

# Welcome to Physics First I Cycle 5 Lesson 1

**OBJECTIVE:** Define energy, work, and potential energy

**VOCAB:** energy, joule, work, potential energy

**CLASSWORK:**

p. 80 “Understanding Vocabulary” #6-7, #9-10

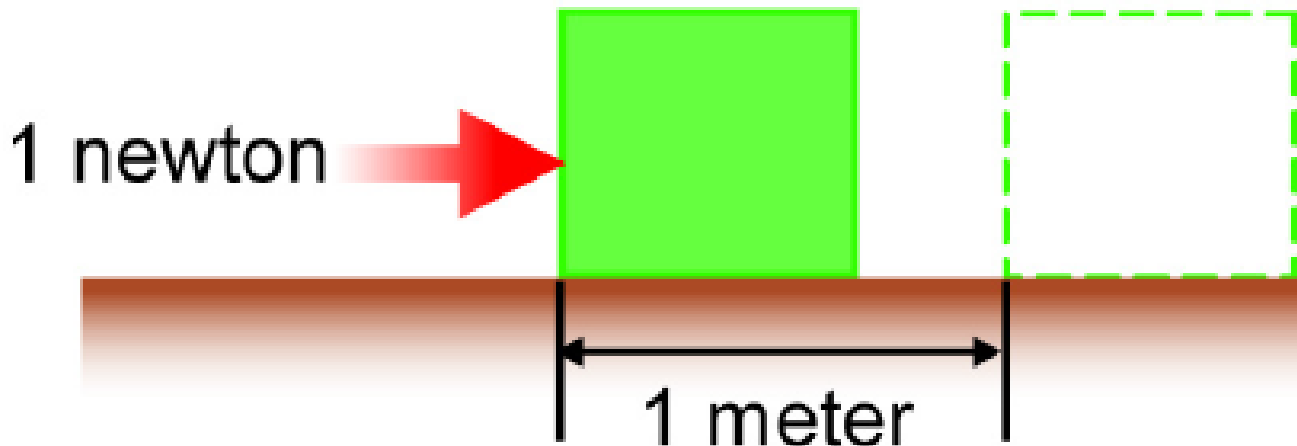
p. 81 “Reviewing Concepts” #13-15, #17

p. 82 “Solving Problems” #10-11

## What is Energy?

**Energy** is a quantity that measures the ability to cause change in matter. We say that energy is the capacity to do **work**. In physics, **work** is a technical term meaning **application of force over a distance**.

Energy is usually measured in **Joules**. One **Joule** is the energy needed to push with a force of 1 Newton for a distance of 1 Meter.  $1 \text{ Joule} = 1 \text{ N} \cdot \text{m} = 1 \text{ kg} \cdot \text{m}^2 / \text{sec}^2$



## What is Work?

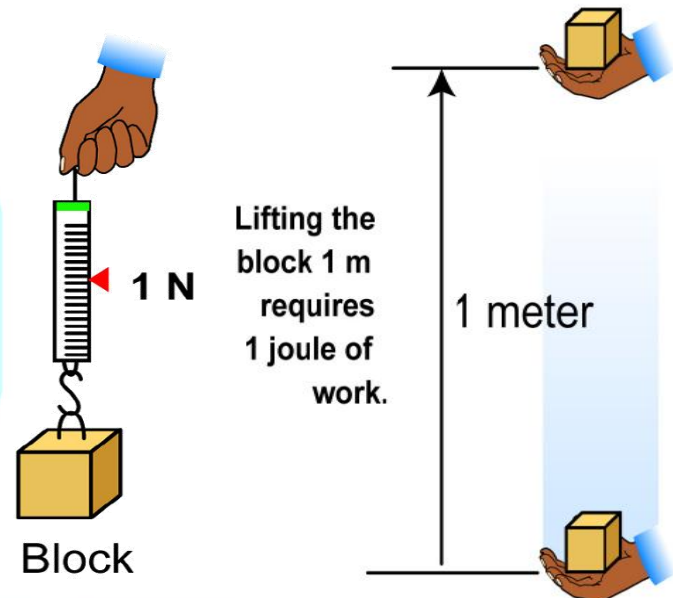
In physics, **work** has a very specific meaning. **Work is the transfer of energy that results from applying a force over a distance.** To calculate **work** you **multiply the force by the distance the object moves** in the direction of the force. If you lift a block with a weight of one newton for a distance of one meter, you do one **joule** of **work**.

### WORK

Work (joules)  $\rightarrow$   $W = Fd$

$F$  Force (newtons)

$d$  Distance (meters)  
in the direction of the force



### Potential Energy

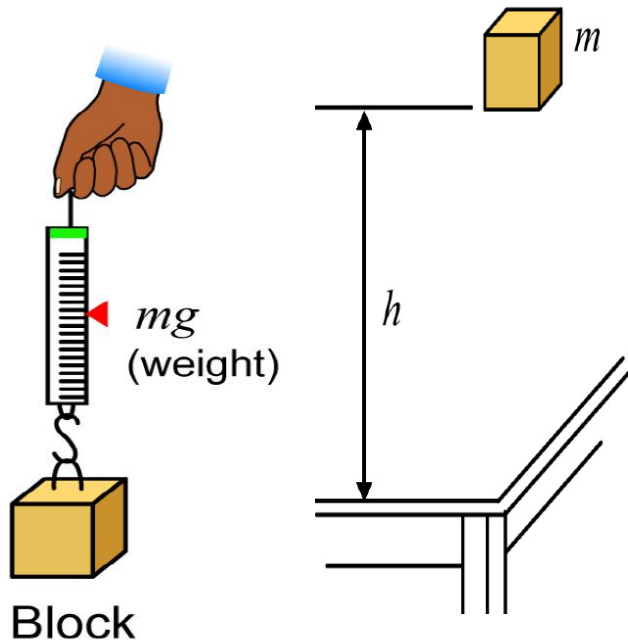
**Potential energy** is energy due to position. The word “potential” means that something is capable of becoming active. **Potential energy** is stored energy.

A stretched spring has more **potential energy** than a relaxed one. This **potential energy** equals the energy needed to stretch the spring initially. The spring can do **work** while relaxing to the original position.

An object raised to a height has more **potential energy** than one resting on the ground. This **potential energy** equals the energy needed to raise the object initially. The object can do **work** while falling back to the ground.

## Gravitational Potential Energy

A block above a table has potential energy. If released, the force of gravity moves the block down to a position of lower energy. The term **gravitational potential energy** describes the energy of an elevated object.



### POTENTIAL ENERGY

Potential energy (joules)  $\rightarrow$   $E_p = mgh$   $\leftarrow$  Height (meters)

Mass (kg)  $\rightarrow$   $m$

Acceleration due to gravity ( $9.8 \text{ m/sec}^2$ )  $\rightarrow$   $g$

The potential energy of this block equals  $m \cdot g \cdot h$

## Gravitational Potential Energy

A 2 kg rock is at the edge of a cliff 20 meters above a lake. What is the potential energy of the rock?

$$E_p = m \cdot g \cdot h$$

$$m = 20 \text{ kg}; g = 9.8 \text{ m/sec}^2; h = 20 \text{ m}$$

$$E_p = 2 \text{ kg} * 9.8 \text{ m/sec}^2 * 20 \text{ m}$$

$$E_p = 392 \text{ kg} \cdot \text{m}^2/\text{sec}^2 = 392 \text{ J}$$

## Gravitational Potential Energy

**Your turn:** Calculate the potential energy of a 4 kilogram cat crouched 3 meters off the ground.

$$E_p = 4 \text{ kg} * 9.8 \text{ m/sec}^2 * 3 \text{ m} = 117.6 \text{ J}$$

**Your turn:** How much work is needed to raise a 10 kilogram weight to a height of 5 meters?

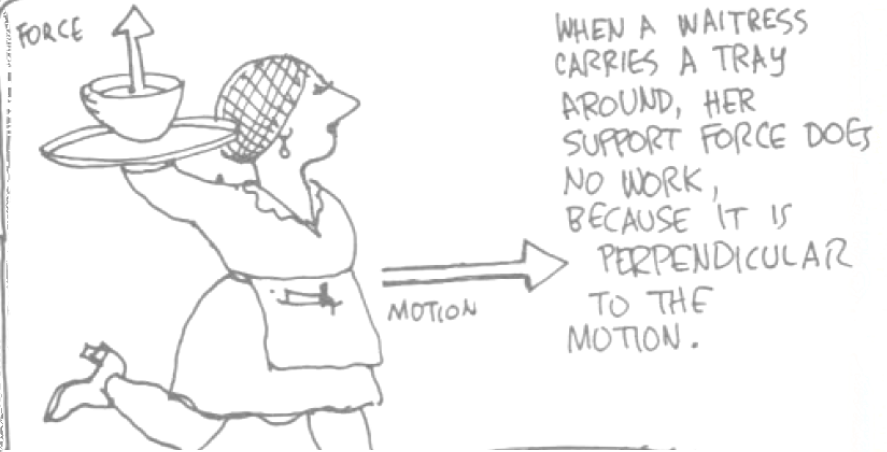
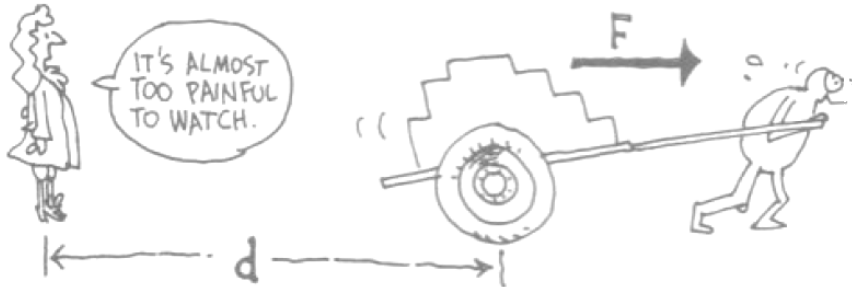
$$E_p = 10 \text{ kg} * 9.8 \text{ m/sec}^2 * 5 \text{ m} = 490 \text{ J}$$

**Thinking question:** How much work is needed to move a 10 kilogram weight horizontally by 50 meters?

**Answer:** none! The force of gravity is perpendicular to the direction of motion. This is definitely 'work' by normal standards, but not in the sense of physics.

### When is "Work" Really Work?

WE ALL HAVE A CONCEPT OF WORK, BUT IN PHYSICS, THE DEFINITION IS VERY PRECISE: WE SAY THAT WORK IS DONE WHEN A FORCE  $F$  MOVES A BODY THROUGH A DISTANCE  $d$ . WORK IS DEFINED AS **FORCE TIMES DISTANCE**.



THIS SHOWS, INCIDENTALLY, THAT, INsofar AS THE MOON'S ORBIT IS CIRCULAR, THE EARTH DOES NO WORK ON THE MOON!! THE GRAVITATIONAL FORCE IS PERPENDICULAR TO THE MOTION.