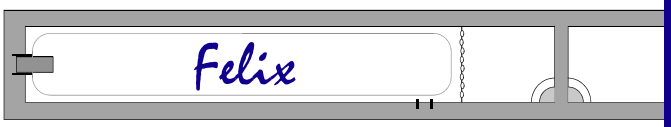
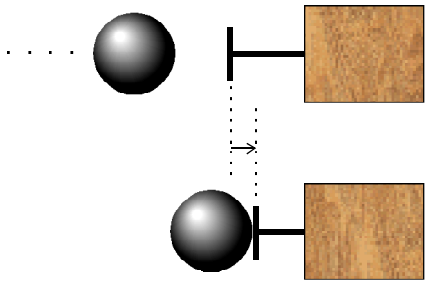
PhyzSpringboard: Kinetic Energy



A nail is partially driven into a block of wood. An iron ball is thrown at the nail, driving the nail some depth into the wood. Without changing any characteristics of the wood or nail, how could a thrown iron ball drive the nail deeper into the wood?



1. Factor 1

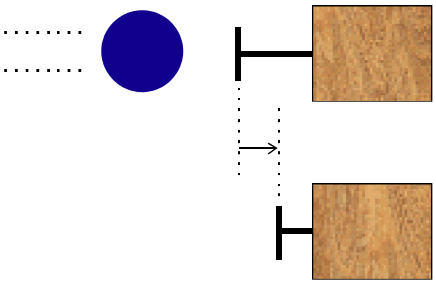
a. One way a thrown iron ball could drive the nail even deeper into the wood is if...

the ball were thrown faster.

b. So the drive depth is (__directly __inversely) proportional to...

speed

c. In symbols, $D \propto v$



2. Factor 2

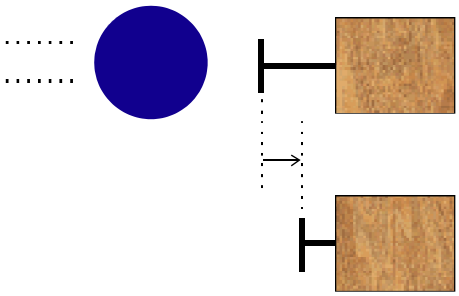
a. Another way a thrown iron ball could drive the nail even deeper into the wood is if...

the ball had more mass.

b. So the drive depth is (__directly __inversely) proportional to...

mass

c. In symbols, $D \propto m$



3. Experimental Finding

a. Consider the following evidence.

Doubling the _____*ball mass*_____ doubles the drive depth.

Doubling the _____*ball speed*_____ quadruples the drive depth; tripling it increases the drive depth by a factor of nine.

b. So the drive depth is ***actually*** (__directly __inversely) proportional to...

SQUARE of the speed.

c. Correct the corresponding symbol proportionality above.

4. The extent to which a thrown ball can drive in a nail is called its kinetic energy.

a. What determines a body's kinetic energy?

Kinetic energy of a body is directly proportional to the mass of the body and the square of the speed of a body.

b. Write a proportionality for kinetic energy.: $KE \propto mv^2$

5. Suppose a body with a mass *m* and a speed *v* had a kinetic energy *KE*. The questions below refer to changes in kinetic energy that result from changing the mass and/or speed of the body. To make these questions easy to answer, rewrite the expression above as an **equation** using 1's for all the variables.

$$KE \propto mv^2$$
$$1 = 1 \cdot 1^2$$

What would be the kinetic energy of a body with

a. a mass of 2*m* and a speed *v*?

$$? = 2 \cdot 1^2 \Rightarrow 2KE$$

b. a mass of *m* and a speed of 2*v*?

$$? = 1 \cdot 2^2 \Rightarrow 4KE$$

c. a mass of 2*m* and a speed of 2*v*?

$$? = 2 \cdot 2^2 \Rightarrow 8KE$$

d. a mass of 2*m* and a speed of *v*/2?

$$? = 2 \cdot (1/2)^2 \Rightarrow KE/2$$

6. Suppose a body with a mass *m* and a speed *v* had a kinetic energy *KE*.

a. What would be the mass of a body with a speed of *v* and a kinetic energy of 2*KE*?

$$2 = ? \cdot 1^2 \Rightarrow 2m$$

b. What would be the speed of a body with a mass of *m* and a kinetic energy of 4*KE*?

$$4 = 1 \cdot ?^2 \Rightarrow 2v$$

c. What would be the speed of a body with a mass of *m* and a kinetic energy of 2*KE*?

$$2 = 1 \cdot ?^2 \Rightarrow \quad 2v$$

7. The actual equation relating kinetic energy to mass and speed is $KE = 1/2\ mv^2$. The 1/2 is simply a constant of proportionality. It doesn't change any of the findings above! If the mass of a body is 1.5 kg and its speed is 8.7 m/s,

a. select the correct value for the kinetic energy of the body from the choices below,

__i. 9.8 J __ii. 13.1 J __iii. 57 J __iv. 113 J

$1/2\ m^2v$ (squared m instead of v)

just $m \cdot v$ (calculated momentum instead of kinetic energy)

$m \cdot v^2$ (forgot 1/2)

b. Identify the mistake made in the calculation of each incorrect choice. Describe it in the space below each incorrect choice.