Work and Energy

WORK

Work measures the effects of a force acting over a distance.

W = F*d

The units are N * m = Joules (J)

(F)*(d) = (W)

Work Practice Problems Pg. 285

1.) F = 5200N

d = 25m   W = F*d

W = ? J   = (5200N)*(25m) = **130,000J**

2.) F = 1N

d = 1m   W = F*d

W = ? J   = (1N)*(1m) = **1J**

Work Practice Problems Pg. 285

3.) F = 125N

d = 14.0m W = F*d

W = ? J = (125N)*(14.0m) = **1750J**

4.) F = 165N

d = .800m W = F*d

W = ? J = (165N)*(.800m) = 132J*30 = **3960J**

Work Practice Problems Pg. 285

5.) d = .5m F = m*g ($g = 9.8m/s^2$)

m = 1200kg

F = ? N = (1200kg)*($9.8m/s^2$) =

12,000N

F = 12,000N W = F*d

d = .5m

W = ?J = (12,000N)*(.5m) = **5880J**

WORK

Q: If you try to lift a car and it doesn’t move…How much work have you done?

A: NONE!!! W = 0J b/c the distance was 0m and W = F* 0m = 0J

ENERGY

When you are doing work you are transferring energy.

There are several types of energy:

Mechanical, electrical, chemical, thermal (heat), Potential and Kinetic.

Warm-Up

Ms. S. applies 40N while tightening a bolt on her car tire. The bolt moves .23m. How much work was done on the bolt?

What type of energy is stored in molecules when they bond?

What type of energy is in an apple hanging from a tree?

POTENTIAL energy (P_E)

Potential Energy (P_E) is the stored energy of an object resulting from the position of the object in a system.

P_E is measured by multiplying the mass of the object times the gravity and then times the height.

$$P_E = m*g*h \qquad (g = 9.8 m/s^2)$$

Units are Joules!!! (J)

POTENTIAL energy (P_E)

Examples of objects with high P_E:

A stretched rubber band

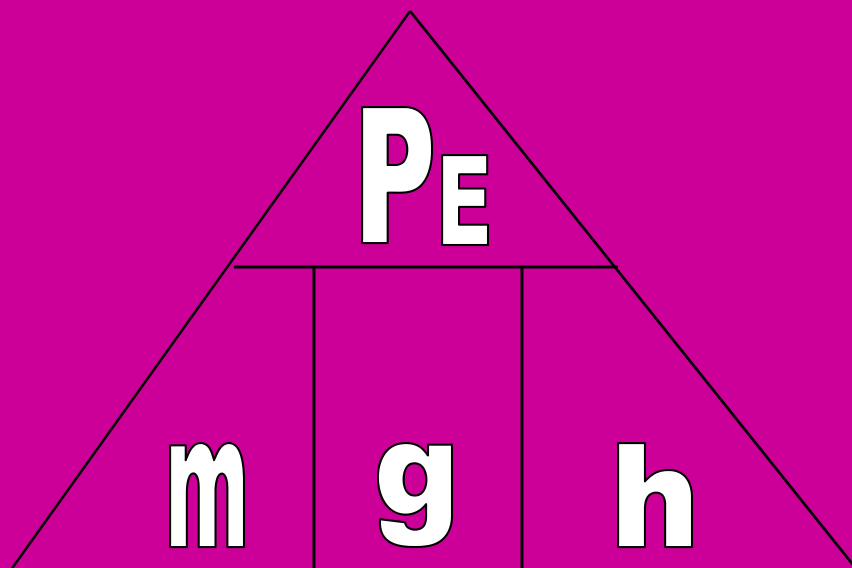
Any hanging object

Any compressed object (like a spring)

Any object that is high up

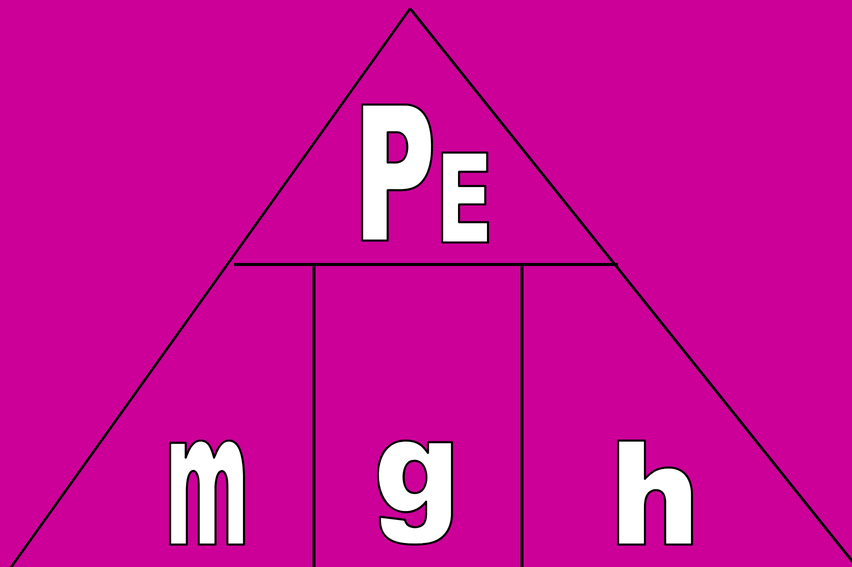
Solving Energy Problems

Plug P_E **= m*g*h** into a Power Triangle



Write the equations when you solve for m and h.

Solving Energy Problems



$$m = \frac{P_E}{g*h}$$

do this 1st

$$h = \frac{P_E}{g*m}$$

do this 1st

Answers to P_E calculations

1.) $P_E = 6856.1J$

2.) m = 4.7kg

3.) h = 19.2m

4.) $P_E = 7763.9J$

5.) m = .35kg

6.) h = 24.7m

KINETIC energy (K_E)

Kinetic Energy (K_E) is the energy of any **moving** object.

K_E depends on the mass and the velocity (speed) of an object. Only ½ of the mass is used, but velocity is squared… so K_E depends mostly on the velocity of the object.

$$K_E = \frac{1}{2}m * v^2$$

Solving Energy Problems

$K_E = ½ m * v^2$

***Remember PEMDAS (order of operations)

1^{ST}: Square the v

2^{nd}: Take half the mass

3^{rd}: Multiply $1/2m * v^2$

Warm-Up

1. A 3.4 kg defensive lineman moving at 2.1 m/s^2 sacks the quarterback, who is standing still. What is the net force of the collision?

2. Give an example of a specific object that has high P_E.

3. Give an example of a specific object that has high K_E.

Units Review

- Force = Newtons (N)
- Speed or velocity = distance/time (d/t = m/s)
- Acceleration = distance/time^2 (d/t^2 = m/s^2)
- Energy (Work, K_E, P_E, T_E) = Joules (J)
- Mass = kilograms (kg)
- Distance or height = meters (m)
- Time = seconds (s)
- Power = Watts (W)

Answers to K_E calculations

7.) K_E = 18,021.61J

8.) K_E = 1292.93J

9.) K_E = 5006.07J

10.) K_E = 38,423.15J

11.) K_E = 1701.51J

12.) K_E = 2795.88J

ENERGY TRANSFER

There are three ways that energy can be transferred:

Conduction – The transfer of energy through matter by direct contact of particles.

Radiation – The transfer of energy in the form of a wave.

Convection – The transfer of energy by the movement of gases or liquids. (only fluids!!!)

EXAMPLES of ENERGY TRANSFER

Conduction: a pot on a stove, a metal spoon in a bowl of soup…the handle gets hot too.

Radiation: how the Earth gets energy from the sun, a microwave

Convection: how refrigerators stay cold…

LAW OF CONSERVATION of ENERGY

Energy cannot be created or destroyed; it can only be transformed from one type to another or transferred. (***The TOTAL ENERGY (T_E) stays the same!!!)*** **$T_E = P_E + K_E$ + heat**

So when an object falls… how is energy transformed?

It goes from P_E to K_E…

LAW OF CONSERVATION of ENERGY

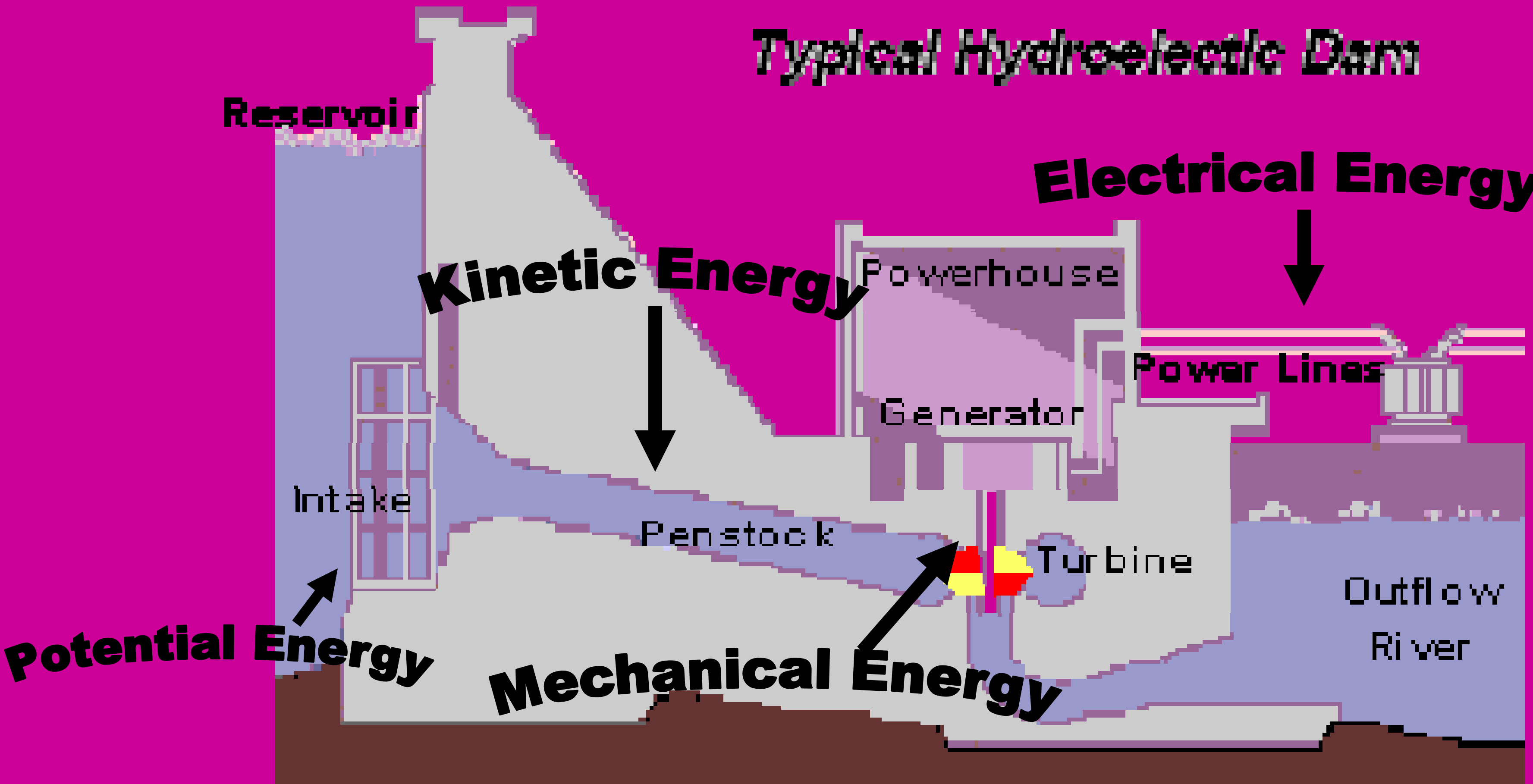
Let's look at some systems where energy transformation is taking place…(i.e. changing from one type of energy to another type of energy.)

A Bungee jumper

A Pendulum

A Hydroelectric Power Plant

HYDROELECTRIC POWER PLANT



LAW OF CONSERVATION of ENERGY

The **TOTAL ENERGY** of a system can be measured by adding P_E + K_E + Heat.

$T_E = K_E + P_E + \text{heat}$

Q: Where does the heat come from???

A: Friction!!! (Rub your hands together and see what happens!!!)

LAW OF CONSERVATION of ENERGY

Why won't the beginning energy ever equal the end energy???

Hint: Can heat be contained in an open system?

NO… please remember that energy is not destroyed, but some of it can escape from the system to the surroundings in the form of heat.

This is why no system will ever be 100% efficient… meaning the beginning energy will never equal the end energy…there is no such thing as a frictionless system!!!

Efficiency

Let's talk about reasonable efficiencies…

Can any system be 100% efficient?

NO… b/c some energy is given off from the system in the form of heat as a product of friction.

Would it be reasonable to have a system that has a very low efficiency?

No… b/c then you are wasting energy.

Efficiency

Let's talk about reasonable efficiencies…

Of the following efficiencies, which is most reasonable?

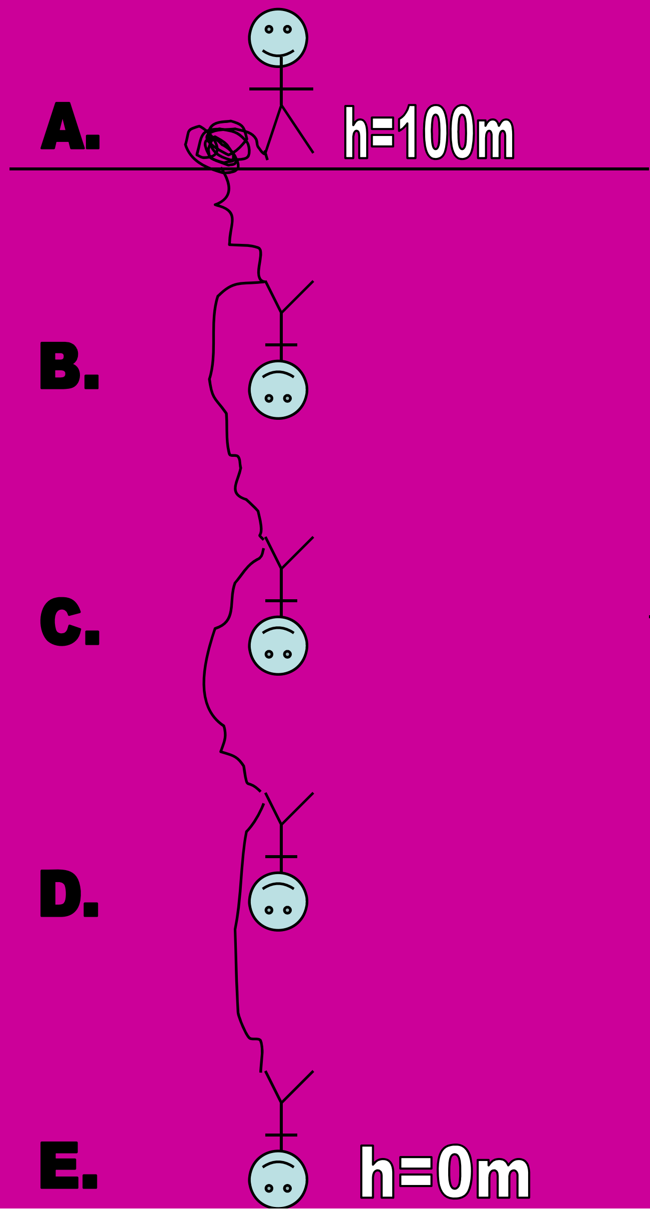
.32%

100%

41%

89%

P_E, K_E, and T_E Calculations



*****For A-E calculate: P_E, K_E, and T_E (assume NO friction)**

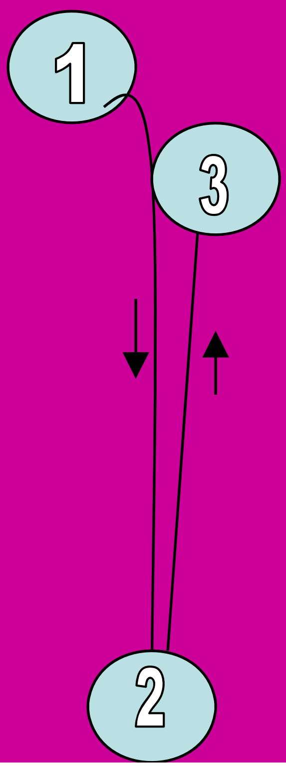
m = 2kg

g = 9.8 m/s^2

____ **mid-point**

Warm-Up

Explain in terms of forces and energy why a ball does NOT bounce higher than the point it was released from.



Power

Running does not require more work than walking… so what is the difference between running and walking?

A: The time it takes!!!

So we need to account for the time it takes to do work… the equation that measures that is Power: it equals the work done over time.

$P = \frac{W}{t}$ (Units for Power are $\frac{J}{s}$ = Watts)

Power

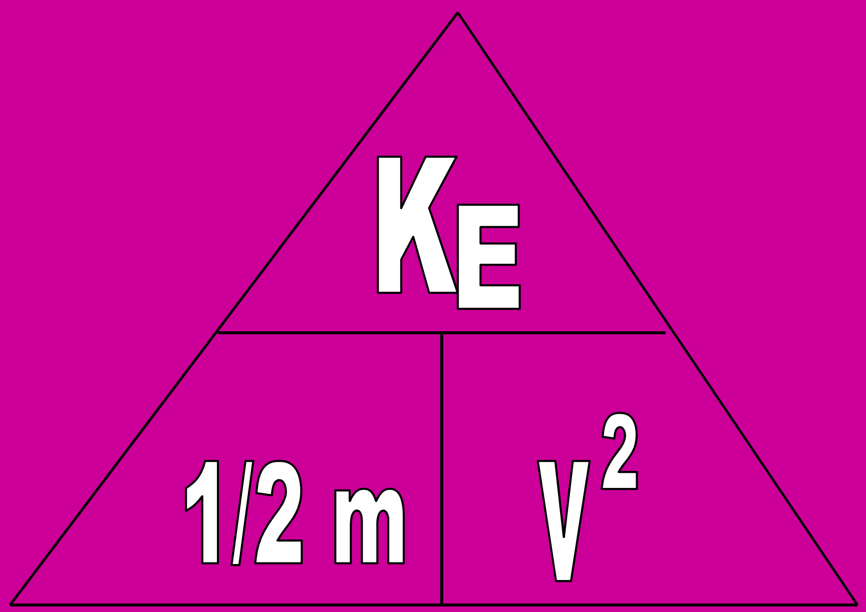
1. While running track, Drew’s legs do 5780J of work in 183s. What is his power output?

2. The chain that is pulling a rollercoaster up the first hill does 24652J of work over a 79s time interval. What is the power output of the chain?

3. It takes Ms. Webb 20s to apply 23N of force to lift a box 5m. What was her power output?

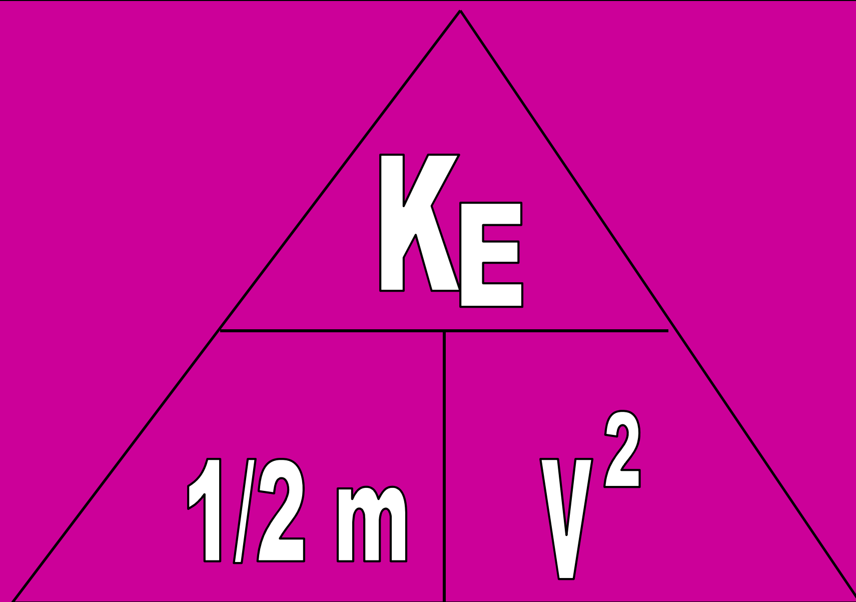
Solving Energy Problems

Plug K_E **= ½ m * v^2** into a Power Triangle



Write the equations when you solve for m and v.

Solving Energy Problems



$$\tfrac{1}{2}m = \frac{K_E}{v^2}$$

$$v^2 = \frac{K_E}{\tfrac{1}{2}m}$$

KINETIC Energy Lab Data
Fill in on DATA TABLE 2

1. v = .140 m/s

2. v = 1.27 m/s

3. v = 1.74 m/s

4. v = .597 m/s

5. v = 1.74 m/s