Virtual Learning

Physics

Work, The Scientific Definition

May 15, 2020

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Objective/Learning Target:

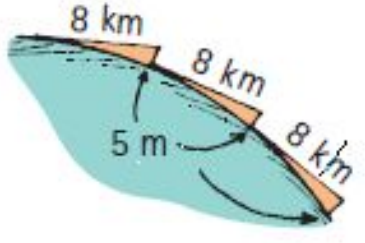
Students will learn the definition of work and use it to solve various problems.

Quick Review #1

Satellites in close circular orbit fall about 5 m during each second of orbit. Why doesn't this distance accumulate and send satellites crashing into Earth's surface?

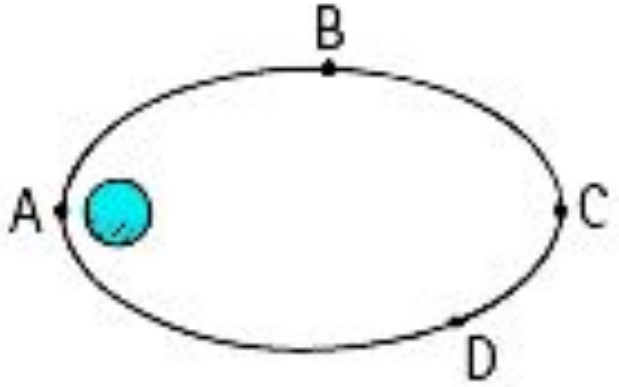
Quick Review #1 Answer

In each second, the satellite falls about 5 m below the straight-line tangent it would have followed if there were no gravity. Earth's surface also curves 5 m beneath a straight-line 8-km tangent. The process of falling with the curvature of Earth continues from tangent line to tangent line, so the curved path of the satellite and the curve of Earth's surface "match" all the way around the planet. Satellites do, in fact, crash to Earth's surface from time to time when they encounter air resistance in the upper atmosphere that decreases their orbital speed.



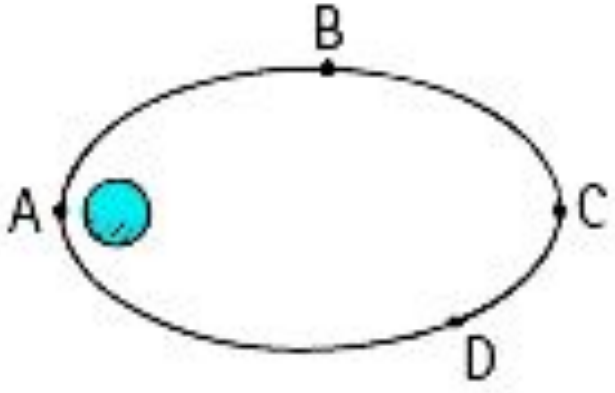
Quick review #2

The orbital path of a satellite is shown in the sketch. In which of the marked positions, A through D, does the satellite have the greatest speed? The lowest speed?

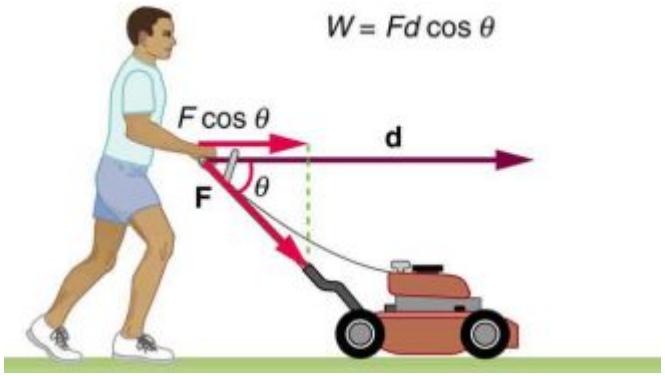


Quick Review #2 Answer

The satellite has its greatest speed as it whips around position A and has its lowest speed at position C. After passing C, it gains speed as it falls back to A to repeat its cycle.



Work



Link: [Work the Scientific Definition]

Directions:

- Read through Work, the Scientific Definition.
- Work through any examples on a separate piece of paper before you scroll down to the solution.
- On a separate piece of paper complete the practice problems on the following slides.
- Check your answers.
- For additional practice check out the conceptual questions and the problems and exercises in the table of contents for the online text linked above.

Practice Problem #1

The second floor of a house is 6 m above the street level. How much work is required to lift a 300-kg refrigerator to the second-story level?

Practice Problem #1 Answer

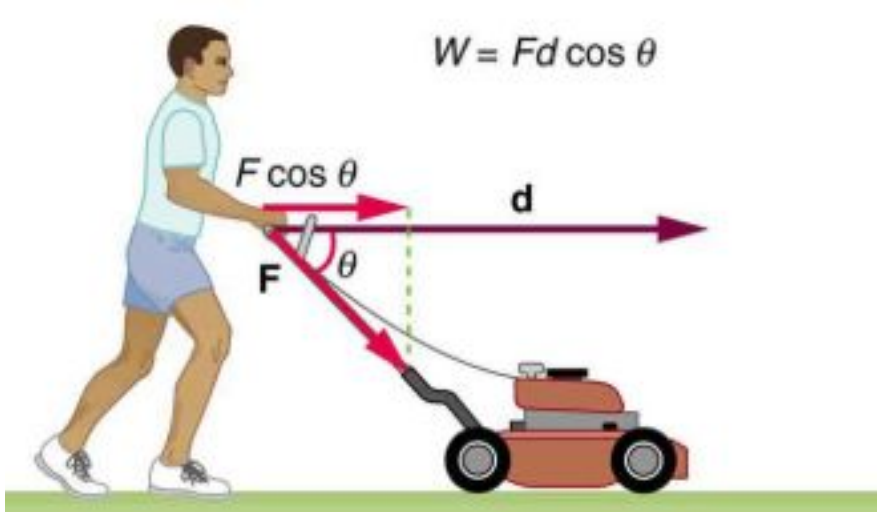
$W = Fd \cos\theta$ Remember F=ma

$= 600\ kg\ (9.8\ m/s^2) \times 6\ m \times \cos 0°$

$= 35{,}280\ J$

Practice Problem #2

How much work is done on the lawn mower by the person in the figure below if he exerts a constant force of 95.0 N at an angle 45^{o} below the horizontal and pushes the mower 35.0 m on level ground?



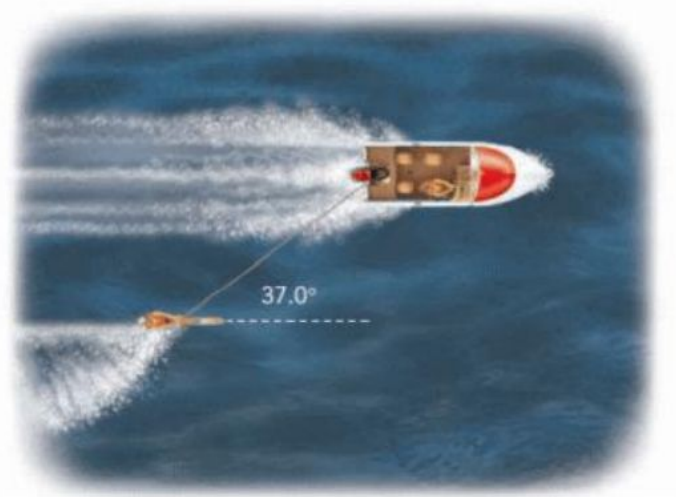
Practice Problem #2

$W = Fd \cos\theta$

$= 95.0\ N \times 35.0\ m \times \cos 45° = 2351\ J$

Practice Problem #3

A water skier, moving at a speed of 9.30 m/s, is being pulled by a tow rope that makes an angle of 37.0° with respect to the velocity of the boat. The tow rope is parallel to the water. The skier is moving in the same direction as the boat.If the tension in the tow rope is 135 N, determine the work that it does in 12.0 s.



Practice Problem #3 Answer

Since the skier is moving in the same direction as the boat, their displacement vector is at an angle of 37º to the force vector of the rope.

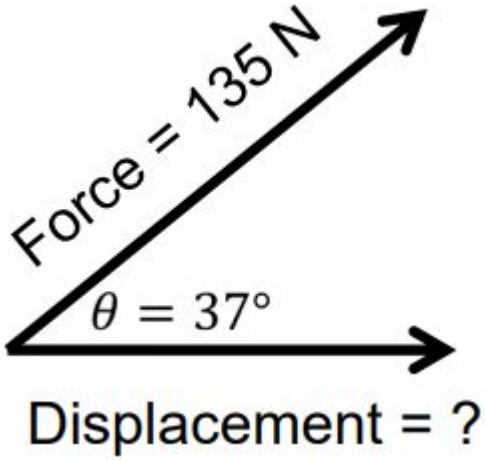
Here we can use the equation: $W = Fd \cos\theta$

We know the velocity of the water skier, and how long they travel, so we can work out their displacement:

$$d = v \times t = 9.30 \text{ m/s} \times 12.0 \text{ s} = 111.6 \text{ m}$$

From there we can calculate the work done:

$W = Fd \cos\theta = 135 \text{ N} \times 111.6 \text{ m} \times \cos 37° = 12032 \text{ J} \rightarrow 12000\text{J}$



Additional Practice

For additional practice check out the conceptual questions and the problems and exercises in the table of contents from the online text linked above.