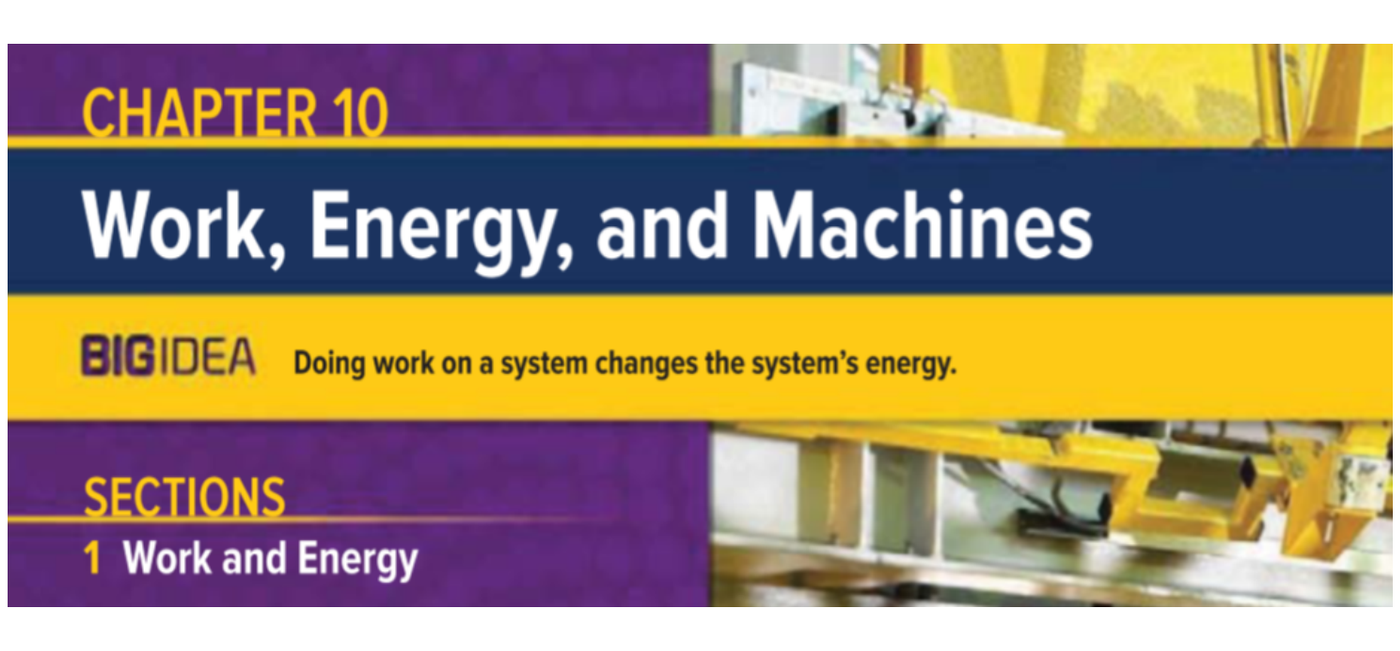
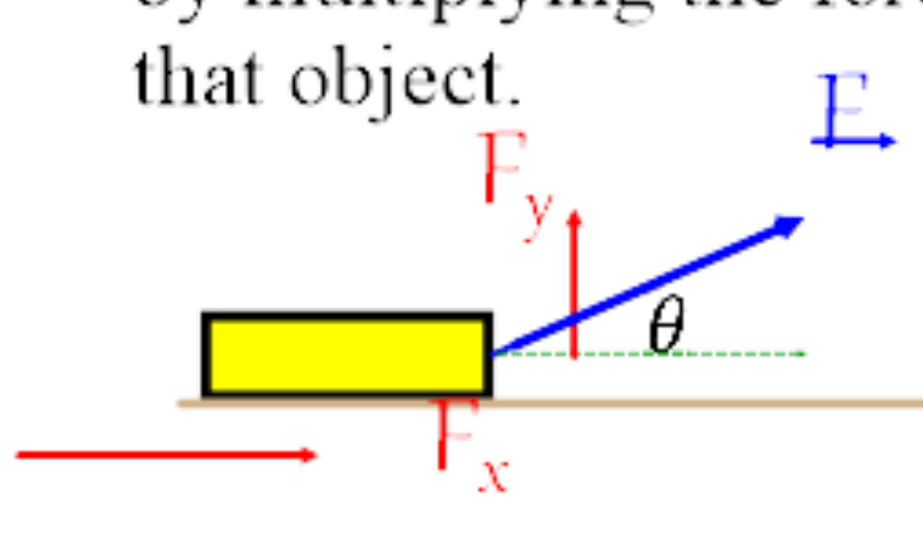


Work

Work is done when a force that is applied to an object moves that object. Work is the energy transferred by a force. The work is calculated by multiplying the force by the displacement of that object.

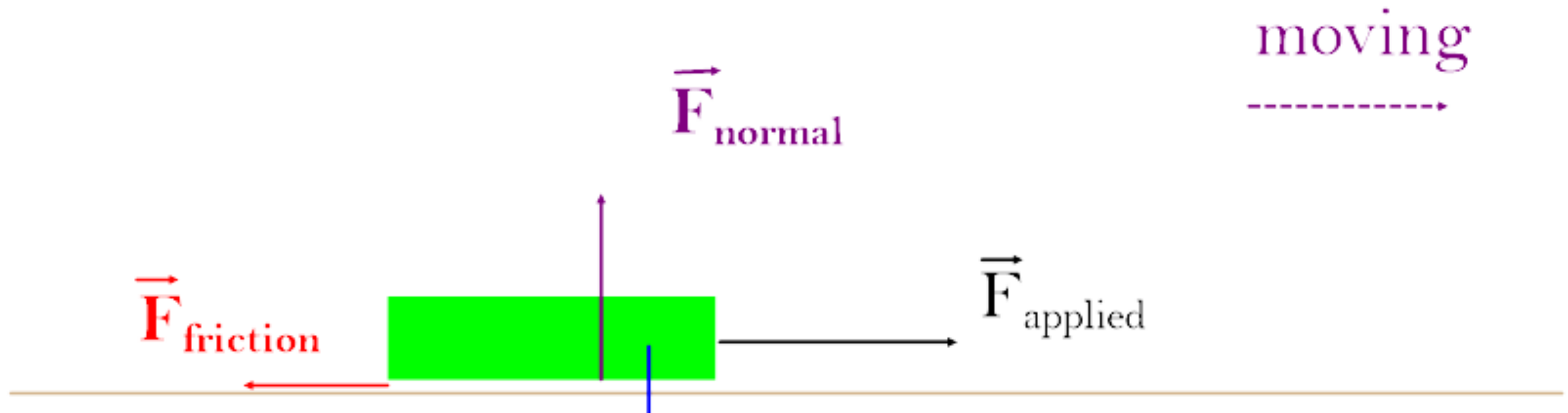
$$W = \vec{F} \cdot \Delta\vec{x} = F \cdot cos(\theta) \cdot \Delta x$$

$$W = F \cdot \Delta x \cdot cos(\theta)$$



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

Energy is the ability to do Work. Both concepts relate to each other.



$W_{Ff} < 0$ (negative)
$\theta = 180°$
$\cos(180°) = -1$

$W_{F_{applied}} > 0$ (positive)
$\theta = 0°$
$\cos 0° = 1$

W_{Fg}, W_{FN} } zero Work
$\theta = 90°$
$\cos 90° = 0$

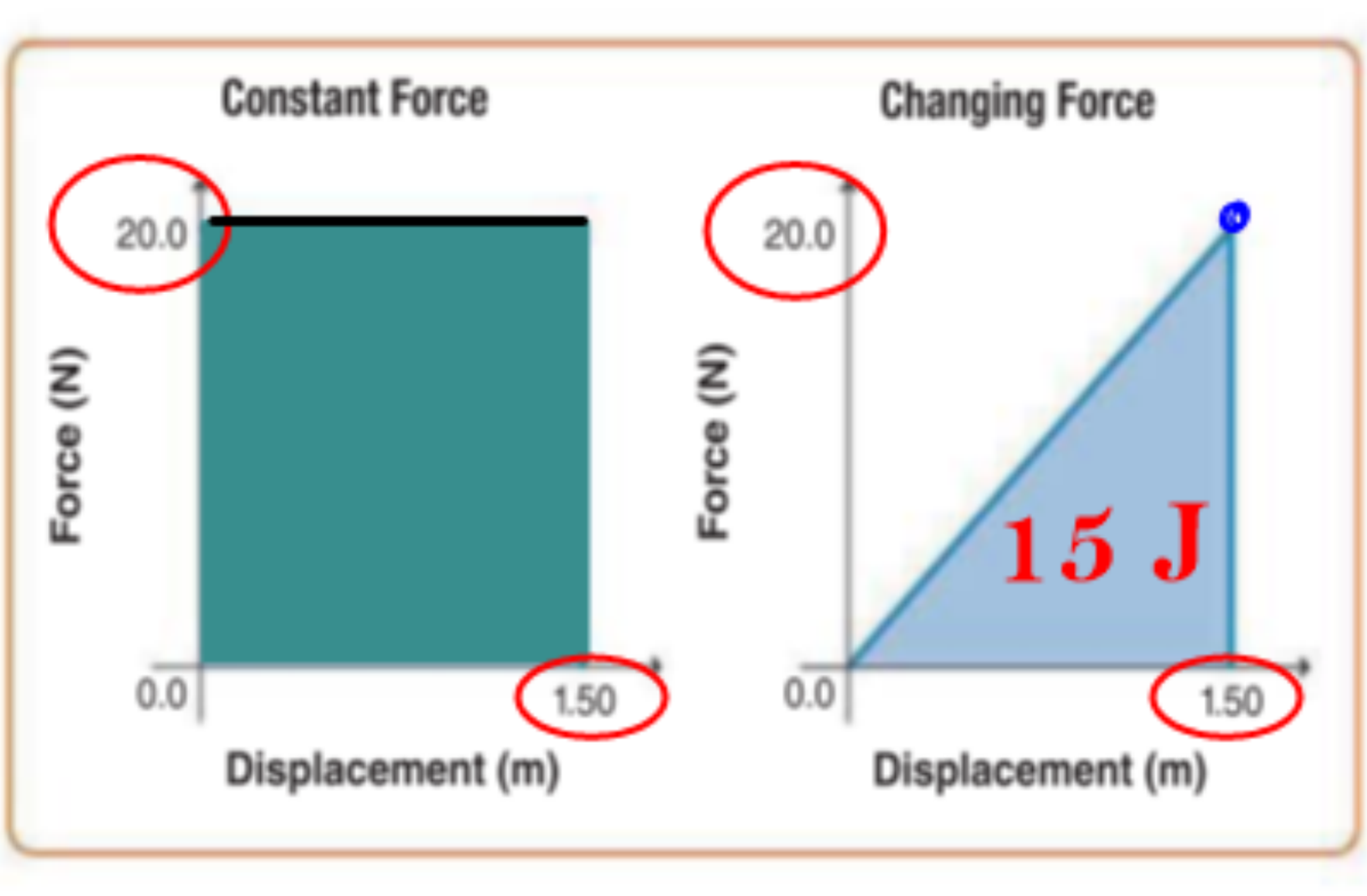


Figure 4 The area under a force-displacement graph is equal to the work.

$W = F \cdot \Delta x \cdot cos(\theta)$

$y \cdot x =$ Area

height · base = A

Recommended video

https://www.youtube.com/watch?v=i7ruTvfeGiM

Concepts

1. Work is the product of the **force** exerted on an object and the distance the object moves in the **direction** of the force.
2. The equation for work is **force times displacement**
3. The unit for work is the **N x m** (Newton times meter) which also called the **Joule (J)**
4. Work is done on an object only if the object **is moving**.
5. Work is done on an object only if the force and displacement are **in the same direction**.

Practice Problems (6-9)

6. A person lifts a package weighing 75 N. If she lifts it 1.2 m off the floor, what work has she done?

$W = F \cdot \Delta y \cdot \cos\theta = 75N \times 1.2m = 90. J$

7. When 142 J of work is done in pushing a box horizontally 13.3 m, how much force is applied?

$W = F \cdot \Delta X \cdot \cos 0°$ (one)

$142 J = F \cdot 13.3m$

$\frac{142 J}{13.3 m} = F = 10.7 N$

8. What work is done when a person pushes a refrigerator with a 720 N force across a floor 12 m? (The force of friction between the refrigerator and the floor is 480 N.)

$$W = F \cdot \Delta x \cdot cos(\theta)$$

$W_p = 720N \times 12m \times \cos 0° = 8640 J$ (one)

$W_{Ff} = 480 N \times 12 m \cdot \cos(180°) = -5760 J$ (−1)

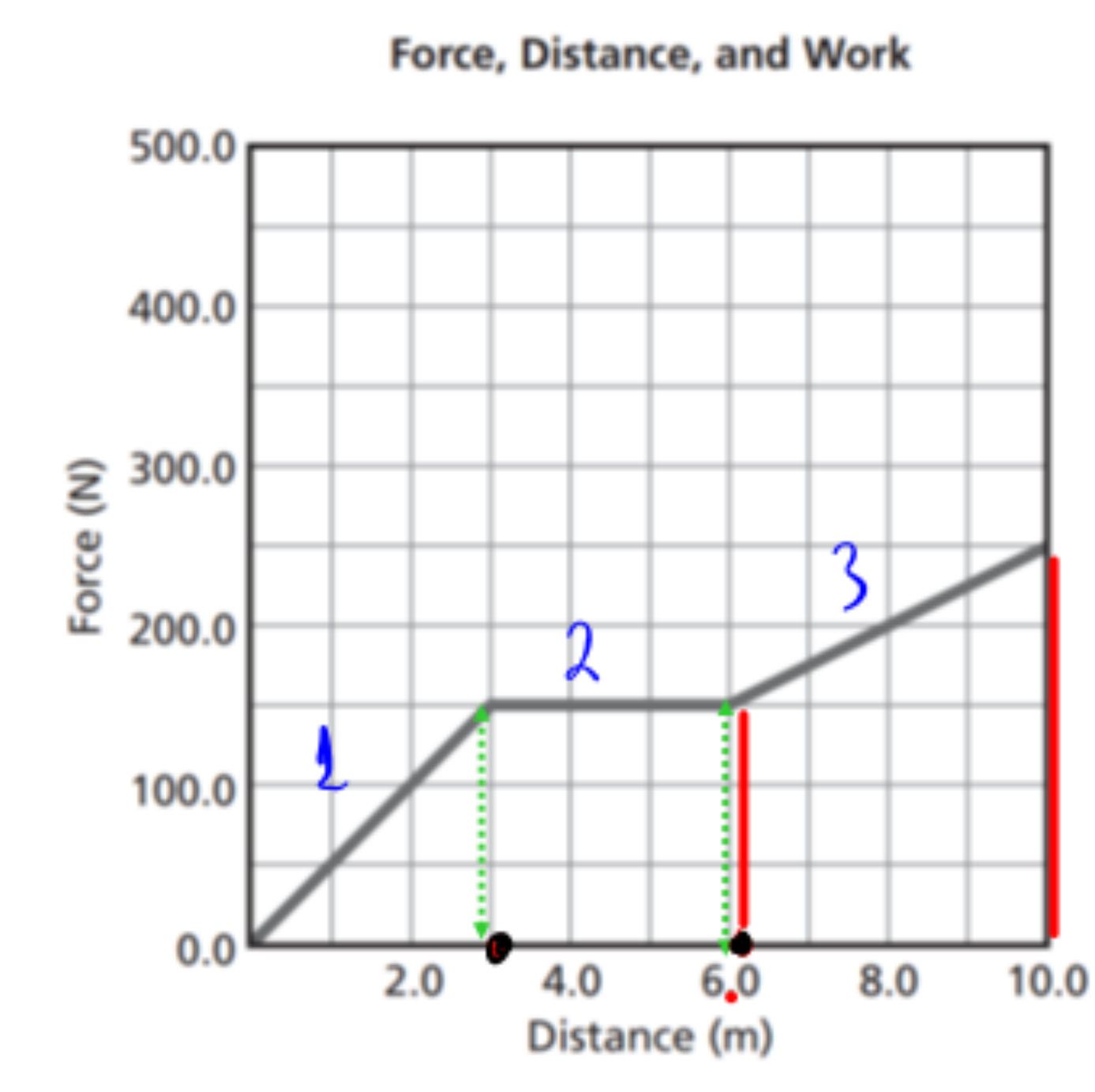
$W_{net} = W_p + W_{Ff} = 8640 J - 5760 J = 2880 J$ Total (Net)

9. A sailor pulls a boat along a dock using a rope at an angle of 60.0° with the horizontal. How much work does the sailor do if he exerts a force of 255 N on the rope and pulls the boat 3.00 m?

$W = F \cdot \Delta X \cdot \cos\theta = 255N \times 3m \times \cos(60°)$

$W = 382.5 J \approx 383 J$

10. An object is moving under the influence of a force according to the graph below. Determine the total work done by the force



$A_1 = \frac{b \times h}{2}$

$A_2 = b \times h$

$A_3 = \frac{(b_1 + b_2)}{2} h$

$W_{net} = A_{total} = \frac{3 \times 150}{2} + 3 \times 150 + \frac{(150 + 250)}{2} 4$

$W_{net} = 1475 J$

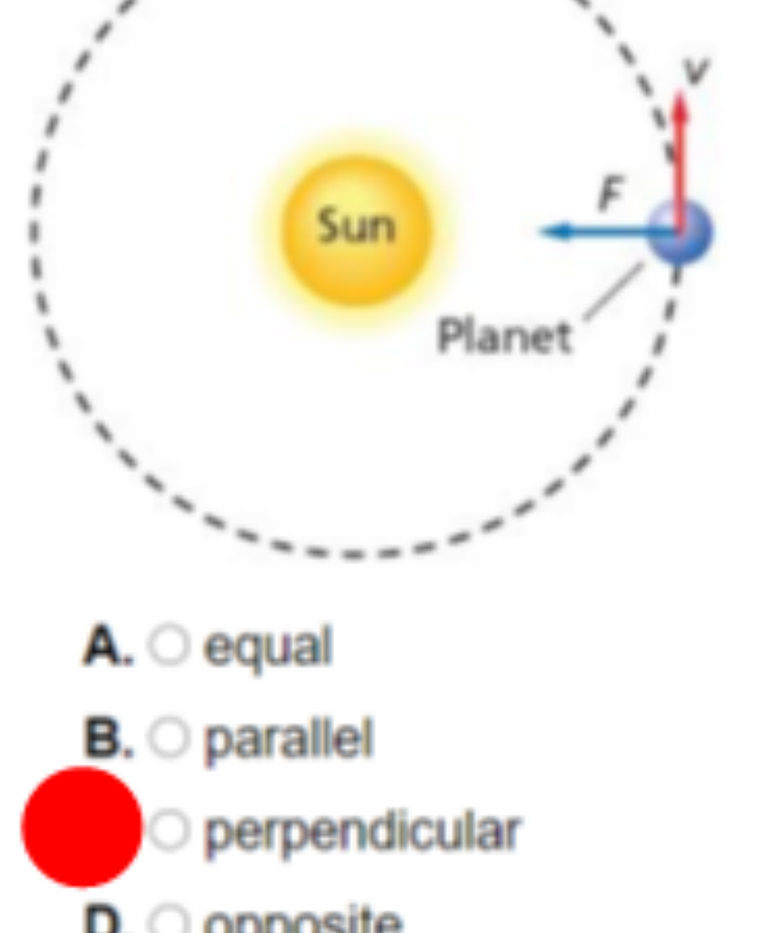
Section Self-Check

1. Energy of motion is called _____.
   - A. kinetic energy ●
   - B. potential energy
   - C. power
   - D. work

2. Which equation represents work?
   - A. KE = 1/2mv²
   - B. W = ΔKE
   - C. W = Fd
   - D. W = Fd cos θ ●

3. Power is measured in _____.
   - A. joules
   - B. kilo-joules
   - C. ohms
   - D. watts ●

4. In this image, the force is _____ to the direction of motion.



   - A. equal
   - B. parallel
   - C. perpendicular ●
   - D. opposite

5. The work-energy theorem states that when work is done on an object, the result is a change in _____.
   - A. kinetic energy ●
   - B. potential energy
   - C. power
   - D. work-energy