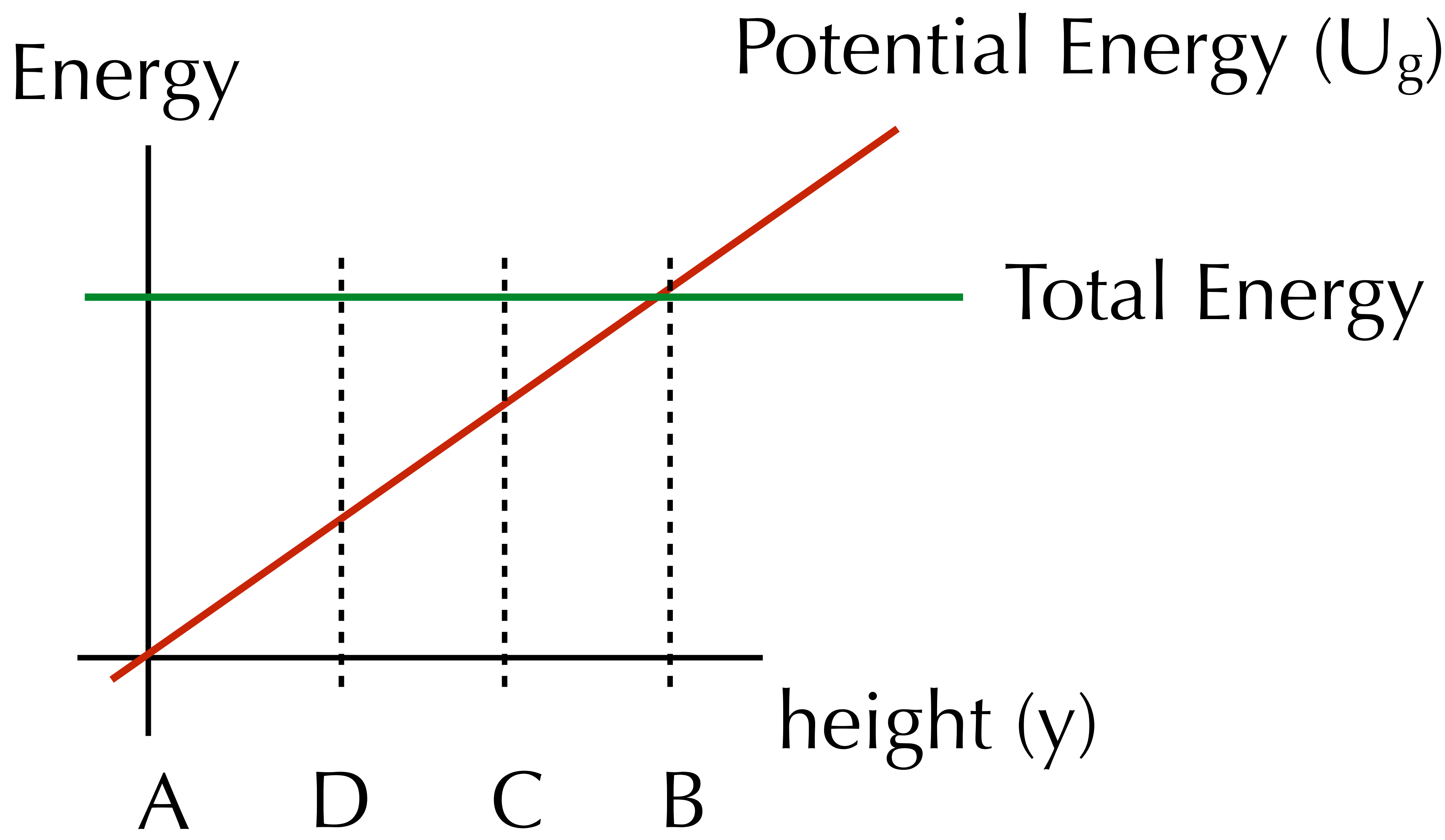
Where is the turning point of the motion?



Energy diagram for ball thrown upward

Question #13

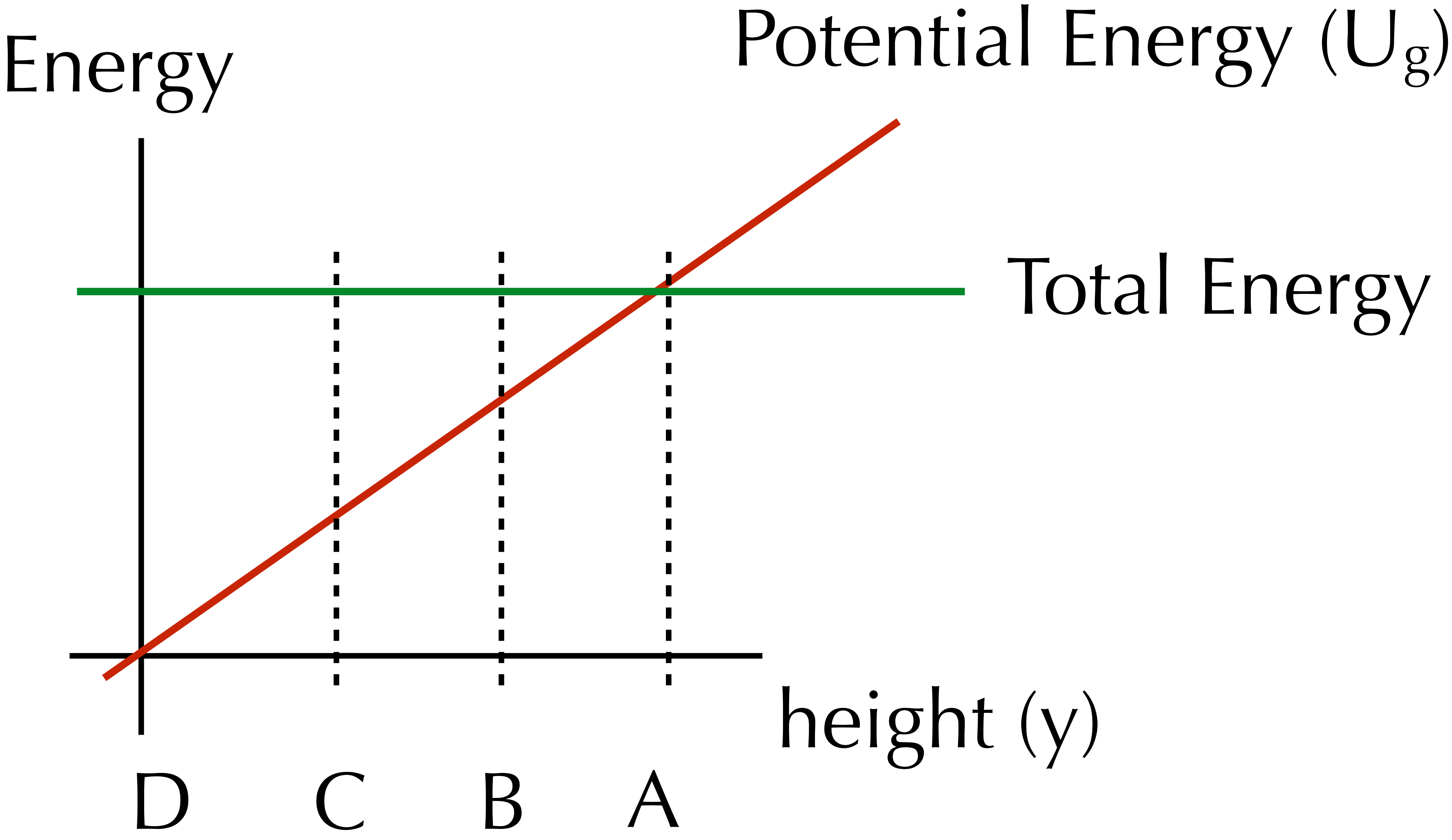
Where does the object have the most potential energy?



Energy diagram for ball thrown upward

Question #14

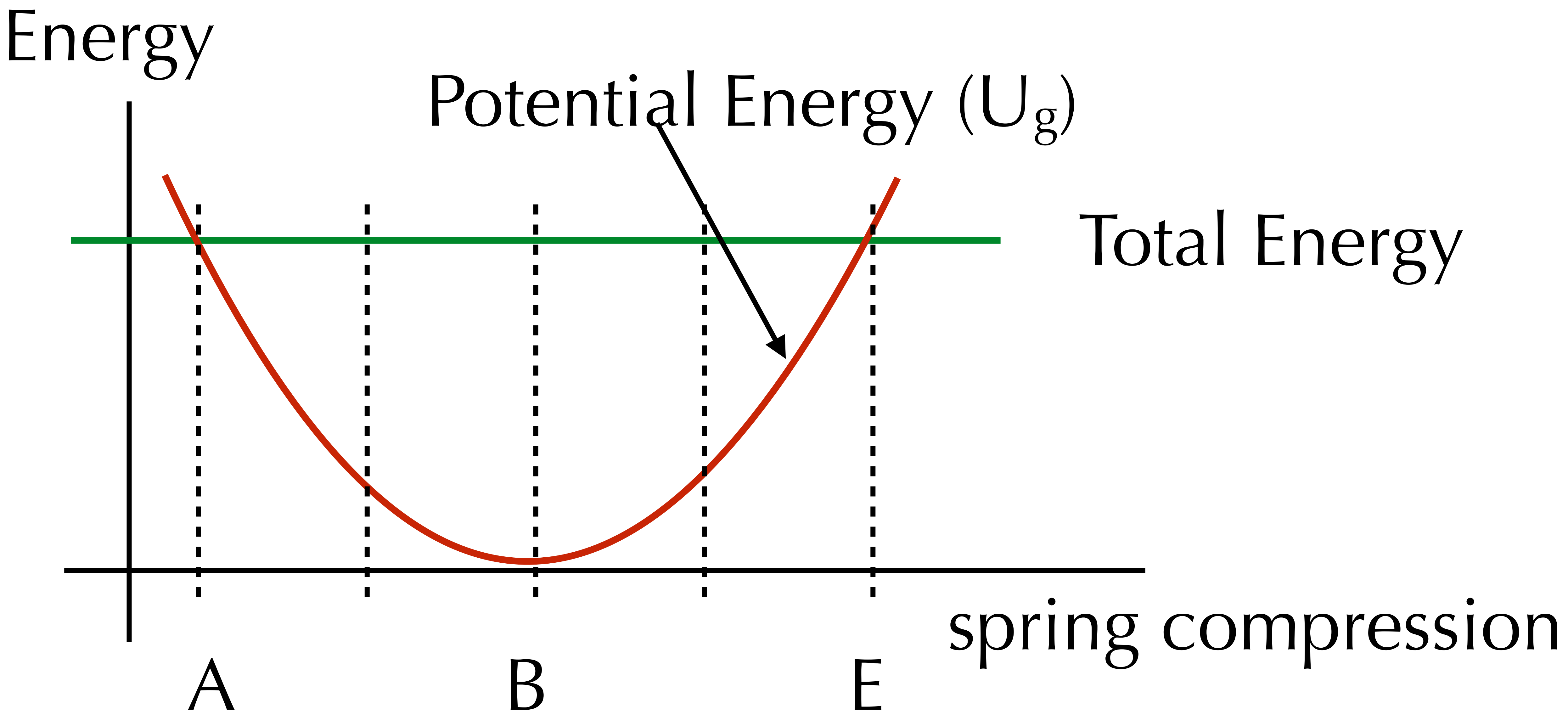
Where does the object have the most kinetic energy?



Energy diagram for mass on a spring

Question #15

Where is(are) the turning points of the motion?



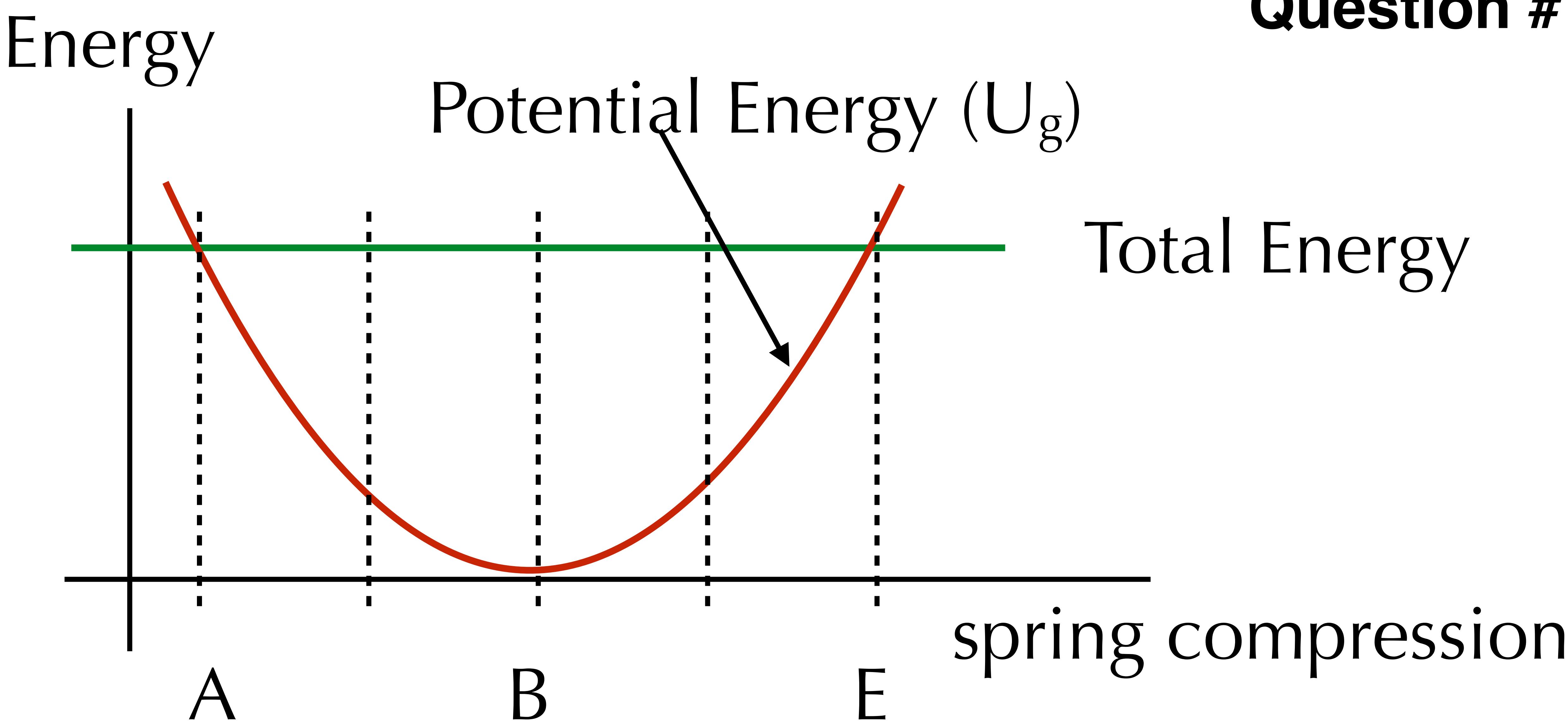
C. All three are turning points.

D. A and E are both turning points

Energy diagram for mass on a spring

Where does the object have the most potential energy?

Question #16



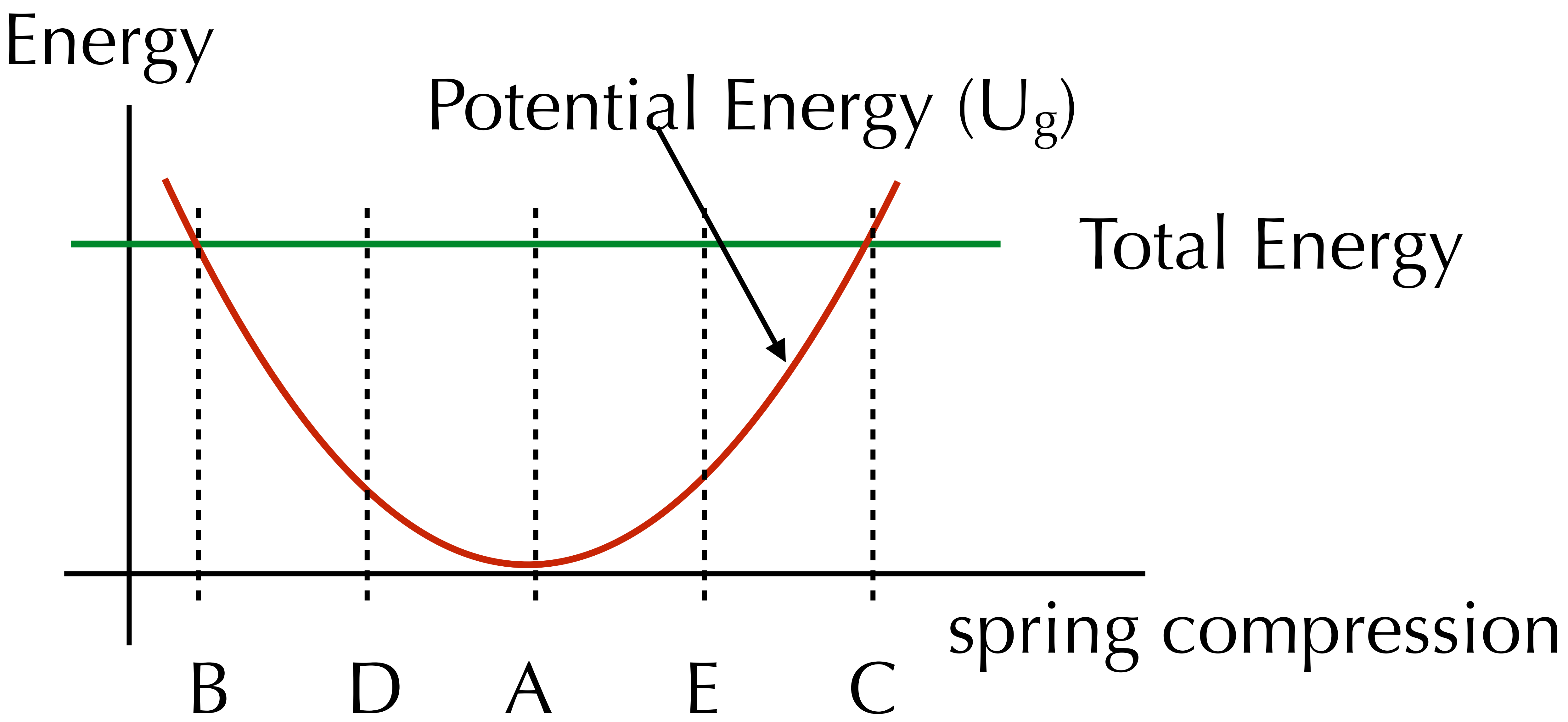
C. At points A and E

D. At points A and C

Energy diagram for mass on a spring

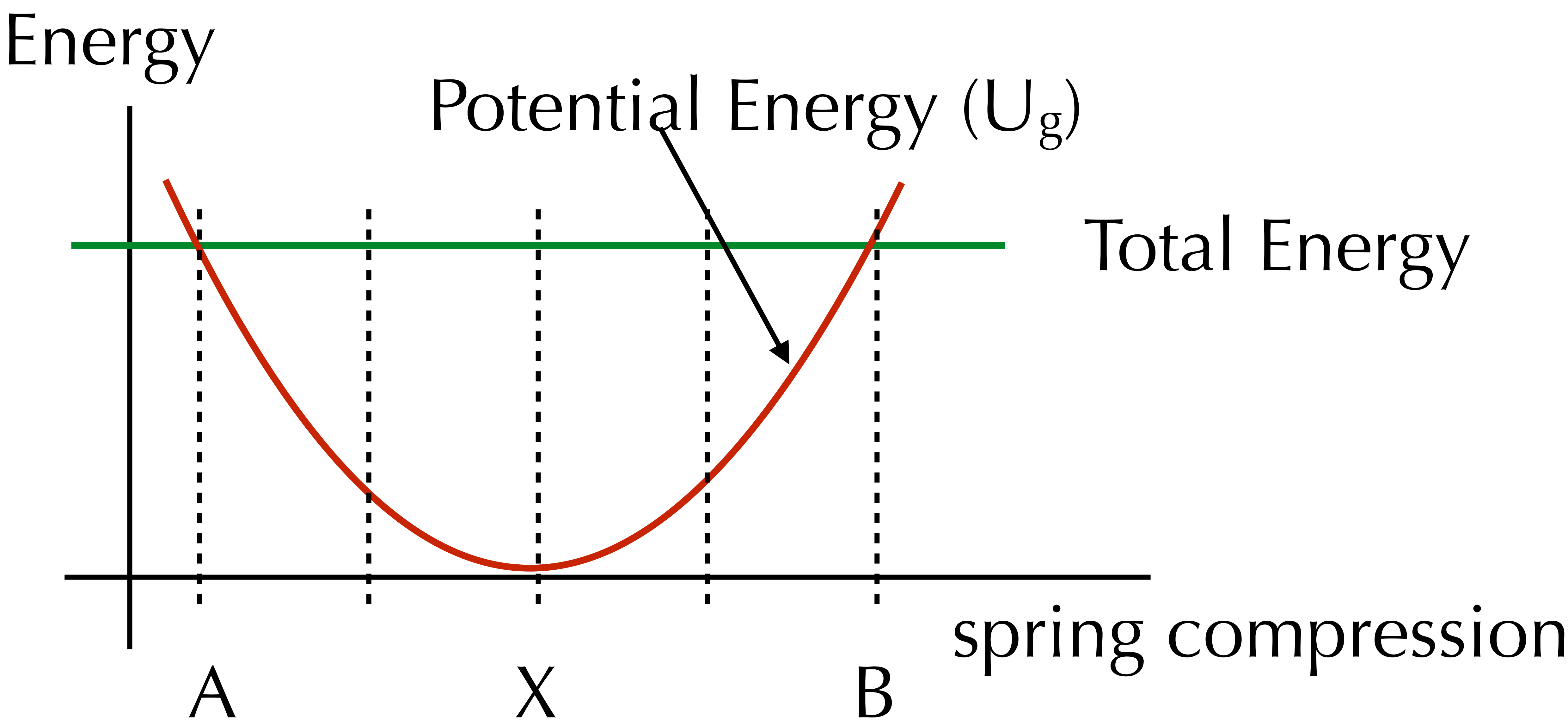
Question #17

Where does the object have the most kinetic energy?



Question #18

Where is the force of the spring on the object negative (left pointing)?

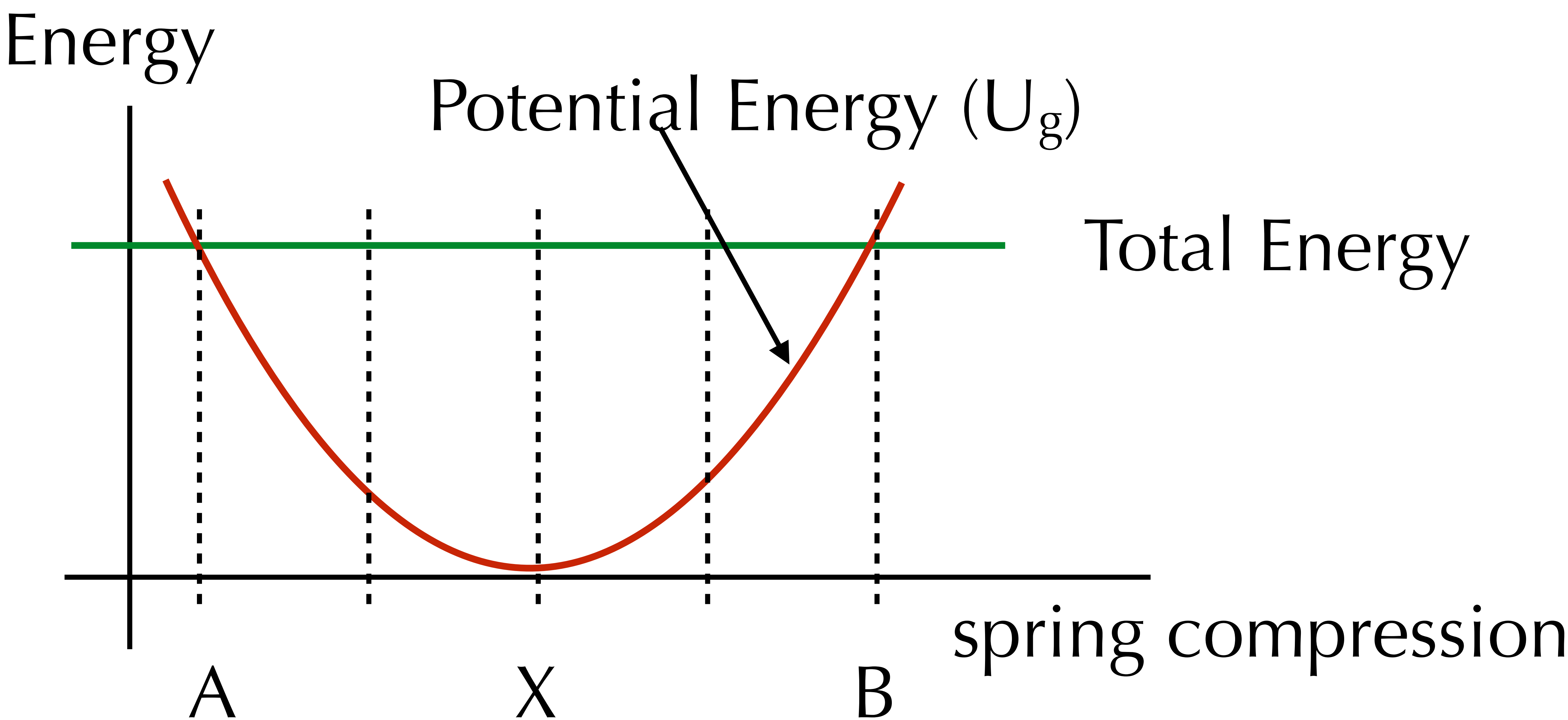


C) anywhere to the **right** of point X.

D) anywhere to the **left** of point X

Question #18

Where is the force of the spring on the object negative (left pointing)?



C) anywhere to the **right** of point X.
D) anywhere to the **left** of point X

$$F = -\frac{dU}{ds}$$

Finding Force from Potential Energy

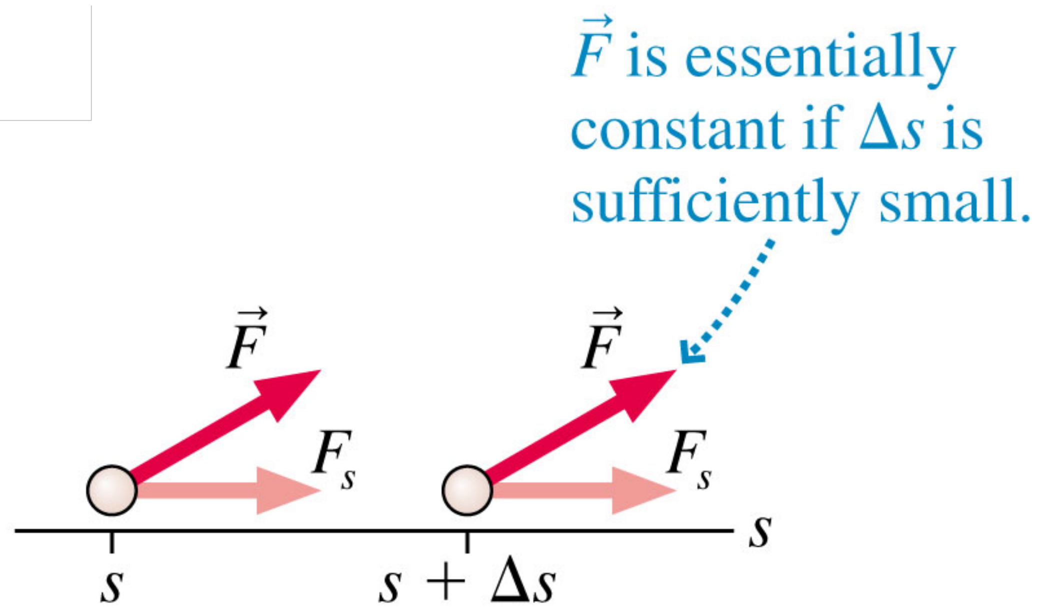
$$W(s \rightarrow s + \Delta s) = F_s \, \Delta s$$

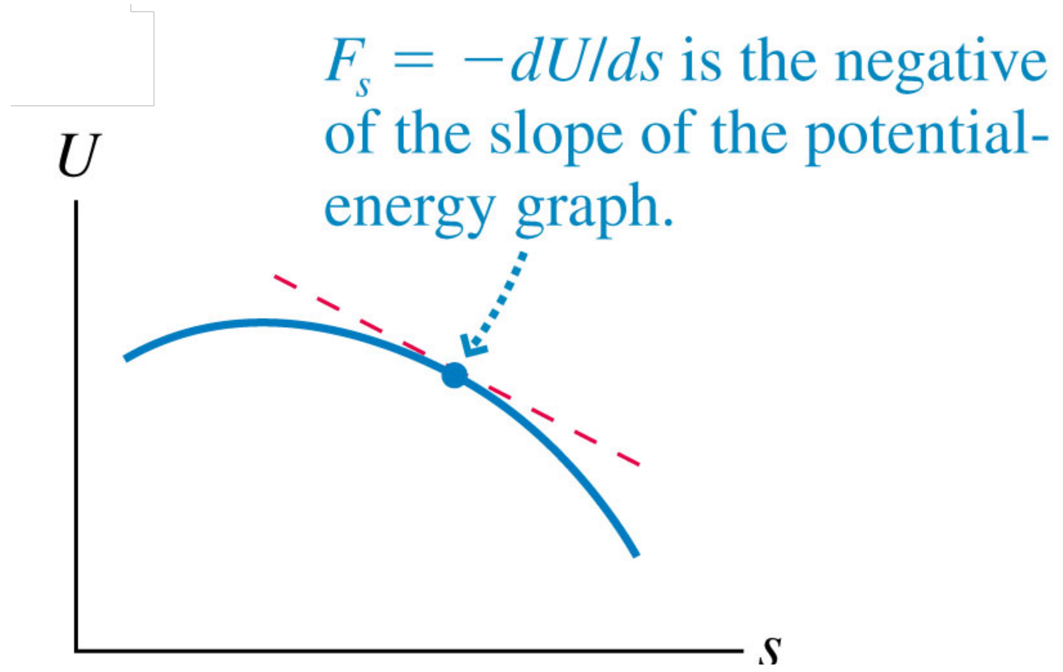
$$\Delta U = -W = -F_s \Delta s$$

$$F_s = -\frac{\Delta U}{\Delta s}$$

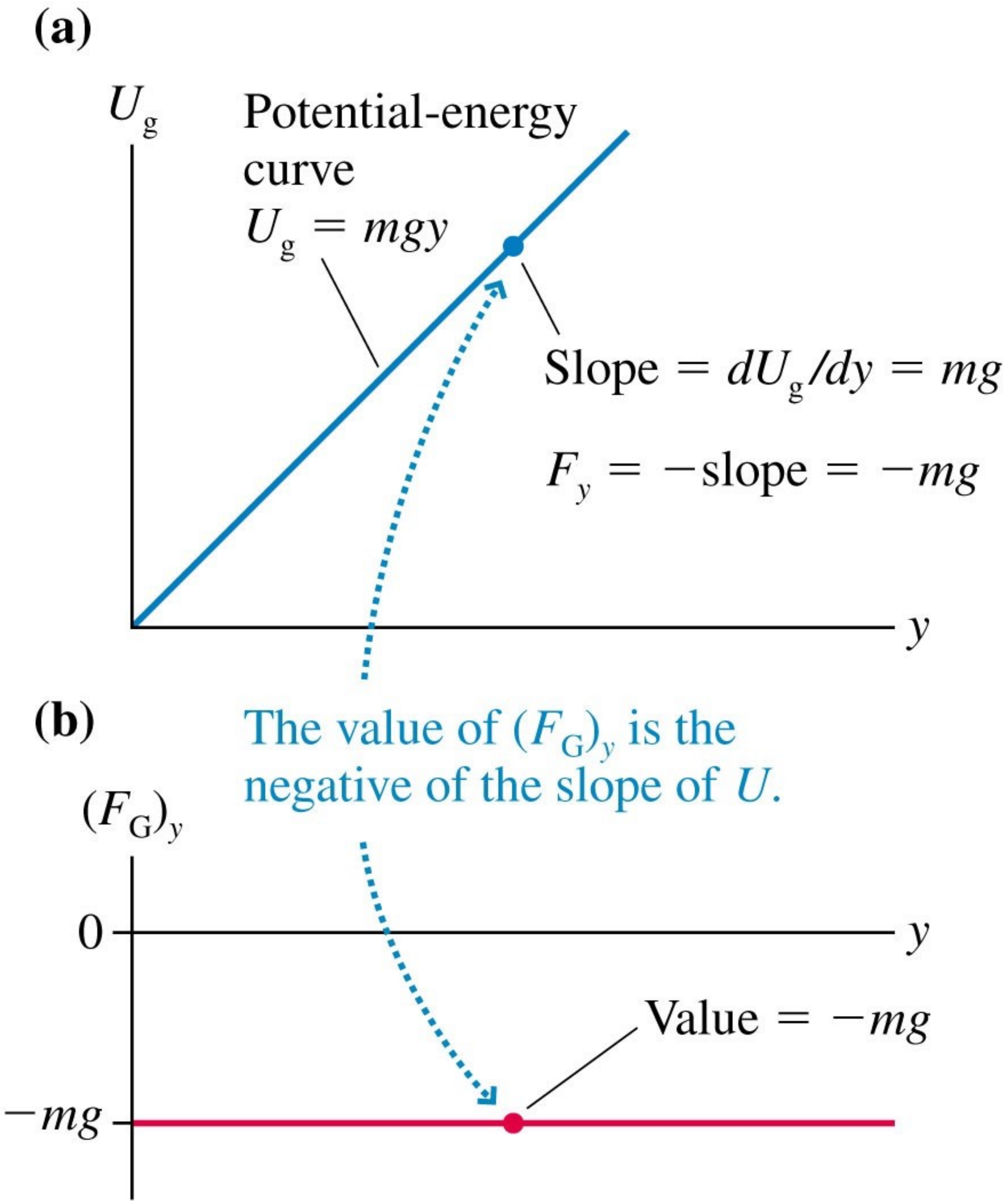
$$F_s = \lim_{\Delta s \to 0} \left(-\frac{\Delta U}{\Delta s} \right) = -\frac{dU}{ds}$$

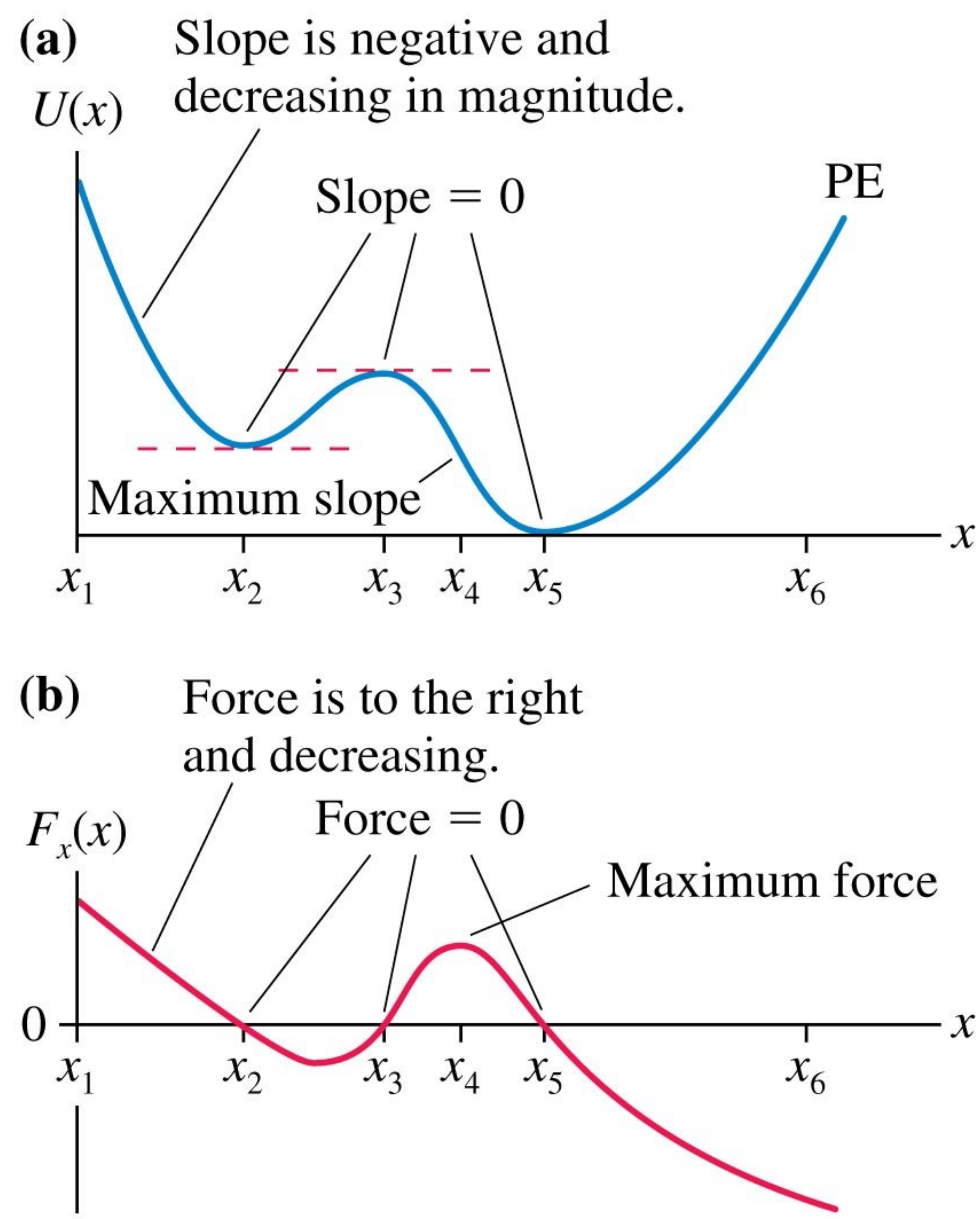
$$U = -\int_{s_1}^{s_2} F_s ds$$



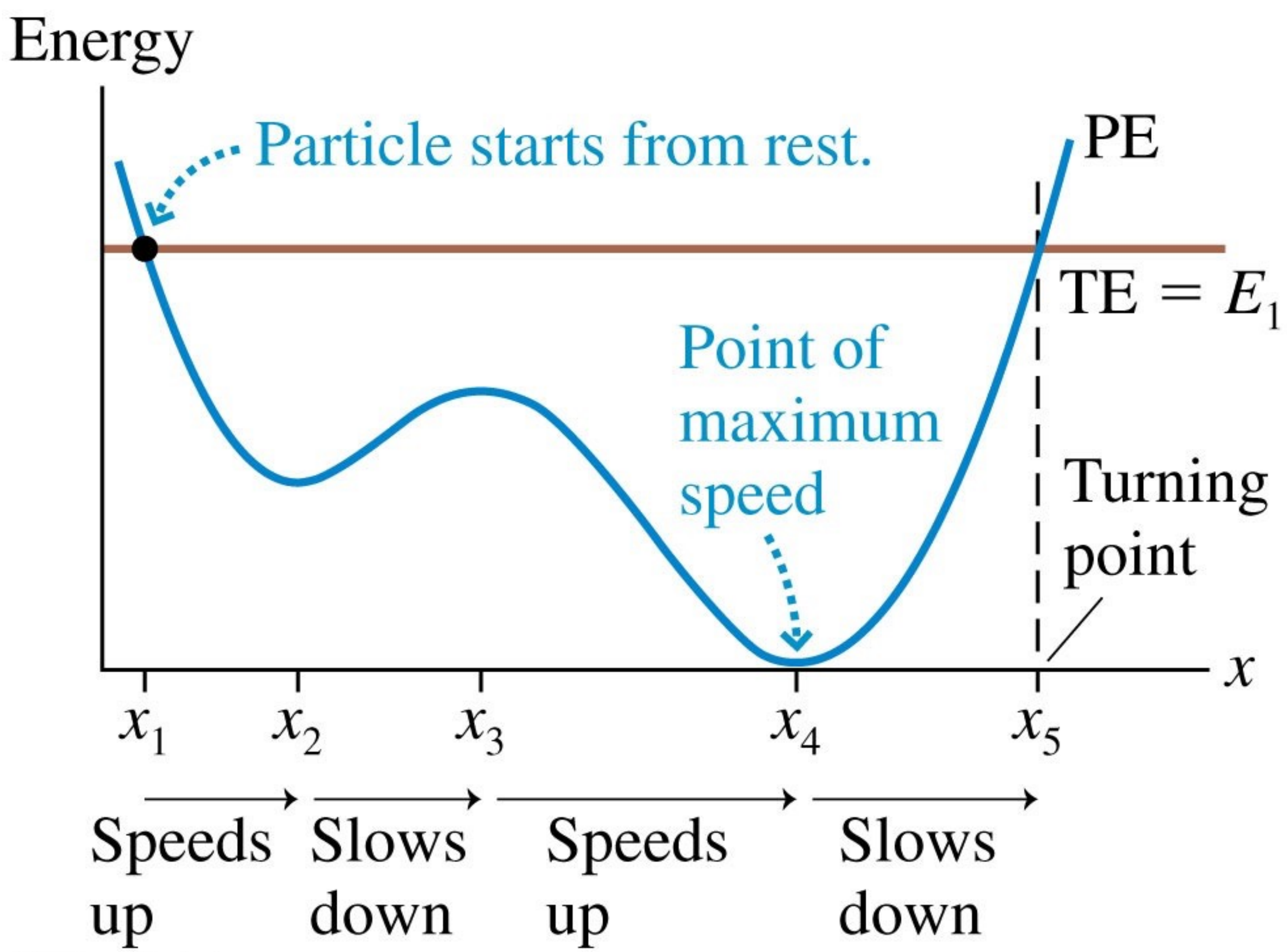


Finding Force from Potential Energy





Energy Diagrams



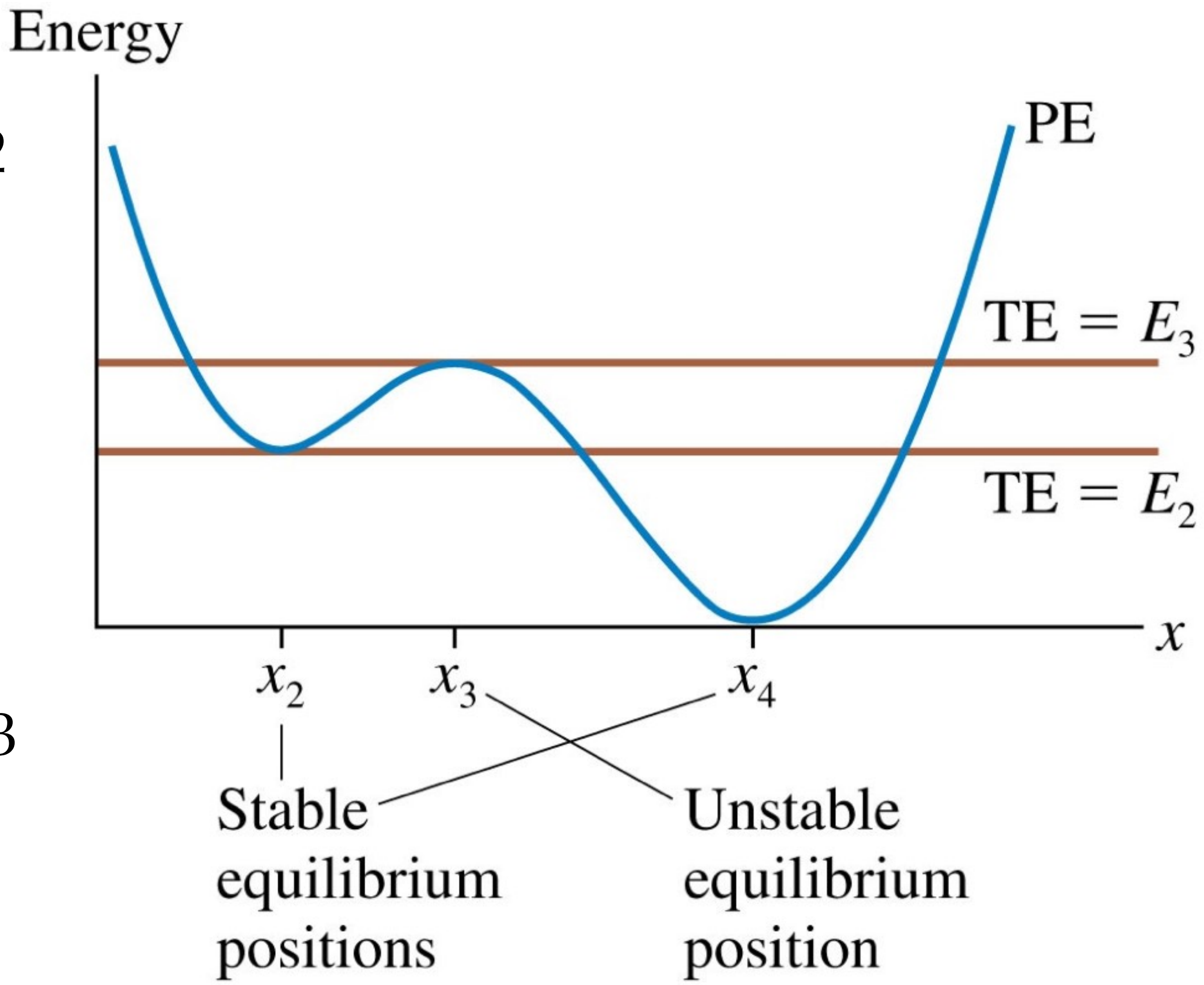
Equilibrium positions: Stable vs. Unstable

Stable Equilibrium

Consider particle with energy E_2

Unstable Equilibrium

Consider particle with energy E_3

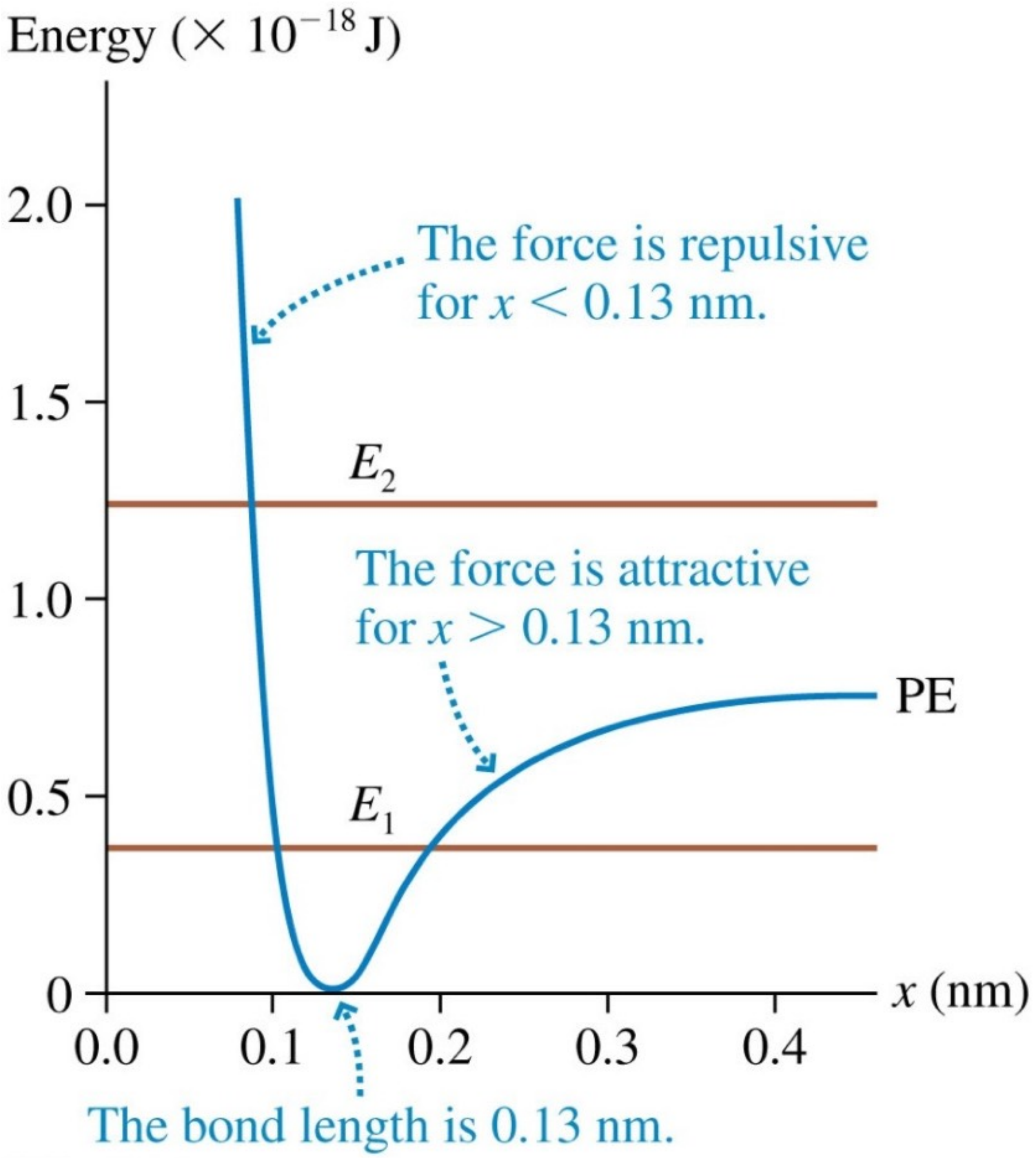


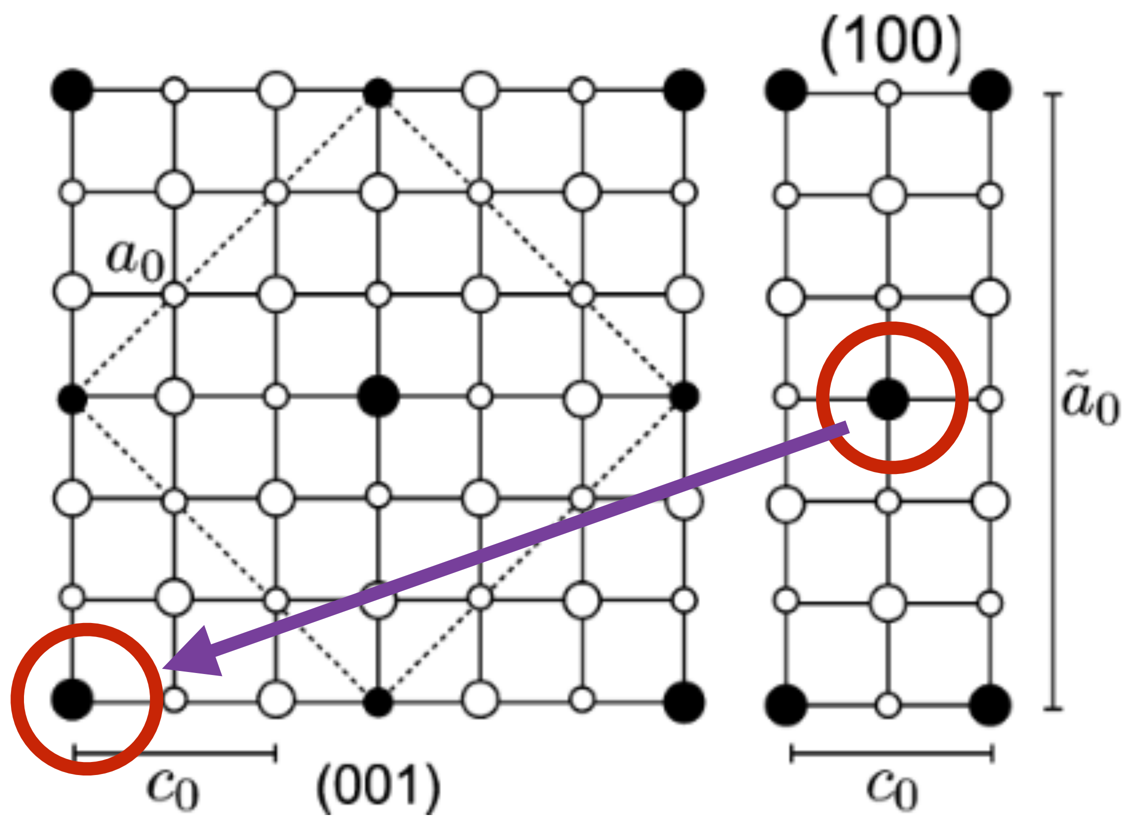
Molecular Bonds

Potential Energy curve for Hydrogen Chloride

When the total energy is E_1, the molecule oscillates and is stable

When the total energy is E_2, the bond is broken and the atoms come apart.




(100)
a_0
$\tilde{a}_0$
c_0
(001)
c_0