Question #21

If it takes 2 minutes to lift this 1,000 N object (at constant speed) a distance of 100 m, what is the rate at which the crane does work on the object?

a) 830 Watts
b) 50,000 J/min
c) a) and b)
d) 50,000 Watts
e) 830 J/min

Question #21

If it takes 2 minutes to lift this 1,000 N object (at constant speed) a distance of 100 m, what is the rate at which the crane does work on the object?

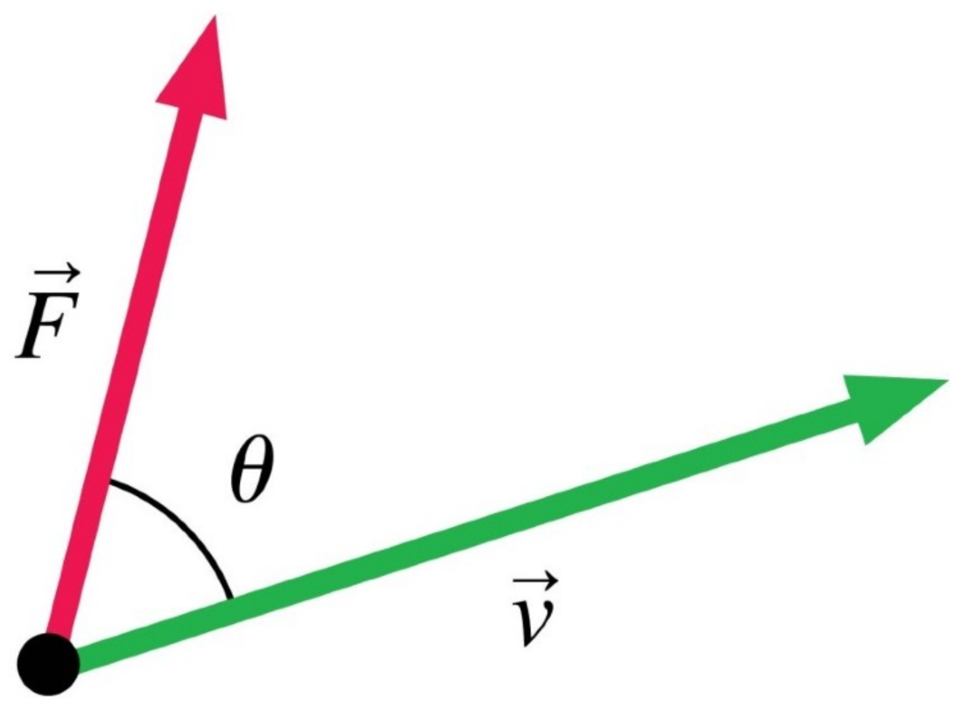
a) 830 Watts
b) 50,000 J/min
c) a) and b)
d) 50,000 Watts
e) 830 J/min

$$P \equiv \frac{dE_{\text{sys}}}{dt}$$

1 watt = 1 W = 1 J/s

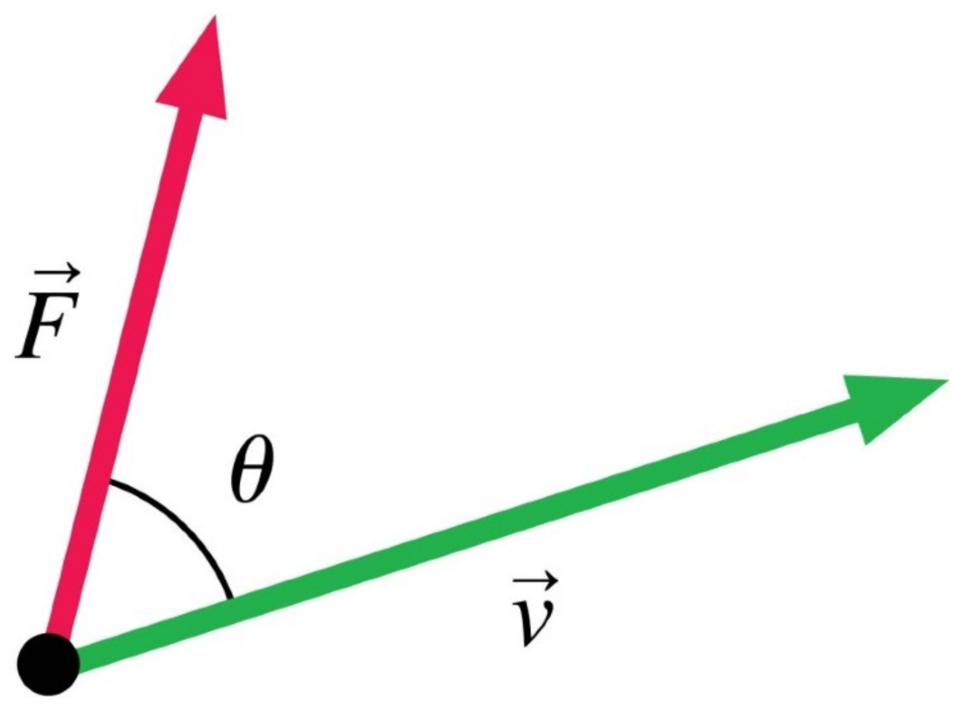
1 hp = 746 W

$$W = \vec{F} \cdot \Delta\vec{r}$$



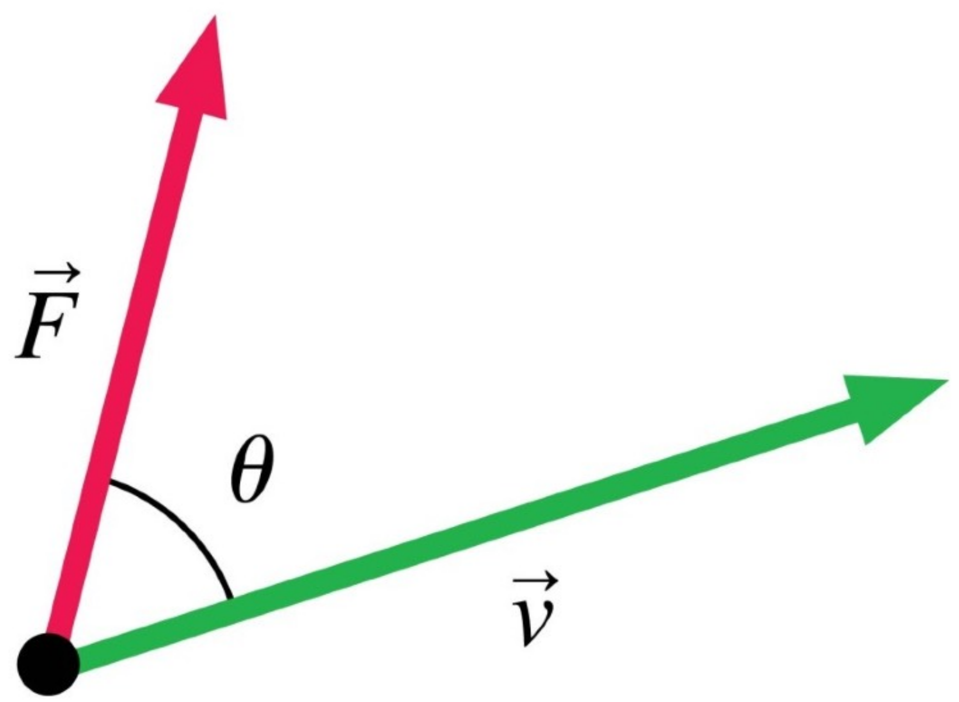
$$W = \vec{F} \cdot \Delta \vec{r}$$

$$P = \frac{dW}{dt}$$



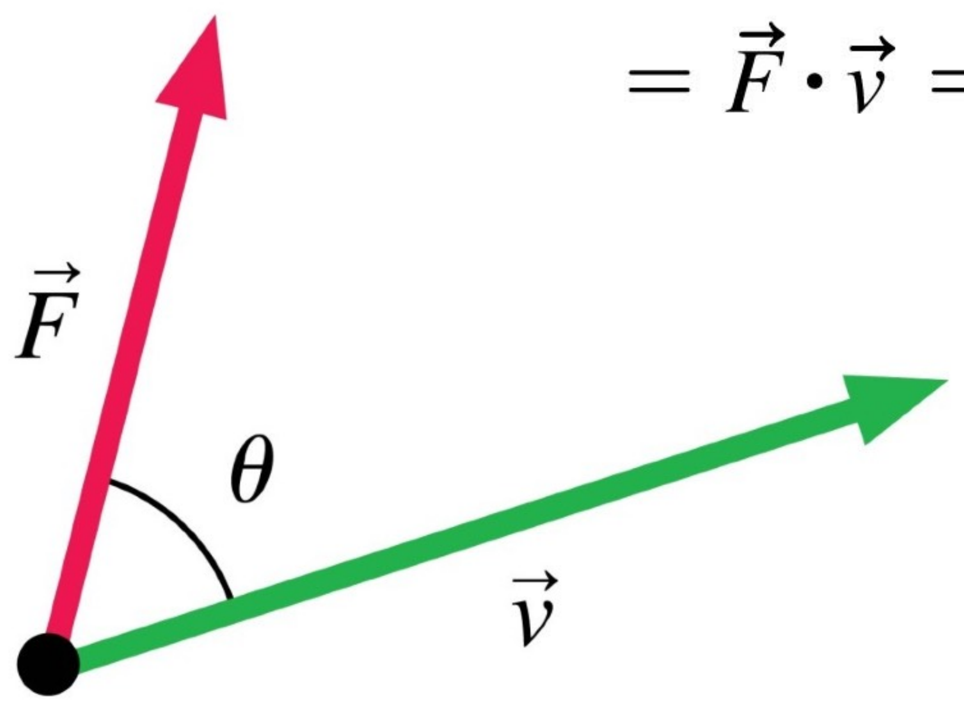
$$W = \vec{F} \cdot \Delta\vec{r}$$

$$\begin{aligned} P &= \frac{dW}{dt} \\ &= \vec{F} \cdot \frac{dr}{dt} \end{aligned}$$



$$W = \vec{F} \cdot \Delta\vec{r}$$

$$\begin{aligned} P &= \frac{dW}{dt} \\ &= \vec{F} \cdot \frac{dr}{dt} \\ &= \vec{F} \cdot \vec{v} = Fv\cos\theta \end{aligned}$$

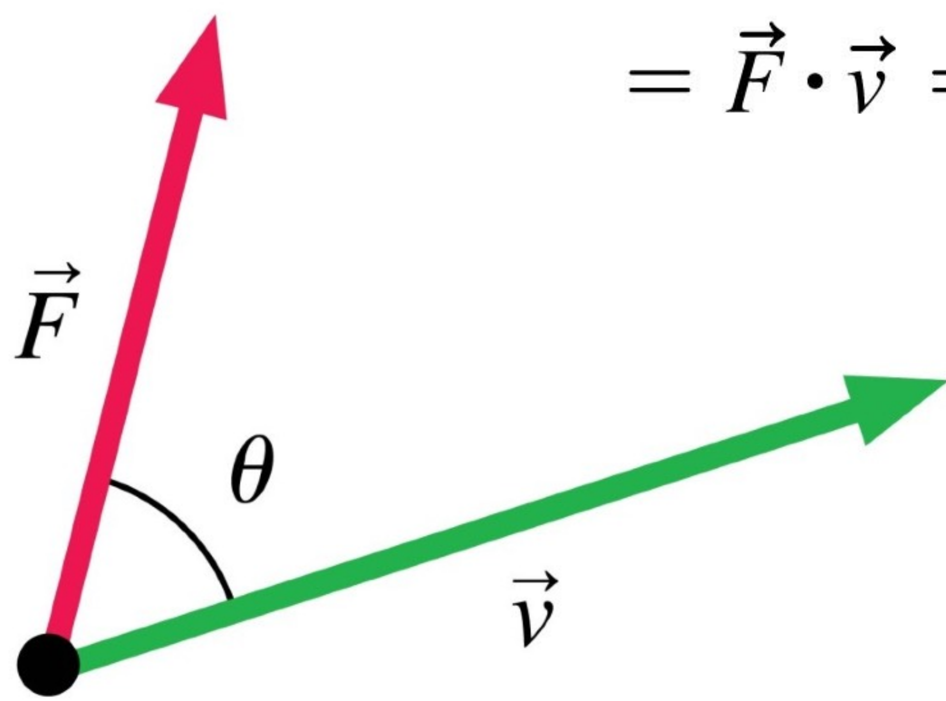


$$W = \vec{F} \cdot \Delta \vec{r}$$

$$P = \frac{dW}{dt}$$

$$= \vec{F} \cdot \frac{dr}{dt}$$

$$= \vec{F} \cdot \vec{v} = Fv\cos\theta$$



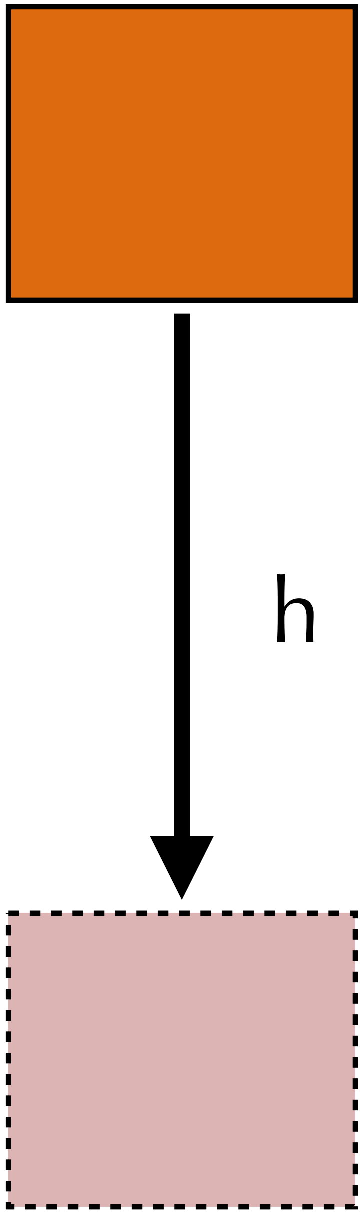
How hard is it to “peel out” at low speed?

Question #22

B $W = -mgh$

C $W = -\frac{mgh}{2}$

D



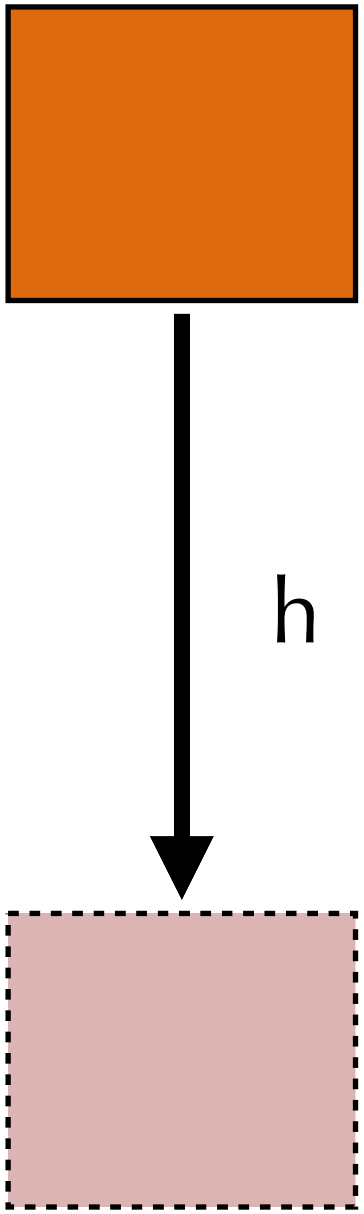
Question #22

How much work does gravity do as this box falls vertically a distance h?

B $$W = -mgh$$

C $$W = -\frac{mgh}{2}$$

D



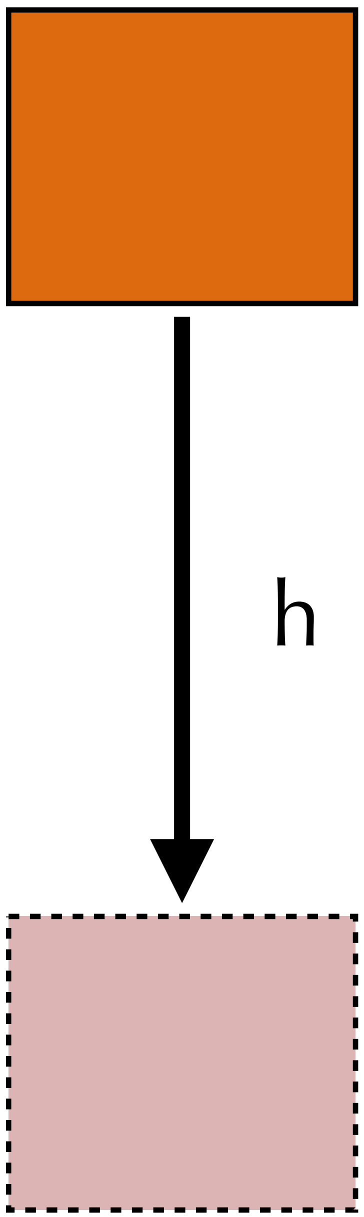
Question #22

How much work does gravity do as this box falls vertically a distance h?

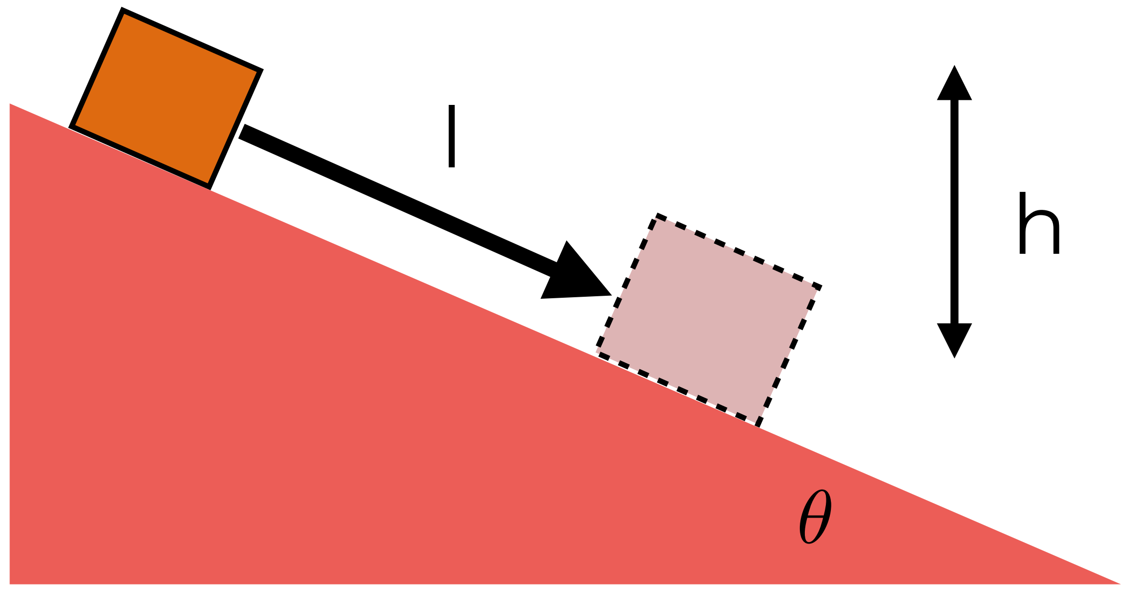
B $W = -mgh$

C $W = -\frac{mgh}{2}$

D $W = mgh$



Question #23



A $W = -mgh$

B

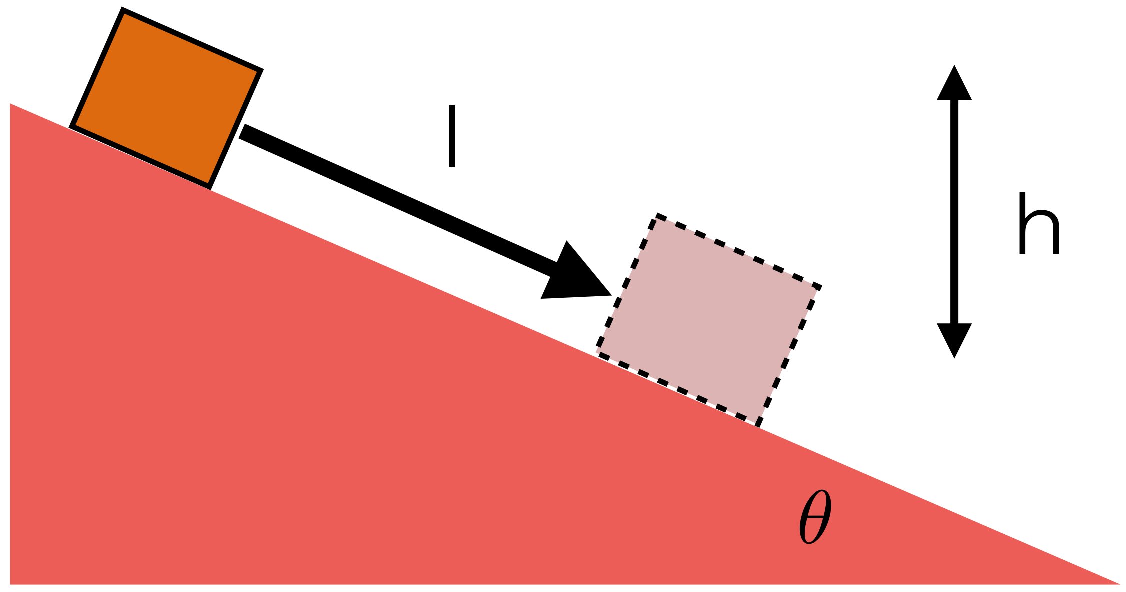
C. Both b) and e) are correct.

D $W = -mgl\sin\theta$

E $W = mgl\sin\theta$

Question #23

How much work does gravity do as the box slides down the incline?



A $W = -mgh$

B

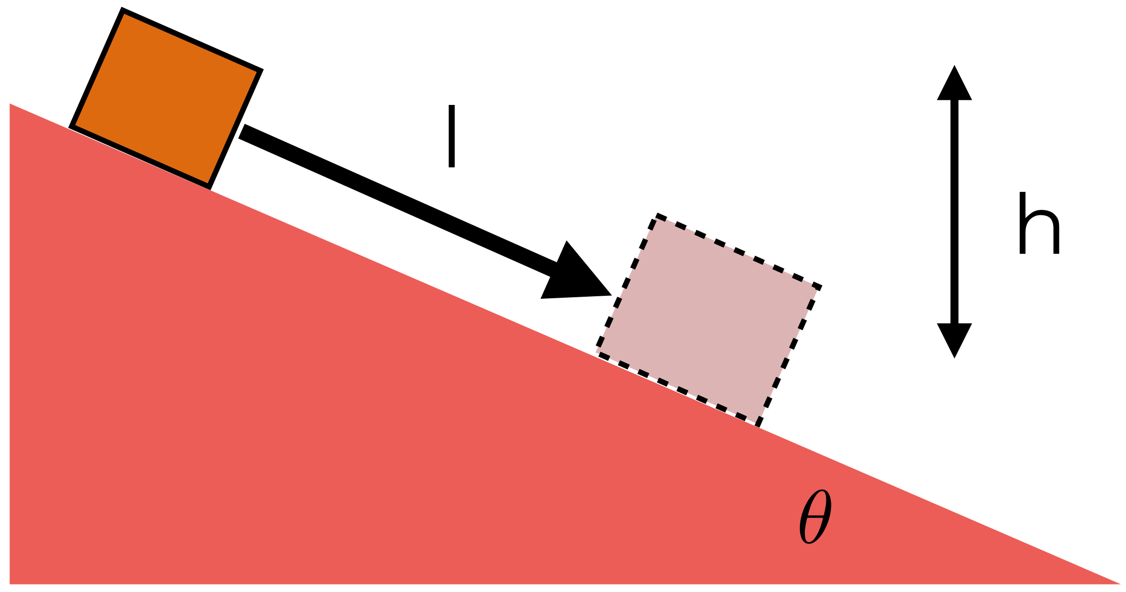
C. Both b) and e) are correct.

D $W = -mgl\sin\theta$

E $W = mgl\sin\theta$

Question #23

How much work does gravity do as the box slides down the incline?



A $W = -mgh$

B $W = mgh$

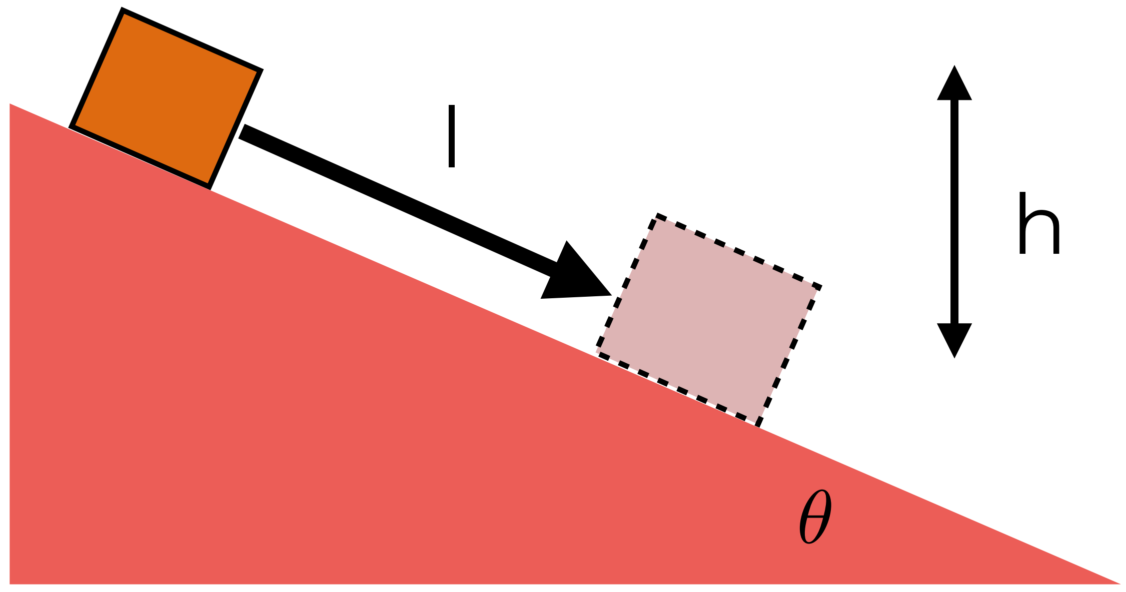
C. Both b) and e) are correct.

D $W = -mgl\sin\theta$

E $W = mgl\sin\theta$

Question #23

How much work does gravity do as the box slides down the incline?



$$W = -\Delta U$$

A $W = -mgh$

B $W = mgh$

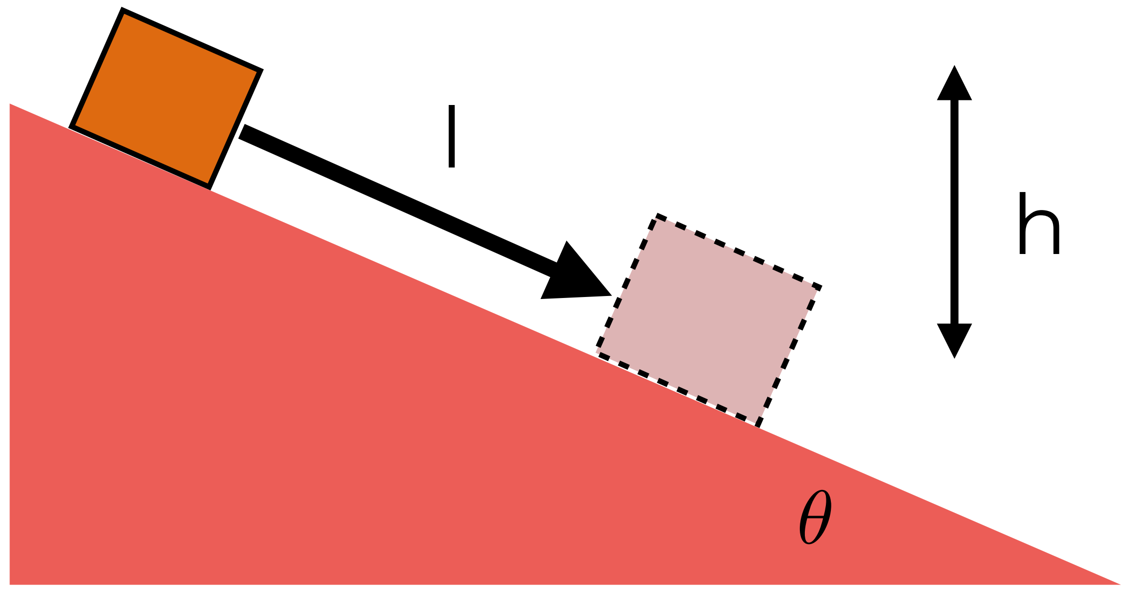
C. Both b) and e) are correct.

D $W = -mgl\sin\theta$

E $W = mgl\sin\theta$

Question #23

How much work does gravity do as the box slides down the incline?



$$W = -\Delta U$$

$$U_g = mgy$$

A $W = -mgh$

B $W = mgh$

C. Both b) and e) are correct.

D $W = -mgl\sin\theta$

E $W = mgl\sin\theta$

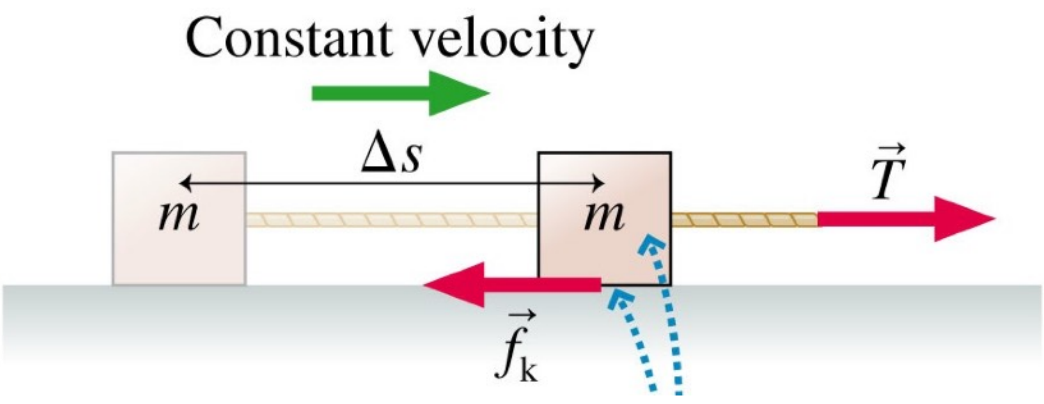
$$\Delta K = W_{\mathrm{net}}$$

but if there are ever springs in the system and/or the vertical position of the object changes, I can just use.

$$\Delta K + \Delta U_s + \Delta U_g = W_{\mathrm{net}}$$

Dissipative Forces

$$\Delta K + \Delta U_s + \Delta U_g = W_{\text{net}}$$



$$\Delta K + \Delta U_s + \Delta U_g + \Delta E_{\text{th}} = W_{\text{net}}$$

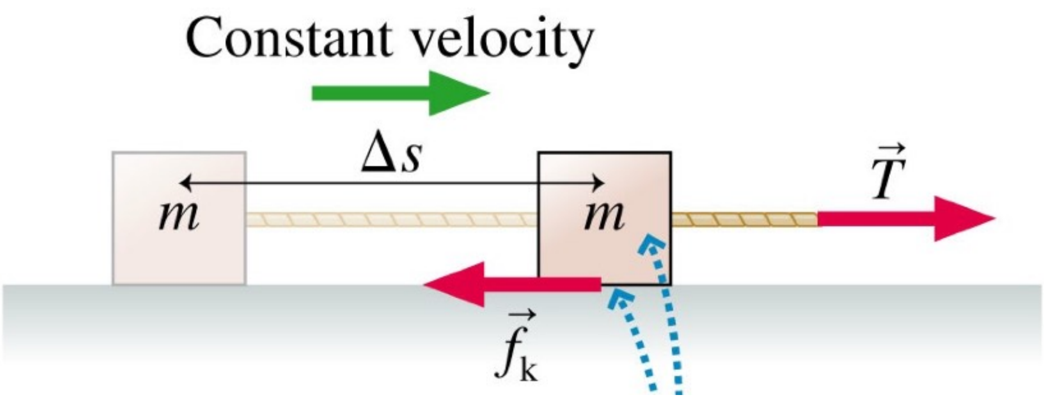
$$\boxed{U_i + K_i + W_{\text{ext}} = U_f + K_f + \Delta E_{\text{th}}}$$

Dissipative Forces

$$\Delta K + \Delta U_s + \Delta U_g = W_{\text{net}}$$

$$\Delta E_{\text{th}} = f_{\text{k}} \Delta s$$

But if friction is present, let's use:



$$\Delta K + \Delta U_s + \Delta U_g + \Delta E_{\text{th}} = W_{\text{net}}$$

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

Using Work and Potential Energy

Question #24

A 70-kg skier is gliding at 2.0 m/s when he starts down a very slippery 50-m long, 10 degree slope. What is his speed at the bottom if the wind exerts a steady 50 N **horizontal** retarding force?

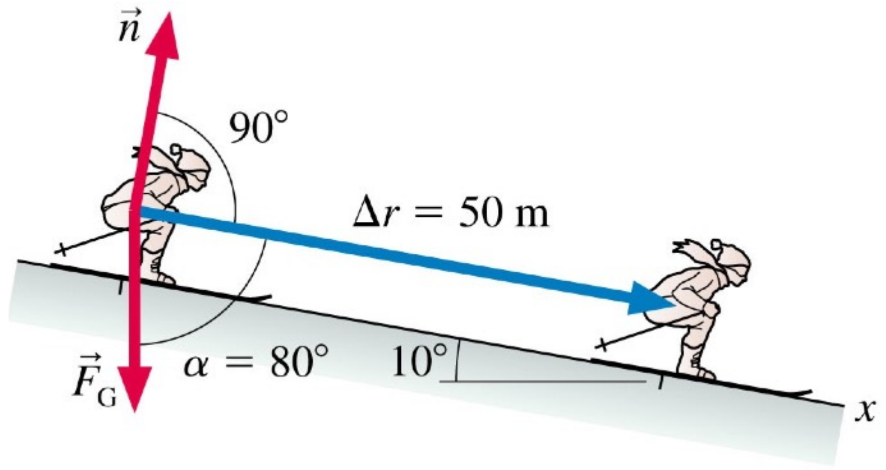
Which equation is a correct statement of conservation of energy for this problem?

B. $mg\Delta r\sin\theta + \frac{1}{2}mv_i^2 - F_W\Delta r\cos\theta = \frac{1}{2}mv^2$

D $mg\Delta r\cos\theta + \frac{1}{2}mv_i^2 + F_W\Delta r\cos\theta = \frac{1}{2}mv^2$

C $mg\Delta r\sin\theta + \frac{1}{2}mv_i^2 + F_W\Delta r\cos\theta = \frac{1}{2}mv^2$

E $mg\Delta r\sin\theta + \frac{1}{2}mv_i^2 - F_W\Delta r\sin\theta = \frac{1}{2}mv^2$



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

A problem

Question #25

A 20-kg person slides down a **rough** 3.0-m-high playground slide. She **starts from rest**, and her speed at the bottom is 2.0 m/s.

Which is a correct statement of conservation of energy for this situation?

E $mgh - mgl\sin\theta = \frac{1}{2}mv_f^2 + \Delta E_{\text{th}}$

A $mgh = \frac{1}{2}mv_f^2 + \Delta E_{\text{th}}$

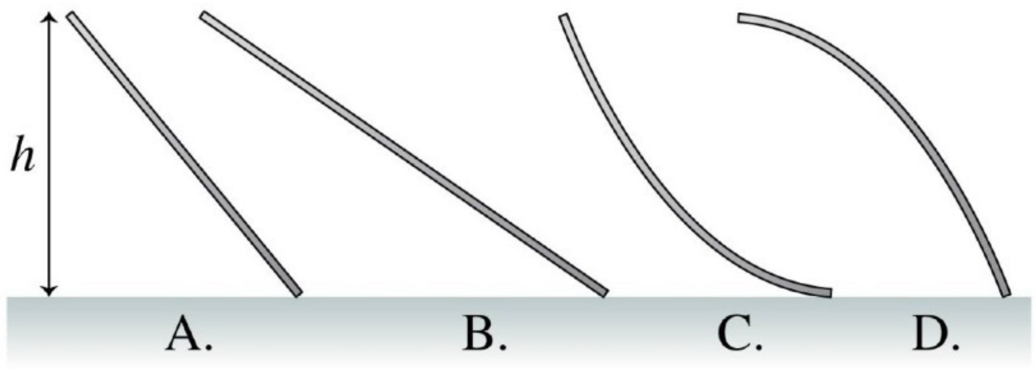
C $mgh + \frac{1}{2}mv_i^2 = \frac{1}{2}mv_f^2 + \Delta E_{\text{th}}$

B. $mgh\cos\theta = \frac{1}{2}mv_f^2 + \Delta E_{\text{th}}$

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

Question #26

A small child slides down the four frictionless slides A–D. Rank in order, from largest to smallest, her speeds at the bottom.



a. $v_D > v_A > v_B > v_C$

b. $v_D > v_A = v_B > v_C$

c. $v_A = v_B = v_C = v_D$

d. $v_C > v_A > v_B > v_D$

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

cons. of energy applet

Another Problem

Question #27

A horizontal spring with a spring constant of 100 N/m is compressed 20 cm and used to launch a 2.5 kg box across a frictionless, horizontal surface. After the box travels some distance the surface becomes rough. The coefficient of kinetic friction of the box on the surface is 0.15. Use work and energy to find how far the box slides across the rough surface before stopping.

D $\frac{1}{2}mv^2 = \mu_k mg\Delta x$

E $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

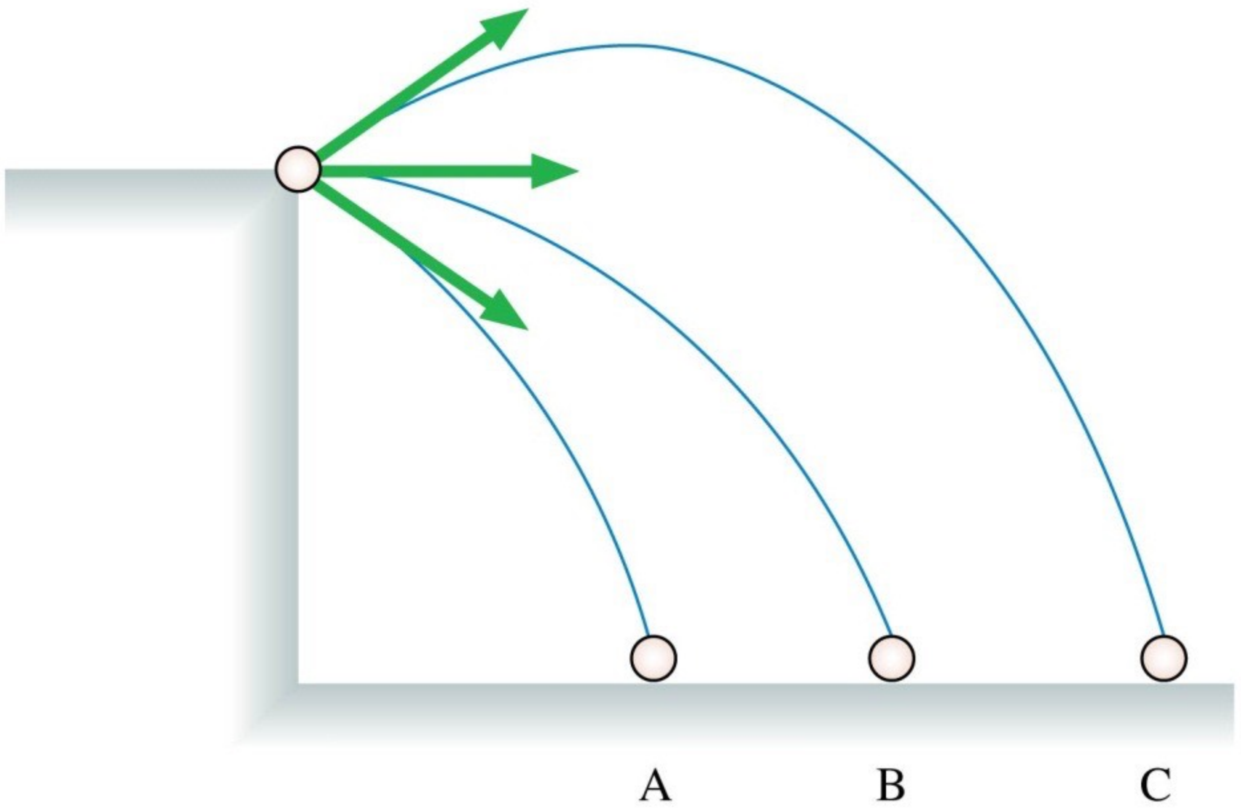
C $\frac{1}{2}kx^2 = \mu_k mg\Delta x$

B. $\frac{1}{2}kx^2 = \frac{1}{2}mv^2 + \mu_k mg\Delta x$

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

Question #28

Three balls are thrown from a cliff with the same speed but at different angles. Which ball has the greatest speed just before it hits the ground?



A. Ball A

B. Ball B

C. Ball C

D. All balls have the same speed.

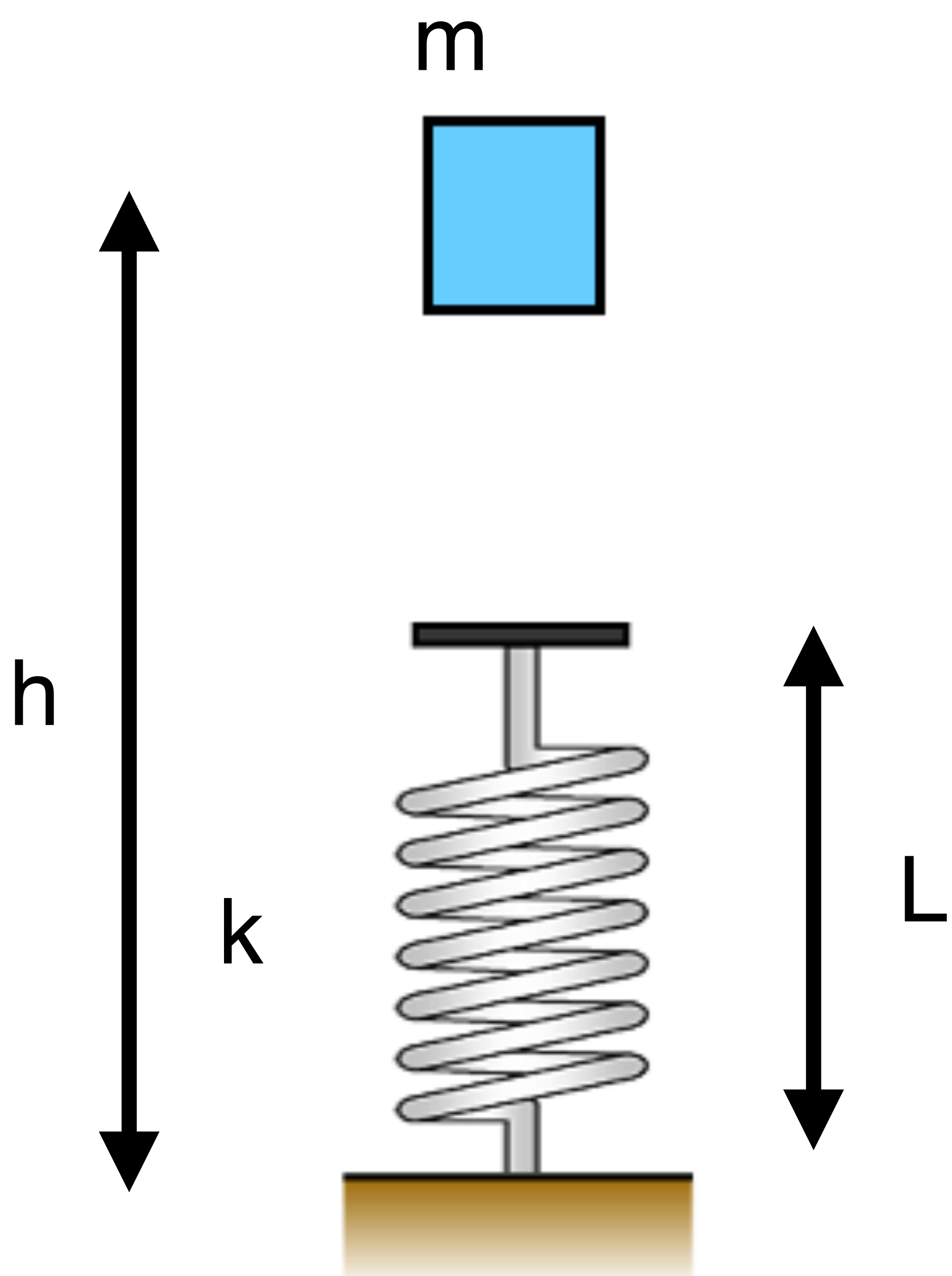
cons. of energy applet

applet

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

Spring potential energy **Question #29**

Challenge



By how much does the spring compress?

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

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

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

B. $mg(h - L + x) = \frac{1}{2}kx^2$

E. Both A and B are correct.

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