Topic V

Energy And Insolation

Topic: Energy and Insolation
Aim:

1. Kinetic Energy - energy in motion
2. Temperature - the average kinetic energy of the molecules of a substance (how fast the molecules are vibrating in a substance)
3. Absolute Zero - The temperature at which all molecules in a substance stop vibrating (0 Kelvin)
4. Heat - is the form of energy being transferred between 2 samples of matter measured in Joules (or calories)

Temperature Water Boils?

_____ °F

_____ °C

_____ K

Temperature Water Freezes?

_____ °F

_____ °C

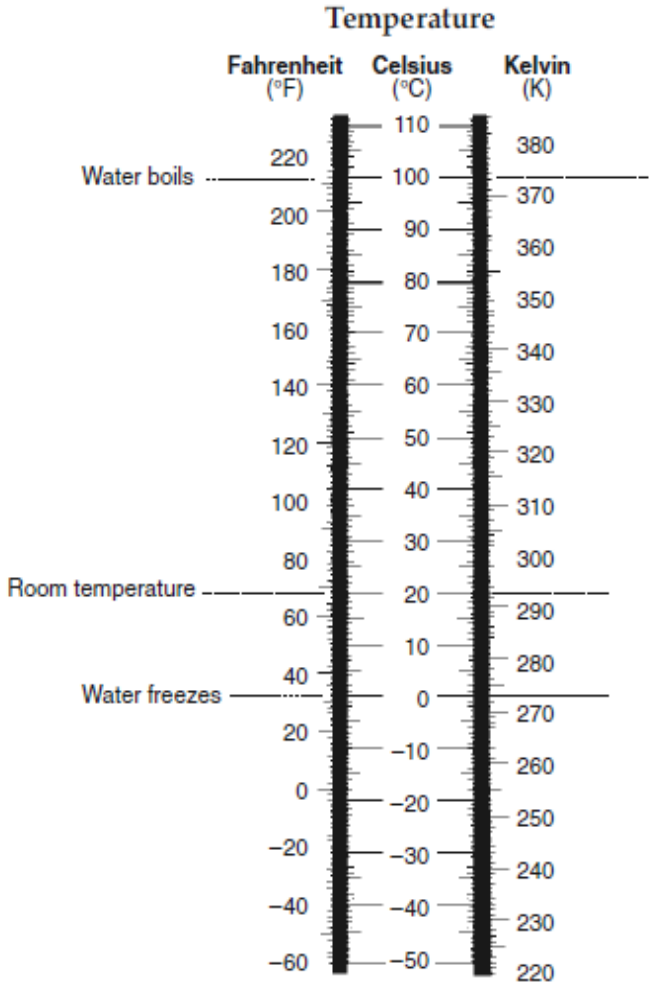
_____ K

Room Temperature?

_____ °F

_____ °C

_____ K



Topic: Energy and Insolation

Aim:

recall | notes

1. How does heat flow through a field or system?

2. What are the three methods of heat energy transfer?

I.

II.

III.

(page 14 ESRT – electromagnetic spectrum)

Energy Transfer Review Worksheet

Directions: Identify each of the following examples of heat energy transfer as conduction, convection, or radiation.

1. A parcel of heated air rises through the troposphere. _____

2. A child gets burnt by touching a hot pot handle. _____

3. Hot magma in the Earth's mantle rises, cools, and sinks once again. _____

4. The Sun's rays penetrate space to heat the Earth. _____

5. A microwave oven heats left-over chicken soup. _____

6. An ice cube melts sitting on a warm surface. _____

7. In the bathroom during a hot shower, warm air rises while the cold air layer forms near the floor. _____

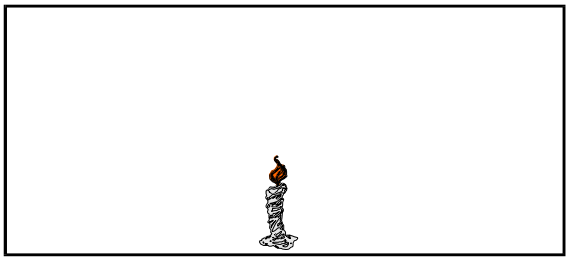
8. A skier gets warm by standing near the fireplace in the lodge. _____

Convection Cell Review

Directions: Draw arrows in the "rooms" below indicating the direction of heat flow by the process of convection.

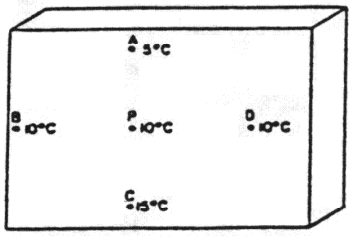
1.

2.



Energy Flow and Energy Transfer

1. The diagram below shows temperature values at various points in a solid piece of aluminum. Toward which point will heat flow from point P?
   (1) A (3) C
   (2) B (4) D



2. The collision of molecules within a substance results in the transfer of energy by
   (1) conduction (3) radiation
   (2) convection (4) insolation

3. During which process of energy exchange does cold air displace warmer air?
   (1) absorption (3) conduction
   (2) convection (4) radiation

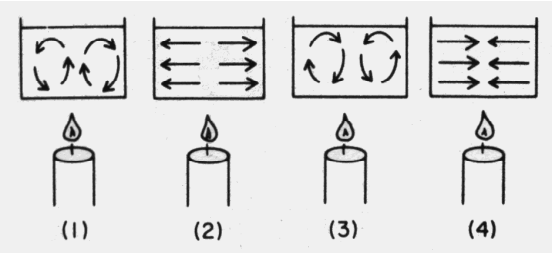
4. Which example of heat transfer is due mainly by convection?
   (1) Heat energy transferred by air moving from the Earth's surface to the upper atmosphere.
   (2) Heat energy transferred by being reflected from a lake's surface to the air above.
   (3) Heat energy transferred through a solid metal door.
   (4) Heat energy transferred from the Sun to the Earth.

5. Which statement is the best example of heat energy transfer by conduction?
   (1) Heat energy is transferred from the bottom to the top of a lake.
   (2) Heat energy is transferred from the surface soil to the rocks below.
   (3) Heat energy is transferred from the Earth's surface to the upper atmosphere.
   (4) Heat energy is transferred from the Sun to the Earth.

6. Conduction is the transfer of heat energy by
   (1) density differences (3) electromagnetic waves
   (2) molecular contact (4) movement through a vacuum

7. By which process does starlight travel through space?
   (1) absorption (3) convection
   (2) conduction (4) radiation

8. Which diagram best represents the transfer of heat by convection in a liquid?

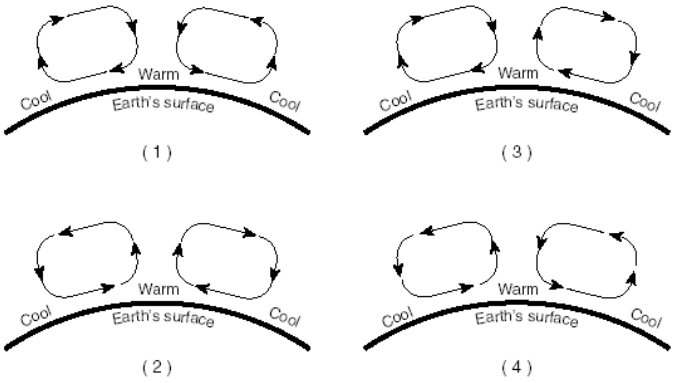


9. What method of energy transfer can travel through outer space?
   (1) conduction
   (2) convection
   (3) advection
   (4) radiation

10. A piece of a plant in a classroom fish tank moved upward and across the tank, away from the heater. When the plant reached the other side of the tank, it sank before moving back toward the heater. What type of energy transfer does this movement represent?
   (1) convection
   (2) conduction
   (3) refraction
   (4) radiation

11. The cross sections below show different patterns of air movement in Earth's atmosphere. Air temperatures at Earth's surface are indicated in each cross section.

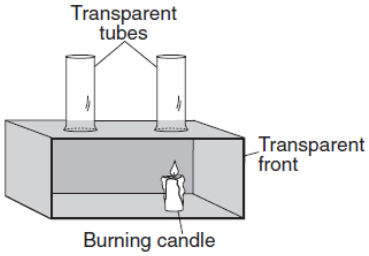
    Which cross section shows the most likely pattern of air movement in Earth's atmosphere that would result from the surface air temperatures shown?



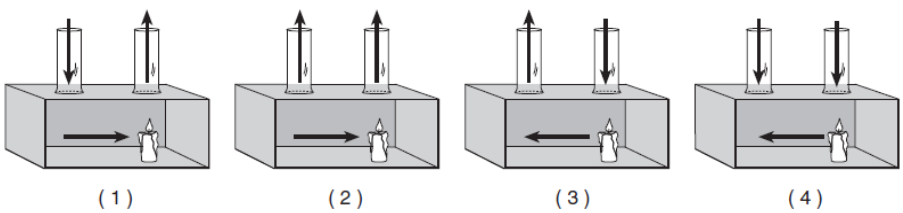
12. Which process transfers energy primarily by electromagnetic waves?
   (1) radiation
   (2) evaporation
   (3) conduction
   (4) convection

13. According to the *Earth Science Reference Tables*, which color of the visible spectrum has the *shortest* wavelength?
   (1) violet
   (2) blue
   (3) yellow
   (4) red

14. The diagram to the right shows a laboratory box used to demonstrate the process of convection in the atmosphere.



Which diagram has arrows that show the direction of airflow that occurs when the candle is burning?



Topic: Energy and Insolation
Aim:

Specific Heat -

the amount of heat (in Joules) required to raise the temperature of 1 gram of a substance by 1 degree Celsius

Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

1.

2.

Topic: Energy and Insolation
Aim:

Properties of Water

Heat energy gained during melting	334 J/g
Heat energy released during freezing	334 J/g
Heat energy gained during vaporization	2260 J/g
Heat energy released during condensation	2260 J/g
Density at 3.98°C	1.0 g/mL

Phase Change	Definition
1. Melting	
2. Freezing	
3. Vaporization (Evaporation)	
4. Condensation	

Specific Heat and Phase Changes

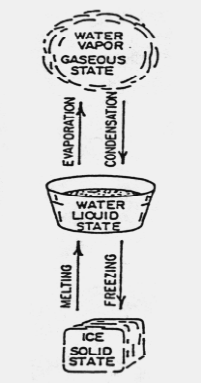
1. Which substance has the highest specific heat?
   1 iron
   2 water
   3 lead
   4 granite

2. If the same amount of heat energy is added to equal masses of each substance listed below, which substance would heat up the quickest?
   1 water
   2 basalt
   3 ice
   4 lead

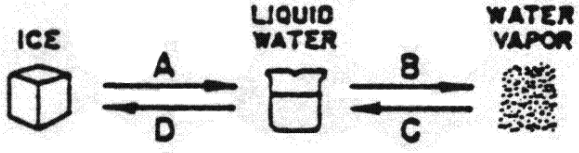
3. Which material would require the greatest amount of heat energy to raise its temperature from 5°C to 10°C?
   1 10 grams of granite
   2 10 grams of dry air
   3 10 grams of lead
   4 10 grams of iron

4. Bodies of water cool more slowly than land areas because
   1 water has a lower specific heat than land materials
   2 some insolation is converted into potential energy as water evaporates
   3 water is a better reflector of sunlight than land is
   4 water has a higher specific heat than land materials

5. Each arrow in the diagram to the right represents a process involving a phase change of water. Each process can take place only if
   1 mass and volume remain constant
   2 heat energy is added or released
   3 the number of molecules is increased or decreased
   4 the dewpoint temperature is increased or decreased



6. A sample of water undergoes the phase changes from ice to vapor and back to ice as shown in the model below. During which phase change does the sample gain the greatest amount of energy?

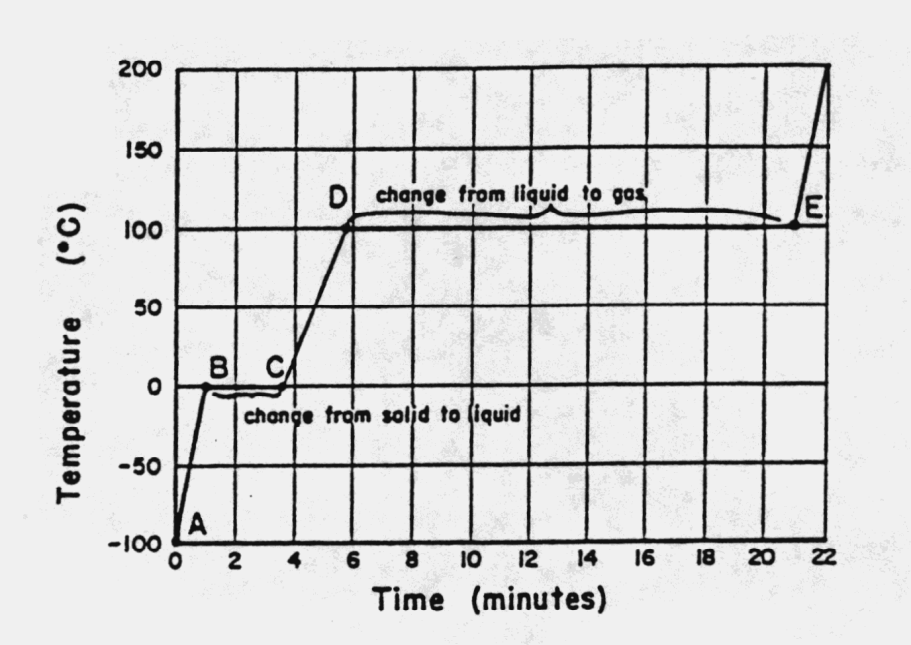


1 A 2 B 3 C 4 D

7. Which phase change requires the addition of 334 Joules/gram?
   1 evaporation
   2 melting
   3 condensation
   4 freezing

Base your answers to questions 8 through 11 on the diagram below.

The graph shows the temperatures recorded when a sample of water was heated from –100°C to +200°C. The phase changes of water are indicated on the graph.



8. The water temperature reached 75°C after the sample had been heated for approximately
   1 5 minutes
   2 2 minutes
   3 6 minutes
   4 4 minutes

9. The line from D to E on the graph represents a phase change. Between points D and E, the water was
   1 condensing
   2 evaporating
   3 freezing
   4 melting

10. The greatest amount of energy was added to the water between points
    1 A and B
    2 B and C
    3 C and D
    4 D and E

11. Between which two points did the temperature change most rapidly?
    (Remember: the steeper the graph line, the faster the rate of change)
    1 A and B
    2 B and C
    3 C and D
    4 D and E

Topic: Energy and Insolation

Aim:

1. What does the term "insolation" mean?

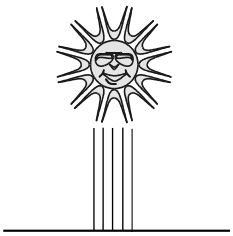
The Sun emits (gives off) all types of radiation, but mainly <u>visible light</u> reaches Earth.

2. How does angle of insolation affect intensity of insolation?

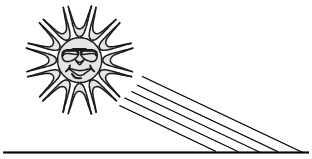
**** special note ****

Angle of Insolation is the same as Altitude of the Sun

a.



b.



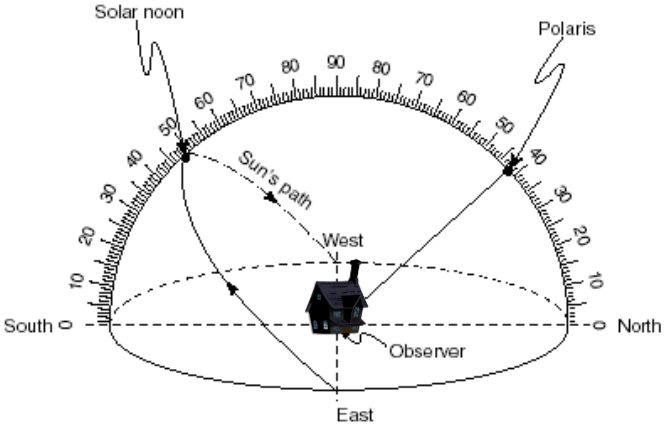
3. How does the angle and intensity of insolation change during the **<u>DAY</u>**?

a. The Sun rises somewhere in the _____, and in the morning the **ANGLE / INTENSITY** of insolation is _____.

b. At solar noon in the Northern Hemisphere, the Sun is _____ and in the morning the **ANGLE / INTENSITY** of insolation is _____.

c. The Sun sets somewhere in the _____, and in the evening the **ANGLE / INTENSITY** of insolation is _____.

d. The highest **TEMPERATURES** during the day occur _____ because the Earth's takes time for the Earth and its atmosphere to warm up.



4. How does the angle and intensity of insolation change during the **YEAR**?

a. The **ANGLE / INTENSITY** of insolation is greatest on _____.

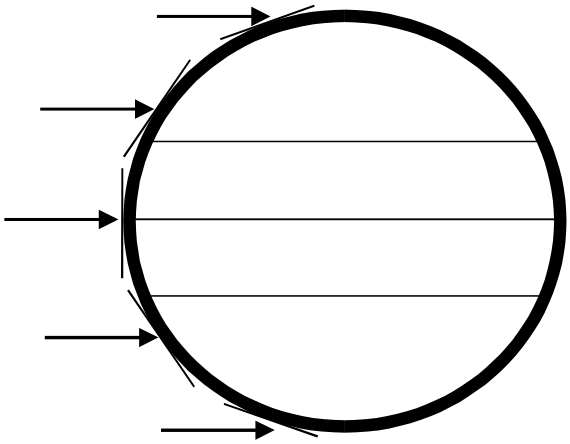
b. The **HIGHEST TEMPERATURES** during the day occur in _____ because the Earth's takes time for the Earth and its atmosphere to warm up.

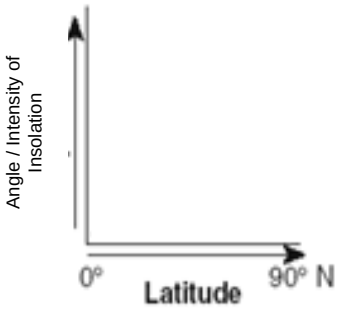
c. The **ANGLE / INTENSITY** of insolation is least on _____.

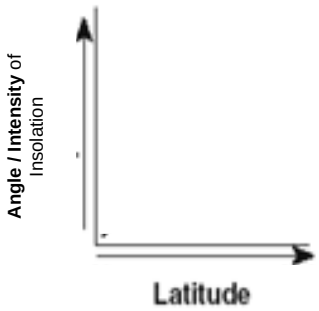
d. The **LOWEST TEMPERATURES** during the day occur in _____ because the Earth's takes time for the Earth to cool down.

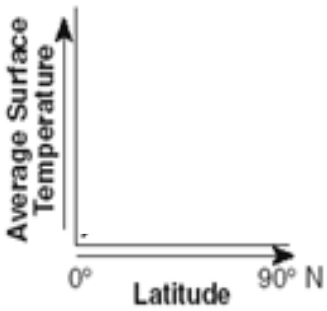
5. How does latitude affect angle and intensity of insolation?

As latitude increases (approaching the polar regions), the angle and intensity of insolation decrease.







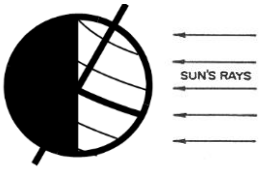


Topic: Energy and Insolation
Aim:

Duration of Insolation -

1.

I

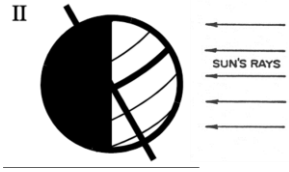


"The Cone of Light" indicates the areas on the Earth that are receiving daylight.

Since the entire Arctic Circle has daylight, this satellite picture was taken during **summer** in the Northern Hemisphere.

2.

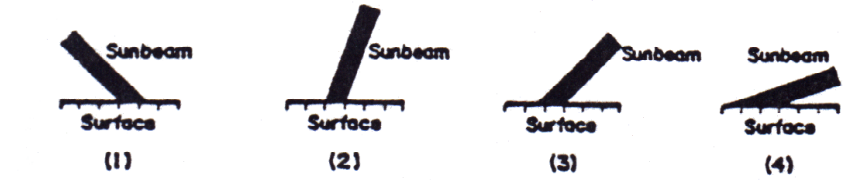
II



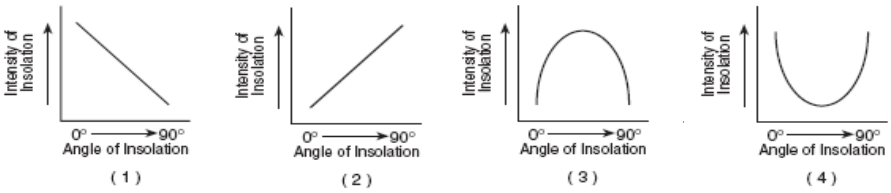
Since the entire Antarctic Circle has daylight, this satellite picture was taken during **winter** in the Northern Hemisphere.

Angle of Insolation and Duration of Insolation

1. Each of the sunbeams in the diagrams below contains the same amount of energy and each sunbeam is striking the same type of surface. Which surface is receiving the greatest amount of energy per unit area where the sunbeam strikes the surface?



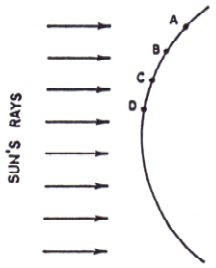
2. Which graph best represents the relationship between the angle of insolation and the intensity of insolation?



3. The diagram below represents a portion of the Earth's surface that is receiving insolation. Positions A, B, C, and D are located on the surface of the Earth.

At which position would the intensity of insolation be the greatest?

(1) A
(2) B
(3) C
(4) D



4. On which date does the maximum duration of insolation occur in the Northern Hemisphere?
(1) March 21
(2) June 21
(3) September 23
(4) December 21

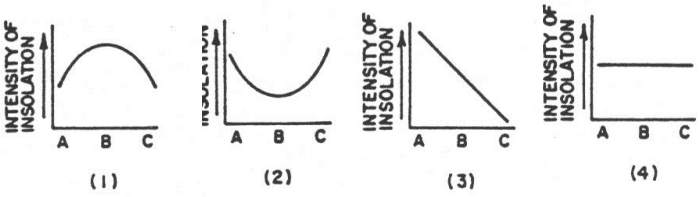
5. What is the approximate duration of insolation at the North Pole on June 21?
(1) 0 (2) 12 (3) 18 (4) 24

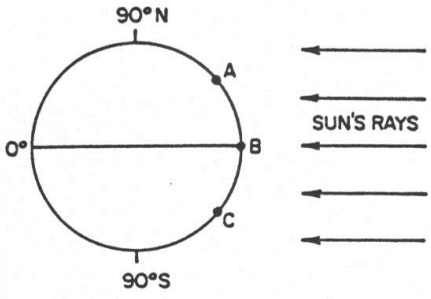
6.. What happens to the angle of insolation on June 21 between solar noon and 6 p.m. in New York State?
(1) It decreased steadily.
(2) It remained the same.
(3) It increased steadily.
(4) It first increased, then decreased.

7. Between the months of January and February, the duration of insolation
(1) decreases steadily.
(2) remains the same.
(3) increases steadily.
(4) first increases, then decreases.

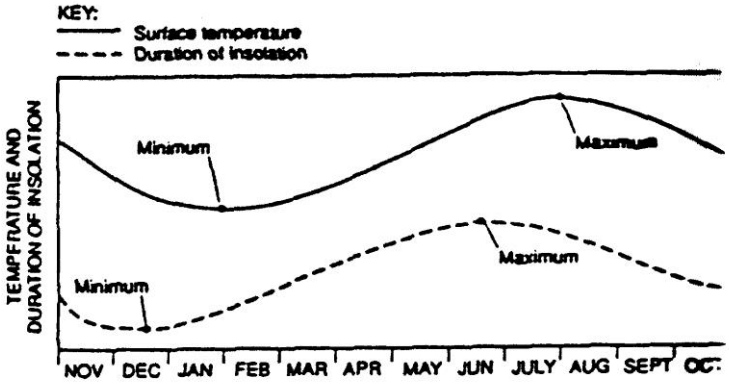
8. The diagram below shows the position of the Earth in relation to rays of light from the Sun. A, B, and C are three positions at the Earth's surface.

Which graph best shows the relationship between intensity of insolation and position on the Earth's surface?

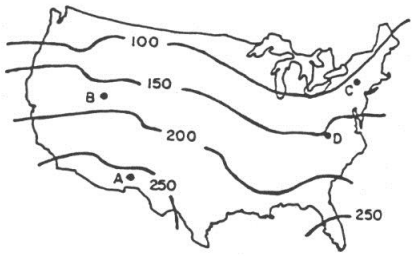




9. Compared to the date of maximum duration of insolation, the date of maximum surface temperature for this location is
   (1) earlier in the year
   (2) later in the year
   (3) the same day of the year

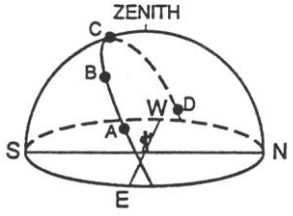


10. The map shows isolines of average daily insolation received in calories per square centimeter per minute at the Earth's surface. If identical solar collectors are placed at the lettered locations, which collector would receive the least insolation?
   (1) A (3) C
   (2) B (4) D



11. The diagram below shows the apparent path of the Sun for an observer in New York State.

For this observer, the intensity of insolation is least when the Sun is at point
   (1) A (3) C
   (2) B (4) D



12. In NY State, which side of a building gets the most insolation in the middle of the day?
   (1) north (2) east (3) south (4) west

13. In New York State, it is observed that the north-facing slopes of mountains usually retain their snow later in the spring than the south-facing slopes. This is caused by the fact that the north slopes of the mountains
   (1) usually are steeper
   (2) receive a greater snowfall
   (3) are protected from the prevailing south winds
   (4) receive less insolation than the south slopes

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Topic: Energy and Insolation

Aim:

1. **Transmission**

Atmospheric Transparency:
how clear the air is
most transparent = more clear

2. **Reflection**

Good reflectors of light are:

3. **Scattering**

4. **Refraction**

5. **Absorption**

Good absorbers of light are:

6. **Radiation or Re-radiation**

General Rule for absorbers and radiators
a good absorber of energy
is a good radiator of energy

Interactions of Light with Matter

1. Which of the characteristics of a material have the greatest effect on the amount of insolation that the material will absorb?
   (1) density and hardness
   (2) hardness and age
   (3) age and roughness
   (4) roughness and color

2. As the amount of reflection caused by dust particles in the atmosphere increases, the amount of insolation reaching the Earth' surface
   (1) decreases (2) increases (3) remains the same

3. Two concrete areas receive the same amount of insolation. One surface is dark-colored and the other is light-colored. The light-colored surface will most likely reflect
   (1) less insolation than the dark surface
   (2) more insolation than the dark surface
   (3) the same amount of insolation as the dark surface

4. What type of surface absorbs the greatest amount of electromagnetic energy?
   (1) smooth, shiny, and dark in color
   (2) rough, dull, and dark in color
   (3) smooth, shiny, and light in color
   (4) rough, dull, and light in color

5. What happens to most of the sunlight that strikes a dark-colored area of the Earth's surface?
   (1) It is reflected and scattered as potential energy.
   (2) It is reflected and diffused as UV radiation.
   (3) It is absorbed and reflected as light.
   (4) It is absorbed and re-radiated as heat.

6. In land areas of equal size located at the same latitude, the most solar radiation would probably be reflected by a
   (1) snow field
   (2) sandy desert
   (3) grassy field
   (4) forest

7. Two identical objects are painted different colors, one black and the other white. If both objects are placed in the sunlight, the amount of energy absorbed by the black object compared to the amount of energy absorbed by the white object is
   (1) less (2) greater (3) the same

8. One result of a large volcanic eruption is that surface air temperatures decrease over a sizable region of Earth. This phenomenon occurs because volcanic eruptions usually *decreases* the
   (1) number of dust particles entering the atmosphere
   (2) transparency of the atmosphere
   (3) amount of moisture in the atmosphere
   (4) amount of scattered light

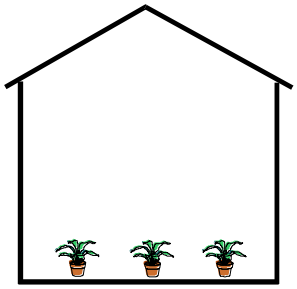
Topic: Energy and Insolation

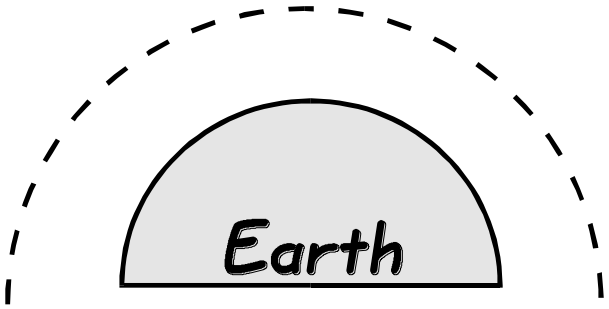
Aim:

recall

notes

1. How does the greenhouse effect work?





2. What factors contribute to the greenhouse effect?

3. What could result from the greenhouse effect?

Terrestrial Radiation and the Greenhouse Effect

1. Electromagnetic energy given off by the Earth' surface is called
   1 convection
   2 insolation
   3 specific heat
   4 terrestrial radiation

2. Which wavelengths of incoming solar radiation are most received by the Earth during the day?
   1 infrared
   2 visible
   3 ultraviolet
   4 X-ray

3. Some scientists believe that the polar icecaps may melt in the next few centuries because
   1 the Earth' magnetic field is shifting
   2 the distance between the Earth and the Sun is decreasing
   3 earthquake and volcanic activity under the polar icecaps are increasing
   4 the amount of pollutants in the atmosphere is increasing

4. Which could occur if the amount of carbon dioxide in the atmosphere increased?
   1 More ultraviolet rays would strike the Earth.
   2 More ultraviolet rays would be given off by the Earth.
   3 More radiation from the Earth would be absorbed by the atmosphere.
   4 More solar radiation would be absorbed by the oceans.

5. Two good absorbers of infrared energy are carbon dioxide and
   1 oxygen
   2 helium
   3 water vapor
   4 argon

6. A greenhouse stays relatively warm on a sunny winter day. Which statement best explains this fact?
   1 The greenhouse traps long-wave infrared energy.
   2 Sunlight is changed to shorter wavelength radiation.
   3 The plants growing in the greenhouse produce heat.
   4 Glass is an excellent absorber of sunlight.

7. Short waves of electromagnetic energy are absorbed by the Earth's surface during the day. They are later re-radiated into space as
   1 visible light rays
   2 X-rays
   3 infrared rays
   4 carbon dioxide

8. The temperature of the atmosphere may increase as the carbon dioxide content of the atmosphere increases. Which statement best explains this increase?
   1 More ultraviolet radiation will be absorbed by the atmosphere.
   2 More infrared radiation will be absorbed by the atmosphere.
   3 Less light will be reflected by the atmosphere.
   4 Less heat will be transferred to the atmosphere.