

**Module 3: Motion in Two Dimensions**  
**Topic 3 Content: Work-Kinetic Energy Practice Solutions**

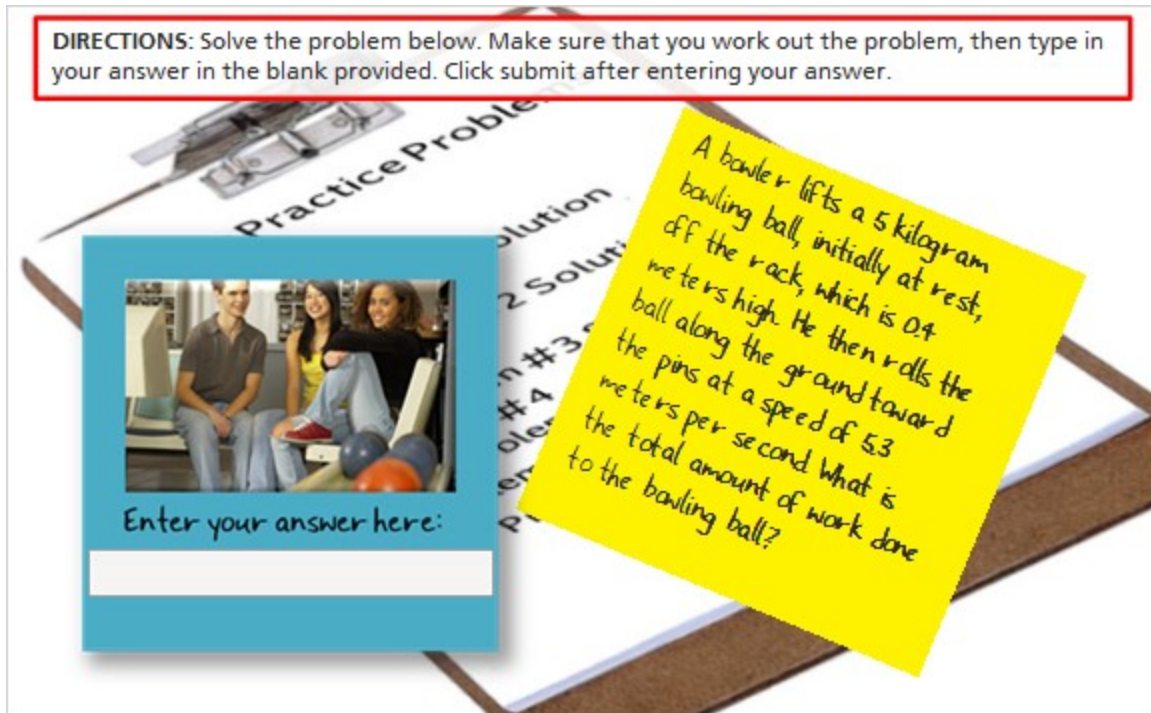


**Introduction**

## Module 3: Motion in Two Dimensions

### Topic 3 Content: Work-Kinetic Energy Practice Solutions

**DIRECTIONS:** Solve the problem below. Make sure that you work out the problem, then type in your answer in the blank provided. Click submit after entering your answer.



The graphic features a clipboard with a document titled "Practice Problem" and "Solution". A yellow sticky note is placed over the document, containing a physics problem. To the left of the sticky note is a blue-bordered box with a photo of three students (two women and one man) sitting together. Below the photo is a white input field with the text "Enter your answer here:".

A bowler lifts a 5 kilogram bowling ball, initially at rest, off the rack, which is 0.9 meters high. He then rolls the ball along the ground toward the pins at a speed of 5.3 meters per second. What is the total amount of work done to the bowling ball?

Enter your answer here:

#### Problem 1

A 6 kg bowling ball is lifted from a shelf 1 meter high to a shelf 1.6 meters high. What is the change in potential energy of the bowling ball?

## Module 3: Motion in Two Dimensions

### Topic 3 Content: Work-Kinetic Energy Practice Solutions

**Problem 1 Solution**

Remember, you can click the magnifying glass to zoom images.

$W = \Delta KE$

Initial:  
 $KE_0 = 0 \text{ J}$

Final:  
 $KE = \frac{1}{2}mv^2 = \frac{1}{2}(5)(5.3^2) = 70.2 \text{ J}$

$\Delta KE = KE - KE_0 = 70.2 - 0 = 70.2 \text{ J}$

$\Delta KE = 70.2 - 0 = 70.2 \text{ J}$

$W = \Delta KE = 70.2 \text{ J}$

To solve this, you will use the work-kinetic energy theorem and find the change in the kinetic energy of the ball.

Initially, it is at rest at a height of 0.4 meters. It has potential energy at this point, but no kinetic energy.

After the ball has been thrown, it is moving, so it now has kinetic energy. The kinetic energy calculates to be 70.2 Joules.

The change in kinetic energy is the final kinetic energy minus the initial kinetic energy, or 70.2 Joules.

The work-kinetic energy theorem tells us that the work done is the change in mechanical energy.

You did not include any calculations related to the initial height of the ball, since the work-kinetic energy theorem is only concerned with the kinetic energy.

#### Problem 1 Solution

To solve this, you will use the work-kinetic energy theorem and find the change in the kinetic energy of the ball.

Initially, it is at rest at a height of zero point four meters. It has potential energy at this point, but no kinetic energy.

After the ball has been thrown, it is moving, so it now has kinetic energy. The kinetic energy calculates to be seventy point two Joules.

The change in kinetic energy is the final kinetic energy minus the initial kinetic energy, or seventy point two Joules.


The work-kinetic energy theorem tells us that the work done is the change in mechanical energy.

You did not include any calculations related to the initial height of the ball, since the work-kinetic energy theorem is only concerned with the kinetic energy.

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### Topic 3 Content: Work-Kinetic Energy Practice Solutions

**DIRECTIONS:** Solve the problem below. Make sure that you work out the problem, then type in your answer in the blank provided. Click submit after entering your answer.



Enter your answer here:

A 1200 kg car traveling at 15 m/s on a level road slams on the brakes and skids to a stop in 45 m. What was the force of friction between the tires and the road?

#### Problem 2

A twelve hundred kilogram car traveling at fifteen meters per second on a level road slams on the brakes and skids to a stop in forty five meters. What was the force of friction between the tires and the road?

## Module 3: Motion in Two Dimensions

### Topic 3 Content: Work-Kinetic Energy Practice Solutions

**Problem 2 Solution**

$W = \Delta KE$

Initial:  
 $KE_0 = \frac{1}{2}mv^2 = \frac{1}{2}(1200)(15^2) = 135,000 \text{ J}$

Final:  
 $KE = 0$

$\Delta KE = 0 - 135,000 = -135,000 \text{ J}$

$W = \Delta KE = -135,000 \text{ J}$

$W = Fd\cos\theta$   
 $-135,000 = F(45)(\cos(180))$   
 $F = 3,000 \text{ N}$

In this problem, you can use the work-kinetic energy theorem to determine the amount of work done to the car, then you'll use the equation for work to determine the force on the car. It is the force of friction acting between the tires and the road that brings the car to a stop.

The work done will be equal to the change in kinetic energy. Kinetic energy is equal to one half times the mass times the speed squared. Initially, the car has 135,000 Joules of kinetic energy.

After the car comes to a stop, the speed is zero, so the kinetic energy is zero.

The change in kinetic energy is therefore -135,000. This is equal to the amount of work done.

Applying the equation for work, you find that the force of friction equals 3,000 Newtons.

#### Problem 2 Solution

In this problem, you can use the work-kinetic energy theorem to determine the amount of work done to the car, then you'll use the equation for work to determine the force on the car. It is the force of friction acting between the tires and the road that brings the car to a stop.

The work done will be equal to the change in kinetic energy. Kinetic energy is equal to one half times the mass times the speed squared. Initially the car has one hundred thirty five thousand Joules of kinetic energy.

After the car comes to a stop, the speed is zero so the kinetic energy is zero.

The change in kinetic energy is therefore negative one hundred thirty five thousand Joules. This is equal to the amount of work done.


Applying the equation for work, you find that the force of friction equals three thousand Newtons.



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**DIRECTIONS:** Solve the problem below. Make sure that you work out the problem, then type in your answer in the blank provided. Click submit after entering your answer.



Enter your answer here:

Chelsea is playing soccer. As she runs towards the goal, her teammate kicks the ball up to her at 3.6 m/s. Chelsea kicks the ball at the goal, doing 12.7 Joules of work to the ball. What is the final speed of the ball? Note: She is kicking the ball in the same direction that it is traveling.

#### Problem 3

Chelsea is playing soccer. As she runs towards the goal, her teammate kicks the ball up to her at three point six meters per second. Chelsea kicks the ball at the goal, doing twelve point seven Joules of work to the ball. What is the final speed of the ball?

Note: She is kicking the ball in the same direction that it is traveling.

## Module 3: Motion in Two Dimensions

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**Problem 3 Solution**

$W = \Delta KE$   
 $W = KE - KE_0$   
 $KE = KE_0 + W$   
 $KE_0 = \frac{1}{2}mv_0^2 = \frac{1}{2}(0.43)(3.6^2) = 2.8 \text{ J}$

$KE = KE_0 + W$   
 $KE = 2.8 + 12.7 = 15.5 \text{ J}$

$\frac{1}{2}mv^2 = KE$   
 $v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{(2)(15.5)}{.43}} = 8.5 \text{ m/s}$

You will again use the work-kinetic energy theorem to solve this problem.

The work of 12.7 Joules is equal to the change in kinetic energy of the ball. If you rearrange the work-kinetic energy equation, you see that the new kinetic energy is equal to the initial kinetic energy plus the work done. Substituting the mass and initial speed into the kinetic energy equation, you find that the initial kinetic energy is 2.79 Joules.

The final kinetic energy is equal to the initial kinetic energy plus the work, so the final kinetic energy is equal to 15.5 Joules.

Again using our kinetic energy equation, rearranged to find the speed, you see that the final speed is equal to 8.5 meters per second.

#### Problem 3 Solution

You will again use the work-kinetic energy theorem to solve this problem.

The work of twelve point seven Joules is equal to the change in kinetic energy of the ball. If you rearrange the work-kinetic energy equation, you see that the new kinetic energy is equal to the initial kinetic energy plus the work done. Substituting the mass and initial speed into the kinetic energy equation, you find that the initial kinetic energy is two point seven nine Joules.

The final kinetic energy is equal to the initial kinetic energy plus the work, so the final kinetic energy is equal to fifteen point five Joules.

Again using our kinetic energy equation, rearranged to find the speed, you see that the final speed is equal to eight point five meters per second.