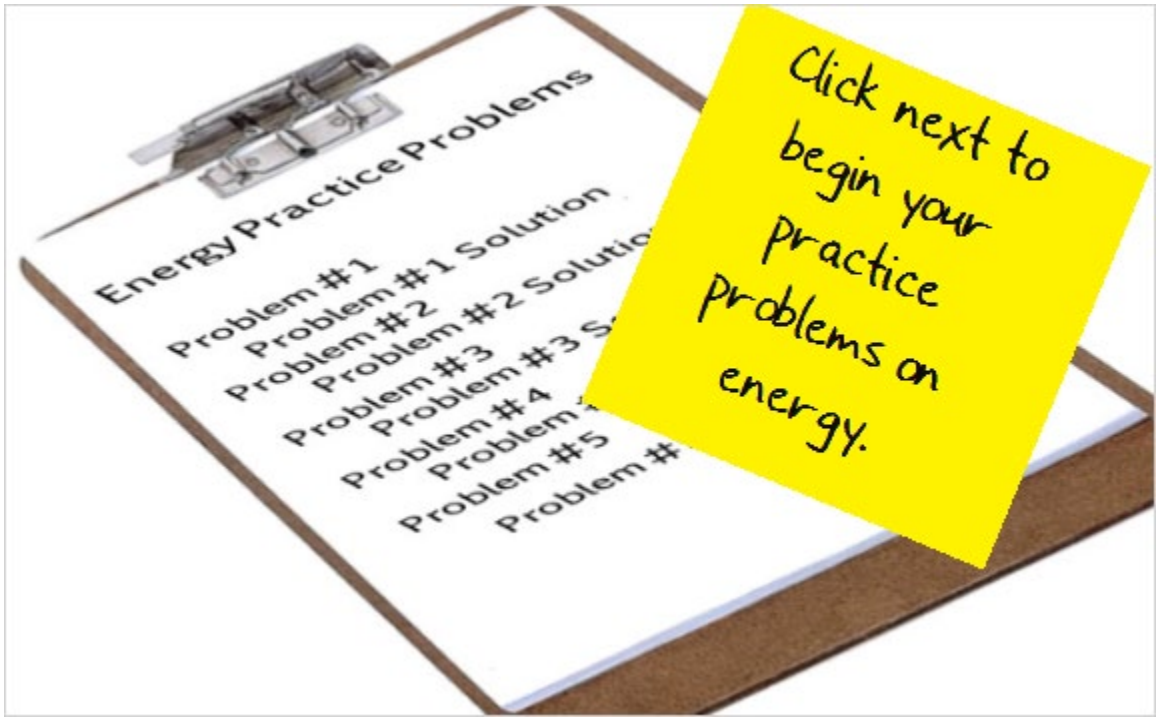
Module 4: Energy
Topic 2 Content: Energy Transformations Practice Solutions



Introduction

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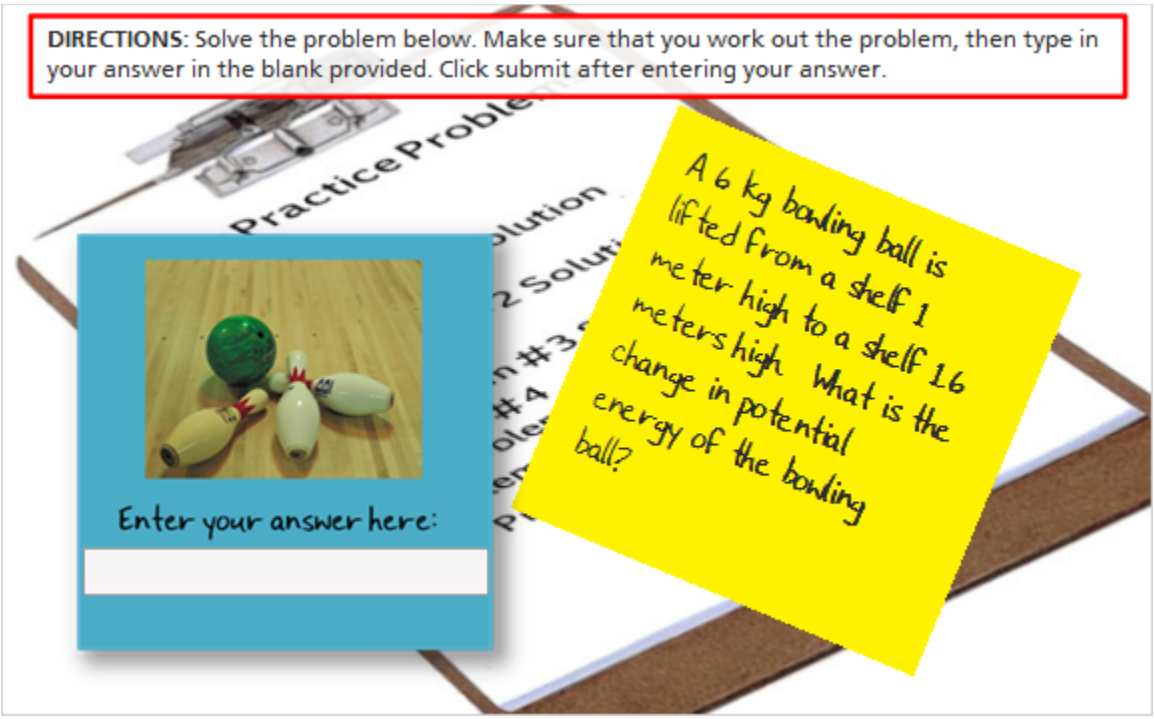

Problem 1

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?

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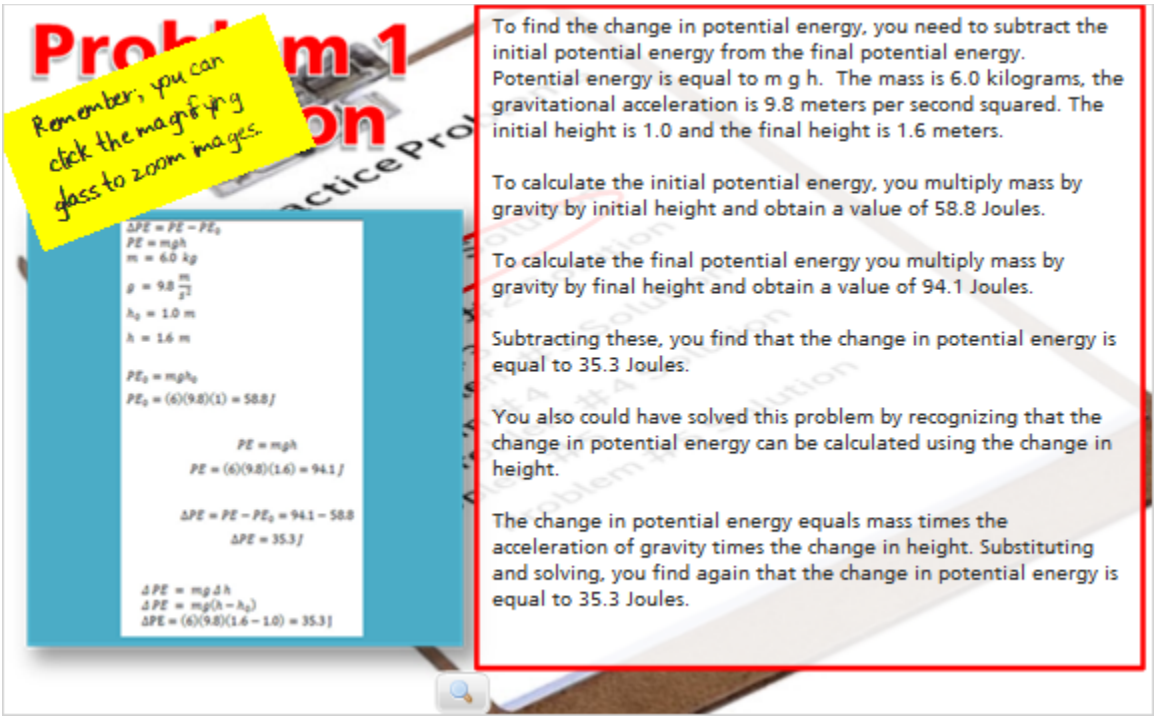

Problem 1 Solution

To find the change in potential energy, you need to subtract the initial potential energy from the final potential energy. Potential energy is equal to m g h. The mass is six point zero kilograms, the gravitational acceleration is nine point eight meters per second squared. The initial height is one point zero meters and the final height is one point six meters.

To calculate the initial potential energy, you multiply mass by gravity by initial height and obtain a value of fifty eight point eight Joules.

To calculate the final potential energy you multiply mass by gravity by final height and obtain a value of ninety four point one Joules.

Subtracting these, you find that the change in potential energy is equal to thirty five point three Joules.

You also could have solved this problem by recognizing that the change in potential energy can be calculated using the change in height.

The change in potential energy equals mass times the acceleration of gravity times the change in height. Substituting and solving, you find again that the change in potential energy is equal to thirty five point three Joules.

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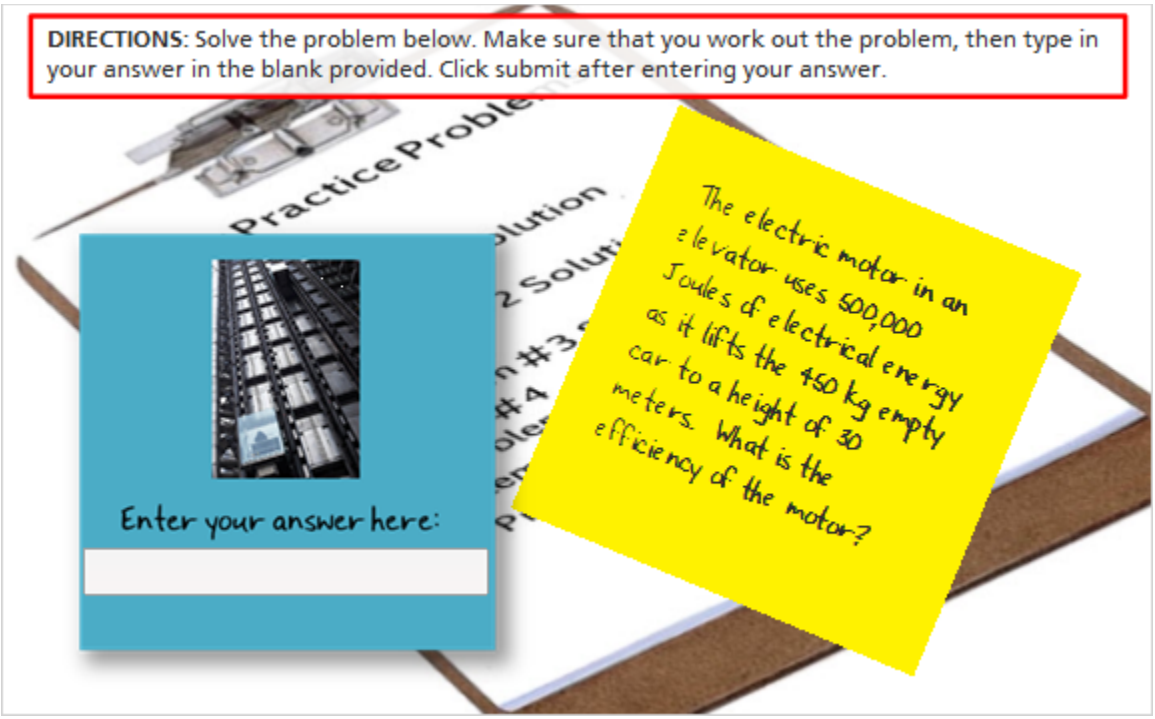
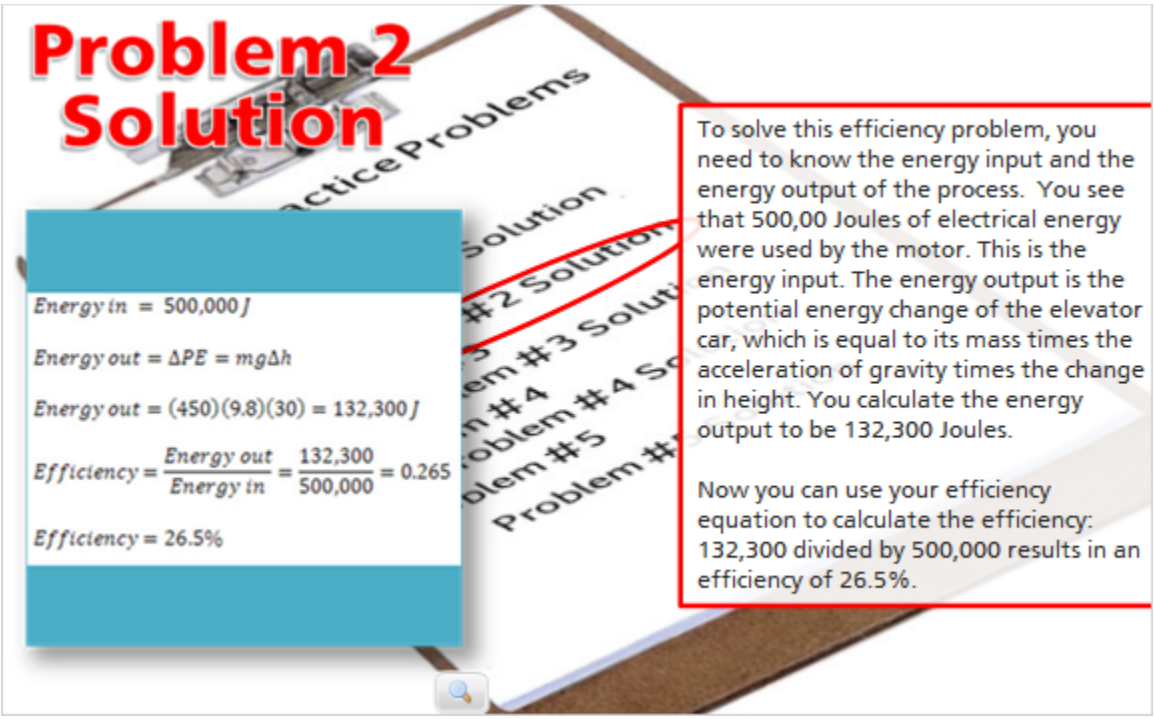


Problem 2

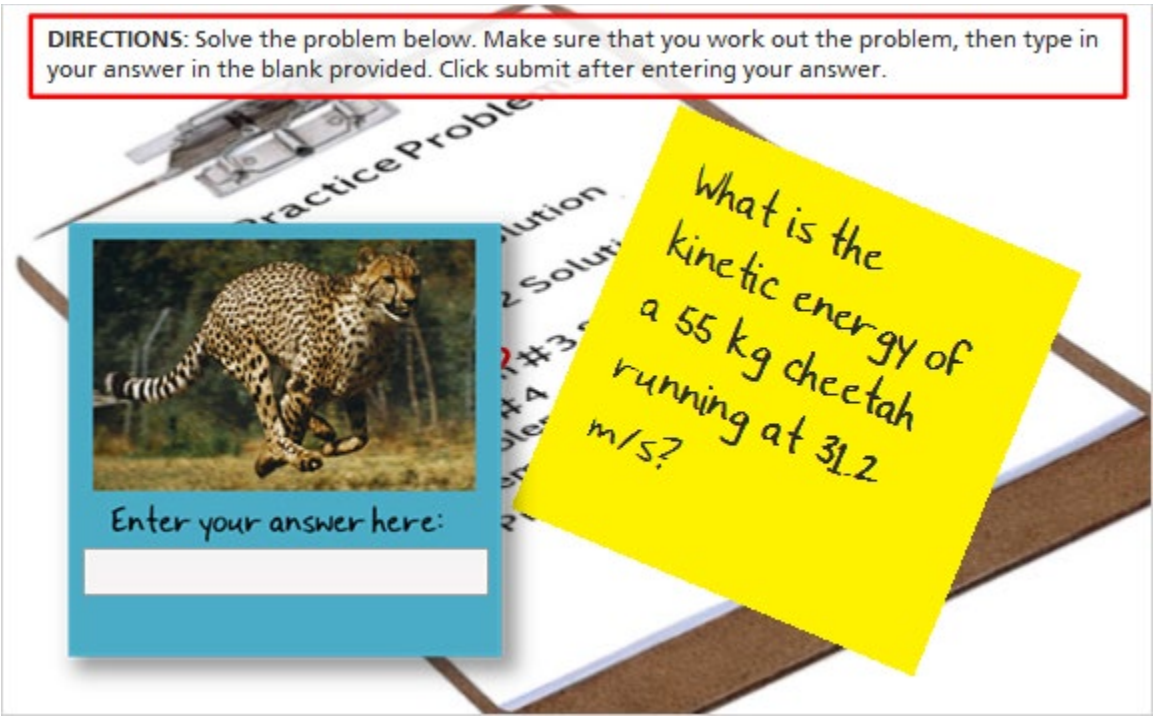
The electric motor in an elevator uses 500,000 Joules of electrical energy as it lifts the 450 kg empty car to a height of 30 meters. What is the efficiency of the motor?



Problem 2 Solution

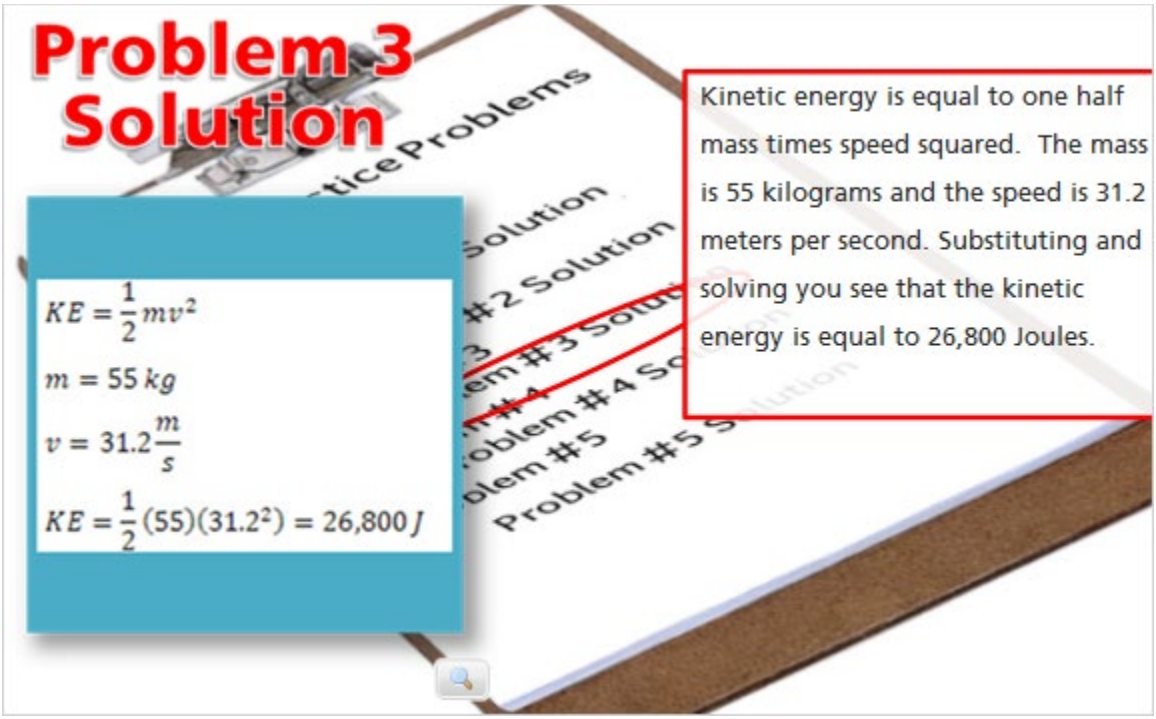
To solve this efficiency problem, you need to know the energy input and the energy output of the process. You see that five hundred thousand Joules of electrical energy were used by the motor. This is the energy input. The energy output is the potential energy change of the elevator car which is equal to its mass times the acceleration of gravity times the change in height. You calculate the energy output to be one hundred thirty two thousand three hundred Joules.

Now you can use your efficiency equation to calculate the efficiency. One hundred thirty two thousand three hundred divided by five hundred thousand results in an efficiency of twenty six point five percent.



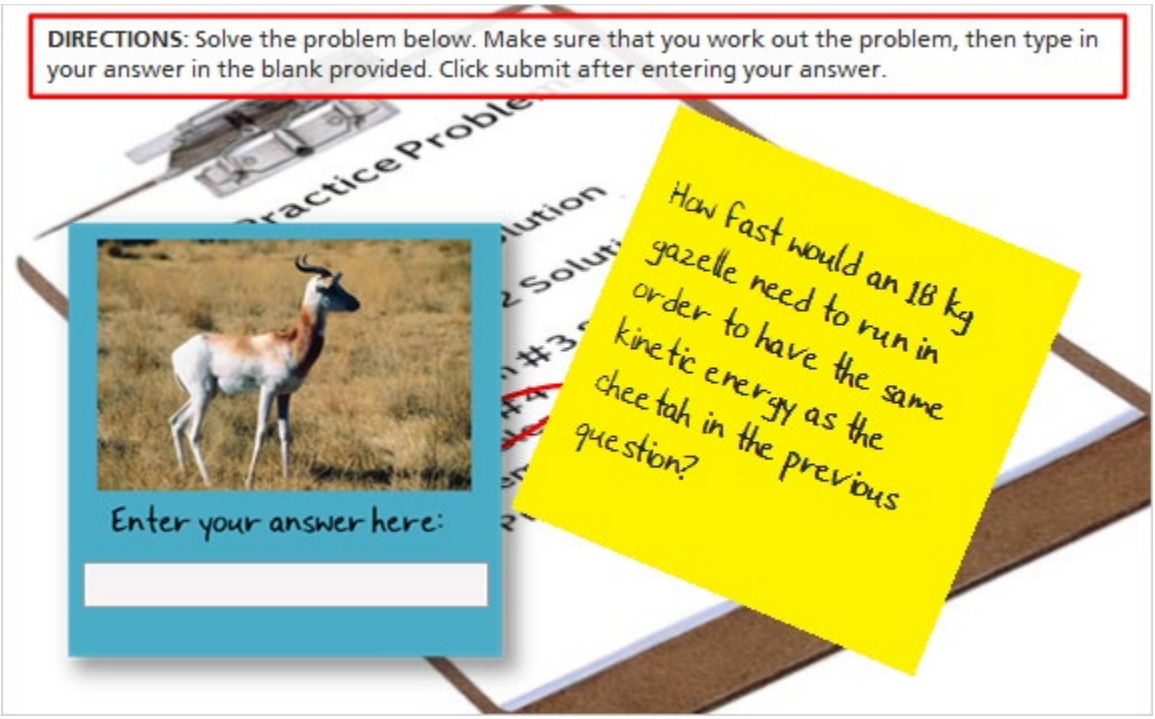
Problem 3

What is the kinetic energy of a 55 kg cheetah running at 31.2 m/s?



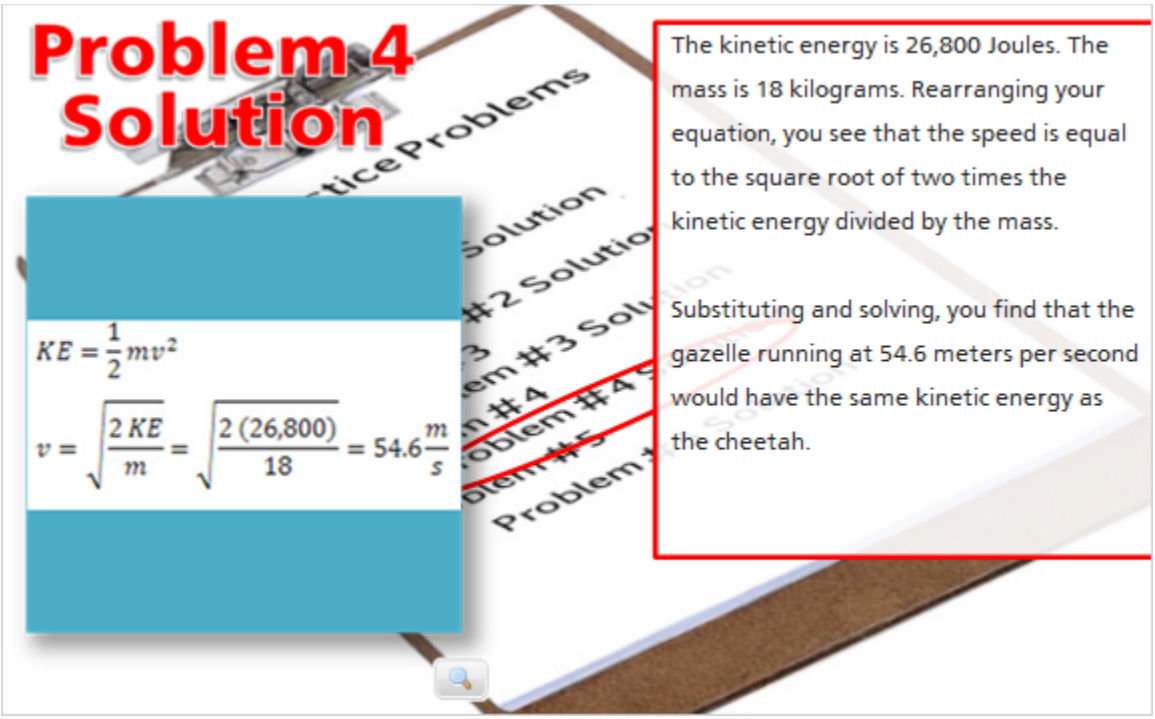
Problem 3 Solution

Kinetic energy is equal to one half mass times speed squared. The mass is 55 kilograms and the speed is 31.2 meters per second. Substituting and solving you see that the kinetic energy is equal to 26,800 Joules.



Problem 4

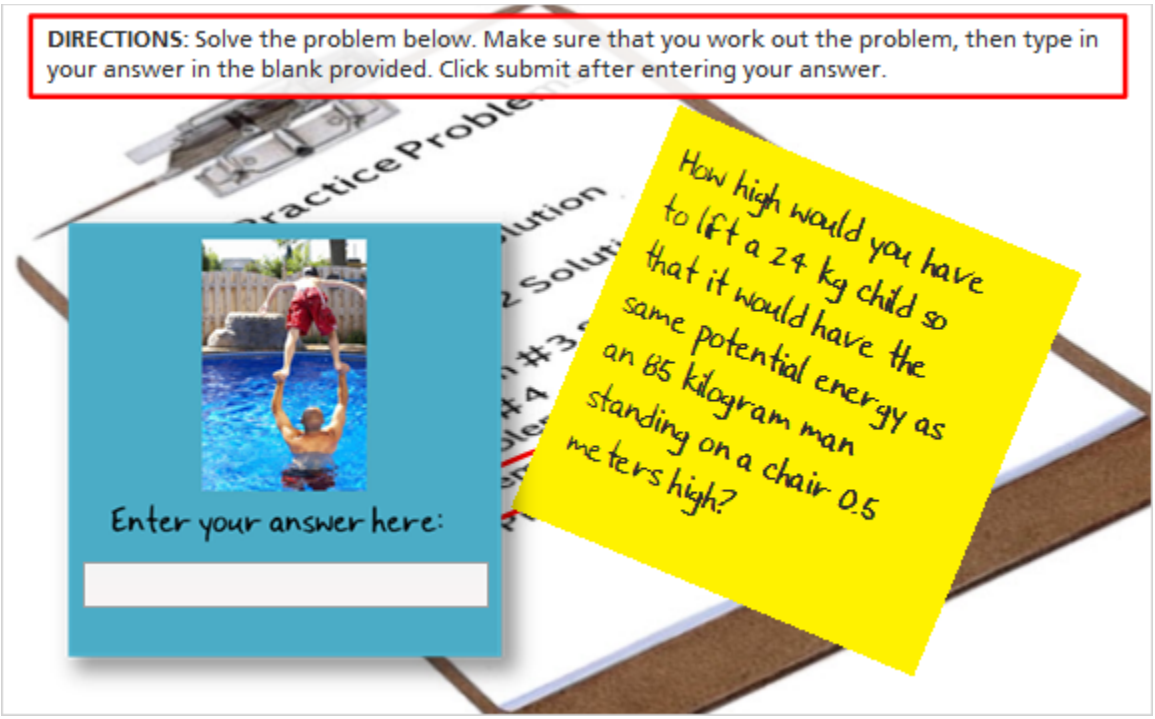
How fast would an 18 kg gazelle need to run in order to have the same kinetic energy as the cheetah in the previous question?



Problem 4 Solution

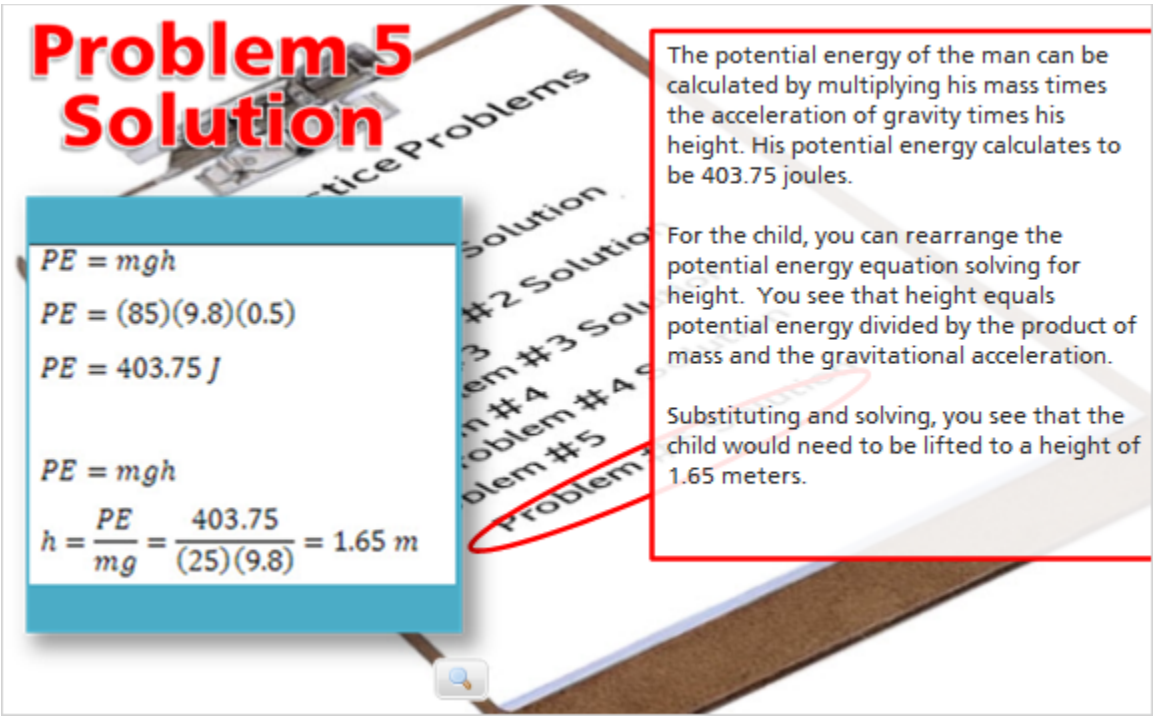
The kinetic energy is 26,800 Joules. The mass is 18 kilograms. Rearranging your equation, you see that the speed is equal to the square root of two times the kinetic energy divided by the mass.

Substituting and solving, you find that the gazelle running at 54.6 meters per second would have the same kinetic energy as the cheetah.



Problem 5

A 950 kilogram elevator is lifted by an electric motor that delivers 14,000 Watts of power. How long does it take the elevator to rise 30 meters?



Problem 5 Solution

The potential energy of the man can be calculated by multiplying his mass times the acceleration of gravity times his height. His potential energy calculates to be 403.75 Joules.

For the child, you can rearrange the potential energy equation solving for height. You see that height equals potential energy divided by the product of mass and the gravitational acceleration.

Substituting and solving, you see that the child would need to be lifted to a height of 1.65 meters.