

And The

ANSWER IS...

Let's Meet Our Teams...

- **InfraRED Radiators**
- **TANGERINE Tasers**
- **Mellow YELLOW Reflectors**
- **GREEN House Gassers**
- **BLUE Sky Diffusers**
- **UltraVIOLET Zappers**

Here's what we're
playing for...

**A good grade on the
Final Exam!**

Ready for a practice
question?

Energy
Balance

The circled symbol:

What is...

$$R_{\text{NET}} = \begin{array}{c} \text{SW} \\ \downarrow \end{array} + \begin{array}{c} \text{SW} \\ \downarrow \end{array} - \begin{array}{c} \text{SW} \\ \nearrow \end{array} - \begin{array}{c} \uparrow \\ \text{LW} \end{array} + \begin{array}{c} \downarrow \\ \text{LW} \end{array} = H + LE + G$$

1. Outgoing longwave radiation
2. Reflected infrared radiation
3. Libido
4. Albedo



Atmospheric
Structure and
Composition

Energy
Balance

Climate
Variability
& Volcanism

Global
Warming,
Ozone & Bio

Odds &
Ends

100

100

100

100

100

200

200

200

200

200

300

300

300

300

300

400

400

400

400

400

500

500


500

500

500

The gases: H₂O and CO₂.

What are...

1. The two most abundant gases.
2. The two most abundant Greenhouse gases. 
3. The two most abundant anthropogenically enhanced Greenhouse gases.
4. The two gases that comprise 99% of the atmosphere



The observation that “the atmosphere is heated from below” is most evident in this layer.

What is...

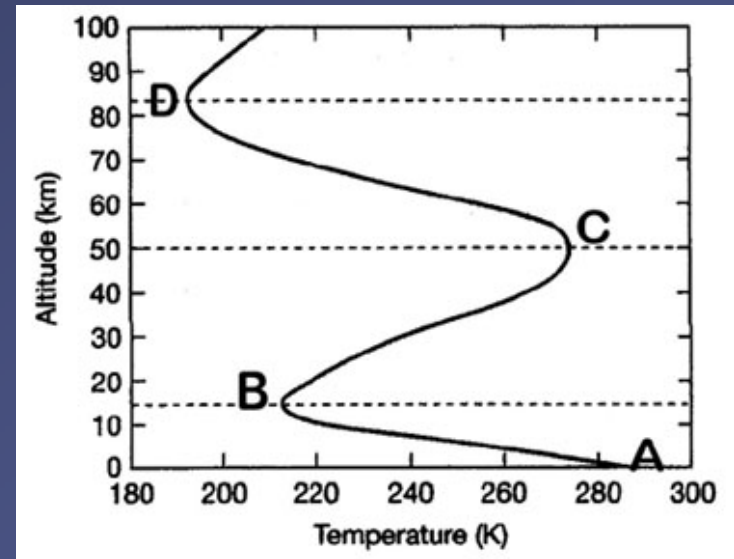
1. Layer A - B



2. Layer B - C

3. Layer C - D

4. Layer D and above



This gas is NOT a Greenhouse Gas.

What is ...

1. O_2



2. O_3

3. CH_4

4. Freon-11 (a CFC)



The residence time of CO₂ gas molecules, once they get into the atmosphere.

What is...

1. ~10-12 years

2. ~50 years

3. ~100 years



4. ~ 500 years



N₂, N, O and O₂ are effective absorbers of extremely harmful X-ray and UVC radiation in this layer.

What is...

1. Troposphere
2. Stratosphere
3. Mesosphere
4. Thermosphere



Evaporation and transpiration are represented by this symbol.

What is...

1. LW

2. SW

3. H

4. LE



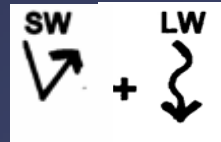
5. G



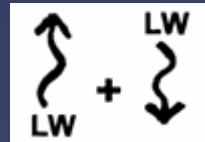
The Greenhouse effect is represented by this symbol.

What is...

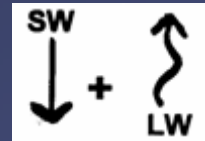
1. This one:



2. This one:



3. This one:



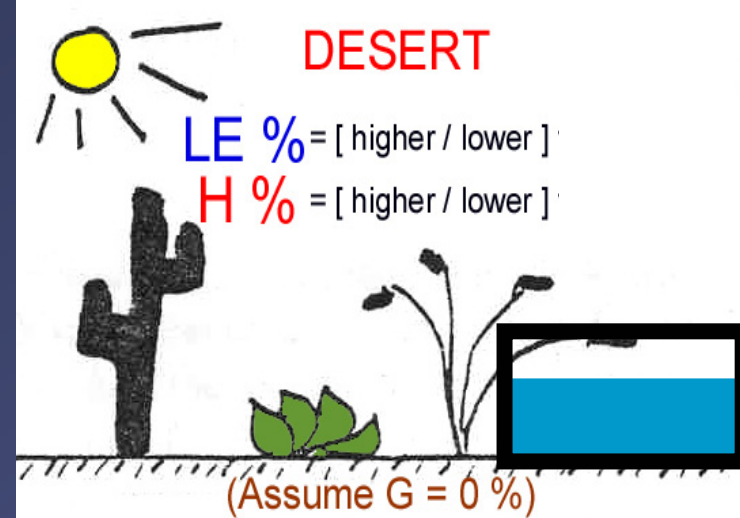
4. H + G

5. None of the above

This will happen after a canal or reservoir is built in a desert.

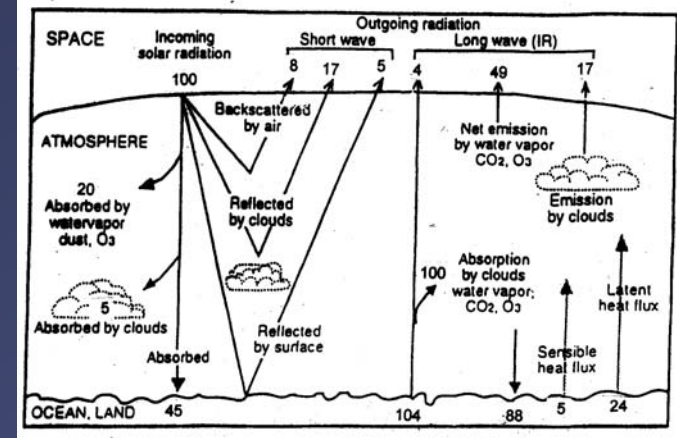
Who is...

1. No change in H or LE
2. More energy goes into H, making it hotter.
3. More energy goes into LE, making it hotter.
4. More energy goes into LE, making it cooler.



Of these 4 choices, **THIS** part of the energy balance and its pathways involves the **MOST** units of energy.

What is...



10% UV energy absorbed by ozone in stratosphere

20% Solar energy reflected back to space by clouds, atmosphere, & surface combined.

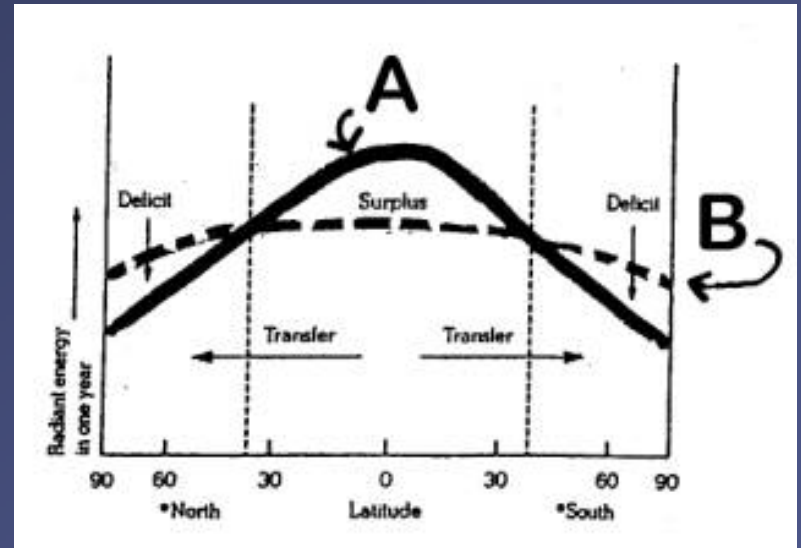
30% IR energy radiated from the Earth's surface directly out to space

40% IR energy re-radiated to the Earth's surface after being absorbed in the atmosphere.

If the Earth had NO atmosphere, this change in curve A or B would occur.

What is...

1. A moves up
2. A moves down
3. B moves up
4. B moves down




A = incoming solar shortwave radiation

B = outgoing terrestrial longwave radiation



**Tree-ring records have shown that this was
NOT a global event.**


What is...

1. The Little Ice Age
2. The Medieval Warm Period 
3. The Maunder Minimum
4. The recent 20th century warming



The LEAST likely to be a climatically effective volcanic eruption with a global influence.

What is a ...

1. High latitude eruption, like Mt St. Helens 
2. Low latitude eruption, like Pinatubo.
3. Sulfur-rich eruption, like Tambora.
4. Highly explosive eruption ejecting material into the stratosphere, like Krakatau.



This is likely to occur during the sunspot cycle we are now in (called the Modern Maximum).

What are...

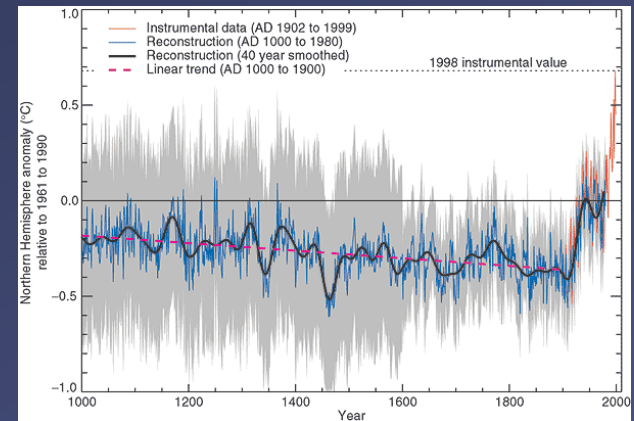
1. More black sunspots on the Sun and cooling on Earth
2. Increased solar brightness and warming on Earth
3. Glacial advances
4. More volcanic eruptions



The “Hockey Stick” diagram is evidence of this.

What is...

1. A period in the Medieval times that was warmer than the 20th century
2. The start of a global ice age – hence more hockey games!
3. The fact that proxy records (like tree rings) can estimate temperatures as accurately as thermometers
4. An unprecedented global warming trend in the 20th century pointing to an anthropogenic cause



The LIKELY after-effect of an explosive, sulfur-rich volcanic eruption.

What is...

1. Lots of reflection of solar SW by ash many weeks after the eruption
2. Stratospheric COOLING and tropospheric WARMING
3. Stratospheric WARMING and tropospheric COOLING
4. A decreased Greenhouse Effect



What scientists now agree is the cause of the Antarctic ozone hole.

What are...

1. Anthropogenically produced CFCs that destroy ozone chemically
2. Sunspot variations that destroy ozone naturally
3. Increased burning of fossil fuels and resulting CO₂ emissions
4. Dramatic decreases in the number of volcanic eruptions



What the SCIENTIFIC debate on global warming is all about.

Whether or not...

1. Global warming is occurring
2. The Greenhouse Effect is real
3. Recently observed global warming is due to anthropogenic causes
4. The Kyoto Protocol should be signed



What the POLICY debate on global warming is all about.

Whether or not...

1. Developing countries should be required to reduce emissions in addition to developed countries.
2. The Kyoto Protocol should be signed.
3. Laws and policies should be enacted in the U.S to reduce GHG emissions.
4. All of the above.



The link between biodiversity and deforestation.

What is...

1. Biodiversity causes deforestation.
2. Deforestation greatly reduces biodiversity.
3. All biodiversity “Hotspots” occur in forested areas.
4. The presence of humans increases both biodiversity and deforestation.



What ozone does in the troposphere vs. stratosphere.

What is...

1. Ozone absorbs IR in the troposphere (acting as a GHG) and absorbs harmful UV in the stratosphere (NOT acting as a GHG).
2. Ozone is “good” ozone in the TROPOSPHERE and “bad” ozone in the STRATOSPHERE
3. The Ozone Hole in the stratosphere allows more SW radiation to reach the Earth’s surface and this is a DIRECT cause of global warming in the troposphere.
4. None of the above



The wavelength range of infrared radiation.

What is...

1. < 0.4 micrometers

2. > 0.7 micrometers



3. 400 – 700 nanometers

4. Longer wavelengths than microwaves



The key factor that makes certain gases act as greenhouse gases!

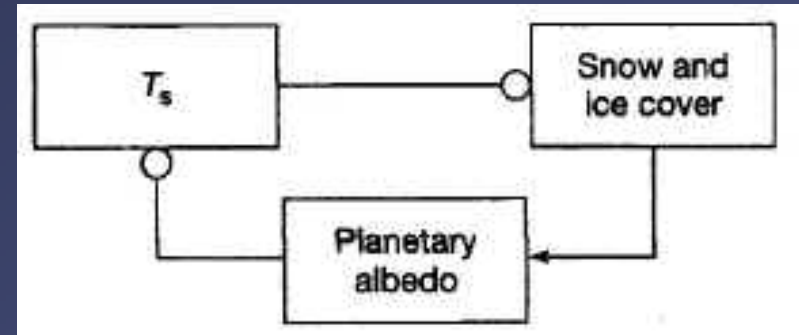
What is...

1. They are diatomic
2. They absorb shortwave radiation and emit longwave radiation
3. They easily reflect IR radiation back to the Earth's surface
4. They absorb and emit infrared radiation



What this feedback loop will lead to.

What is...

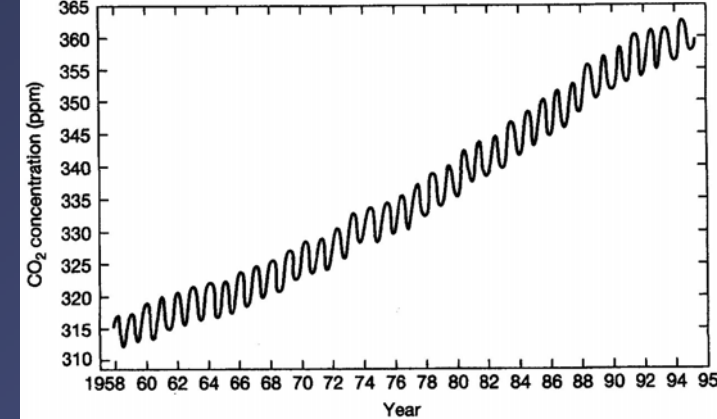


1. A self-regulated return to an equilibrium state
2. An ice age followed by a warm period.
3. A self-amplifying change in the Earth's surface temperature
4. A runaway Greenhouse Effect!



This is illustrated by the Keeling Curve.

What is...



1. Quasiperiodic variations with an upward trend
2. Increasing variance with a constant mean
3. A step change with an abrupt jump
4. The “breathing” of the Southern Hemisphere forests.



Quantum behavior of certain molecules (bending, rotation, vibrations)

What is...

1. Why photons leap to higher energy states
2. Behavior explained by Newton's Laws
3. The reason LE is not sensed as heat
4. The reason some gases are greenhouse gases and others are not.



THE END!!

**THANKS FOR A
GREAT SEMESTER
NATS CLASS!!**

