Electromagnetic Spectrum and Principles of black Body Radiation

1. All objects above zero degrees Kelvin radiate e-m energy.

2. E-m energy travels in waves at the speed of light.

3. The length of the wave is used to divide the e-m spectrum into bands.

4. The hotter the object, the more energy it emits.

5. The hotter the object, the shorter the wavelength emitted.

6. The shorter the wavelength, the more energy the wave carries.

7. For objects that do not generate their own energy (like the earth), there must be a balance between energy received from the sun and the amount returned to space.

8. Note that a given place on the earth receives light for only 12 hours, but radiates energy continually (24 hours), therefore incoming energy must be more intense (have shorter wave length) than out going energy.

9. There must be an equilibrium temperature at which out-going long wave energy is equal to incoming short wave energy. If in coming energy increases, then the equilibrium temperature must rise as the amount of out-going long wave energy also increases (spring and day). The opposite is also true (fall and night).

Wave length	Name	Instrument(s)
<.0001 μM	Gamma Rays	Gamma Ray Spectrometer
.0001 - .01 μM	X-Rays	X-Ray Spectrometer
.01 - .4 μM	Ultraviolet (UV)	UV Spectrometer
.4 - .7 μM	Visible Light	Camera and Film
.7 – 1.4 μM	Near Infrared (NIR)	Multispectral Scanner, TV
1.4 – 2.5 μM	Mid Infrared (MIR)	MSS
2.5 – 100 μM	Far or Thermal Infrared (FIR)	MSS
100 μM – 100MM	Microwaves	Radar, Microwave, Radiometer
100MM – 10,000 KM	Radio waves	radio

IN THE VISIBLE PART OF THE SPECTRUM

.4 - .43 μM	Violet
.43 - .49 μM	Blue
.49 - .53 μM	Green
.53 - .58 μM	Yellow
.58 - .63 μM	Orange
.63 - .70 μM	Red

Energy and Radiation
Sun, Earth's Surface and atmospheric Processes

Almost all of the energy that drives processes on the earth comes from the sun and is coming incoming solar radiation or __________________. This energy drives the physical processes (winds, ocean currents, hydrologic cycle) and the life processes (photosynthesis) at the earth's surface and atmosphere. Understanding the budget is essential to understanding these processes. Ultimately there is a __________________ between the sun's energy that is intercepted by the earth (and its atmosphere) and the amount that is returned to space. The amount coming in equals the amount going out, so the earth as a whole (planet) has an ________________ ________________ where these amounts balance.

All of the energy that the sun produces is some part of the ________________ ________________. This energy may be converted from one form to another, which involves a change in frequency and wavelength (which are inversely related.) ________________ frequency energy has a ________________ wavelength and carries a lot of energy. The very shortest wavelengths of energy, ________________ and ________________ ________________ are hazardous because of the large amounts of energy forms. The longest wavelengths are ________________ ________________ and ________________ and are much less dangerous. In between the extremely short wavelengths and the very long wavelengths is the middle part of the spectrum where most energy exchange takes place. In this middle part of the spectrum, the sun's energy cascades through the atmosphere as ________________ ________________. The energy returns to space as ________________ ________________. About 9% of the energy is ________________ and is absorbed in the stratosphere by the ________________ ________________. This absorption causes the stratosphere to be relatively warm. About 50% is ________________ ________________ consisting of the colors of the spectrum known as ________________. The remaining 41% is ________________ ________________. Human eyes are not sensitive to this energy, but it behaves just like light, i.e. it can be ________________, ________________ or ________________. The amount reflected is determined by the material's ________________. This is important because reflected energy does no _______________, and is lost to the system. Since the gases that comprise the atmosphere and the water are ________________, radiant energy is transmitted through both.

Balance	reflected	transparent
Isolation	electromagnetic spectrums	
X-rays	equilibrium temperature	
Short wave	transmitted	
Microwaves	high	
Ultraviolet	short	
Gamma rays	long wave	
Absorbed	ozone (layer)	
Roy G. Biv	radio waves	
Visible light	near infrared	
Albedo	work	

Once the energy is absorbed by the surface, it is then re-radiated as long wave or ________________ energy, which is the same as ___________ ___________. Once this energy moves upward from the ground surface, another term is the atmosphere, primarily ___________ ___________ and ___________ ___________. This heat energy is then ________________: part of it goes out to space, but part of it is directed back towards the surface. This is called ___________ ___________ and keeps the lower atmosphere warmer than it would otherwise be. Since the earth's atmosphere is relatively transparent with respect to light, but somewhat "opaque" with respect to heat, the analogy is often made to a ________________.

Human activity can modify the rate at which these energy transfers take place. Burning of ___________ ___________ (___________, ___________ and ___________ ___________) to generate electricity (among other things) pours more carbon dioxide into the atmosphere. This ___________ radiant heat loss (to space) and makes the lower atmosphere ___________ with mo change in the amount of solar energy coming in.

Human intervention affects both the lower atmosphere (________________) and the upper atmosphere (________________). A particular class of chemicals vital to modern industry known as ___________ destroys ozone in the stratosphere. With less ozone to absorb dangerous ultraviolet radiation, the potential health consequences are higher rates of ___________ ___________ and eye problems such as ___________. Less UV absorption would also result in a cooler stratosphere.

Finally, human activity modifies the surface of the earth and thus the energy transfers there. The clearing of ___________ ___________ ___________ lowers the absorption of ___________ used in photosynthesis. Such clearing also modifies the surface energy budget. While claims that tropical rain forests will become ________________ are exaggerated, there is less no question that this clearing increases the potential for ___________ ___________. With the soil less able to hold moisture, there is less water ________________ from the surface. Since evaporation is a ___________ ___________, the ground temperature would rise. Less water evaporating from the soil would also result in less water vapor in the atmosphere, so ___________ ___________ would decrease. In terms of ___________ ___________, such changes represent ________________ feedbacks where one change accelerates another change.

Troposphere	warmer	fossil fuels
Sensible heat	cataracts	deserts
Soil erosion	ground radiation	evaporated
Re-emitted	thermal infrared	cloud cover
Carbon dioxide	water vapor	systems theory
CFCs	coal, oil, natural gas	positive
Skin cancer	tropical rain forest	
Counter-radiation	CO_2	
Greenhouse	stratosphere	
Cooling process	retards	