How about some practice questions for TEST #2, Homer?

WE STARTED WITH SOME CLICKER REVIEW QUESTIONS . . . .

Quickie CLICKER SELF-TEST REVIEW !! . . . ➔

Channel 28

Q1 -The **"Goldilocks Problem"** refers to the question: "Why is Venus too hot, Mars too cold, and Earth's temperature just right!" Your textbook explains that . . .

1. Earth's temperature is "just right" because Earth has a **greenhouse effect** and Venus and Mars do not.

2. Earth's temperature is "just right" due to: (a) **the inverse-square law** (the Earth being just the right distance from the Sun), (b) the **greenhouse effect,** and (c) **the Earth's reflectivity** – all working together

3. Earth's temperature is "just right" because the Earth radiates like a black body and is just the right distance from the Sun – Mars is too close & Venus too far.

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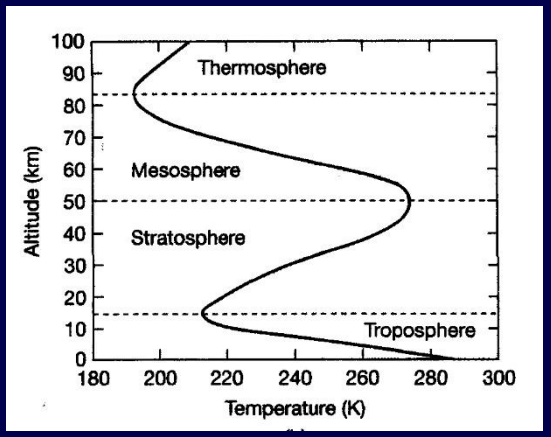
Q2 The atmospheric layer of **the troposphere** is important to global climate change because:



1. it is the layer that is heated up **primarily** by gases that can absorb high-energy **shortwave radiation** coming in directly from the Sun

2. it is the layer in which **temperature INCREASES with altitude** in the atmosphere

3. it is the layer with a high concentration of **ozone** that absorbs harmful **ultraviolet radiation**.

4. it is the layer in which most of the absorption by **greenhouse gases** occurs in the atmosphere

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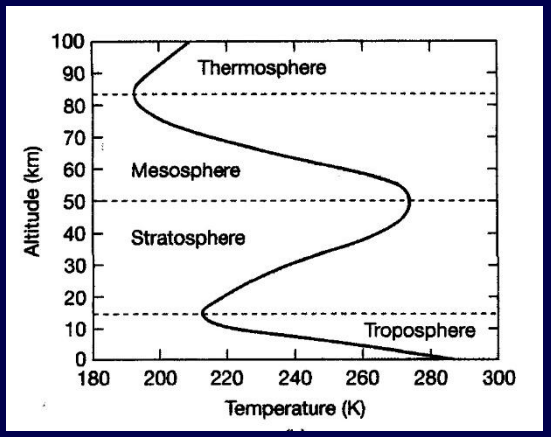

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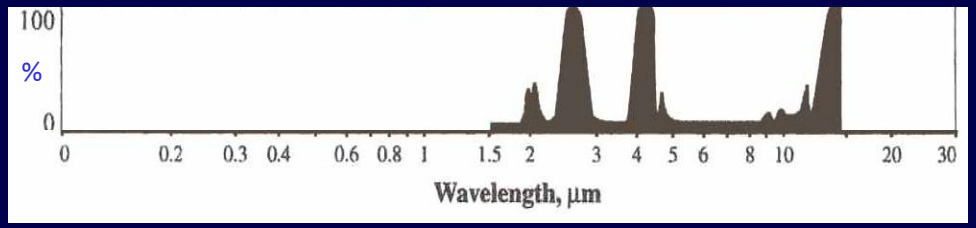
Q3 - Which of the following is a correct statement about this absorption curve:



1. the curve represents absorption by a gas that can absorb both **visible light** and **infrared radiation**

2. **t**he curve represent absorption by a gas that is likely to be a **Greenhouse Gas.**

3. **t**he curve represents absorption by a gas that protects the Earth from **ultraviolet (UV) radiation**

4. **t**he curve represents absorption by a gas that can absorb **ultraviolet, infrared,** & **visible** light wavelengths of radiation.

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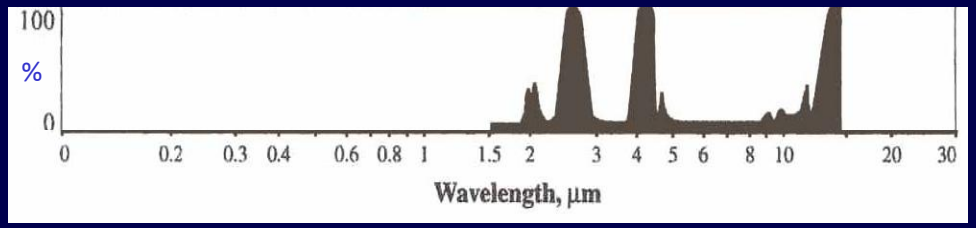

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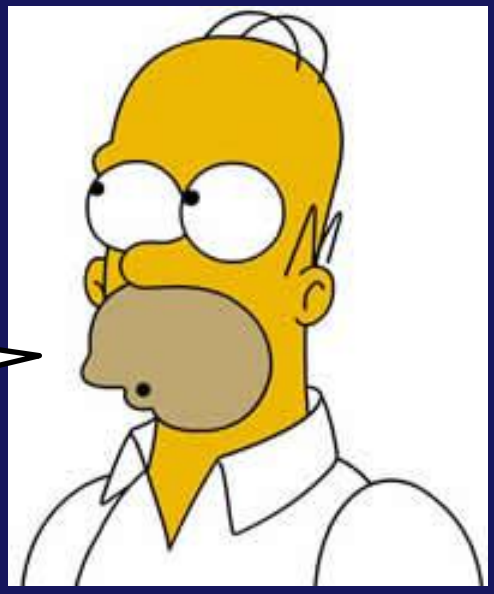
Ready for some more SCIENCE Homer?

**Alright brain,
you don't like me
and I don't like you;
but let's get through this
and I can get back
to killing you
with beer!**



Homer gives his brain a pep talk

Disclaimer: Homer's approach to learning science is not endorsed by Dr H!

TOPIC # 8 - Review pp 43-44

LAWS OF THERMODYNAMICS & MOTION

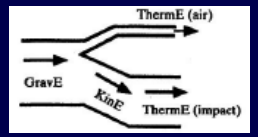
Keys To Energy Transfer & Energy Conservation

PART A - THERMAL ENERGY BACKGROUND

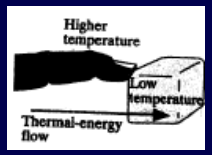
-- *Atoms & molecules are in constant motion*
-- *More molecular kinetic energy ➔ hotter substance*

PART B - ENERGY TRANSFORMATIONS & THE LAWS OF THERMODYNAMICS

1st : *Energy can be transformed but total remains the same = Law of Energy Conservation*

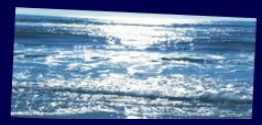


2nd: -- *Heat won't flow spontaneously from cold to hot*
-- *Heat engines are always less than 100% efficient*
-- *"Irreversiblity" (energy disperses)*



TOPIC # 8 (cont.)

Review p 45

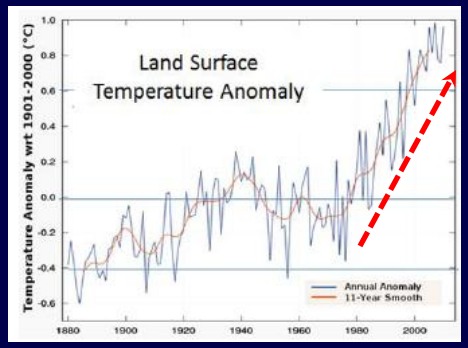

PART C - TEMPERATURE RESPONSE & THERMAL ENERGY STORAGE IN DIFFERENT SUBSTANCES:

LOW Specfic Heat / Capacity = heats up quickly, loses heat quickly, cannot store large amounts of thermal energy

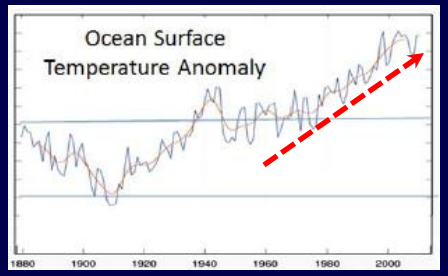
example: air + sand; atmosphere + land mass

HIGH Specific Heat / Capacity = heats up slowly, loses heat slowly, can store large amounts of thermal energy

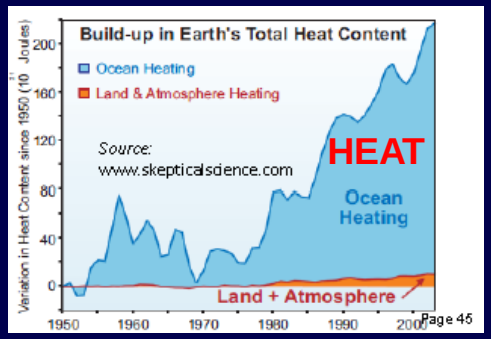
example: water, ocean



Land: Low specific heat / capacity

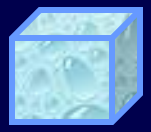
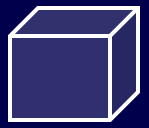


Ocean: High specific heat / capacity



Ocean: Huge storage reservoir of heat !

Specific Heat = the amount of thermal energy (in calories) required to raise the temperature of 1 gram of ***any substance*** by 1°C.

HIGHEST	LOWER	LOWEST
Specific heat = 1.00 calorie	Specific heat = 0.24 calorie	Specific heat = 0.20 calorie
		
1 g of water	1 g of air	1 g of sand

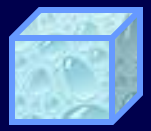
vs. vs.

Review p 45

Heat Capacity = represents the capacity of a substance to absorb heat in relation to its ***volume*** and ***density***.

HIGHEST

Heat capacity =
1.00
calorie / cubic cm

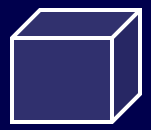


1 cubic cm
of water

vs.

LOWEST

Heat capacity =
0.00024 – .00034
calorie / cubic cm



1 cubic cm
of air

vs.

LOWER

Heat capacity =
0.1 – 0.6 *higher if wet*
calorie / cubic cm

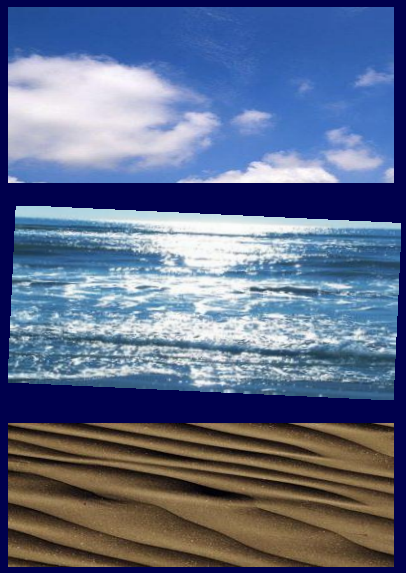
1 cubic cm
of sand

Review p 45

REVIEW: Assume you have an equal volume of WATER, AIR & SAND.

Which will HEAT UP THE FASTEST if the same amount of thermal energy is transferred into the substance?

1. AIR
2. WATER
3. SAND



Explanation:

The lower the heat capacity, the quicker the response to a transfer of heat into the substance!

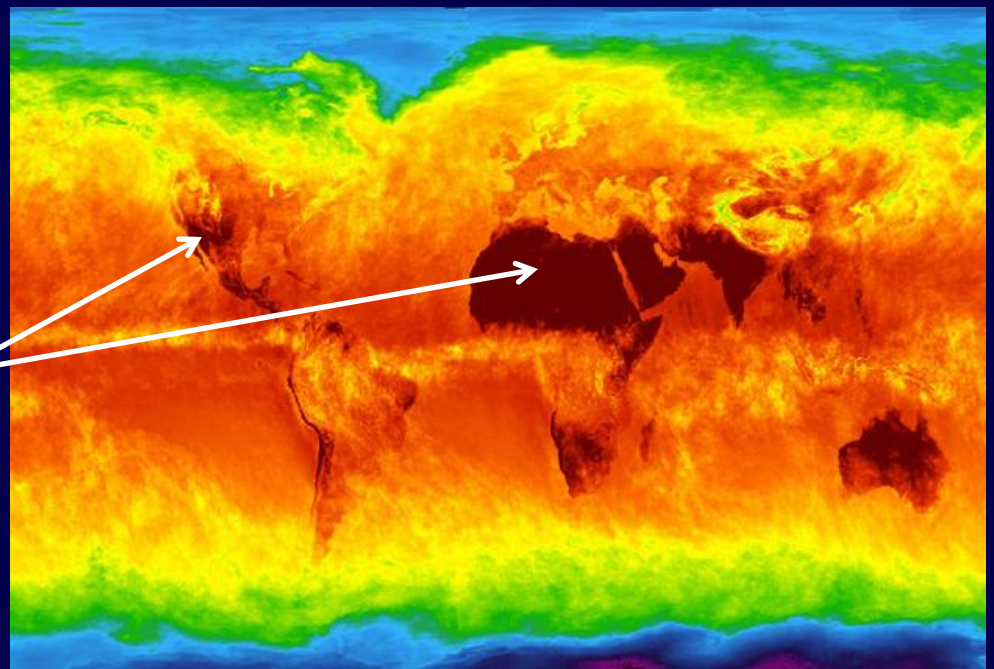
REVIEW: As global warming is occurring we will be able to detect it FIRST where?

1 = the ocean temperature

2 = the land surface temperature (i.e., soil)

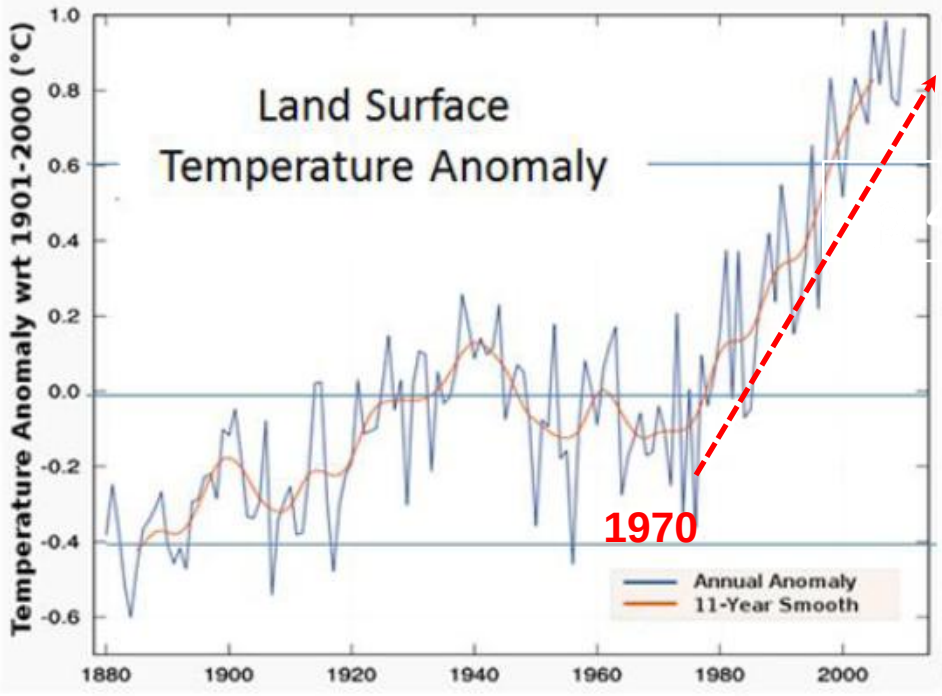
3 = actually, they will both heat up at the same rate

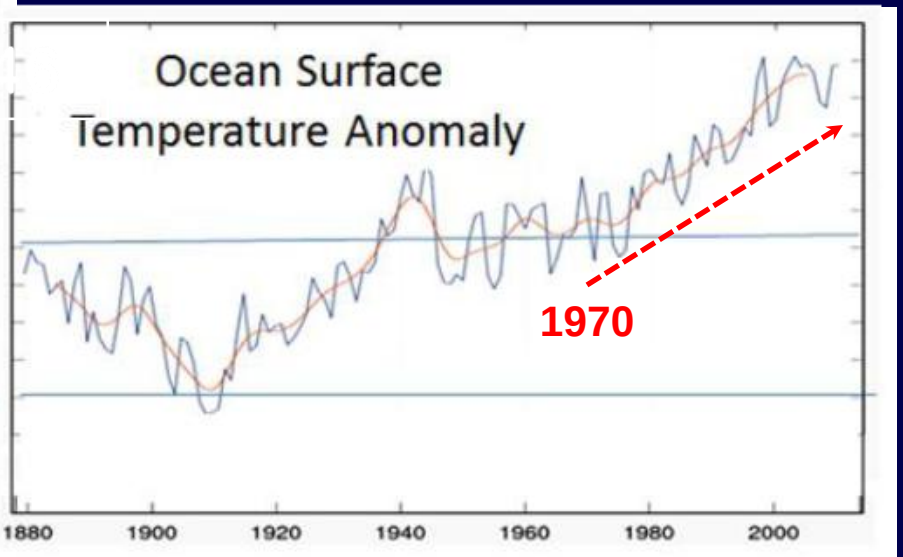
Note where the hottest temperatures occur



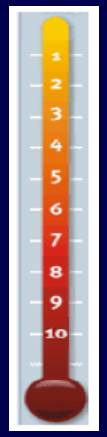
INDICATOR INTERLUDE . . .

Q. Why does the ocean surface warm more slowly than the land surface?





http://www.ncdc.noaa.gov/cmb-faq/anomalies.php



INDICATOR INTERLUDE . . .

Q. Why is the heat CONTENT of the ocean so much greater than the land?

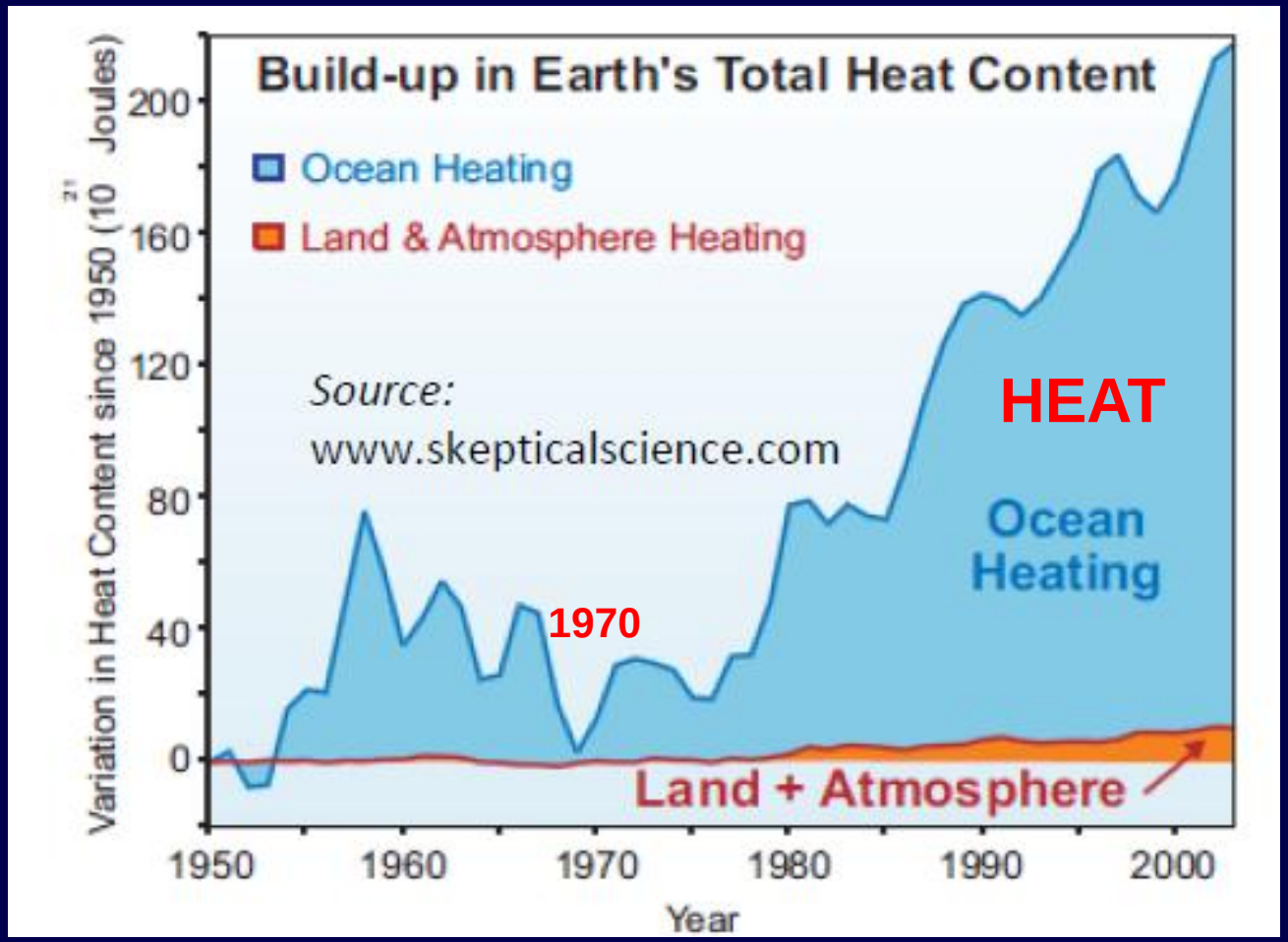


Figure: Total Earth Heat Content from 1950 (Murphy 2009). Ocean data from Domingues et al 2008.
http://www.skepticalscience.com/How-do-we-know-global-warming-is-still-happening.html

One last quick review point . . . .

Heat generally causes *EXPANSION* of a substance.

WHY?

When the temperature of the substance increases:

-- the molecules jiggle faster
-- more energetic collisions occur between the molecules
-- molecules are forced to move farther apart
-- thereby expanding the substance and making it LESS DENSE.

Top of p 46

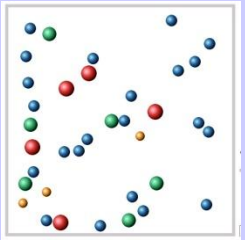
As air heats up, it expands, hence hot air is less dense than cold air & tends to RISE.

Likewise, cold air is more dense than hot air & tends to SINK

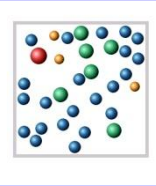
We call this movement (circulation) of air (or water) **CONVECTION** & it is a form of HEAT TRANSFER

These thermal differences play an important role in driving ATMOSPHERIC CIRCULATION, WEATHER & GLOBAL CLIMATE PATTERNS . . . . .

HOT



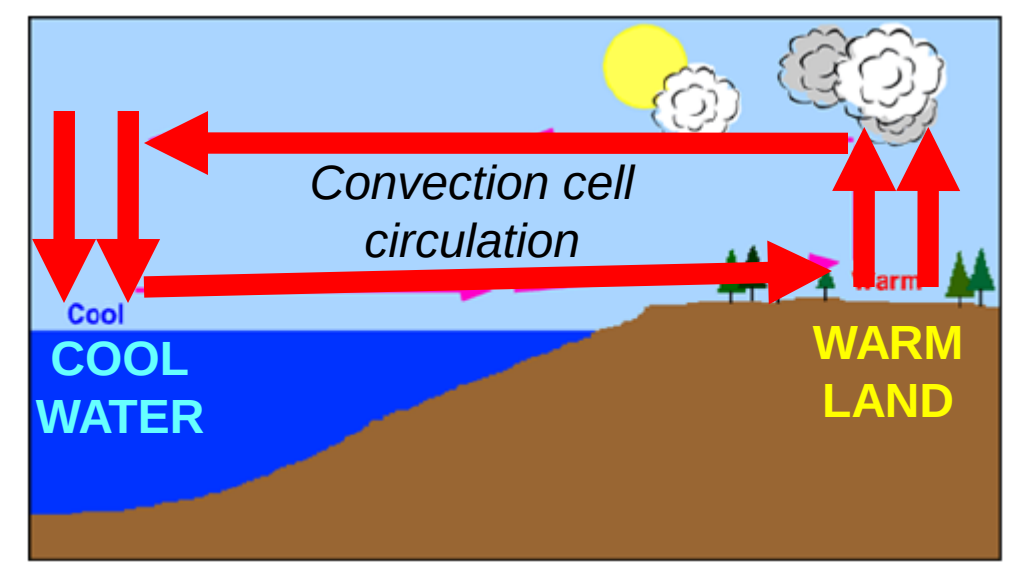
COLD

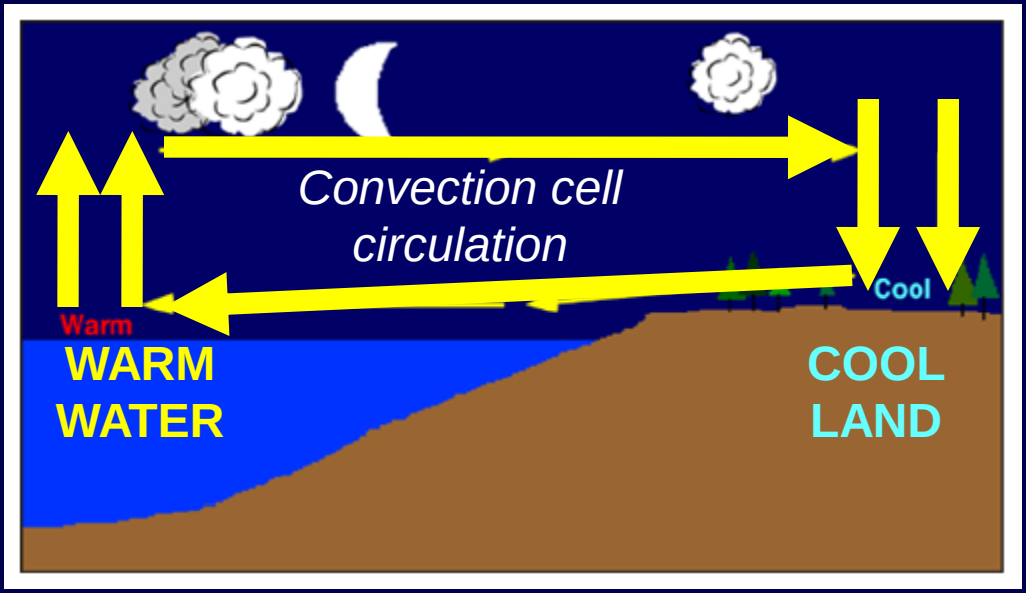


Example:

Sea Breezes & Land Breezes are driven by <u>CONVECTION</u>

(this will be connected to global climate patterns later this semester)





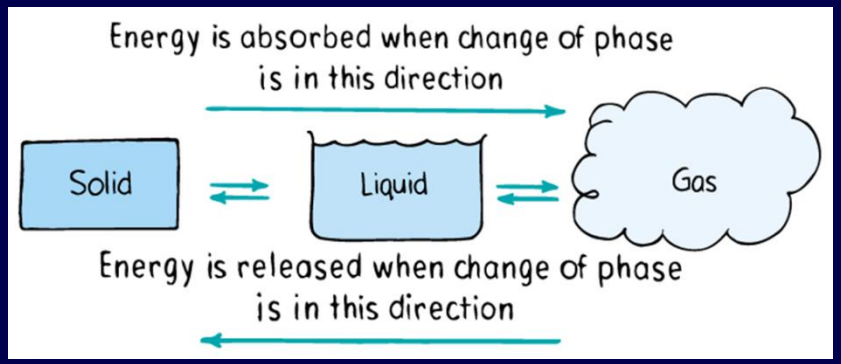
"Convection" is a form of Heat Transfer"

The next section will be covered later on with TOPIC #10:

PART D - THERMAL ENERGY & PHASE CHANGES

Phase Changes in Matter:

solid => liquid => gas OR solid <= liquid <= gas



It will <u>not</u> be on TEST #2 !!

SKIP TO PART E (p 47) . . . .

PART E

THERMAL ENERGY TRANSFER

(aka "Heat Transfer")

Heat Transfer = the process by which thermal energy moves from one place to another

THERMAL ENERGY TRANSFER

(aka “Heat Transfer”)

There are 3 ways that heat can travel:

CONDUCTION = passage of thermal energy through a body **without large-scale movement** of matter within the body. Most effective in SOLIDS.

CONVECTION = passage of thermal energy through a fluid (liquid or gas) **by means of large-scale movements** of material within the fluid, as in a convection cell. Most effective in GASES & LIQUIDS.

RADIATION = the transfer of thermal energy by ***electromagnetic radiation.*** The only one of the three mechanisms of heat transfer that does not require atoms or molecules to facilitate the transfer process, i.e., **does not even need MATTER as a medium to transfer energy!**

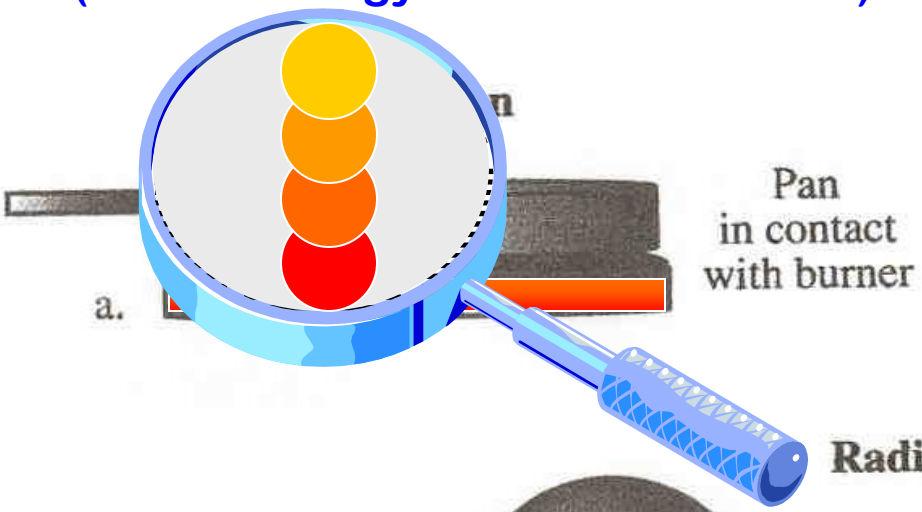
HEAT TRANSFER

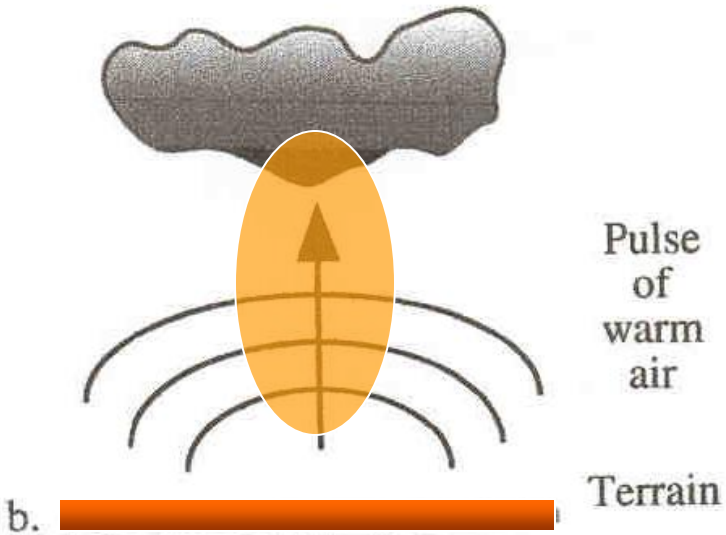
CONVECTION

Mass of warm air or liquid heats, expands, rises

CONDUCTION

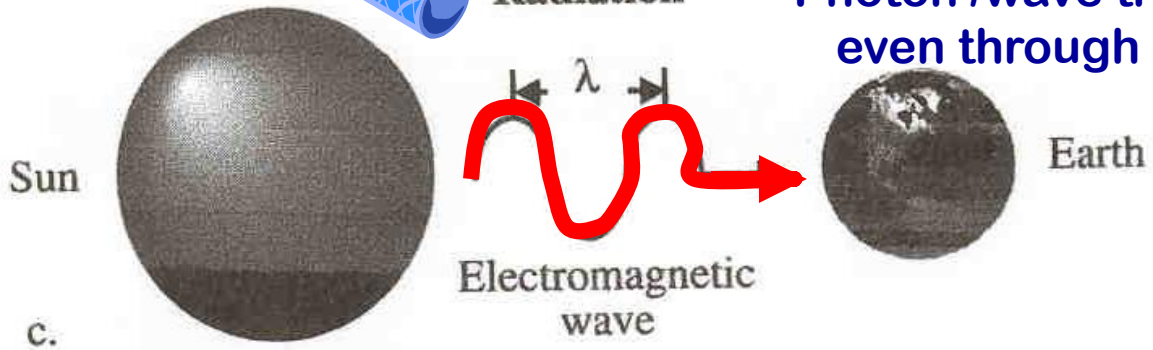
Jiggling molecule ➔ jiggling molecule
transfer of heat
(kinetic energy at molecular scale)





RADIATION

Photon /wave transport: even through a void!



Electromagnetic Radiation

(a KEY POINT about it!)

Electromagnetic energy (radiation) is not heat energy.

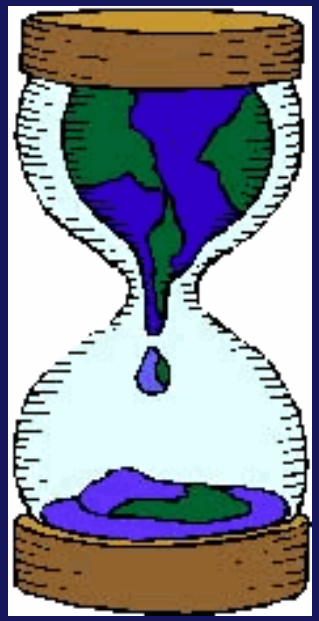
It does not become heat (jiggling molecules) until it strikes an object, is absorbed by the object and sets the molecules in the object in motion, thereby heating up the object.

KEY CONCEPT:

The sun's energy comes in as radiant (electromagnetic) energy, and is converted to measurable heat only after it is absorbed (e.g., by the surface of the earth, a gas in the atmosphere, etc.).

Got all that Homer?

A short
“Homer Simpson”
Break!



http://www.youtube.com/watch?feature=player_embedded&v=7Y3mfAGVn1c

PART F

ENERGY TRANSFORMATIONS & NEWTONS LAWS OF MOTION

1st Law of Motion
(Law of Inertia)

A moving object will continue moving in a straight line at a constant speed . . .

. . . and a stationary object will remain at rest . . . unless acted on by an unbalanced force.

Newton's Laws in everyday life:

1st LAW =

The LAW of INERTIA!

EASY WAY of remembering the 1st Law:

The key word is **"continue."**

If a body is at rest, it **continues** to stay at rest; if moving, it **continues** to move in a straight line.

It can't start or stop moving on its own without some external force, i.e. "a body does not accelerate itself."

2nd Law of Motion

(Newton's Law of Motion)

The acceleration (a) produced on a body by a force (F)

is proportional to:
the magnitude of the force (F)

and inversely proportional to:
the mass (m) of the object.

$a = F / m$ or $F = ma$

2nd Law: F = ma

Acceleration ∝ net force / mass

∝ = "is proportional to"

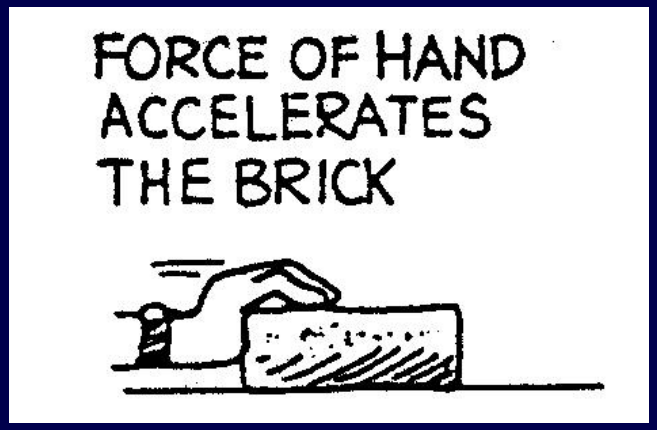
or

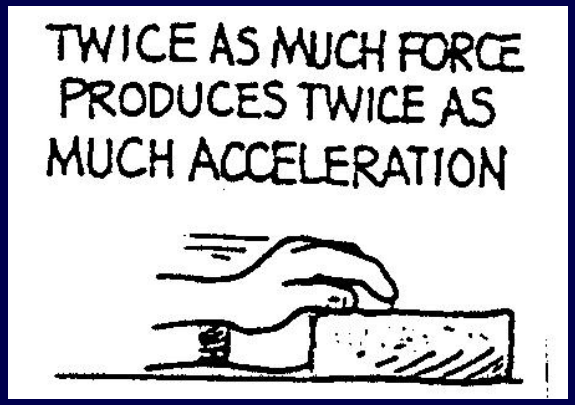
a ∝ F/m

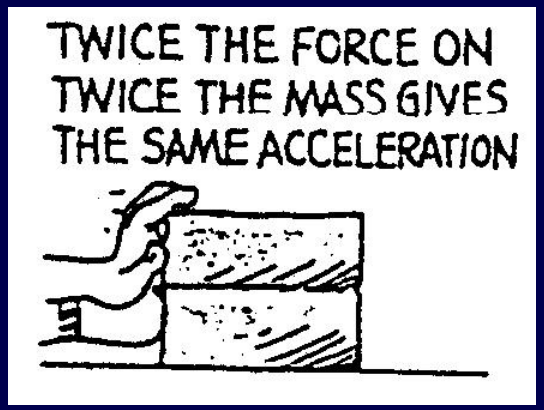
(with appropriate units of m/s^2 for a, newtons for F, kilograms for m)

a = F/m or **F = ma**

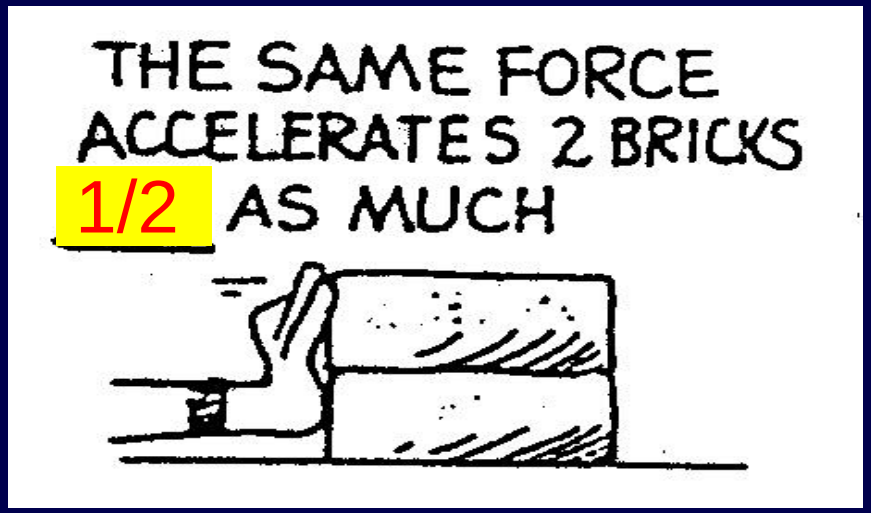
F = ma





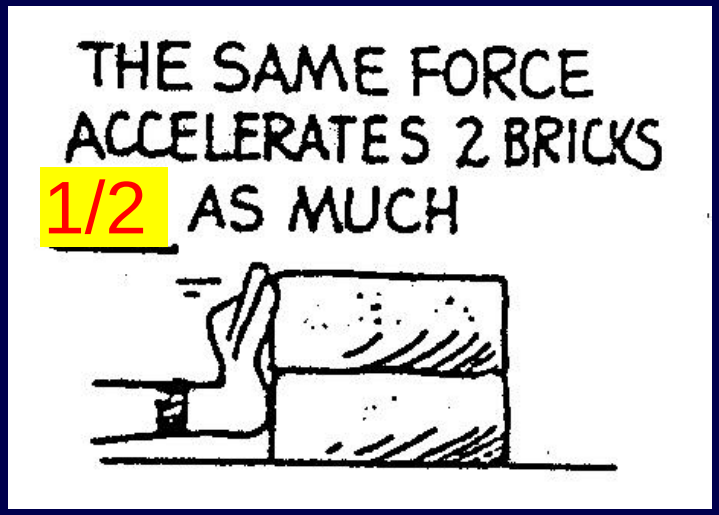


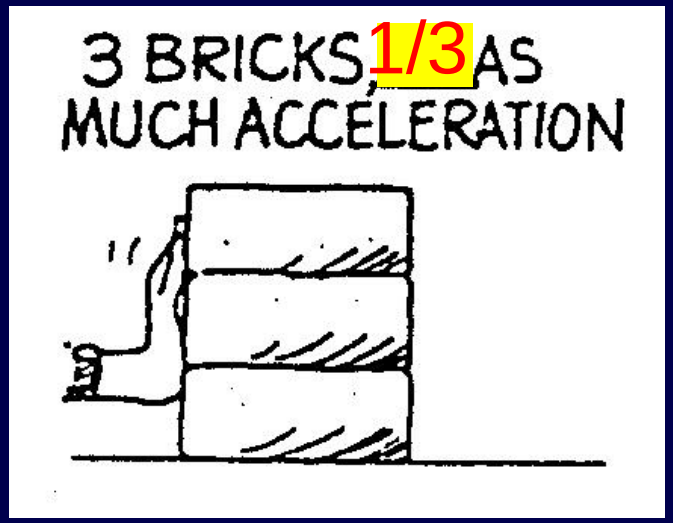
"the same force" = force of ONE hand only



F = ma

"the same force" = force of ONE hand only





CHOICES FOR ABOVE:

A = 3 times

B = 6 times

C = 1/3

3rd Law of Motion
(Law of Force Pairs)

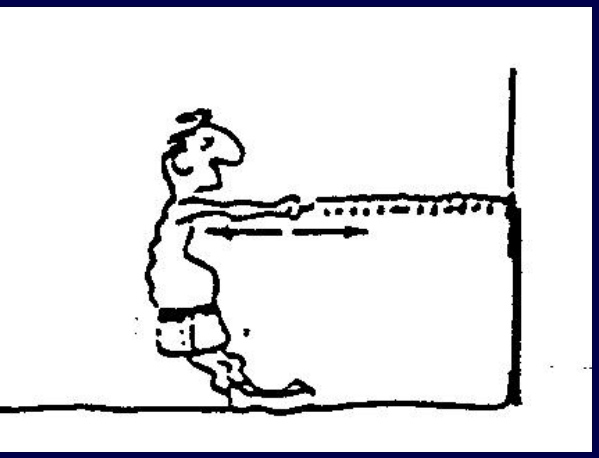
For every action there is an equal and opposite reaction.

3rd Law = "Law of Force Pairs"

- **Forces always occur in pairs**; an **action** and a **reaction**. To every action force there is an equal and opposite reaction force;

- whenever one body exerts a force on a second body, the second body exerts an equal and opposite force on the first body.

- The two forces are equal in strength but opposite in direction. **There is never only a single force in any situation.**

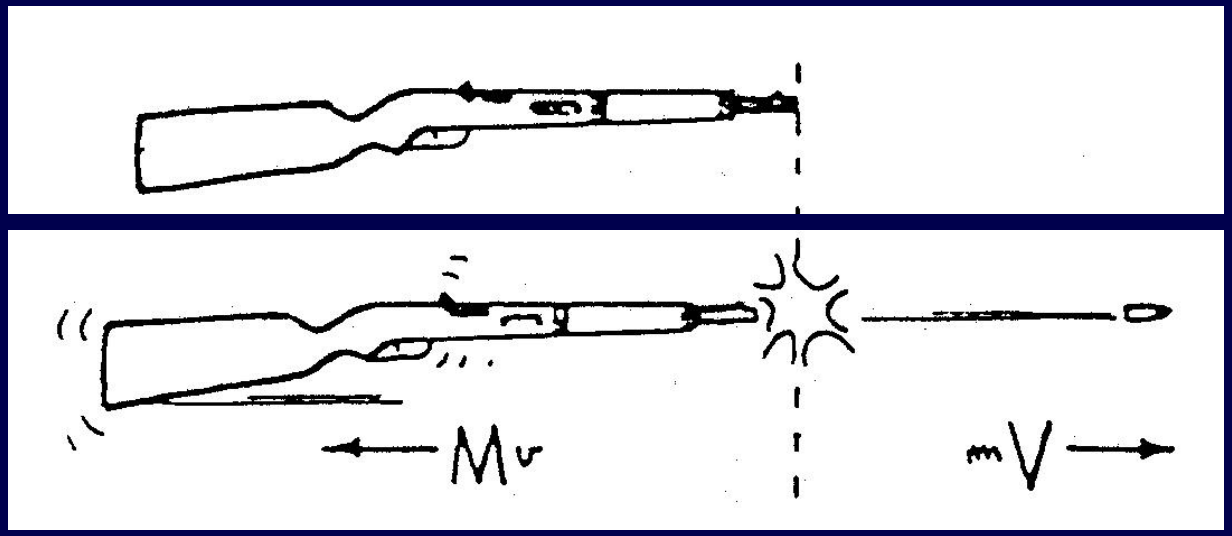


ACTION: Man pulls on spring

REACTION : _____ pulls on _____

String pulls on man

3rd Law: Force exerted on the bullet is exactly equal to the force exerted on the rifle, hence the rifle kicks back.



2nd law reminds us that mass is involved!

Acceleration of bullet is large
(due to small mass of bullet)

$$\frac{F}{m} = a$$

Acceleration of recoiling rifle is smaller
(due to larger mass of rifle)

$$\frac{F}{m} = a$$

Remember this quote?

Newton's passage from a falling apple to a falling moon was an act of the prepared imagination.

~ John Tyndall (1820-1893)

Isaac Newton's Apple Tree in Lincolnshire, England

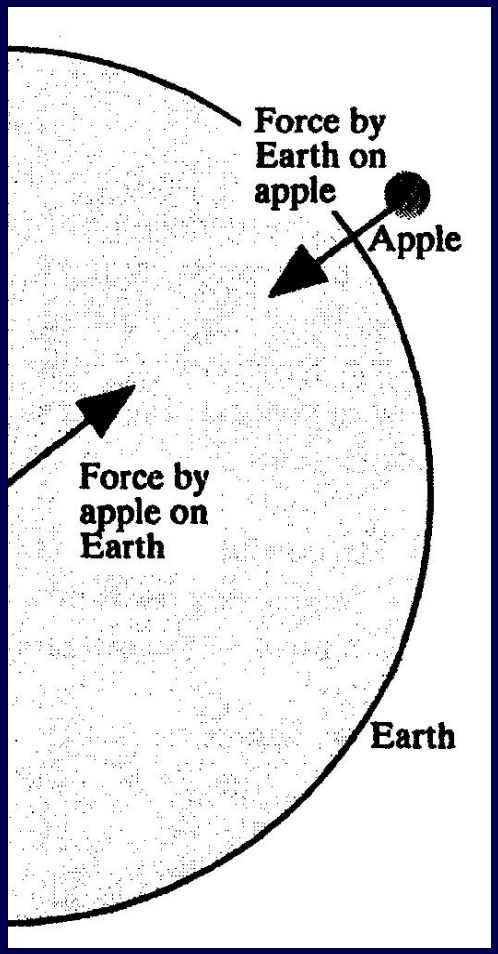
➔ Inspiration emerges from a well-informed mind!

NEWTON'S INSPIRATION = apple & moon!

Earth pulls on apple (gravity)

but . . .
THE APPLE ALSO PULLS ON THE EARTH!

(so small it cannot be measured -- but it is there)



➔ He then likened the **force pairs** between the apple & earth to the apple & the moon!

Application of the Law of "FORCE PAIRS" :

Momentum = inertia in motion; or more specifically, the product of mass of an object and its velocity.

Momentum = mass x velocity

or $P = m v$

An *external* **force applied over time** is required to **change the momentum** of a body . . .

Application of the Law of "FORCE PAIRS" :

Momentum = mass x velocity = time x force

An opposite FORCE slows the truck in both cases:

Wall is opposite FORCE slowing down the truck over short TIME interval

MASS x VELOCITY = TIME x **FORCE**

Haystack is opposite FORCE slowing down the truck over long TIME interval

MASS x VELOCITY = **TIME** x FORCE

MOMENTUM IS CONSERVED before and after in each "crash" case above

MOVIE TIME!

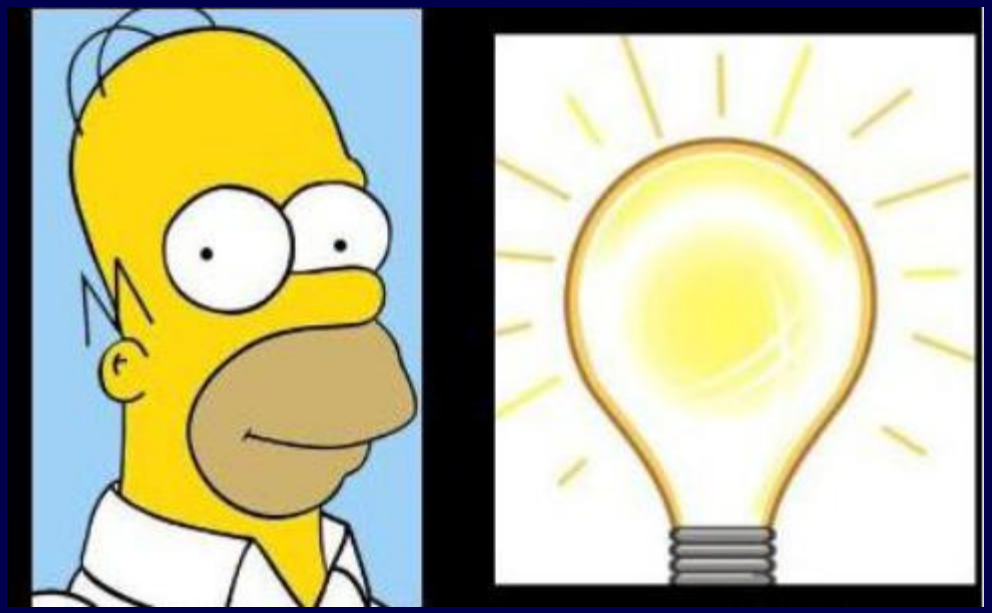
LINKING
THE LAWS OF MOTION
TO LIFE . . . .

“UNDERSTANDING CAR CRASHES
It’s Basic Physics”

GROUP TIME!

ENERGY EFFICIENCY & LIGHT BULBS

Which type of light bulb should Homer buy???



Flip to the Class Notes Appendix: p 117

The Law of Conservation of Energy:

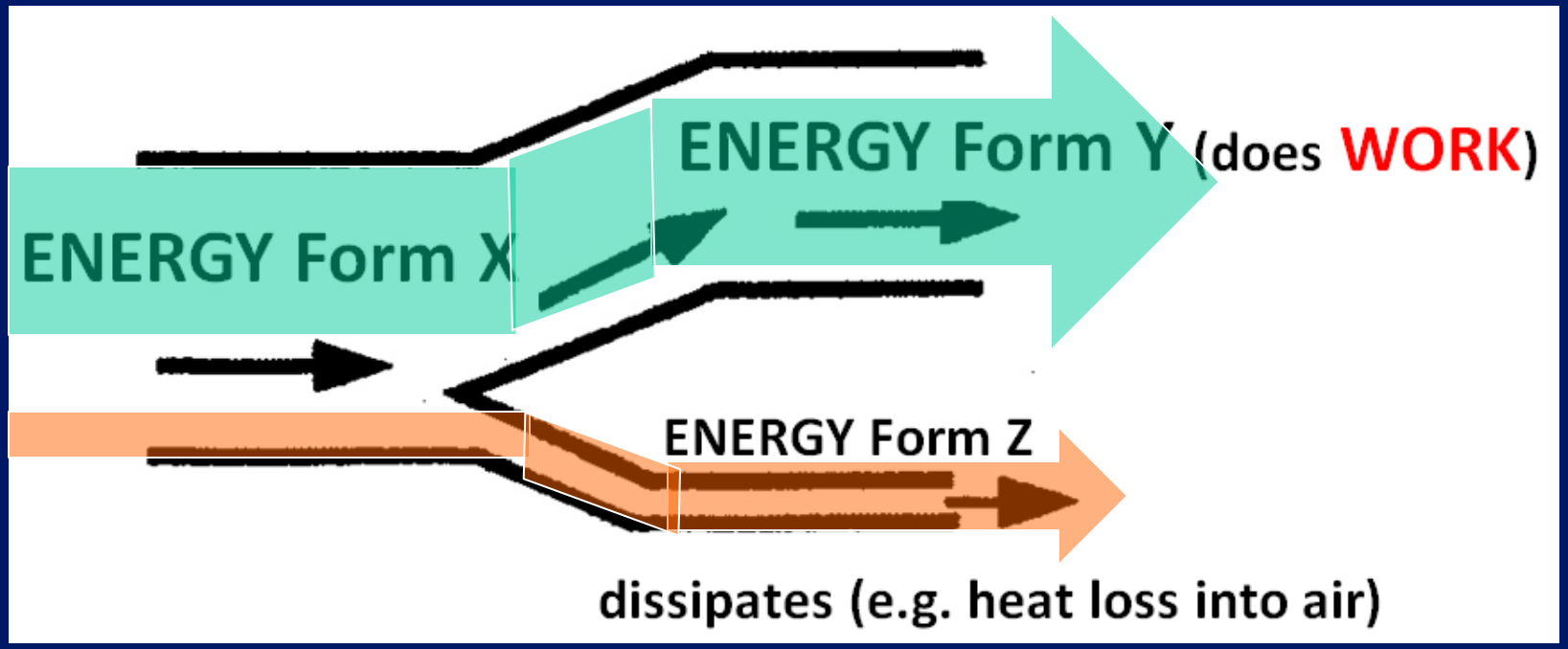
Energy cannot be created or destroyed.

It <u>can</u> be transformed (converted) from one form to another . . . . but

THE TOTAL AMOUNT OF ENERGY NEVER CHANGES.

A KEY POINT:
IN EVERY ENERGY CONVERSION . . .

- Some of it goes where you want it:



- Some goes elsewhere:
(usually as heat loss or “exhaust”)

Although energy may not be destroyed, it can become INEFFICIENT

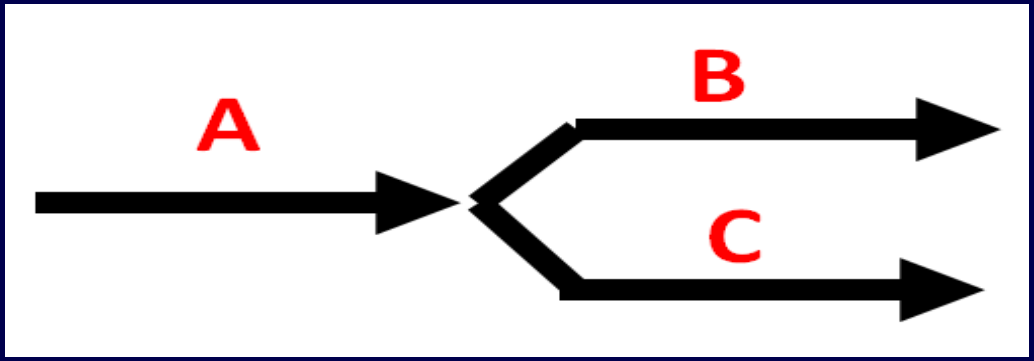
i.e., is not easily used or available to do work!

Efficiency = work done / energy used

*This concept is critically important for designing successful **GREEN TECHNOLOGIES** & for mapping out **SOLUTIONS** for addressing climate change*

How would you draw an energy flow diagram for a LIGHT BULB?

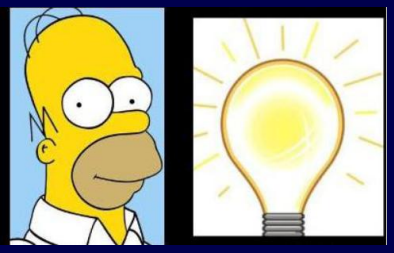
Here is a simple and unlabeled ENERGY FLOW DIAGRAM for a generic LIGHT BULB.



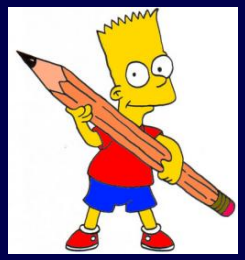
(the width of the arrows has not been adjusted to show the relative amounts of energy in each type of energy flow.)

Which arrow is which?

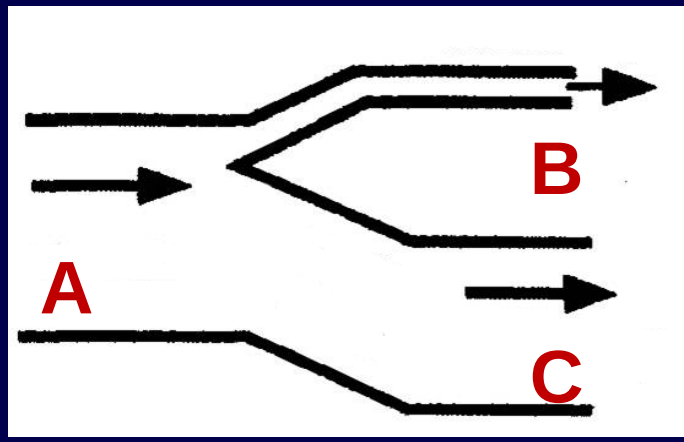
Choices: *light* (**electromagnetic energy**)
electricity (**electrical energy**)
heat (**thermal energy**).



Homer doesn't want to give up his incandescent light bulbs but they are very inefficient and lose 90% or their energy as heat!



So Bart drew Homer this ➔ energy flow diagram for the bulb with different pipe widths!



Q3. Select the # with the correct labels for Bart's diagram:

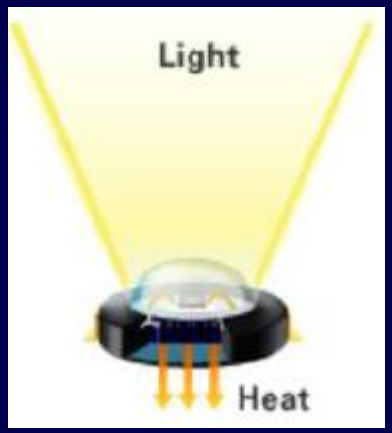
1. A = Electrical E B = Thermal E C = Light E
2. A = Light E B = Thermal E C = Electrical E
3. A = Electrical B = Light E C = Thermal E
4. A = Thermal E B = Electrical E C = Light E

INCANDESCENT BULBS: electricity passes through a metal filament until it becomes so hot that it glows.

Release 90% of their energy as heat.

COMPACT FLUORESCENT BULBS (**CFL**): electric current is driven through a tube containing gases. Reaction produces ultraviolet light ➔ visible light aided by the fluorescent coating on the inside of the tube.

Release about 80% of energy as heat.



LED bulbs use **LIGHT EMITTING DIODES** to produce light. The movement of electrons through a semiconductor material illuminates the tiny LED light sources.

LEDs can approach 80% efficiency

(i.e., 80% of the electrical energy is converted to light energy.)

Draw a **proper** **ENERGY FLOW DIAGRAM** for each type of light bulb:

Width of the arrows should properly represent (**electrical energy**) converted into *light* (**electromagnetic energy**) and *heat* (**thermal energy**).

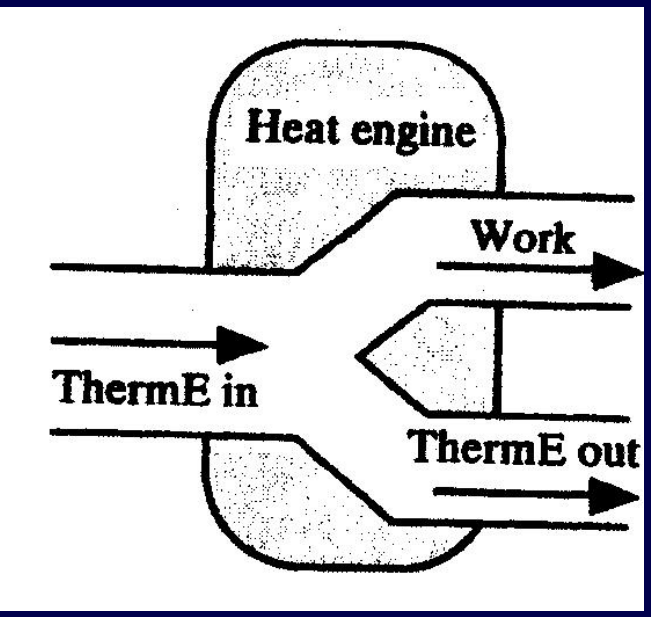
THE ARROW WIDTHS WILL BE DIFFERENT FOR EACH TYPE OF LIGHT BULB!

		RANK
	**Diagram for Incandescent bulb:**	
	Diagram for CFL bulb:	
	Diagram for LED w/ 80% efficiency:	

Then . . .
based on your Energy Flow Diagrams, RANK the amount of thermal energy being emitted by each bulb type based on the bulb's expected temperature -- from coolest (#1) to hottest (#3)

➔Turn to p 117

The 2nd Law stated another way:



← Energy flow diagram for a heat engine.

"2nd Law" = Any process that uses thermal energy as input to do the work must also have thermal energy output -- or **exhaust!**

WHAT TO REMEMBER: heat engines are always less than 100 % efficient!

➔ IMPROVED ENERGY EFFICIENCY IS A KEY ASPECT OF GREEN TECHNOLOGIES!

LINK TO ELECTRICITY PRODUCTION:

Rank the following systems for producing electricity in terms of energy efficiency

Which is the MOST efficient? __

A) burning fossil fuel (coal) for electricity

Coal-fired electric power plant

B) sunlight to electricity in a solar panel

Photovoltaic (PV) panel

C) hydro power turbines generating electricity

Hydroelectric plant

LINK TO ELECTRICITY PRODUCTION:

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LINK TO ELECTRICITY PRODUCTION:

Rank the following systems for producing electricity in terms of energy efficiency

Which is the LEAST efficient? __

A) burning fossil fuel (coal) for electricity

Coal-fired electric power plant

B) sunlight to electricity in a solar panel

Photovoltaic (PV) panel

C) hydro power turbines generating electricity

Hydroelectric plant

LINK TO ELECTRICITY PRODUCTION:

Rank the following systems for producing electricity in terms of energy efficiency

Which is the LEAST efficient? __

A) burning fossil fuel (coal) for electricity

Coal-fired electric power plant

B) sunlight to electricity in a solar panel

Photovoltaic (PV) panel

C) hydro power turbines generating electricity

Hydroelectric plant

LINK TO ELECTRICITY PRODUCTION:

Rank the following systems for producing electricity in terms of energy efficiency

Most efficient = __C__ Least efficient = __B__

A) burning fossil fuel (coal) for electricity ~ 33-38%

Coal-fired electric power plant

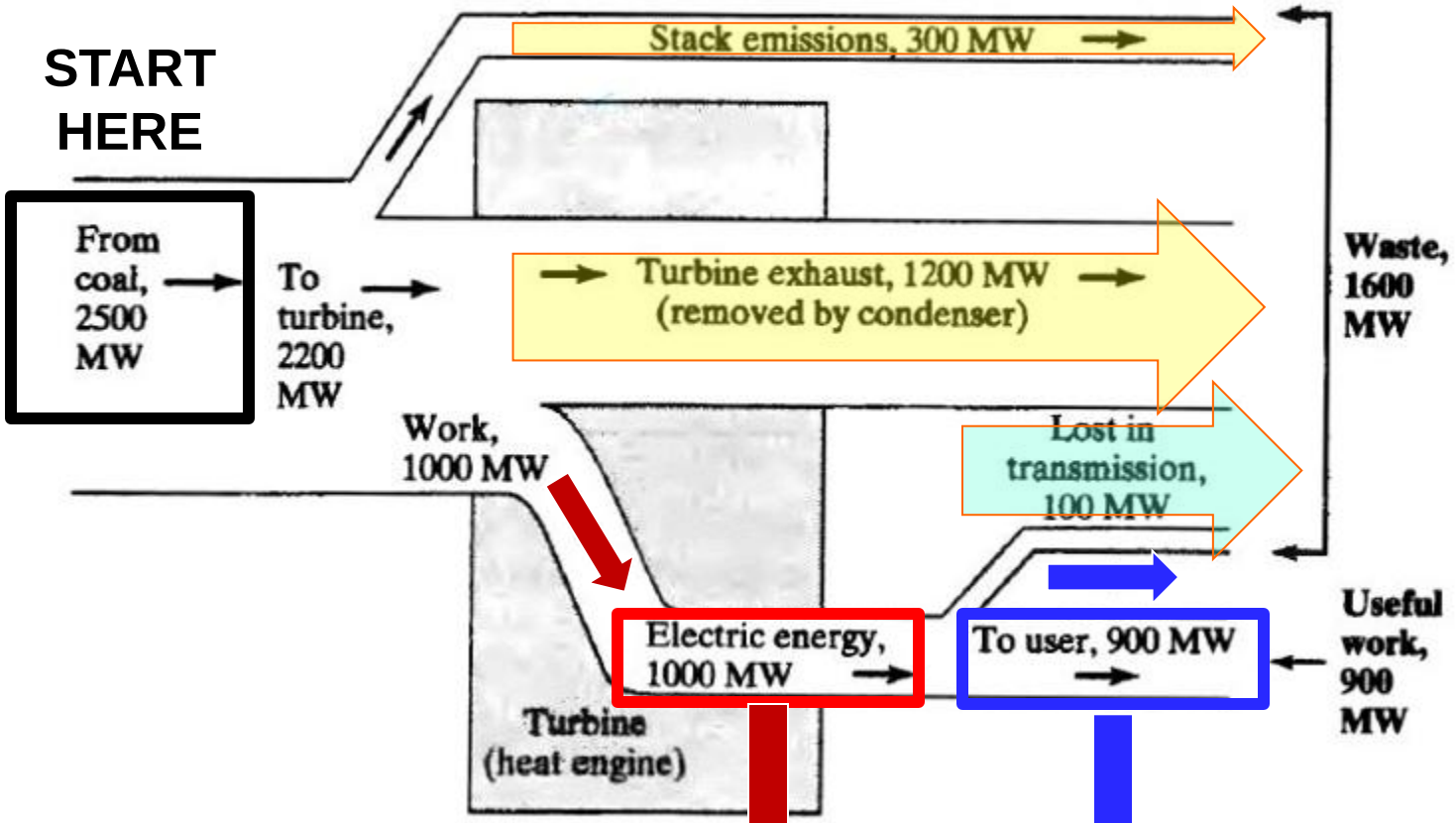
B) sunlight to electricity in a solar panel ~15-20%

Photovoltaic (PV) panel

C) generating electricity ~85-90%

Hydroelectric plant

ENERGY TRANSFORMATIONS & THE COAL POWER PLANT



Energy flow diagram for a typical 1000 mega tt (MW) coal-fuele electric generating plant

Energy Efficiency of ELECTRICITY GENE RATION = 40%:

(1000 MW electrical energy produced ÷ 2500 MW i coal fuel = 0.40 = 40%)

Energy Efficiency of PRODUCING USEFUL ELECTRICITY = 36 %:

(900 MW electrical energy produced ÷ 2500 MW in coal fuel = 0.36 = 36%)

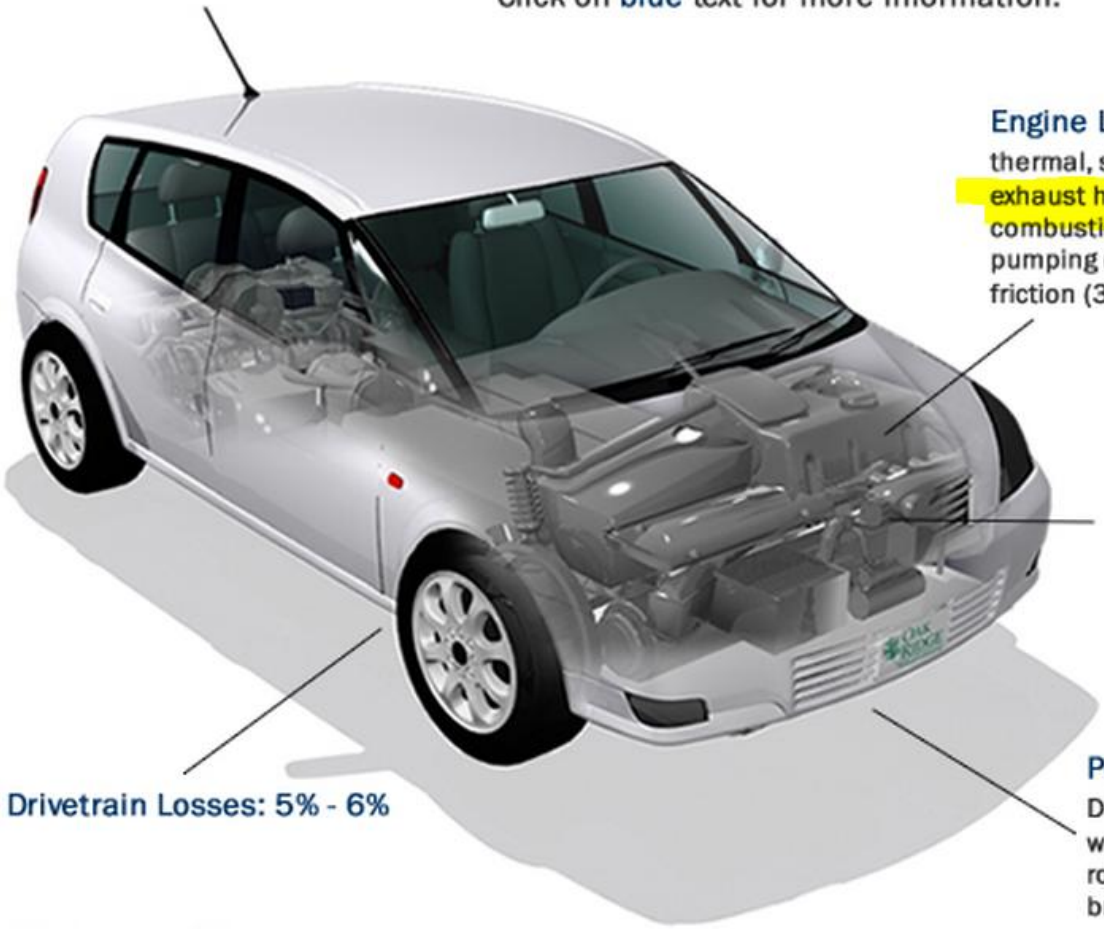
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

www.fueleconomy.gov

the official U.S. government source for fuel economy information

Energy Requirements for Combined City/Highway Driving

Click on blue text for more information.



Engine Losses: 70% - 72%
thermal, such as radiator, exhaust heat, etc. (60% - 62%)
combustion (3%)
pumping (4%)
friction (3%)

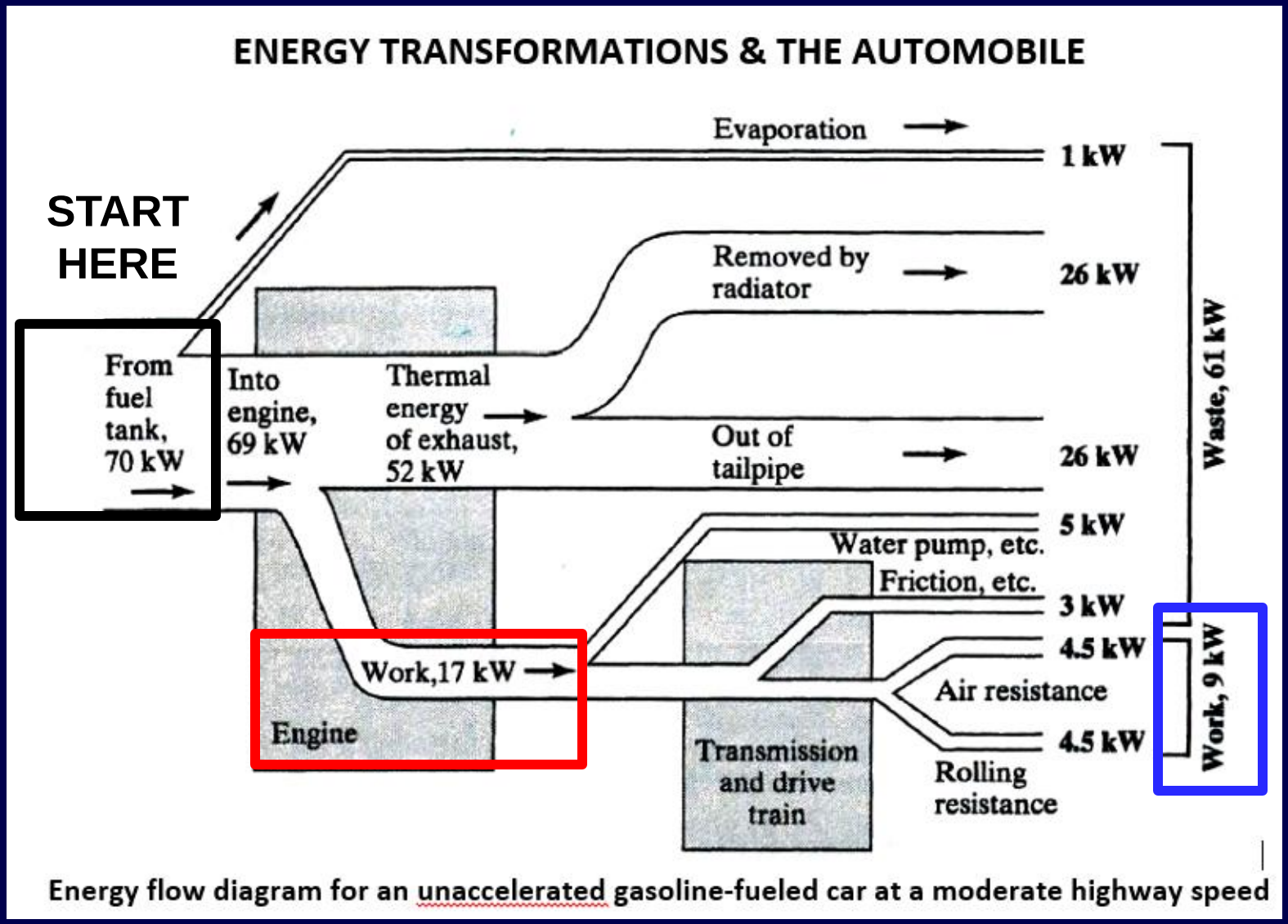
Parasitic Losses: 5% - 6%
(e.g., water pump, alternator, etc.)

Drivetrain Losses: 5% - 6%

Power to Wheels: 17% - 21%
Dissipated as
wind resistance: (8% - 10%)
rolling resistance (5% - 6%)
braking (4% - 5%)

Idle Losses: 3%
In this figure, they are accounted for as part of the engine and parasitic losses.

http://www.fueleconomy.gov/feg/atv.shtml



Q1. What % of the energy in the fuel does work RUNNING THE ENGINE?

Q2. What % of the energy in the fuel eventually does "work" that MOVES THE CAR (by overcoming air resistance and rolling resistance)?

OK . . .
GET TO WORK
ON G-2

If your group doesn't finish, there will be time to finish up G-2 after Test #2 next Tuesday.

Can I go now????

YES!!

But study hard for TEST #2 Homer!