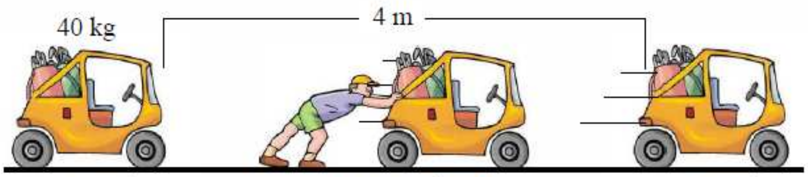
Name: ____________________

Period: ____________________

Efficiency

4.4

In the real world, energy transfers are not perfect and energy is lost to friction. The more energy that is lost, the less efficient the transfer of energy.



V = 0 m/s	F = 25 N; d = 4 m	V = 2 m/s
KE = 0 J	W_{in} = 100 J	KE = 80 J
	Energy added	***Energy gained***

If all of the energy was transferred, 100 J of work would become 100 J of kinetic energy. Yet friction took 20 J and converted it into thermal energy. The transfer was 80% efficient.

Energy gained by the object (in J)

Efficiency (in %) → $Eff = \frac{W_{out}}{W_{in}} \times 100$

Energy you tried to give the object (in J)

Understanding percent: $\% = \frac{part}{whole} \times 100$

You know that on a test 95 problems out of 100 is 95%. 95 is the part of the whole 100 points (the total). So 42 points out of 60 total points is 42/60 = .70 or 70%.

Work In — How much **energy you tried to give** to the object thru an energy transfer or work.

Work Out — How much **energy** is actually **gained** by the object (how much it got out).

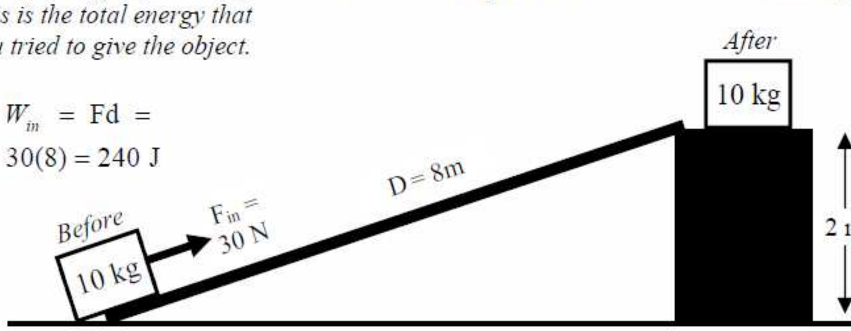
Here work is done on the object, pulling it up the ramp. This is the total energy that you tried to give the object.

Work tried to put in 240 J.

The object only got out 200 J.

$W_{in} = Fd =$

$30(8) = 240$ J



$W_{out} = Ep_{gained}$

$= mgh$

$= 10(10)2$

$= 100(2)$

$= 200$J

$Eff = \frac{W_{out}}{W_{in}} \times 100$

$Eff = \frac{E_p}{W} \times 100$

$= \frac{200 \text{ J}}{240 \text{ J}} \times 100$

$= .83 \times 100$

$= 83\%$

Efficiency in Energy Transfers

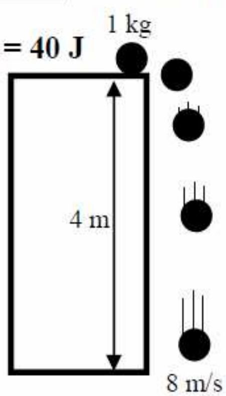
In the real world no energy transfer is really 100% efficient, due to friction. In an energy transfer, the W_{in} is the energy it starts with.

W_{in} = 40 J

W_{in} = PE = mgh

= 1(10)4 = 40 J

W_{in} is the total energy that could be given to the object. For a dropped object, the available energy is potential energy.



Air friction slows the object, removing energy.

W_{out} is the energy actually gained by the object. For a dropped object it gained kinetic energy.

W_{out} = 32 J

$W_{out} = KE = (\frac{1}{2})mv^2$

$= (\frac{1}{2})1(8)^2 = 32$ J

$Eff = \frac{W_{out}}{W_{in}} \times 100 = \frac{E_k}{E_p} \times 100$

$= \frac{32 \text{ J}}{40 \text{ J}} \times 100$

$= .80 \times 100$

$= 80\%$

So 20% was lost to air friction.

Consumer Efficiency

There are a lot of steps consumers can take to increase efficiency, whether with their cars (idle less), their houses (add insulation), or buying more efficient appliances. More efficient means less money spent on energy and less pollution for the environment.

Compact fluorescent light bulbs give the same amount of light, but produce less heat. Thus, they are more efficient and cheaper to use.

Fluorescent: uses only 15 W. Very little energy is lost to heat.

Both of these light bulbs give the same amount of light.

Incandescent: uses 60 W. At least 45 W is lost as heat.

1. Identify W_{in} and W_{out} for each of the following situations.

A. An object is pushed up a ramp. There is friction on the ramp.

W_{in} = _________ W_{out} = _________

B. An object is against a compressed spring. The spring is released and pushes the object, but the object rubs against the ground.

W_{in} = _________ W_{out} = _________

C. An object is launched into the air with an initial velocity. It goes to the top. There is air friction.

W_{in} = _________ W_{out} = _________

D. An object is at the top of a ramp. It slides down the ramp. There is friction.

W_{in} = _________ W_{out} = _________

E. An object at rest is accelerated by a force, but because of friction it is not moving as fast afterwards as it should.

W_{in} = _________ W_{out} = _________

F. An object is dropped. There is air friction.

W_{in} = _________ W_{out} = _________

2. A 6 kg object is at rest on the ground. It is pushed for 20 m with a 3 N force. It is moving 4 m/s afterwards.

A. W_{in} =

B. W_{out} =

C. Calculate efficiency.

D. How much energy was lost to friction?

3. A 2 kg object is moving 6 m/s. It compresses a spring 1 meter that has a spring constant of 8 N/m.

A. W_{in} =

B. W_{out} =

C. Calculate efficiency.

D. Where did the energy go?

4. A 3 kg object falls off an 8 m tall ledge. Due to friction it is only going 11 m/s at the ground.

A. W_{in} =

B. W_{out} =

C. Calculate efficiency.

D. How much energy was lost to friction?

5. A 2 kg object is pushed up a 12 m long ramp by a 7 N force to get the object to the top of a 3 m tall table.

A. W_{in} =

B. W_{out} =

C. Calculate efficiency.

D. How much thermal energy was created?

6. A 6 kg object is at the top of a 2 m tall ramp. Due to friction it is only moving 5 m/s at the bottom.

A. W_{in} =

B. W_{out} =

C. Calculate efficiency.

D. How much thermal energy was created?

7. A 6 kg object is moving 1 m/s. It is pushed by a 4 N force for 20 m. It is going 5 m/s afterwards.

A. W_{in} =

B. W_{out} =

C. Calculate efficiency.

D. How much thermal energy was created?