Science 10 Unit D: Energy Flow in Global Systems

Energy and Phase Changes

Review: Match the definition to the correct term:

1. Biosphere
2. Lithosphere
3. Atmosphere
4. Hydrosphere
5. Troposphere
6. Altitude
7. Thermosphere
8. Climate
9. Adaptation
10. Anecdotal Evidence
11. Insolation
12. Angle of Inclination
13. Solstice
14. Equinox
15. Latitude
16. Albedo
17. Convection
18. Wind
19. Coriolis Effect
20. Jet Stream

a. band of fast-moving air in the stratosphere

b. average weather conditions that occur in a region over a long period of time

c. layer of gases that surround Earth

d. reports from people about a particular event

e. sun's highest (or lowest) point in the sky

f. when number of daylight hours equals number of night-time hours

g. all the water on Earth

h. imaginary lines running parallel to equator

i. distance above Earth's surface, measured from sea level

j. conditions suitable for supporting life

k. deflection of an object from a straight line path by

l. atmospheric layer farthest from Earth's surface

m. percent of solar radiation that a surface reflects

n. solid portion of Earth

o. degree by which poles are tilted from perpendicular

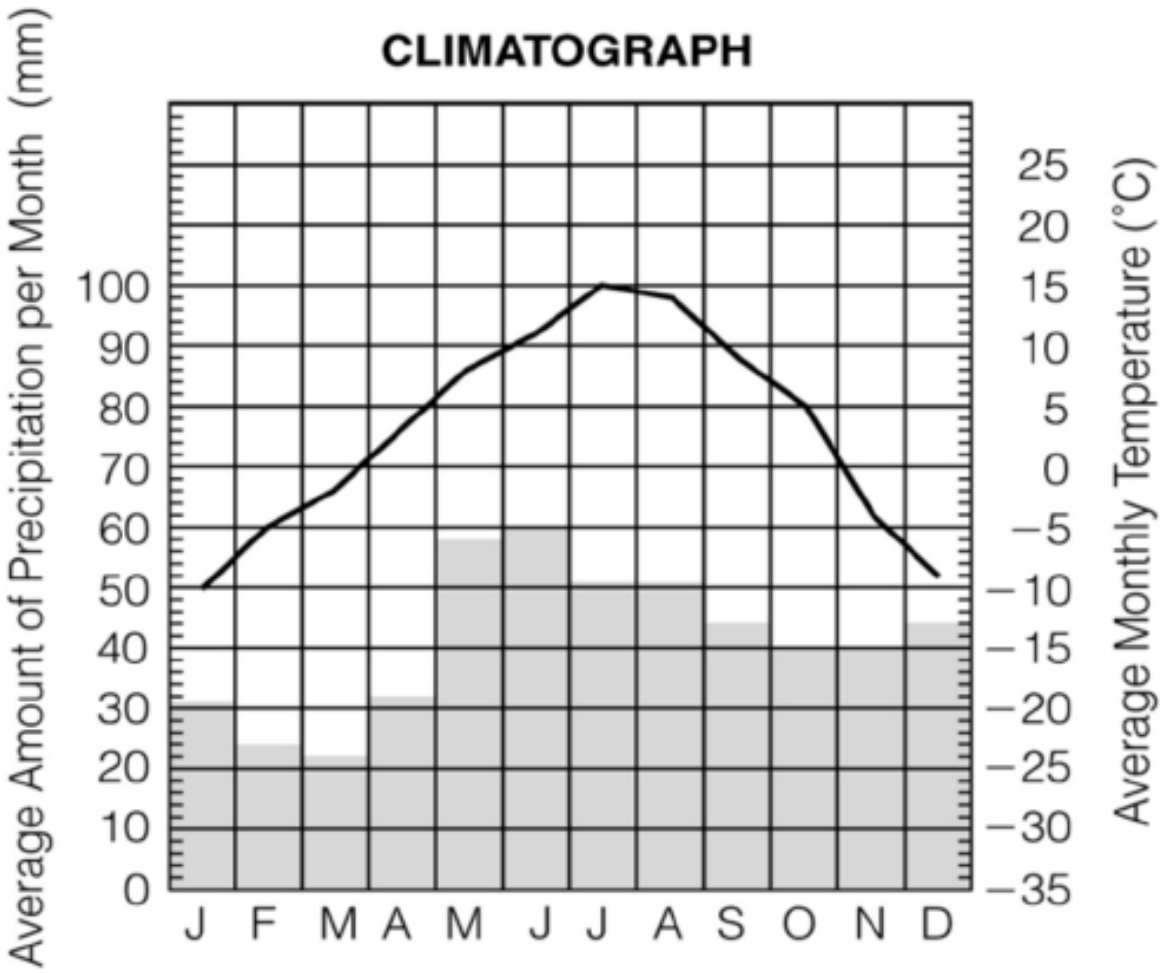
p. amount of solar energy received by a region on Earth's surface

q. atmospheric layer in which most weather occurs

r. any change in structure or function making an organism more suited to its environment

s. transfer of thermal energy through movement of particles from one location to another

t. movement of air from area of high pressure to area of



Ex) What is the average temperature in July of this region?

What is the average rainfall in May?

Review: what is a mole?

Review: How many moles are present in 5.0 g of ammonia?

Review:

Specific Heat Capacity

Recall that KE is measured as temperature. Specific Heat Capcity is a way of determining how much energy is needed to produce a temperature change in a substance.

$$Q = mc\Delta t$$

Question!

What is Q?

Question!

What is Δt ?

Question!

What is c ?

Note: there is a nice list of c's in your data booklet!

Thermodynamics

Heat Capacities of Some Common Compounds

Compound	Specific Heat Capacity (J/g°C) or kJ/kg°C
Water (liquid)	4.19
Methanol	2.55
Ethanol	2.46
Gold	0.129
Water (solid)	2.01
Water (gas)	2.01
Zinc	0.388
Copper	0.385

ex) What amount of energy is needed to raise the temperature of 15.0 g of zinc from 23˚C to 55˚C?

ex) What mass of ethanol solution is required to absorb 250 kJ of heat for a change in temperature of 10˚C?

ex) 5.00×10^2 g of ice is cooled from -10°C to -41.5°C. What is the kinetic energy released?

In the previous questions, we have examined the effect of substances like water absorbing thermal energy and producing a change in temperature.

But what else happens when a compound absorbs (or loses) a LOT of thermal energy?

— **cool.**

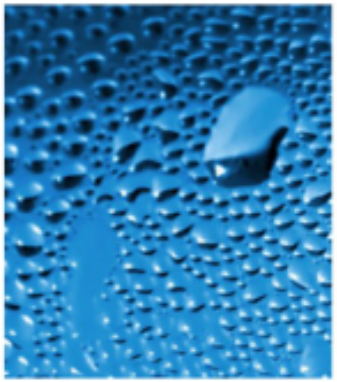
Increased thermal energy not only causes temperature increases, but also causes phase changes.

There are 4 phase changes:

Vapourization: absorb energy, liquid to gas

vapourization of liquid nitrogen

Condensation: release energy, gas to liquid



condensation of water

Fusion: absorb energy, solid to liquid

mmm...enthalpy

Solidification: release energy, liquid to solid

hang ten

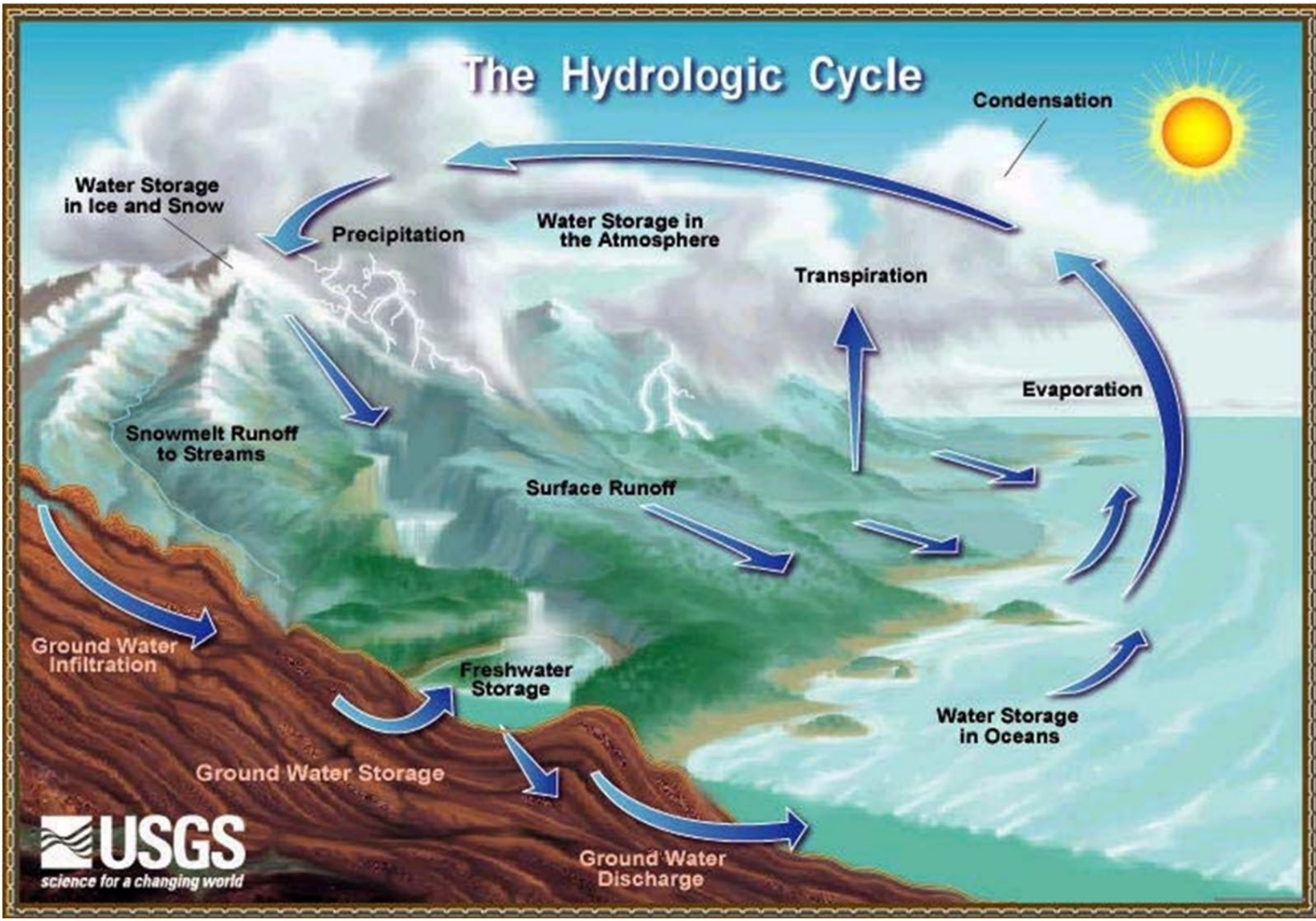
The melting point and fusion point of a substance are one and the same.

i.e. Iron melts at 1538 °C. It also fuses at 1538 °C.

All of these phase changes take place in the Earth's hydrologic cycle:

Hydrologic (water) Cycle

- **Water plays a critical role by:**
  - **Maintaining global heat balance.**
  - **Acting as a solvent in reactions.**
- **Movement of water through environment: from atmosphere to Earth.**
- **Volume of water remains constant, specific amounts vary in phases; water continuously cycles.**


The Hydrologic Cycle
Condensation
Water Storage in Ice and Snow
Precipitation
Water Storage in the Atmosphere
Transpiration
Evaporation
Snowmelt Runoff to Streams
Surface Runoff
Ground Water Infiltration
Freshwater Storage
Water Storage in Oceans
Ground Water Storage
Ground Water Discharge
USGS
science for a changing world

We can calculate the amount of thermal energy envolved in a phase change using the following equations:

$$Q = n\Delta H_{fus}$$

$$Q = n\Delta H_{vap}$$

where:

n = number of moles of the substance

ΔH_{fus} = heat of fusion (kJ/mol)

ΔH_{vap} = heat of vapourization (kJ/mol)

Q = thermal energy

Note: you may also need to use n = m/M to solve for n for these problems!

Extra Note: a table of heats of fusion and vapourization is also listed in your data booklet.

Heats of Fusion of Various Substances

Substances	Heat of Fusion kJ/mol
Water	6.01
Copper	12.93
Gold	12.72
Ethanol	5.02
Methanol	3.22
Zinc	7.07

Heats Of Vaporization Of Various Substances

Substances	Heat of Vaporization kJ/mol
Water	40.65
Copper	300.4
Gold	324
Ethanol	39.40
Methanol	35.21
Zinc	123.6

ex) The molar enthalpy of vaporization of water is 40.8 kJ/mol.

a) How much potential energy is required to vaporize 10 kg of water?

ex) When 27.05 kJ of thermal energy is added to 4.50 mol of ice at 0.0 °C, the ice melts completely. From this information, determine the heat of fusion of water.

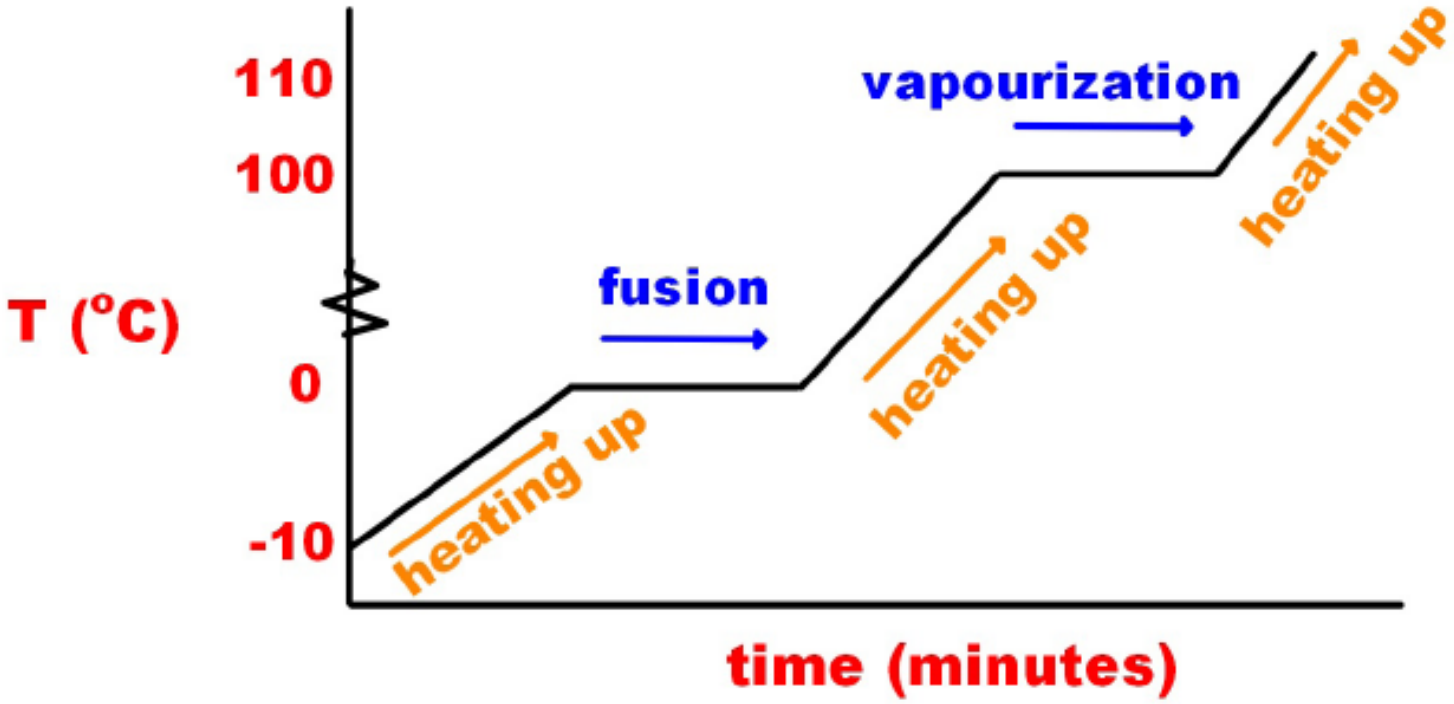
ex) When 150 g of water changes from liquid to vapour, 339 kJ of energy is absorbed. Use this information to determine the heat of vaporization of water.

ex) If the heat of vaporization of methanol is 3.48 kJ/mol and a sample of methanol absorbs 8.70 kJ of heat energy, how many moles of methanol are in the sample?

Graphing Phase Changes

Phase changes can be seen clearly on graphs of temperature vs. time.

Consider the following graph representing the heating of water from -10°C to 110°C.



*Note that temperature does not increase during a phase change.