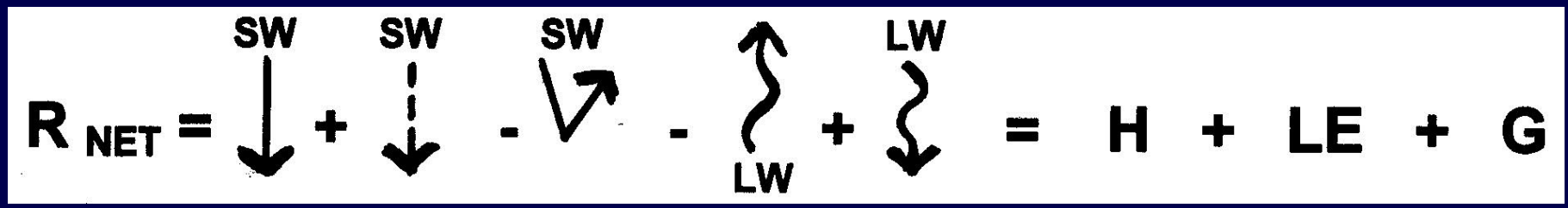
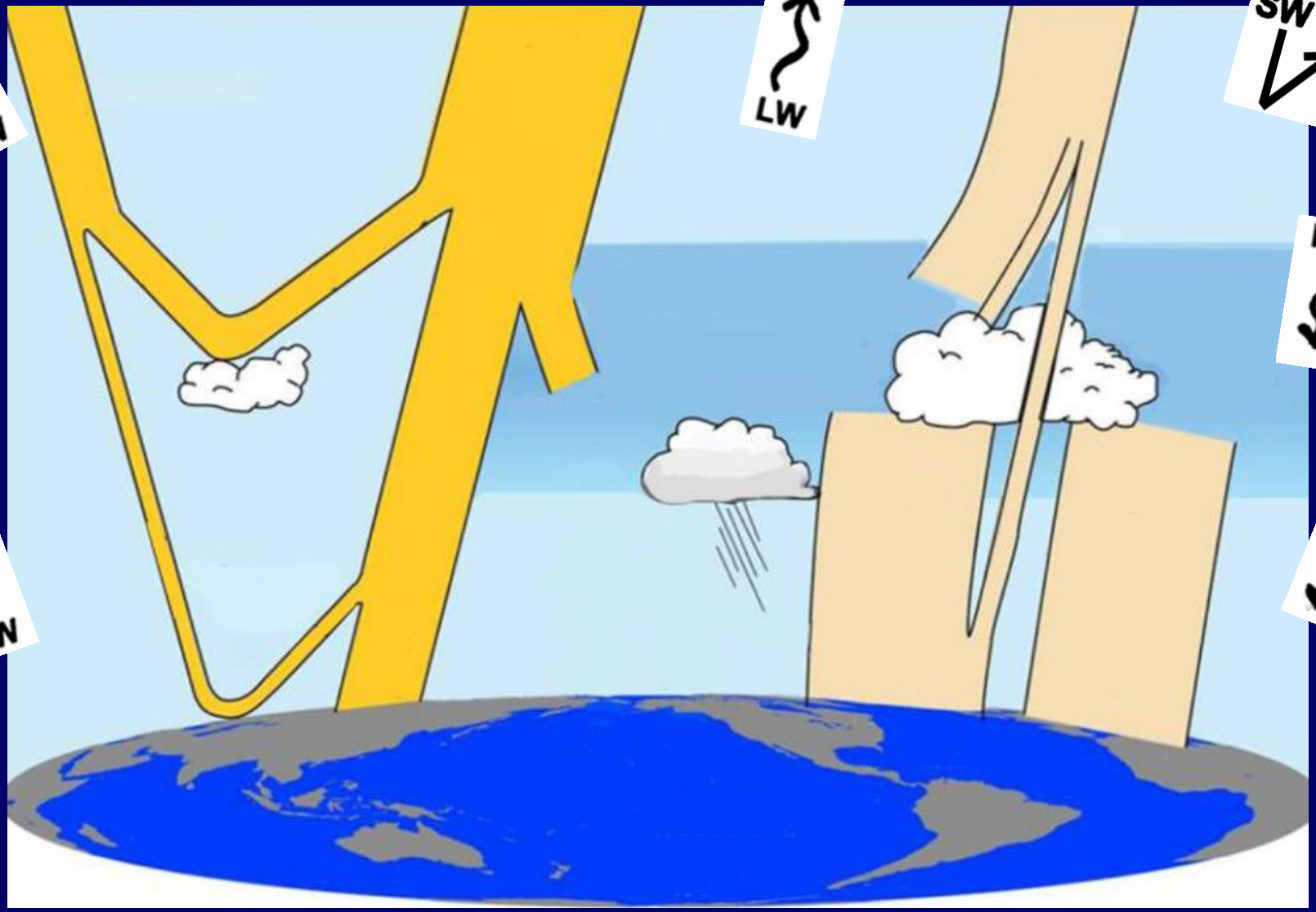
Topic # 8
THE EARTH'S GLOBAL ENERGY BALANCE
PART II



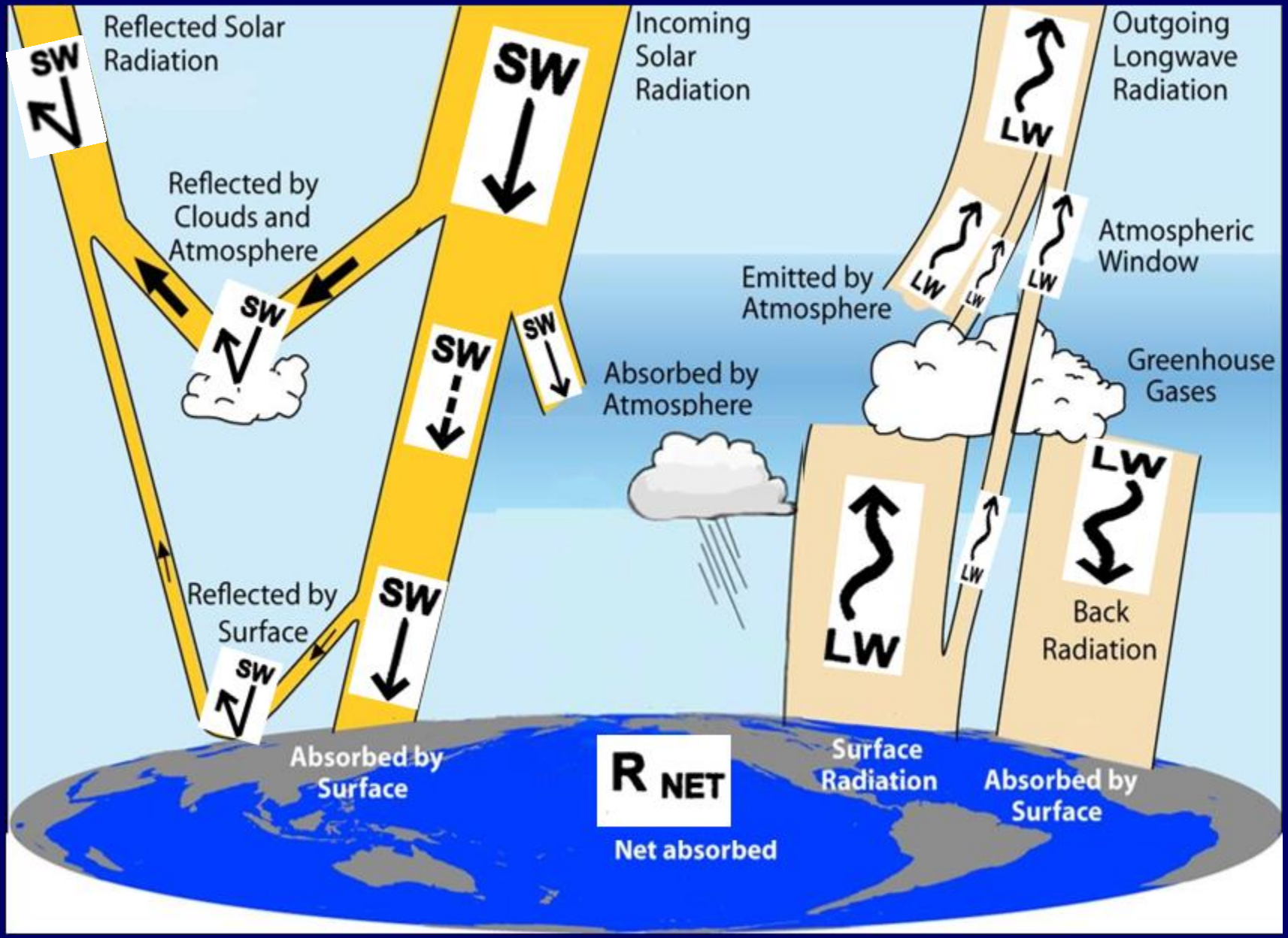
HANDS ON WITH THE SYMBOLS!

Can you label the PATHWAYS on this diagram with the CORRECT SYMBOL ?

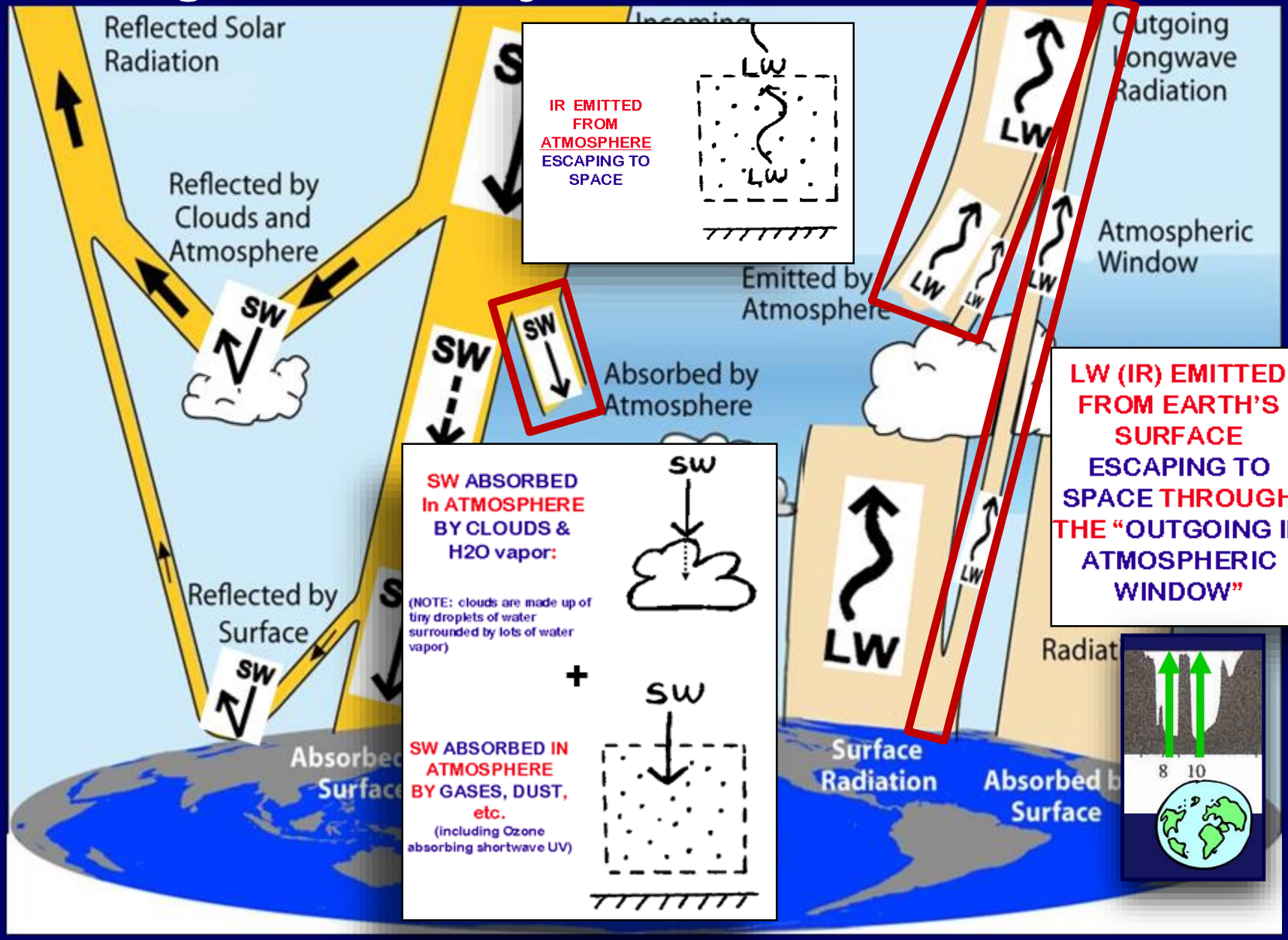
PLACE THE SYMBOLS IN THE RIGHT PLACE:



Should look something like this:



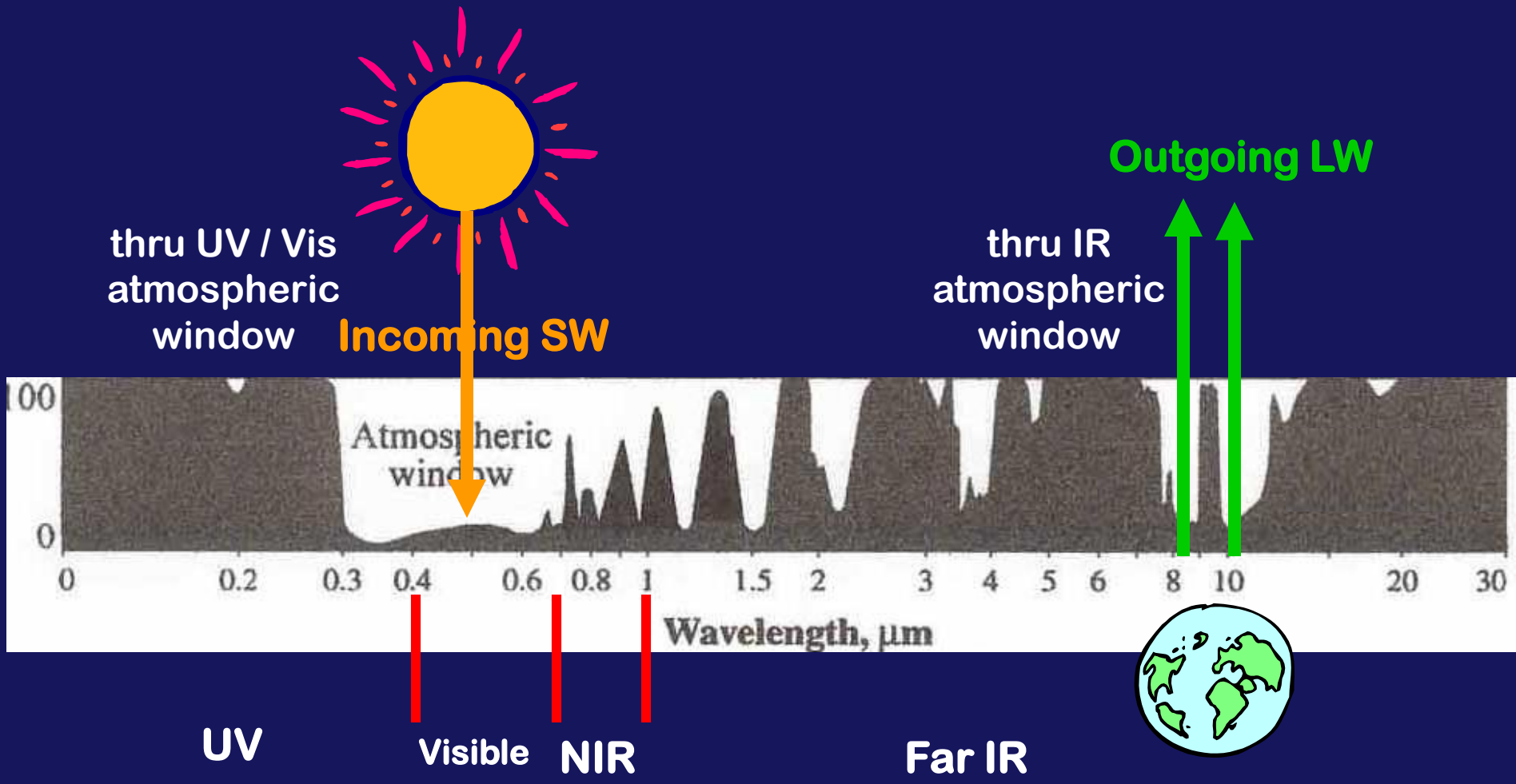
Naming the Pathways . . . .



Link back to Appendix pp 107-108

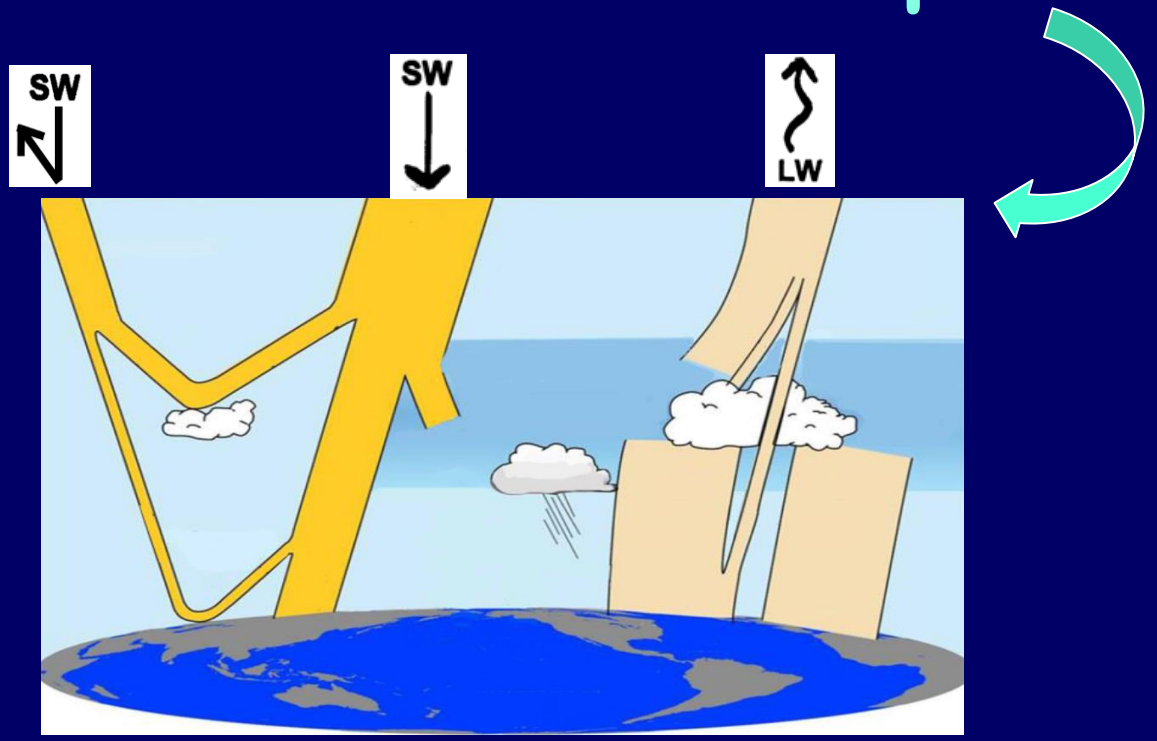
BALANCES at the TOP of the Atmosphere!

OVERALL BALANCE: Incoming = Outgoing



Review

Incoming + Outgoing Energy BALANCE at the TOP of the Atmosphere!

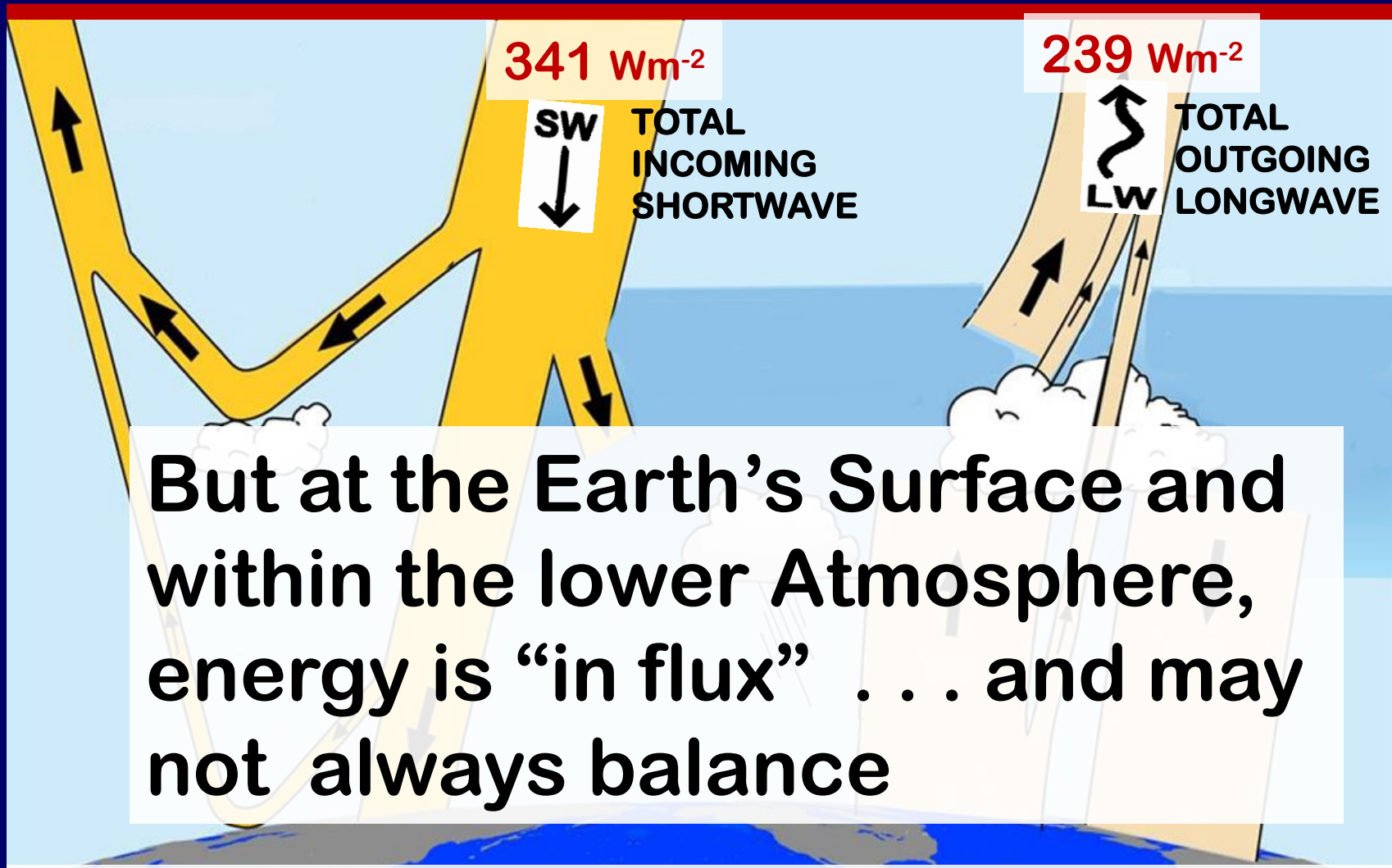


Unit of energy = joule / sec = 1 watt

When watts of energy are delivered to a surface we use:

Watts per meter ^{2} = W/m^{2} = Wm^{-2}

Watts / meter ^{2} measured at the "TOP" of the Atmosphere:



But at the Earth's Surface and within the lower Atmosphere, energy is "in flux" . . . and may not always balance

The WIDTH of the arrows represents how much energy is in each pathway

(averaged globally per year)

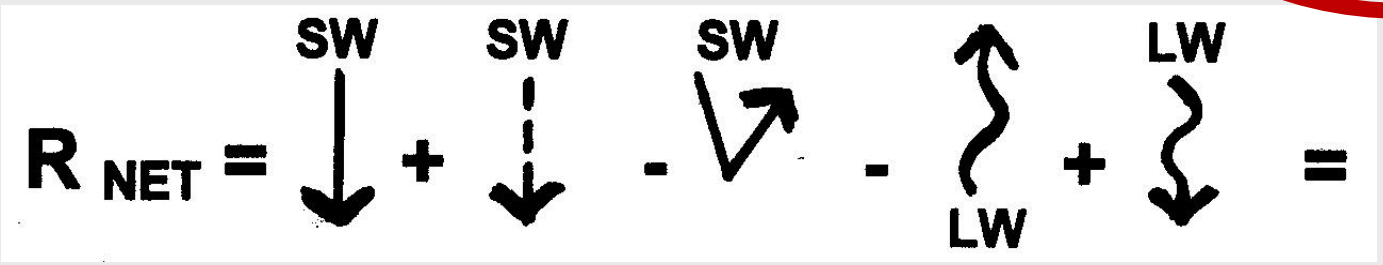
Review p 49

BANK ACCOUNT ANALOGY:

IN - OUT = Your Account Balance

+ Balance = Net Funds available to do stuff!

NET RADIATION = In – Out = Whatever is left over



If at the Earth's Surface, there is a NET SURPLUS of energy "left over" . . . .

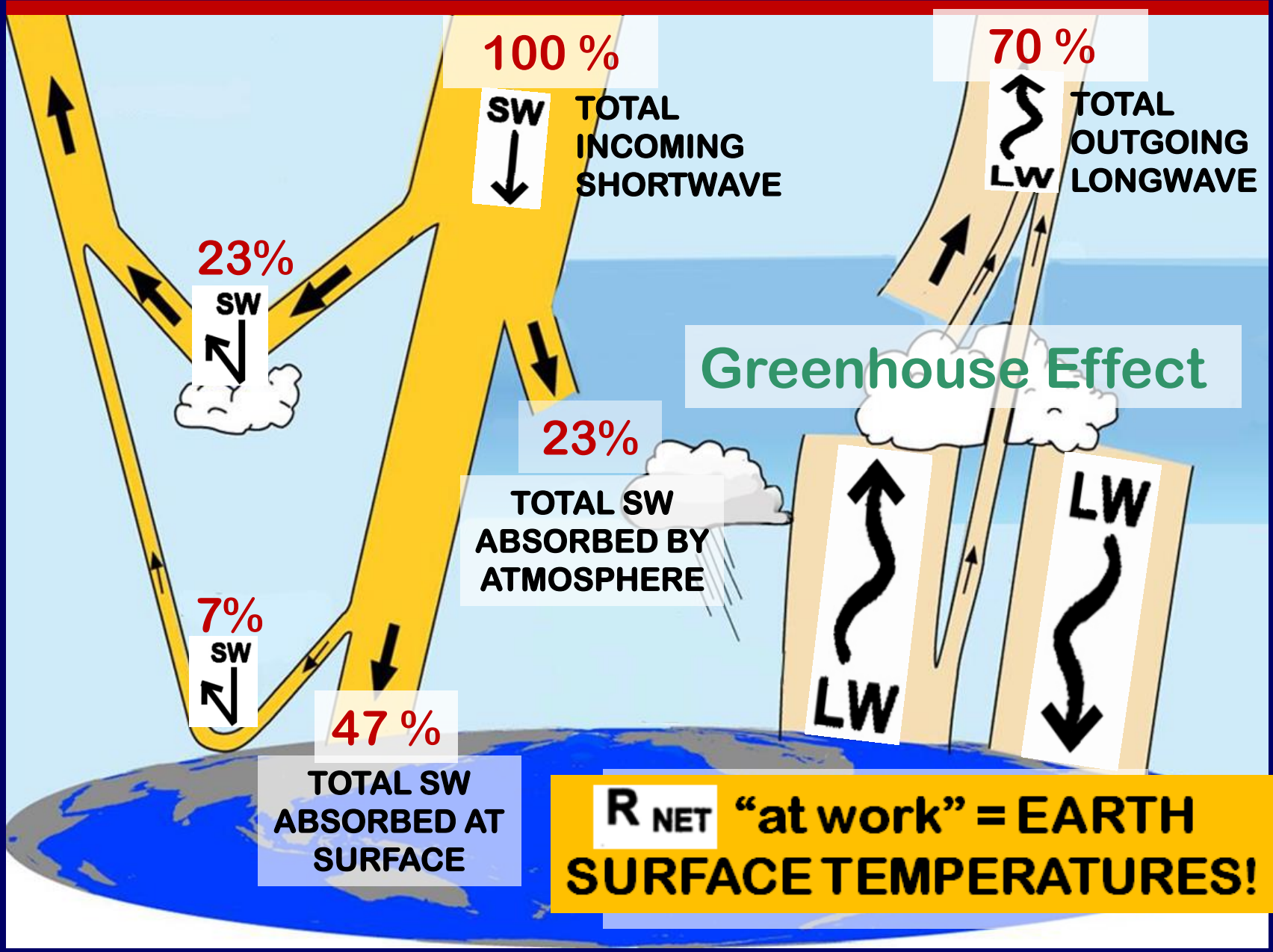
➔it can be used to DRIVE WEATHER & CLIMATE

➔through HEAT TRANSFER processes into the ATMOSPHERE

➔ OR it can be STORED for awhile at the SURFACE (in the ground or ocean).

p 47 bottom

Percent % measured at the "TOP" of the Atmosphere:



CHECKPOINT

THINK . . . then share
What's still fuzzy . . .
what's now perfectly clear
about Topic #8?

THE FINAL PART OF TOPIC # 8:

The RIGHT side of the ENERGY BALANCE EQUATION . . .

Left side of equation

$$R_{NET} = SW\downarrow + SW\downarrow - SW\nearrow - LW\updownarrow + LW\updownarrow = H + LE + G$$

Right side of equation

R net = "net" left over energy can be used to DRIVE WEATHER & CLIMATE through HEAT TRANSFER processes or it can STORED by the Earth (in the ground or ocean).

$$R_{NET} = H + LE + G$$

WHAT ARE :

H LE G

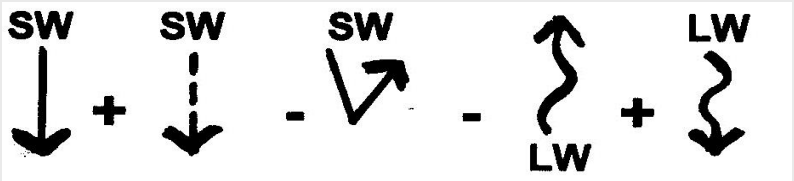
?

Review of: HEAT TRANSFER PROCESSES

"There are 3 ways that Heat can travel"

MATTER may or may not be involved:

- **Radiation**



- **Conduction**
- **Convection**

involve MATTER:

plus . . .

PHASE CHANGES

in MATTER

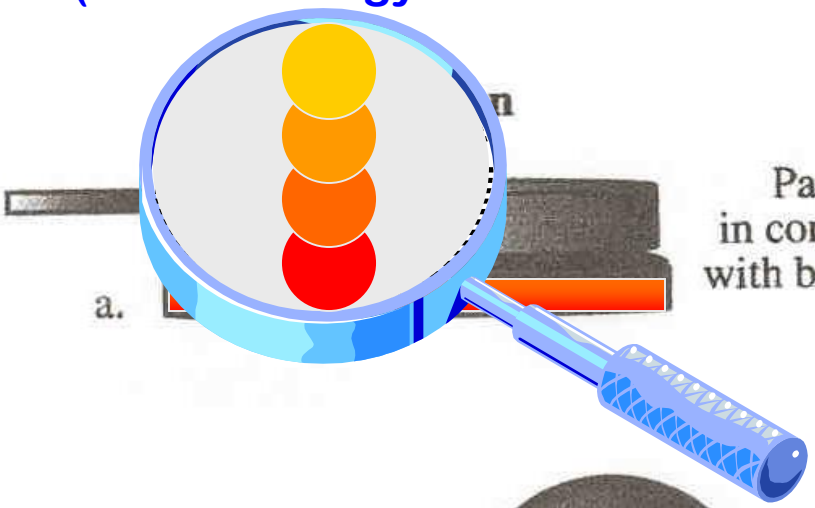
review

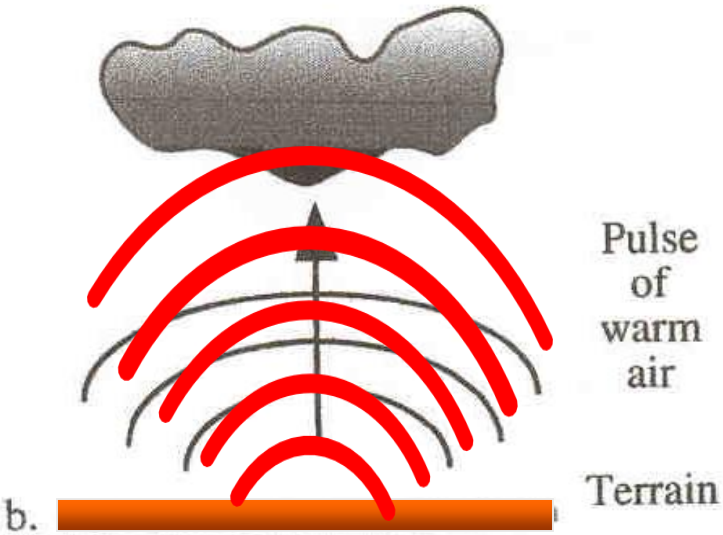
CONVECTION

Mass of warm air or liquid heats, expands, rises

CONDUCTION

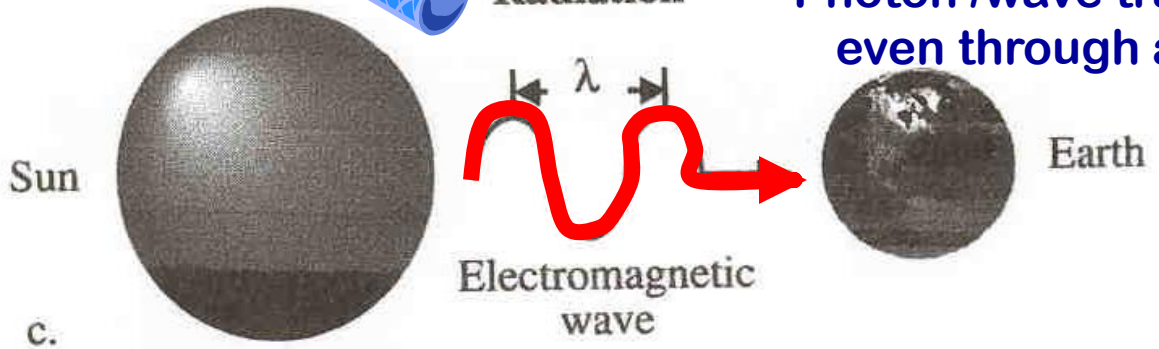
Jiggling molecule ➔ jiggling molecule
transfer of heat
(kinetic energy at molecular scale)





RADIATION

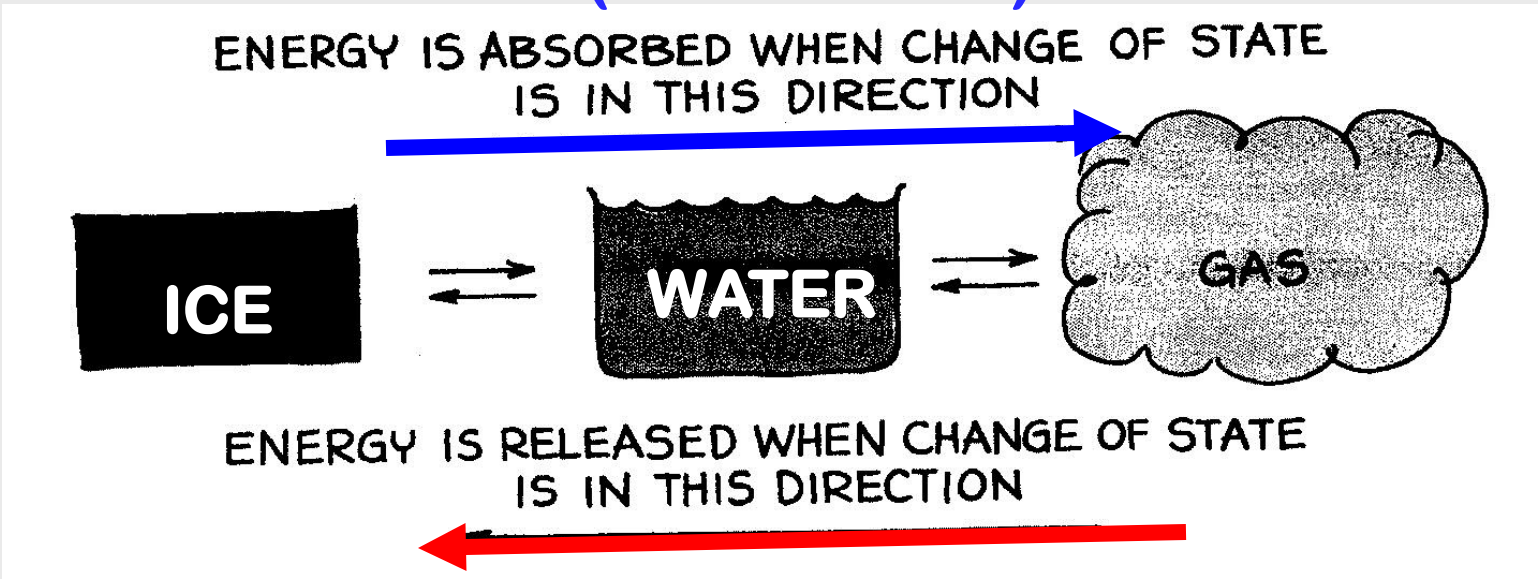
Photon /wave transport: even through a void!



review

HEAT TRANSFER & STORAGE DURING PHASE CHANGES: LE & H

LE = LATENT (hidden) ENERGY (LE stored)



(LE released, hence it can be sensed as H)

H = SENSED (via thermometer) ENERGY

DEFINITION: **LE**

LATENT ENERGY

= the amount of energy released or absorbed by a substance during a **change of <u>PHASE</u>** such as when water evaporates.

➔ temp change is <u>NOT</u> SENSED

DEFINITION:

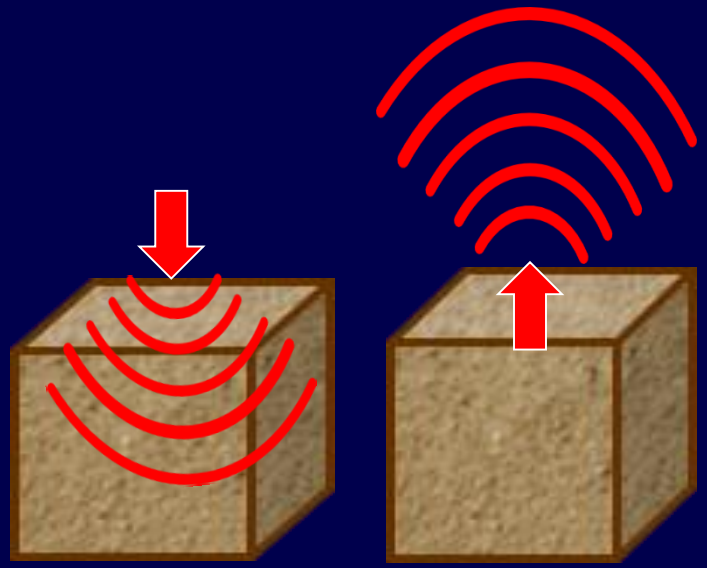
H

SENSIBLE HEAT

= the amount of energy released or absorbed by a substance **during a change in <u>TEMPERATURE</u>**

➔ Temp change is SENSED

(NO phase change!)



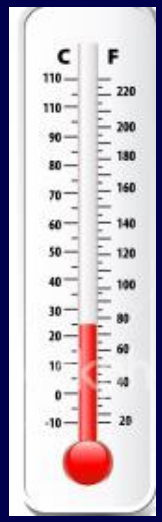
Soil absorbs heat during day & heats up

Soil releases heat at night & cools off

EASIER WAY TO REMEMBER:

H

SENSIBLE HEAT = the energy or heat of molecular motion. It can be **"SENSED"** with a thermometer, and we "feel" it as heat.



LE

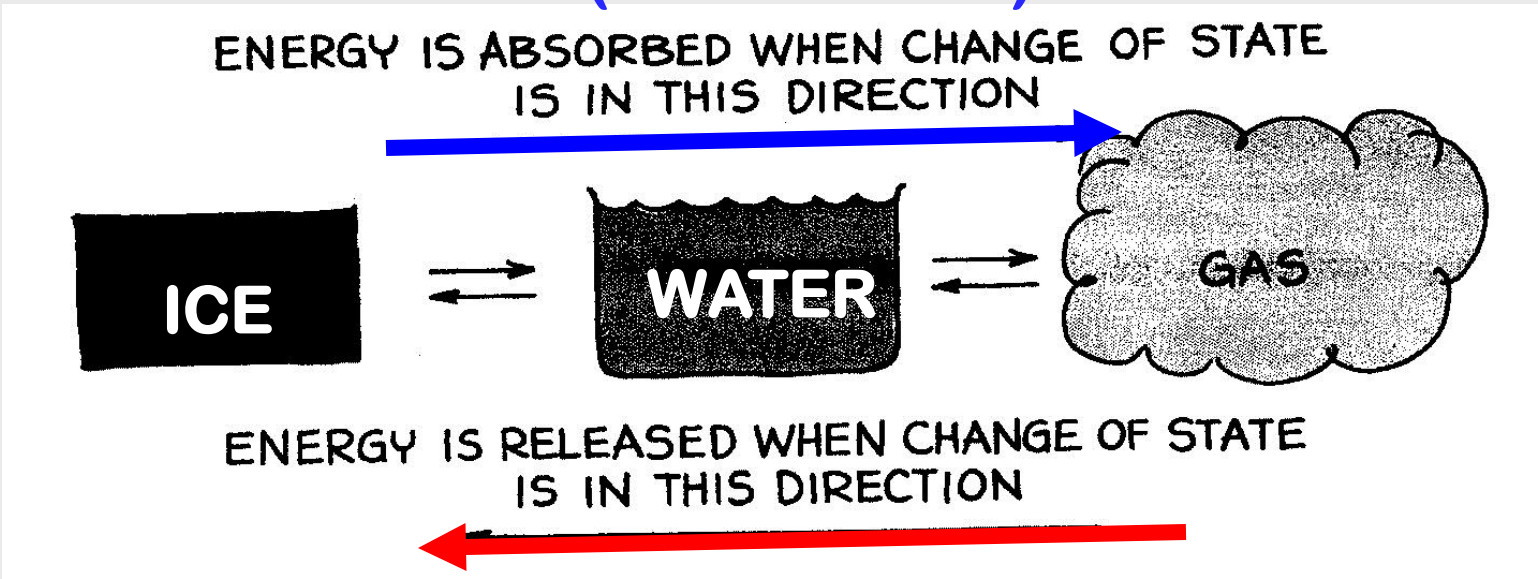
LATENT ENERGY = energy is there, but it is **NOT SENSED** (by a thermometer, the environment . . . or YOU!)

(Latent means "HIDDEN)

involves PHASE CHANGES

HEAT TRANSFER & STORAGE DURING PHASE CHANGES: LE & H

LE = LATENT (hidden) ENERGY (LE stored)

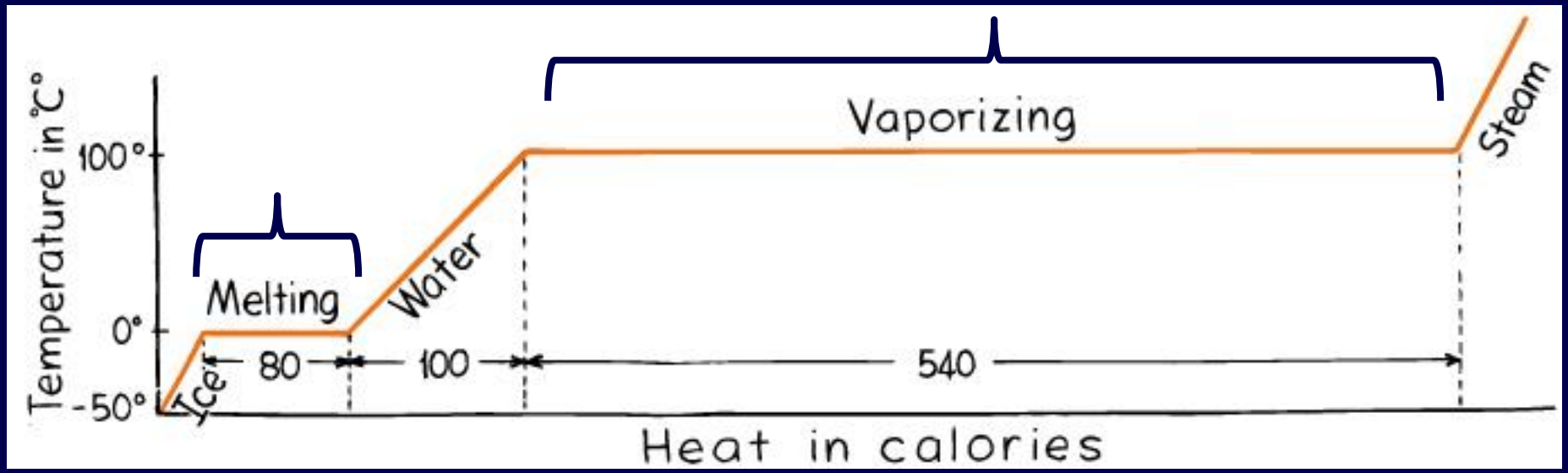


(LE released, hence it can be sensed as H)

H = SENSED (via thermometer) ENERGY

THOUGHT QUESTION:

In this graph, what's happening to the energy in the portions where the graph is <u>horizontal</u>?



HINT: it has to do with

SENSIBLE HEAT (H)

&

LATENT HEAT (LATENT ENERGY) LE

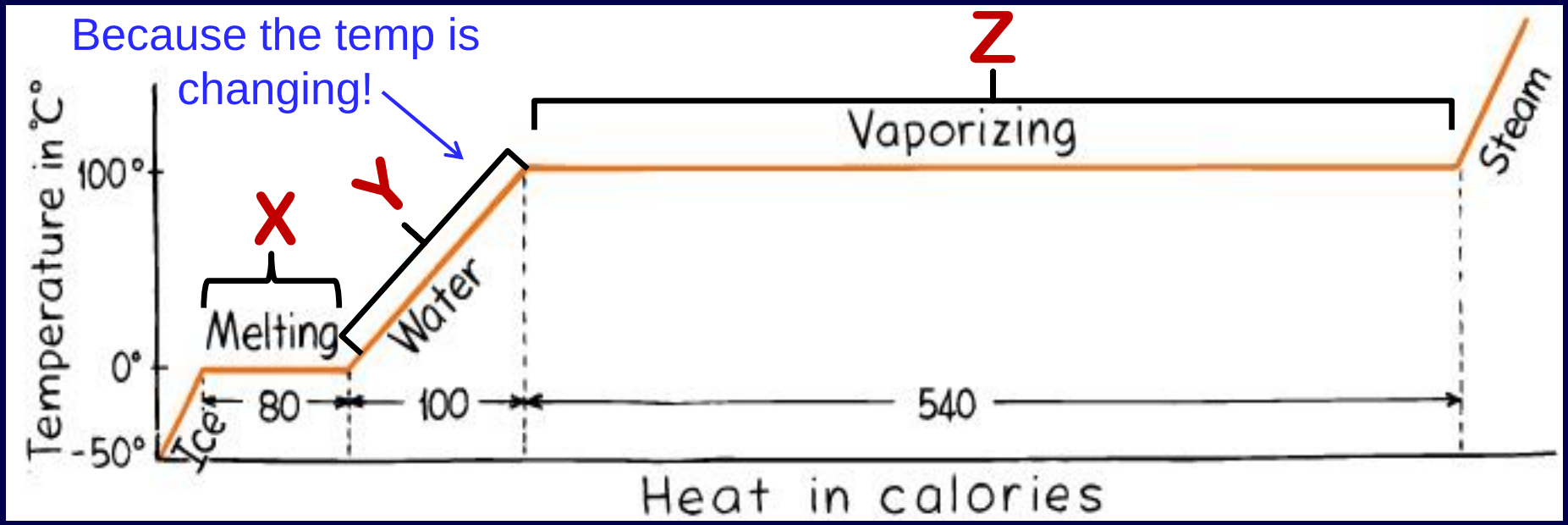
Clicker Q1 -- Which segment or segments of the graph represent(s) **SENSIBLE HEAT (H)** ?

1 = X & Z

2 = X only

3 = Y only

4 = Z only

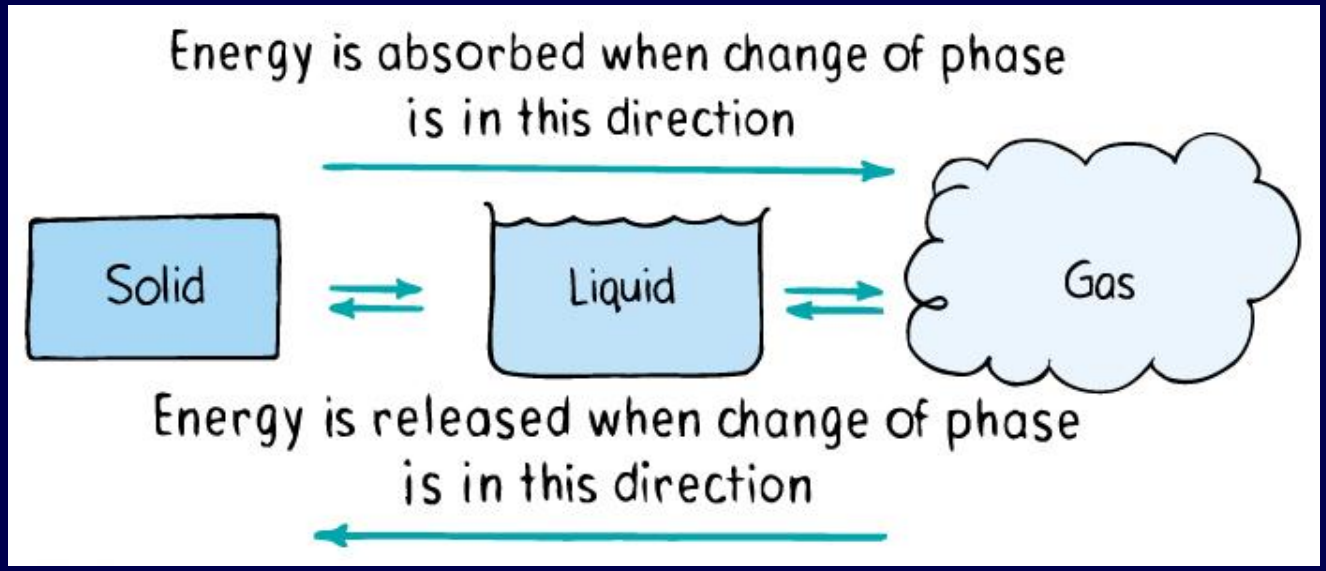


Clicker Q2 - In a phase change from ice to water or water to water vapor, <u>WHAT</u> is absorbing the energy?

1 = the surrounding environment

2 = the H_2O molecules

3 = both the environment & the H_2O

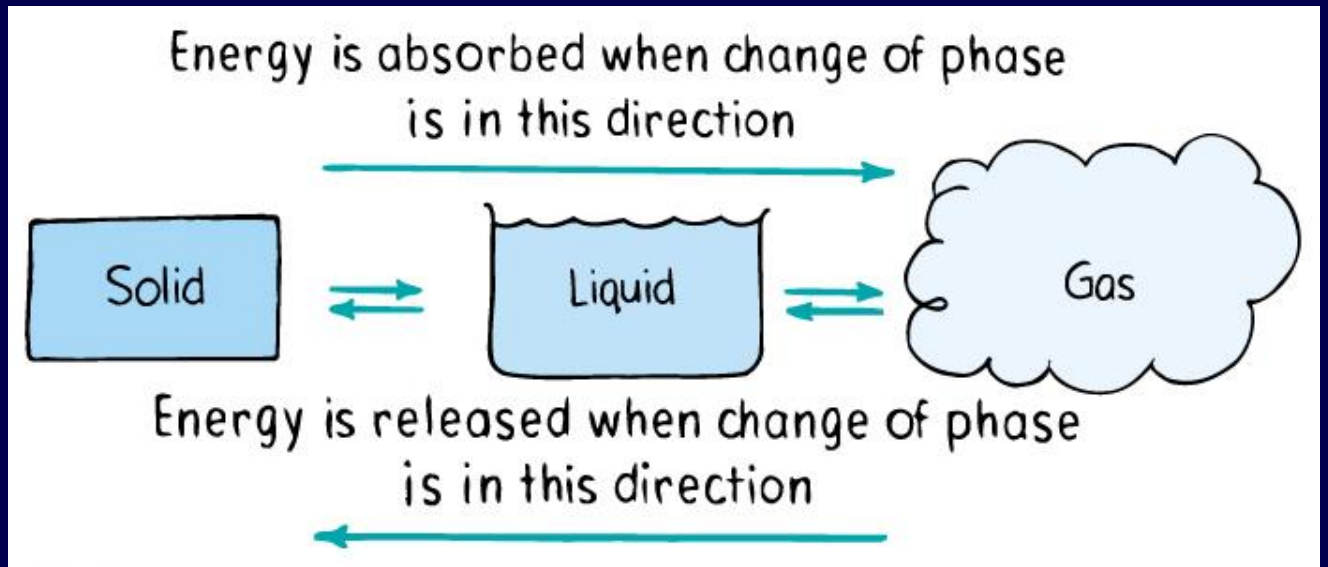


Clicker Q3 - In a phase change from water vapor to liquid water or liquid water to ice, TO WHERE is the energy being released?

1 = into the surrounding environment

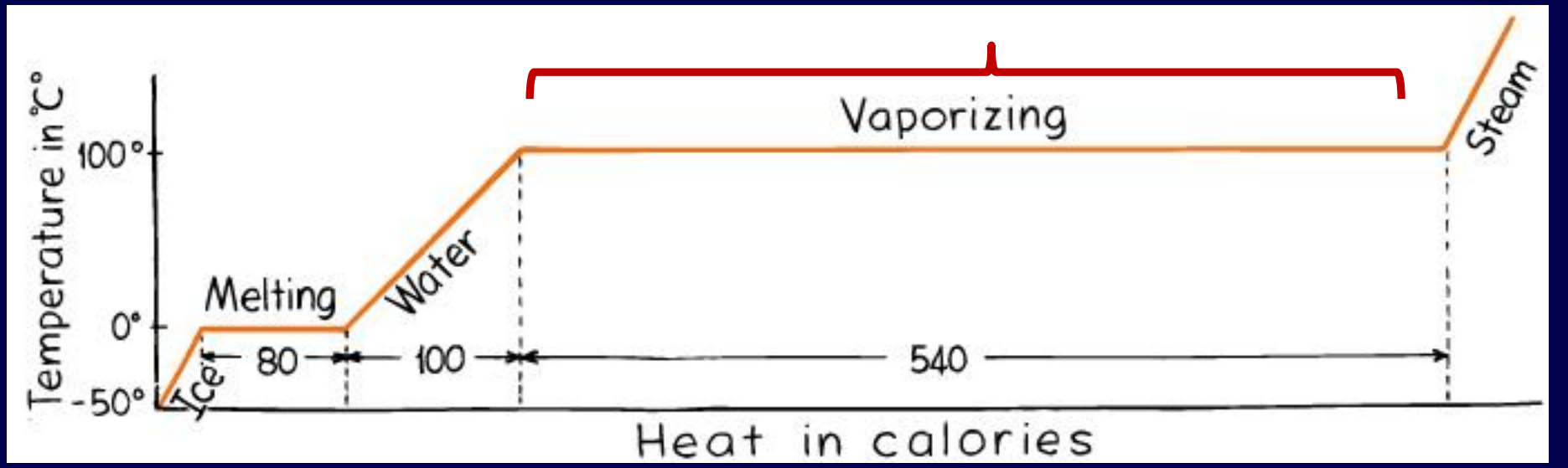
2 = into the H_2O molecules

3 = into both the environment & the H_2O

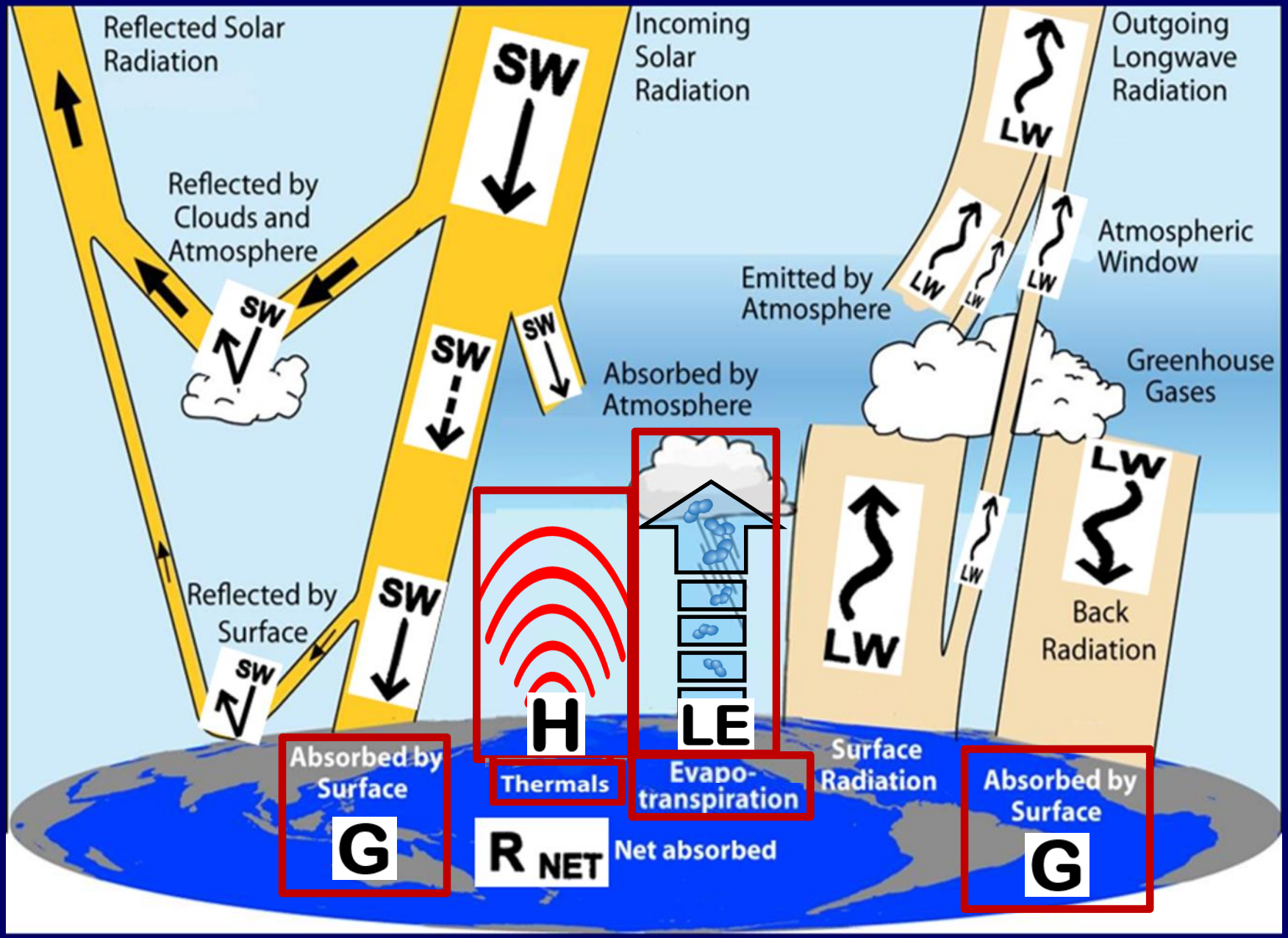


This is what drives tropical storms & HURRICANES!!

When it rains, all the energy which WAS stored in the water vapor is released <u>into the environment</u> (the atmosphere) to warm up the air and keep the hurricane building!



One more set of PATHWAYS to add:



Link to the Right Side of Equation:

$$H + LE + G$$

Conduction & convection
plus energy stored & released during phase changes (latent energy => sensible heat, etc.)

Link to the Right Side of Equation:

WHAT IS G???

G = GROUND STORAGE

ENERGY CONDUCTED into soil or CONVECTED & CONDUCTED into water (e.g. ocean) and temporarily STORED THERE

Tends to "zero out" over an annual cycle or several years

SO WHAT IS G???

G

Temporary

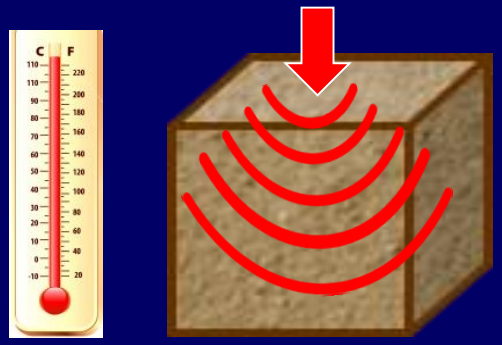
"Ground"

Storage

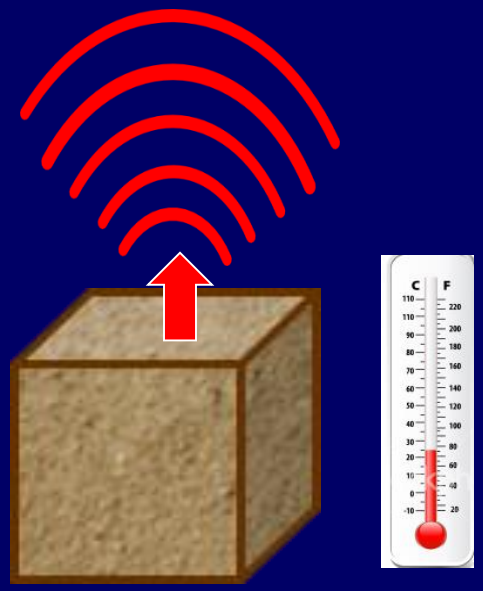
of energy

↓

(in land or ocean)

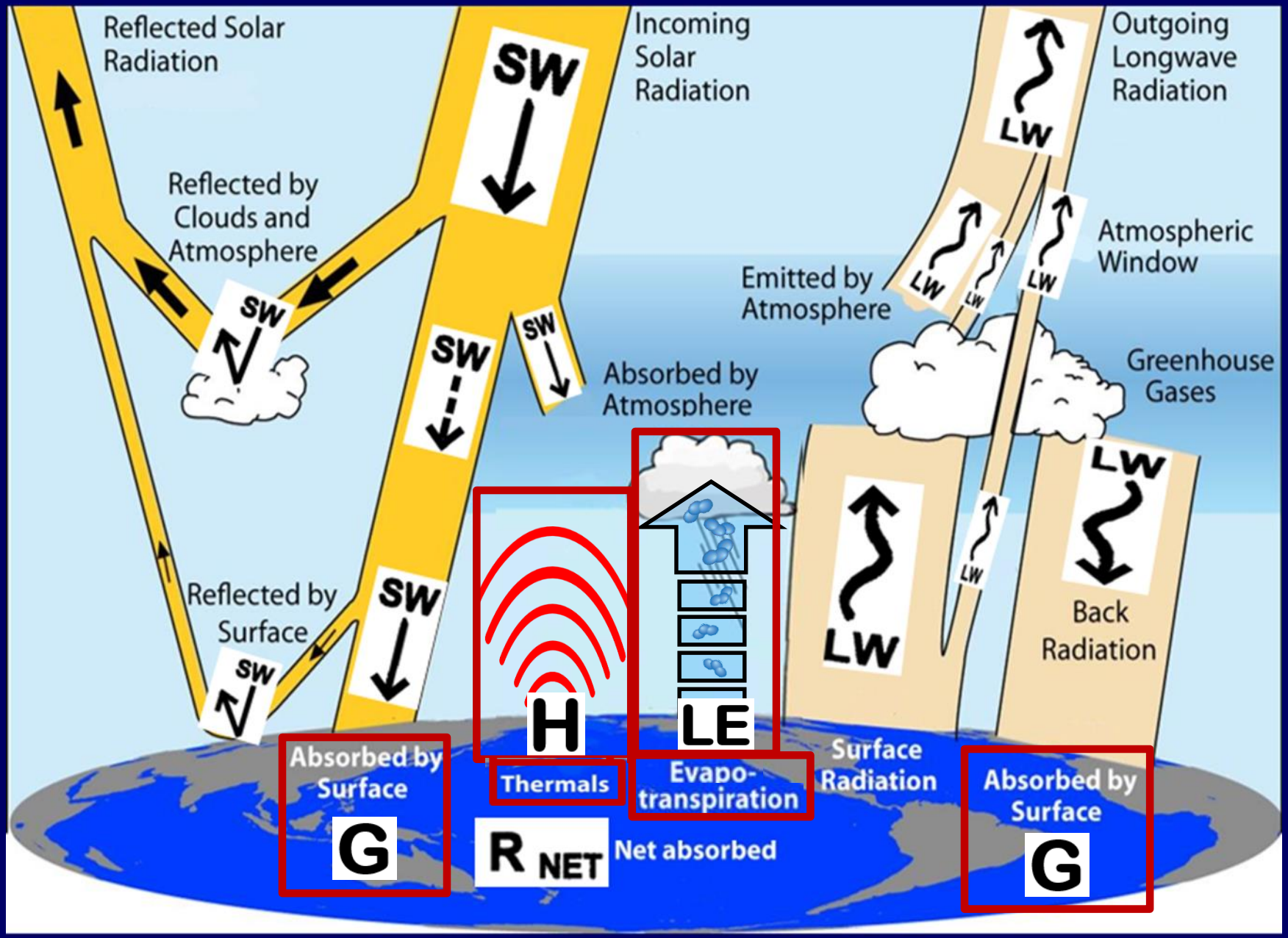


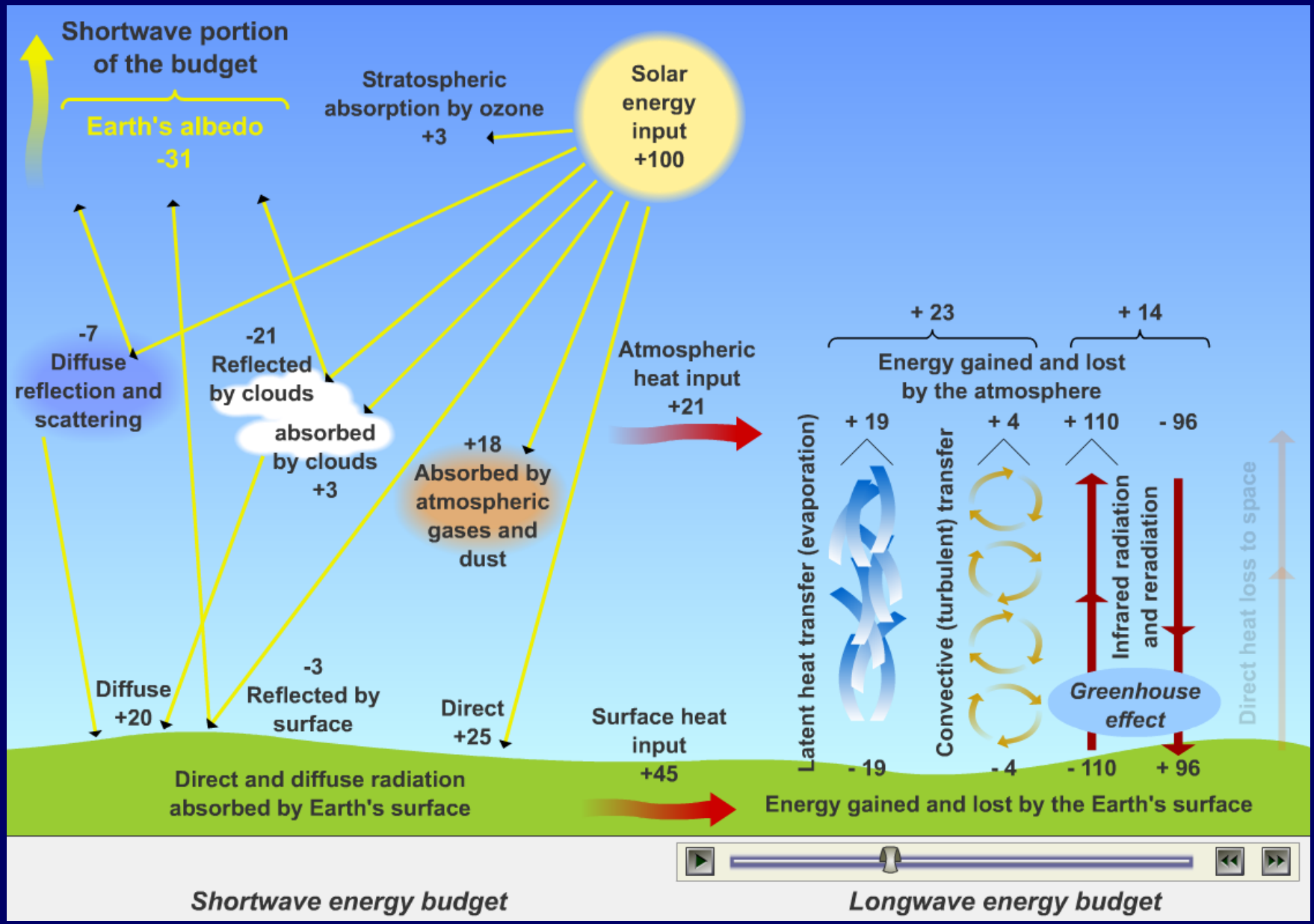
Soil **absorbs** heat during day & **heats** up



Soil **releases** heat at night & **cools** off

THE COMPLETE PICTURE:



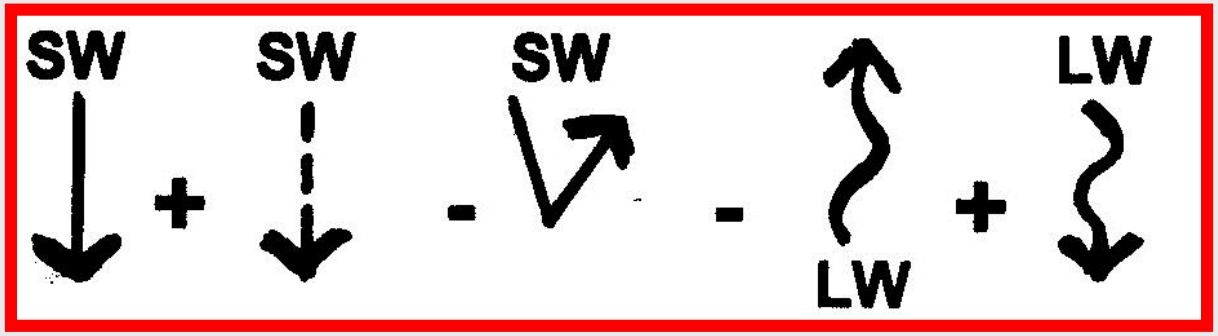


SHORTWAVE & LONGWAVE ENERGY FLOW & BUDGET:
http://mesoscale.agron.iastate.edu/agron206/animations/10_AtmoEbal.html

G-3 ASSIGNMENT

Applying the Energy Balance Terms

1 – #10 : Left side of equation



11 - #13: Right side of equation

H + LE + G

DIRECTIONS: On the G-3 FORM and p 49, you see a list of things you might observe at one time or another in your daily lives.

Each has something to do with one or more components (symbols) of the Energy Balance Equation.

Your task is to decide which SYMBOL (or SYMBOLS working together) *are most directly related to or responsible for the observed phenomenon.*

To ANSWER: Write #1 – 13 on the WHITEBOARD and together as a group, place the SYMBOLS that are involved in each # on the White Board.

Then COPY the symbols on your GROUP ANSWER FORM & **WRITE** a **BRIEF EXPLANATION on** how or why it is connected to the observed phenomenon.

See example provided for #1 .

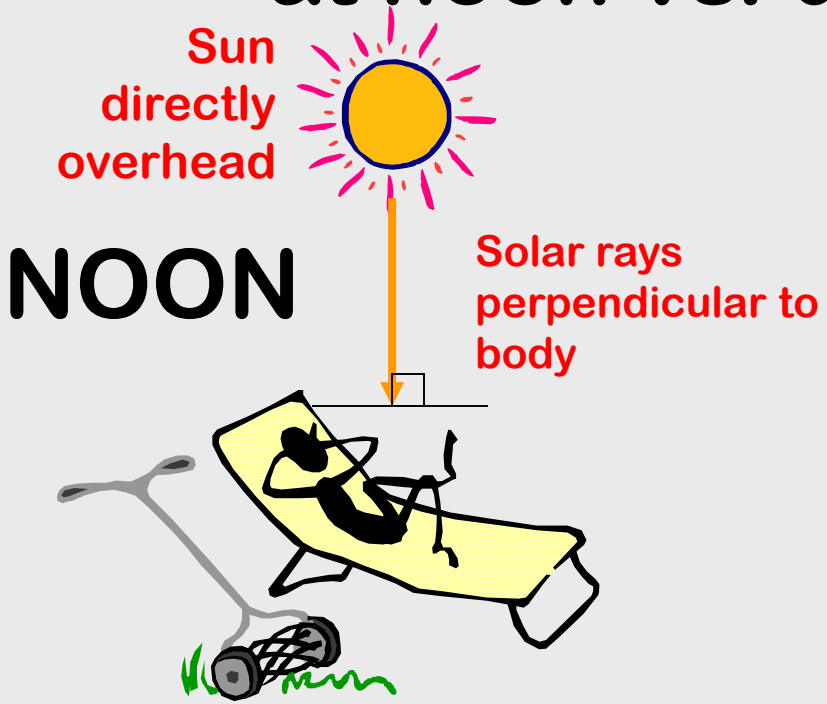
Follow writing directions on the group form!! EVERYONE WRITES!

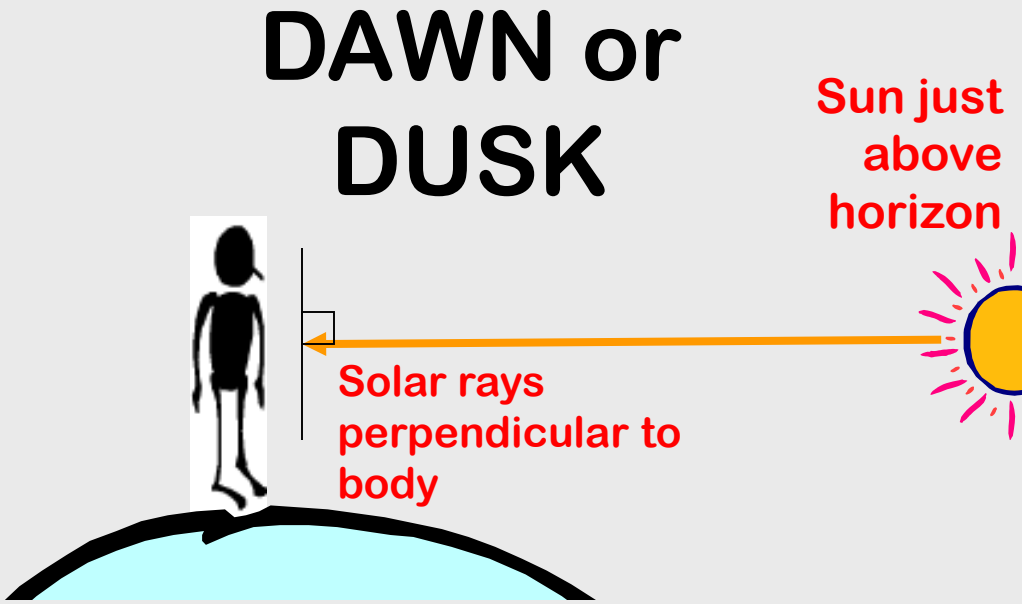
Practice:
blue skies

1. Sunglasses while skiing

2. Bright even though cloudy

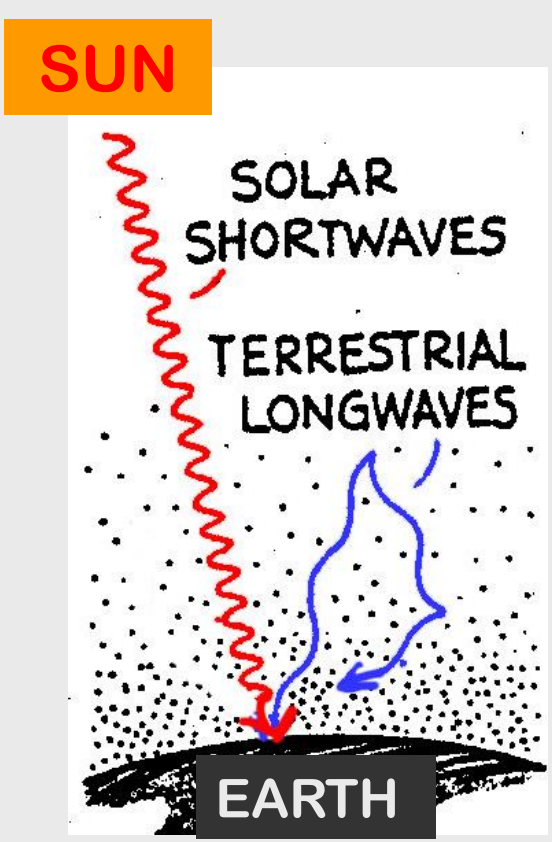
3. More intense solar radiation (tan /skin damage, etc.) at noon vs. dawn or dusk

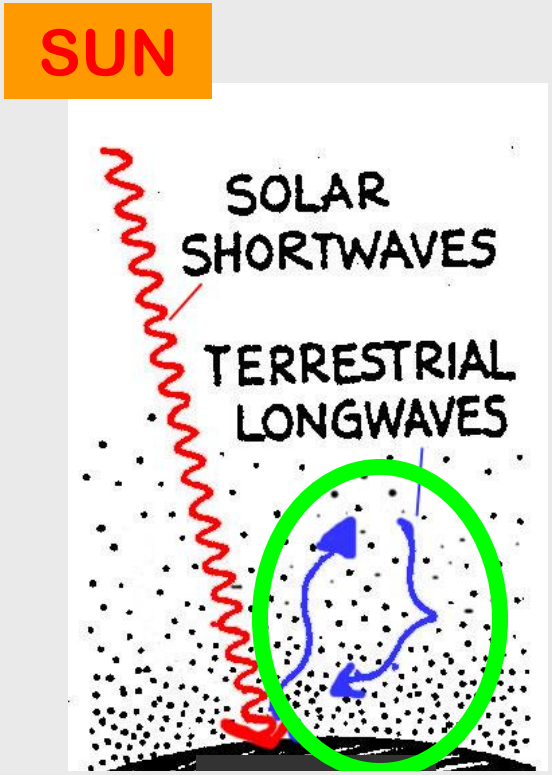




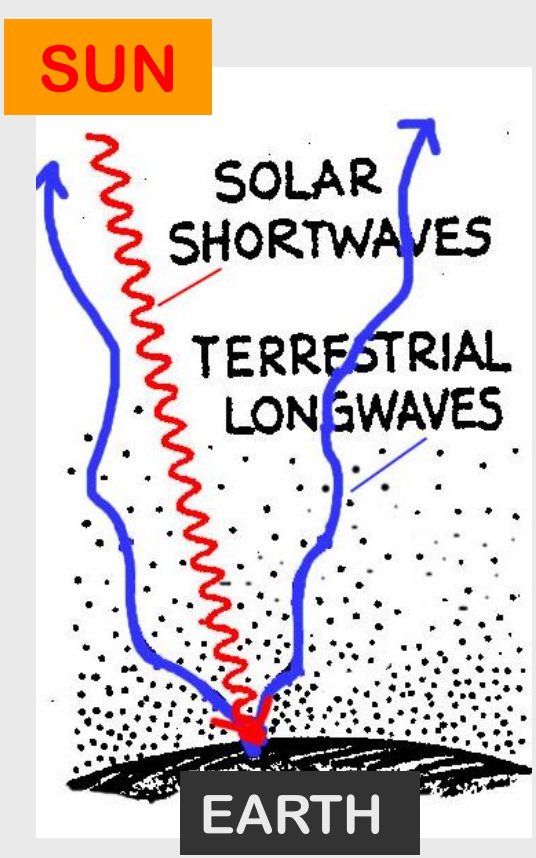
4. The Greenhouse Effect →

To illustrate the GREENHOUSE EFFECT:





Greenhouse effect



B is better than the others . . . But only the circled part represents the GH Effect!! . . .

5. Red sunsets

6. Infrared cameras & Imagery

7. Shadow on sunny day

8. Rainbow

9. Black streaks

10. Parking on blacktop

11. Hot air balloon

12. Pigs cooling off in the mud

13. Evaporative coolers work best in the desert

To be continued on
Wednesday . . . .