SOLAR RADIATION RECEIPT AT THE EARTH'S SURFACE

Influences on the amount:

*
*
*

Motions of Earth

A. **Rotation of Earth** =
   1.
   2.
   3. At equator: 1070 mph
   4. rotation rate =

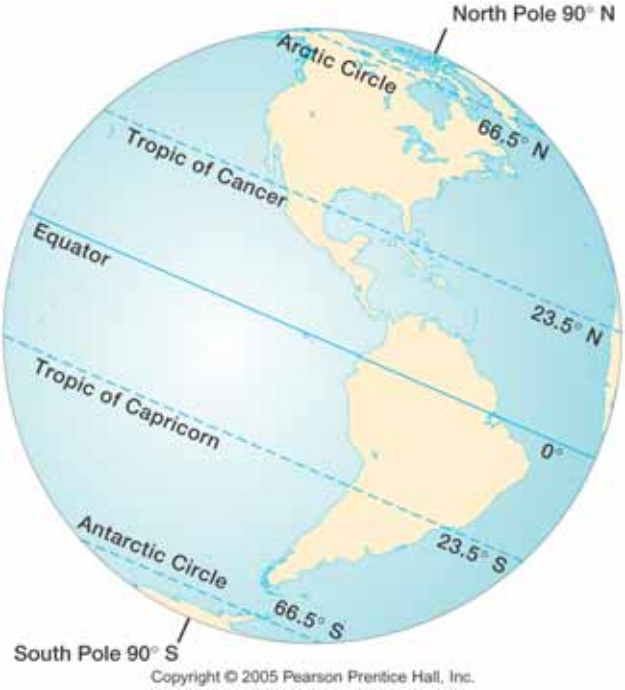
B. **Revolution of Earth**
   1. period is _____ solar days
   2. Gregorian calendar: _____ days. _____ _____
   3. _____ around the sun and _____

C. Astronomical terms:
   1. **Perihelion**: _____
      a.
   2. **Aphelion**: _____
      a.
   3.

Why the Earth has Seasons…

D. _____

1. The Earth presently has a _____ from vertical
2. This influences the _____ received at the surface.



Terminology:

*** Plane of the Ecliptic:**
*** Circle of Illumination:**
*** Subsolar point (declination):**

Astronomical Seasonal Midpoints and Daylength

1. **Summer Solstice**:
    a. occurs around _____
    b. sun overhead at _____
    c. Latitudes north of _____ - daylight _____; south of _____ (_____) have _____

2. **Winter Solstice**:
    a. occurs around _____
    b. sun overhead at _____
    c. Latitudes south of _____ - daylight the _____ (_____); latitudes north of _____ (_____) - _____

3. **Equinox**: _____
    a.
    b.
    c. sun overhead at _____

****

Solar Elevation Angle and Solar Intensity

1. Solar Altitude (elevation angle) (NSA or *a*):

2. To compute this, we need:
    -
    -

we will do this in lab

**Zenith Angle (z):

we will do this in lab also

2. Solar Intensity

* The angle of the sun's rays determine the _____ received at the _____
    *
    *

SOLAR RADIATION

A. Radiation is _____ and a method of _____.

Radiation does not need a _____ to _____; energy from the sun travels through the _____

B. Unit of energy: _____

Facts and Concepts of Radiation

A. Energy propagated in the form of _____
B. One property of radiation is its _____. From the sun, there are a wide range of _____ ( ).

C. Amount of energy carried by each individual _____ (particle) varies with _____. *

D.

Radiation Laws

1. The wavelength of peak radiation depends upon _____.

<u>Wein's Law</u>: demonstrates that as temperature of body _____, wavelength of maximum emission _____ (to).

Calculcations:

λ_{max} = wavelength _____

2. Hot objects emit _____ energy than cold objects

<u>Stefan-Boltzmann Law</u>: demonstrates that as the temperature _____, the total amount of radiation _____ rapidly.

INCOMING SHORTWAVE (SOLAR) RADIATION

* Solar radiation reaches us in _____, traveling at about 300,000 km (186,000 miles) per second over the distance of 150 million km (93 million miles) to earth.
* How much of the sun's energy do we receive?
* _____ of the total radiation emitted by the sun is received by the earth

* The amount of solar radiation is _____ when it reaches the top of the Earth's atmosphere.

Solar Constant = 1.96 cal/cm^2/min or 1372 W/m^2

How much reaches the surface?
Atmosphere acts as a _____.

Factors controlling radiation receipt…

1.
2.
3.

4.

a. if it continues to the surface, it is called _____
b. if it is directed back out to space it is called _____
   * shorter wavelength ( ) are _____
   * dusty atmosphere _____
   * sunrise / sunset: sun's rays must travel through _____
     _____

5. Reflection: _____ or _____ (α) defined as:

$$\alpha = \frac{reflected}{incident} x100\%$$

Average albedo of Earth/Atmosphere is _____; hence _____
_____

Factors Influencing Albedo

1.
   a.
   b.

2.
   a.
   b.

* Water
   a.
   b.

TERRESTRIAL RADIATION (_____)

A. Earth _____ in the _____ part of the spectrum.

B. _____ because Earth _____ than sun.

C. Called _____, _____, or _____

D. Earth's temperature is 300K so λmax = _____ μm (_____).
Earth's radiation has 20x longer wavelength than radiation from the sun.

HEAT BALANCE

* All objects radiate energy. . . so why doesn't everything get colder?
   •

* At night, an object get colder; _____
Vice versa for objects warming.

* _____: _____

* The Earth and sun act like _____
  (1) At all times, _____
  (2) Earth is also constantly _____
  (3) Assume no other methods of heat transfer so if rate of _____ = rate of _____ then Earth is in a state of _____

* For Earth: the _____ temperature is

* At the present time, the average global temperature is _____
  • Why is there a difference???

*

* For example, _____ and _____ absorb _____ radiation, but are _____ absorbers of _____ radiation. These are the _____.

* Kirchoff's Law: states that _____ are _____
  at a particular wavelength and _____ are _____ at the same wavelength. Especially true for _____ and is responsible for _____

* They also emit radiation in the _____ wavelength. The radiation that returns back to the surface is called _____

* This process makes the lower atmosphere _____

* This is the _____

* Enhancement of this effect by _____

* This could lead to _____

COUNTER-RADIATION

A. CO_2, water vapor, etc. _____ radiation _____ and _____.

B. Act as _____ for Earth

C. _____ is readily absorbed by atmosphere in contrast to _____

D. _____ is best known as the _____.

RADIATION BALANCE

A. **Net radiation (Q*)** is the _____.
It is computed as the _____ minus radiation _____ the earth

B. $Q^* = S_{dn} - S_{up} + L_{dn} - L_{up}$ = net radiation, where:

S_{dn} =

S_{up} =

L_{dn} =

L_{up} =

C. Annual Radiation Balance

1. Equator:
2. Poles:
3. Are the tropics getting hotter and the poles getting colder?
4. _____. The _____ and to a lesser extent the _____ act as giant thermal engines that _____

* Balance achieved by _____. HOW?

-

-

-

Earth's Annual Energy Balance

* Earth's overall average equilibrium temperature _____ from year to year
* Earth/Atmosphere must _____
_____

Earth-Atmosphere Energy Balance

Radiation fluxes alone: _____ with _____ at the surface and _____ in the _____

Sensible heat (_____ + _____ / _____) + latent heat _____ the imbalance in the Earth's energy system.

Energy _____.