PHYSICAL GEOGRAPHY

THERKALSEN

HANDOUT PACKET

SECTION ONE

For review complete the exercises on the following page.

List the Coordinates of the following locations:

A: ________________________

B: ________________________

C: ________________________

D: ________________________

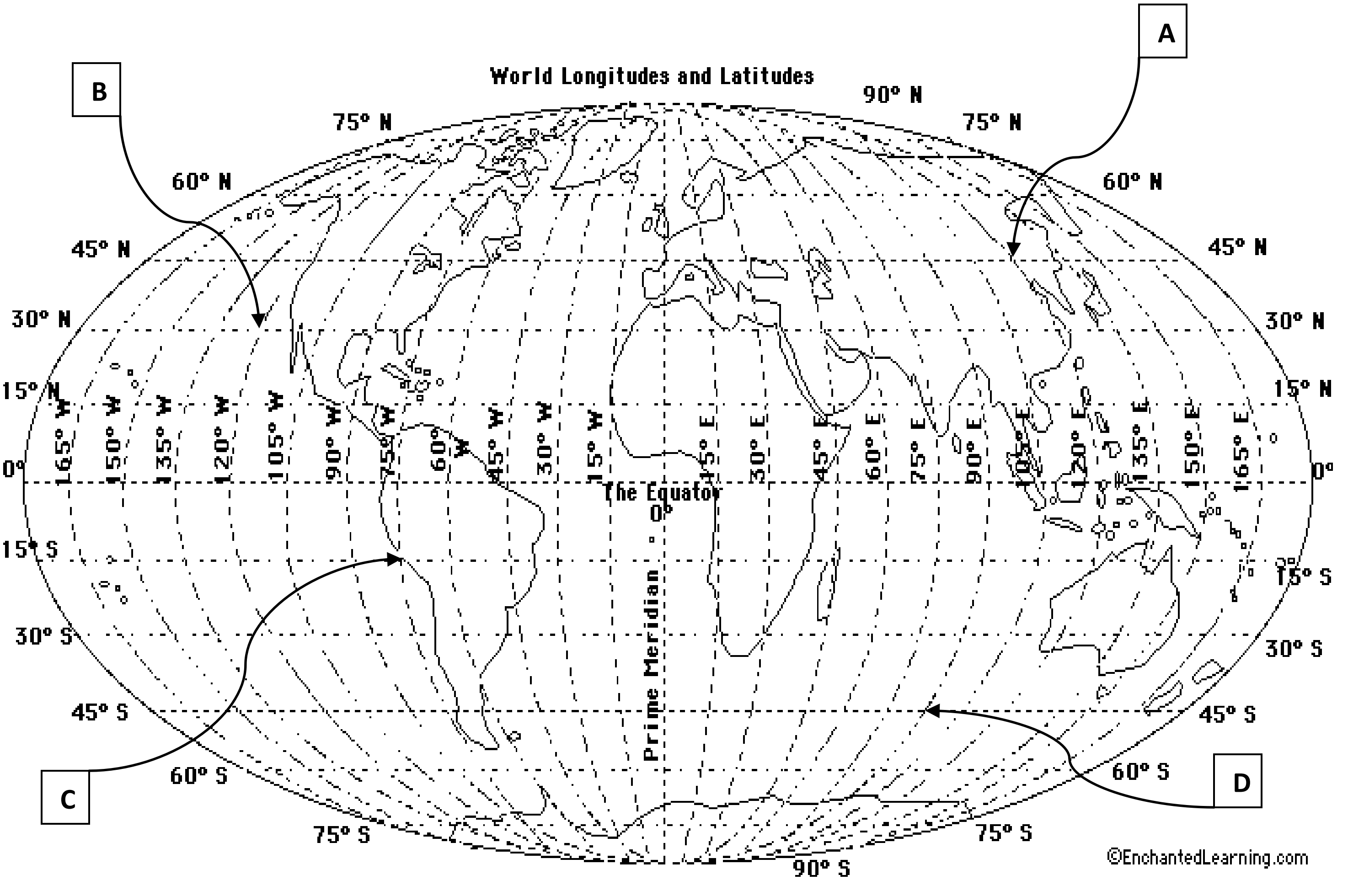
Place a letter on the map where the location given is found

E: 45°North, 80° West

F: 78°South, 117°East

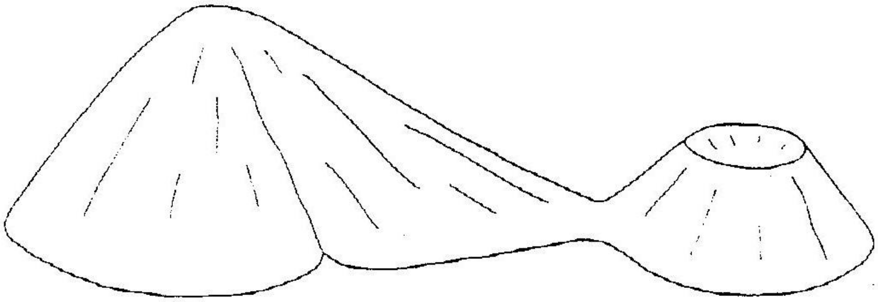
G: 12° North, 114°West

H: 24°South, 45°East

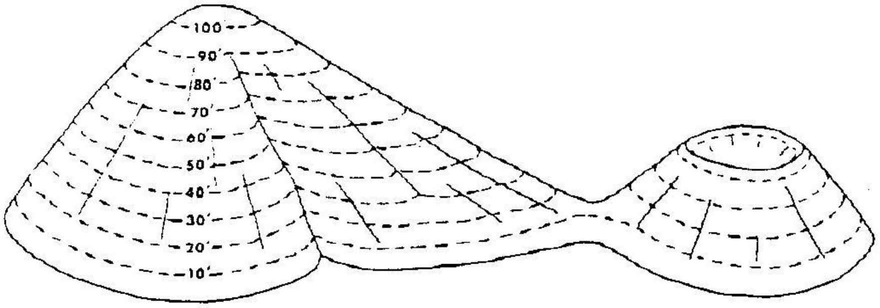


Reading Contours

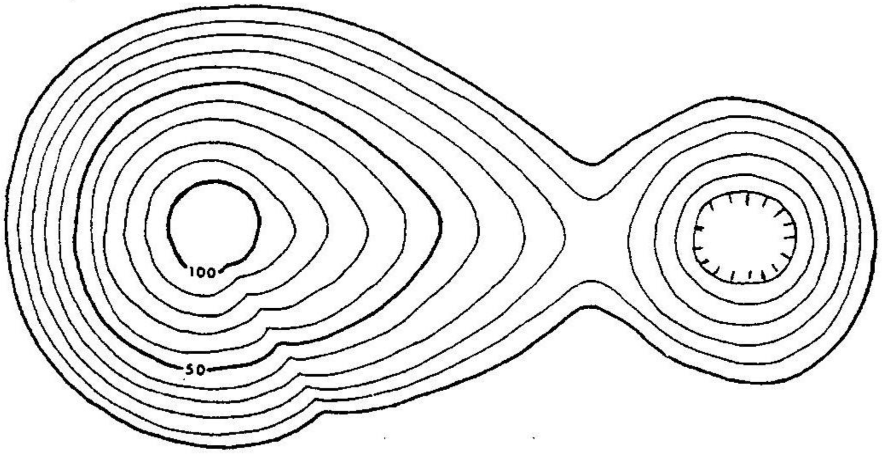
One of the most helpful features on a topographic map are elevation lines called ***contours***. Contour lines are drawn for specific intervals of elevation above a datum plane, usually sea level. Any contour acts as a boundary separating higher elevations on one side from lower elevations on the other. The easiest way to understand contours and how they work is to visualize an island such as the one sketched below. Then imagine that someone with an altimeter very carefully traced out one path that is exactly 10 feet above sea level, another at 20 feet above sea level, and then all of the others to the top of the island at 10 foot intervals. These paths are superimposed on the island in sketch B, and they are in effect contours. If you were to fly over the island and take a photograph looking straight down, the picture would be a contour map (sketch C).



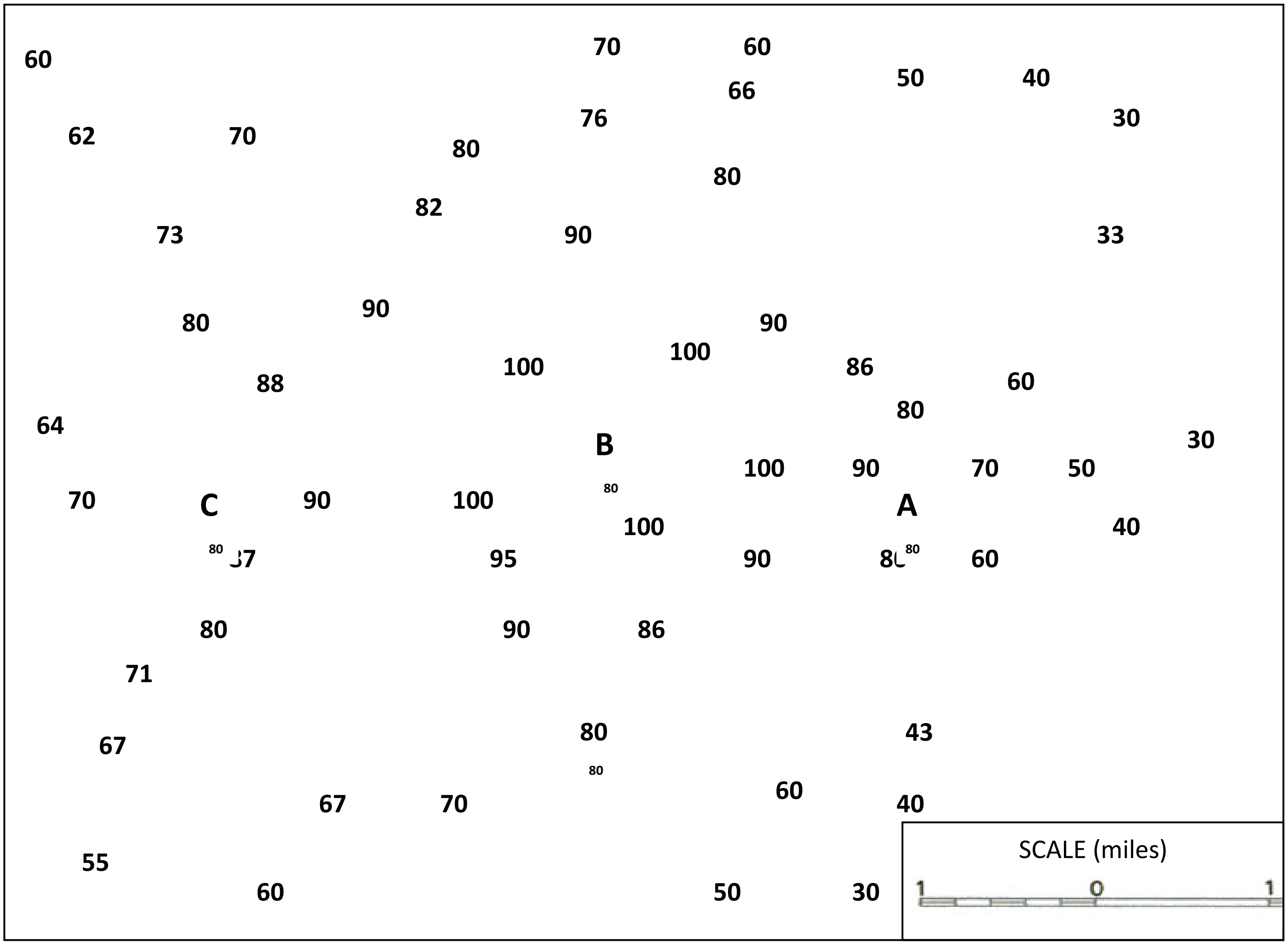
A



B



PRACTICE DRAWING YOUR OWN ISOLINES



Assume this is a topographic map; use a contour interval of 10 feet

1. What type of feature is this? Make a simple ***profile sketch*** of this feature.

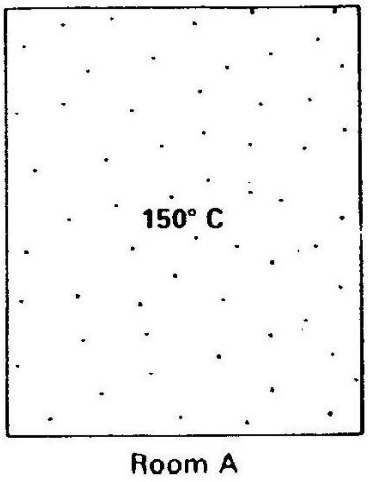
3. What are the elevations of points **A,B**, and **C**

A:_______________ **B:**________________ **C**_________________

2. Which side has the steepest **gradient**? How do you know?

“ENTROPY:” An Illustration

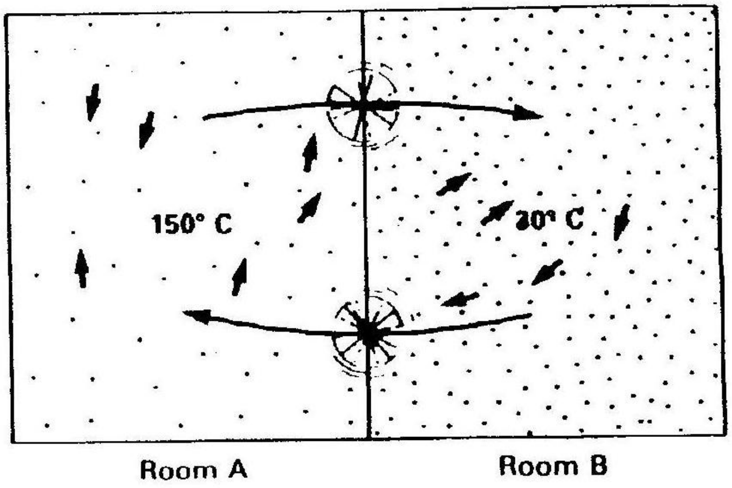
(t_1) *No “Energy Gradient”*



Entropy. A room heated uniformly (Room A left) has heat energy, but none can be harnessed to do work in the room.

(t_2) *The Result of “Differential Heating”*

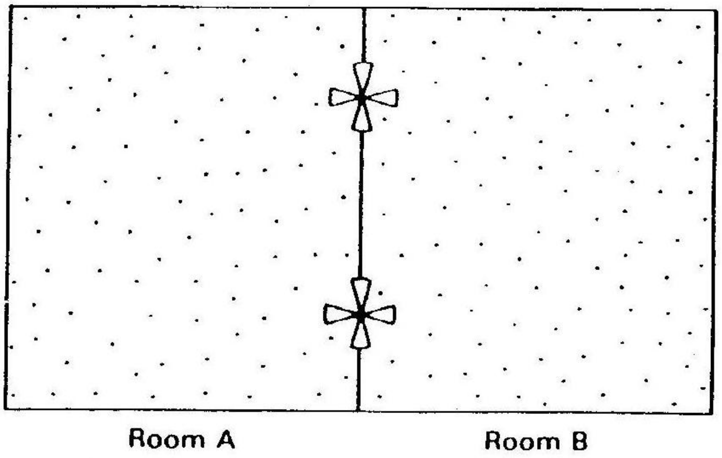
If the room were connected to a *cold* room and holes were made between the rooms at the top and bottom of the common wall (right), the colder, more dense air from room B would flow through the lower opening into room A. The hot air in room A would tend to rise into room B. If vanes were placed in the openings, the flow of air could be harnessed to make the blades rotate as in a windmill.



- ➢ **Now exists an ______________________________**
- ➢ **Thus, ____________________________________**

(t_3) The Result of "Work"

Once the two rooms became uniformly heated, the heat would no longer be harnessable within the two-room system.



- **"Work" eliminates the** ____________________
- **Thus: (1)** ____________________

  (2) ____________________

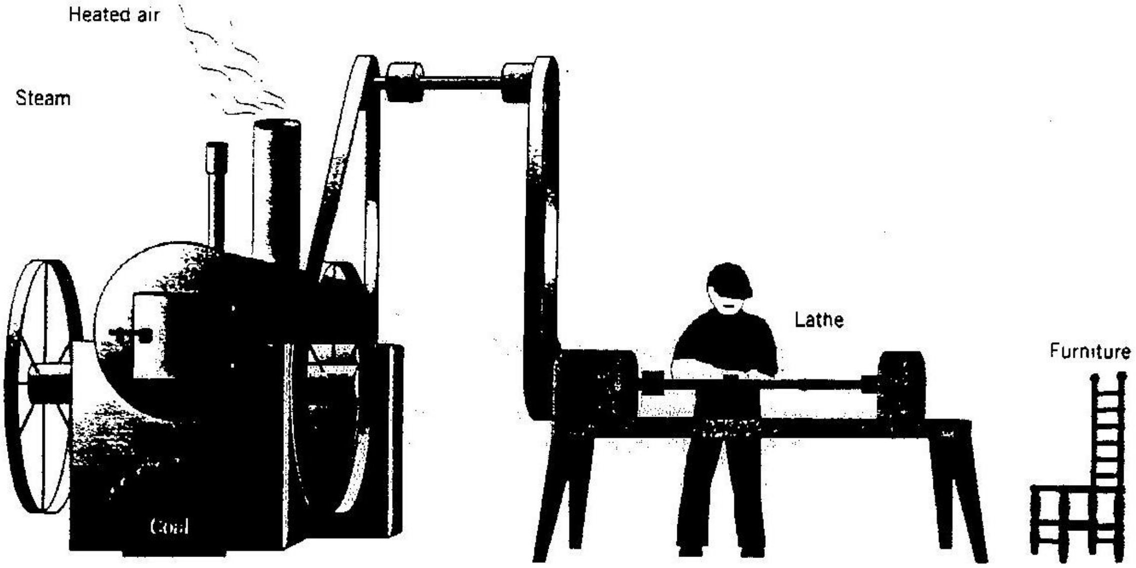
What might happen if a third room were then hooked up to this system?

THE SECOND LAW OF THERMODYNAMICS

To better understand why we cannot recycle energy, imagine a closed system (i.e., it receives no other input) containing a pile of coal, a tank of water, air, a steam engine, and an engineer (Figure 8.5). Suppose that the engine runs a lathe that makes furniture. The engineer lights a fire to boil the water, creating steam to run the engine. As the engine runs, the heat from the fire gradually warms the entire system. When all the coal is completely burned, the engineer will not be able to boil any more water and the engine will stop. The average temperature of the system is now higher than the starting temperature. The energy that was in the coal is now dispersed throughout the entire system, much of it as heat in the air. Why can't the engineer recover all that energy, recompact it, put it under the boiler, and run the engine? The answer is because of the second law of thermodynamics. Physicists have discovered that no real use of energy can ever be 100% efficient. Whenever useful work is done, some energy is inevitably converted to heat. Collecting all the energy dispersed in this closed system would require more energy than could be recovered.

Our imaginary system begins in a highly organized state, with energy compacted in the coal. It ends in a less organized state, with the energy dispersed throughout the system as heat. The energy has been degraded, and the system is said to have undergone a decrease in order. The measure of the decrease in order (the disorganization of energy) is called **entropy.** The engineer did produce some furniture, converting a pile of lumber into nicely ordered tables and chairs. The system had a local increase of order (the furniture) at the cost of a general increase in disorder (the state of the entire system). All energy of all systems tends to flow toward states of increasing entropy.

FIGURE 8.5 Diagram of a system closed to the flow of energy, containing wood, water, and a steam-driven engine.



The Crime of Galileo: Indictment and Abjuration of 1633

Whereas you, Galileo, son of the late Vincenzio Galilei, of Florence, aged seventy years, were denounced in 1615, to this Holy Office, for holding as true a false doctrine taught by many, namely, that the sun is immovable in the center of the world, and that the earth moves, and also with a diurnal motion; also, for having pupils whom you instructed in the same opinions; also, for maintaining a correspondence on the same with some German mathematicians; also for publishing certain letters on the sun-spots, in which you developed the same doctrine as true; also, for answering the objections which were continually produced from the Holy Scriptures, by glozing the said Scriptures according to your own meaning; and whereas thereupon was produced the copy of a writing, in form of a letter professedly written by you to a person formerly your pupil, in which, following the hypothesis of Copernicus, you include several propositions contrary to the true sense and authority of the Holy Scriptures; therefore (this Holy Tribunal being desirous of providing against the disorder and mischief which were thence proceeding and increasing to the detriment of the Holy Faith) by the desire of his Holiness and the Most Emminent Lords, Cardinals of this supreme and universal Inquisition, the two propositions of the stability of the sun, and the motion of the earth, were qualified by the Theological Qualifiers as follows:

1. The proposition that the sun is in the center of the world and immovable from its place is absurd, philosophically false, and formally heretical; because it is expressly contrary to Holy Scriptures.
2. The proposition that the earth is not the center of the world, nor immovable, but that it moves, and also with a diurnal action, is also absurd, philosophically false, and, theologically considered, at least erroneous in faith.

Therefore . . . , invoking the most holy name of our Lord Jesus Christ and of His Most Glorious Mother Mary, We pronounce this Our final sentence: We pronounce, judge, and declare, that you, the said Galileo . . . have rendered yourself vehemently suspected by this Holy Office of heresy, that is, of having believed and held the doctrine (which is false and contrary to the Holy and Divine Scriptures) that the sun is the center of the world, and that it does not move from east to west, and that the earth does move, and is not the center of the world; also, that an opinion can be held and supported as probable, after it has been declared and finally decreed contrary to the Holy Scripture, and, consequently, that you have incurred all the censures and penalties enjoined and promulgated in the sacred canons and other general and particular constituents against delinquents of this description. From which it is Our pleasure that you be absolved, provided that with a sincere heart and unfeigned faith, in Our presence, you abjure, curse, and detest, the said error and heresies, and every other error and heresy contrary to the Catholic and Apostolic Church of Rome.

1630 A.D. *[See note below. The date should be 1633]* Ita pronunciamus nos Cardinalis infrascripti.

F. Cardinalis de Asculo.
G. Cardinalis Bentivolius
D. Cardinalis de Cremona.
A. Cardinalis S. Honuphri.
B. Cardinalis Gypsius.
F. Cardinalis Verospius.
M. Cardinalis Ginettus.

GALILEO'S ABJURATION.

I, Galileo Galilei, son of the late Vincenzio Galilei of Florence, aged 70 years, tried personally by this court, and kneeling before You, the most Eminent and Reverend Lord Cardinals, Inquisitors-General throughout the Christian Republic against heretical depravity, having before my eyes the Most Holy Gospels, and laying on them my own hands; I swear that I have always believed, I believe now, and with God's help I will in future believe all which the Holy Catholic and Apostolic Church doth hold, preach, and teach.

But since I, after having been admonished by this Holy Office entirely to abandon the false opinion that the Sun was the centre of the universe and immoveable, and that the Earth was not the centre of the same and that it moved, and that I was neither to hold, defend, nor teach in any manner whatever, either orally or in writing, the said false doctrine; and after having received a notification that the said doctrine is contrary to Holy Writ, I did write and cause to be printed a book in which I treat of the said already condemned doctrine, and bring forward arguments of much efficacy in its favour, without arriving at any solution: I have been judged vehemently suspected of heresy, that is, of having held and believed that the Sun is the centre of the universe and immoveable, and that the Earth is not the centre of the same, and that it does move.

Nevertheless, wishing to remove from the minds of your Eminences and all faithful Christians this vehement suspicion reasonably conceived against me, I abjure with sincere heart and unfeigned faith, I curse and detest the said errors and heresies, and generally all and every error and sect contrary to the Holy Catholic Church. And I swear that for the future I will neither say nor assert in speaking or writing such things as may bring upon me similar suspicion; and if I know any heretic, or one suspected of heresy, I will denounce him to this Holy Office, or to the Inquisitor and Ordinary of the place in which I may be.

I also swear and promise to adopt and observe entirely all the penances which have been or may be by this Holy Office imposed on me. And if I contravene any of these said promises, protests, or oaths, (which God forbid!) I submit myself to all the pains and penalties which by the Sacred Canons and other Decrees general and particular are against such offenders imposed and promulgated. So help me God and the Holy Gospels, which I touch with my own hands.

I Galileo Galilei aforesaid have abjured, sworn, and promised, and hold myself bound as above; and in token of the truth, with my own hand have subscribed the present schedule of my abjuration, and have recited it word by word. In Rome, at the Convent della Minerva, this 22nd day of June, 1633.

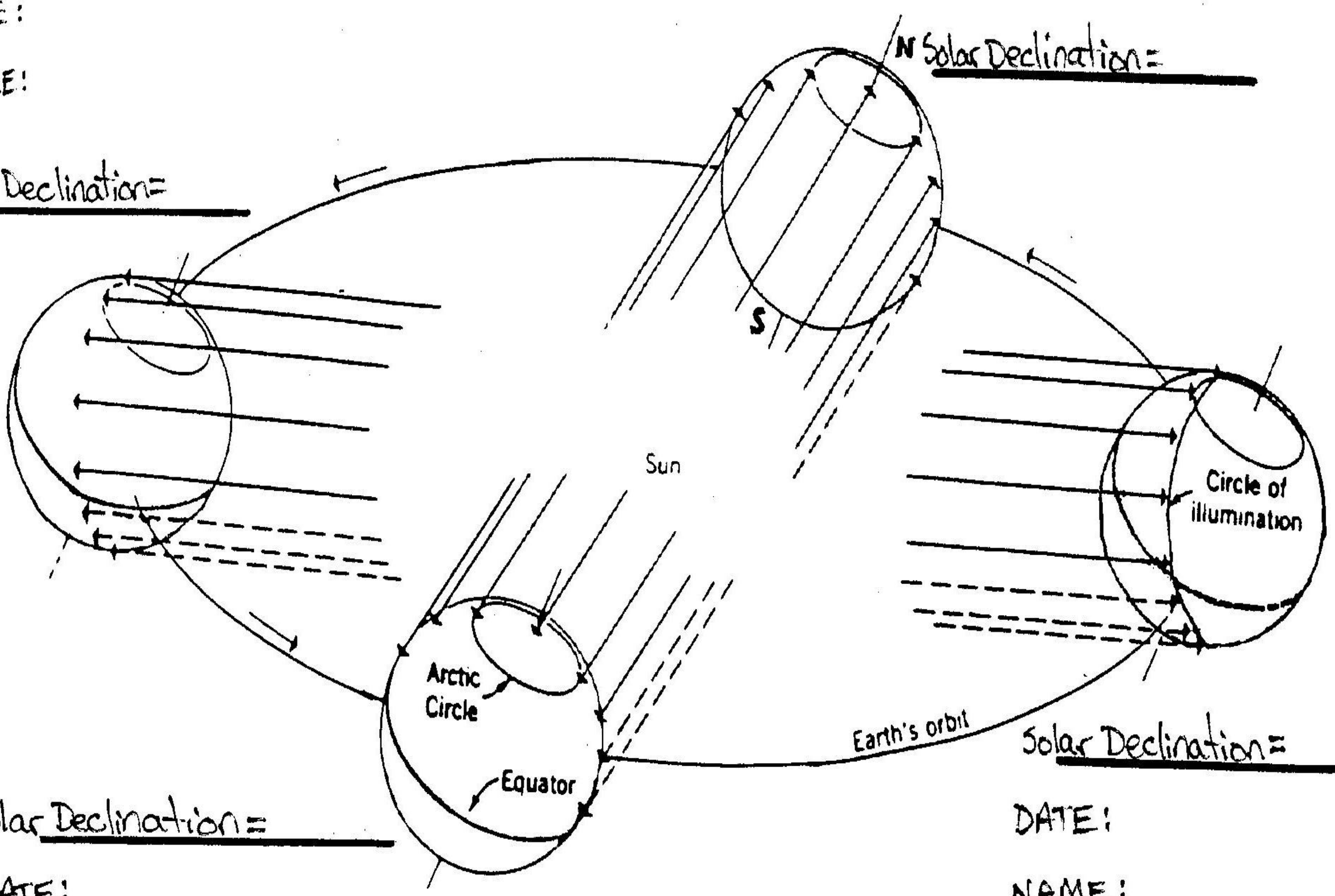
I, GALILEO GALILEI, have abjured as above, with my own hand.

EARTH-SUN RELATIONS:

DATE :
NAME :

DATE :
NAME :
lar Declination=

N Solar Declination=



Solar Declination=
DATE:
NAME:

Solar Declination=
DATE:
NAME:

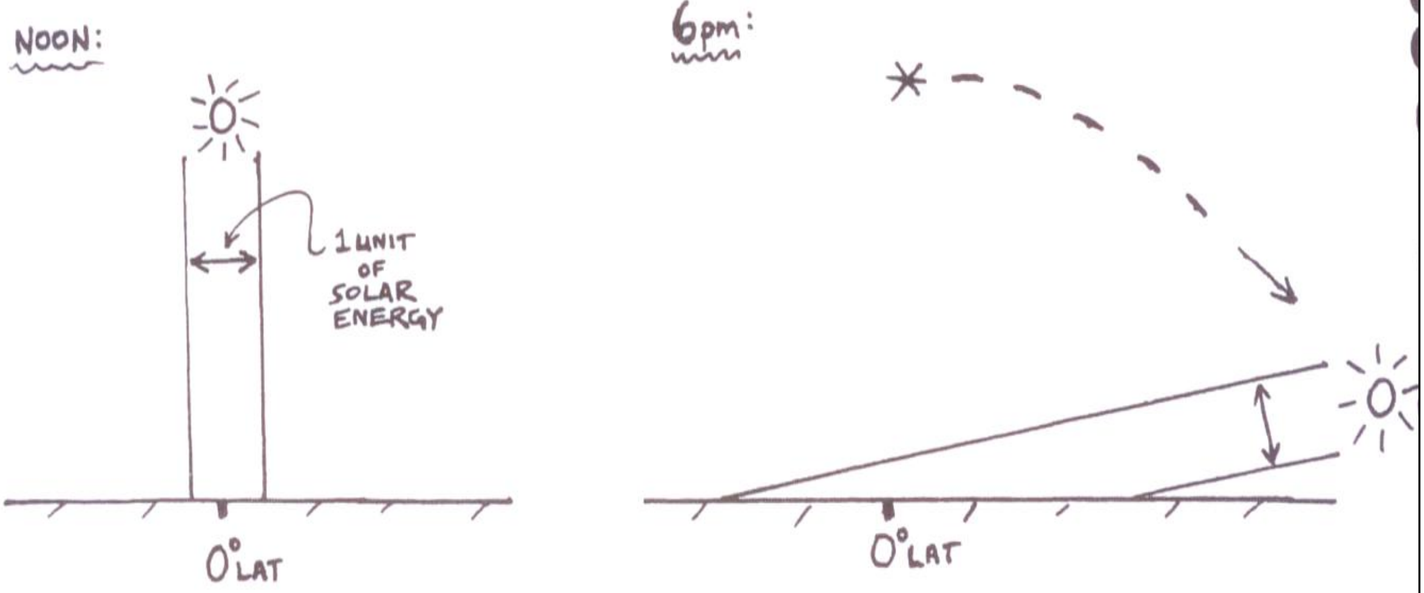
SUN ANGLE:

(1): Daily

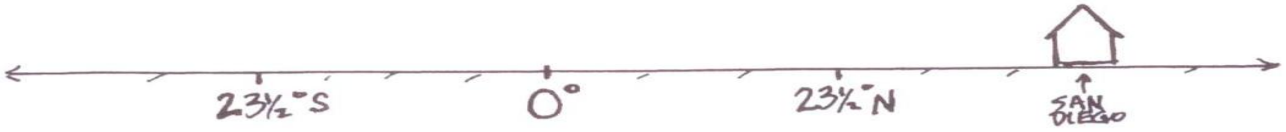
DATE:

SOLAR DEC:

DATE: SOLAR DEC:	Noontime insolation receipt: 6 pm insolation receipt:



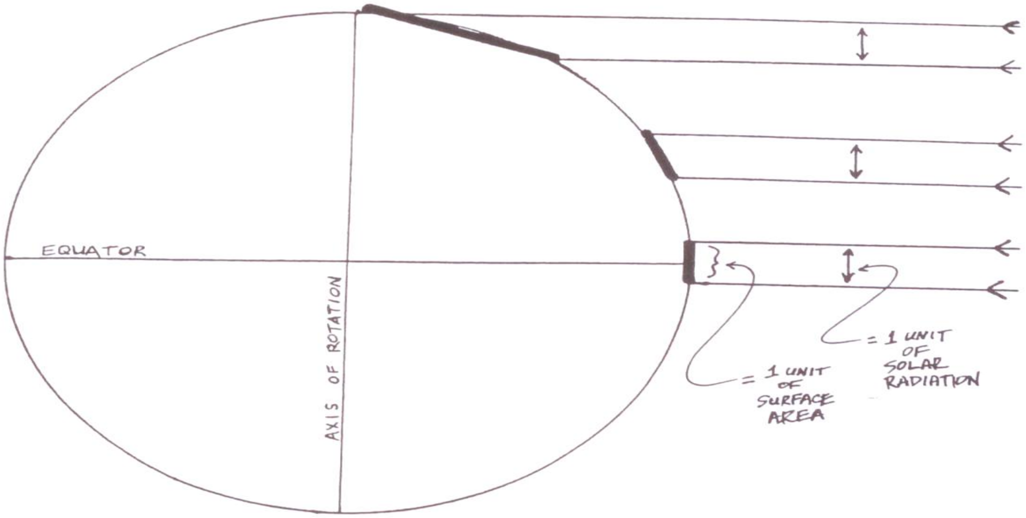
(2) Seasonal



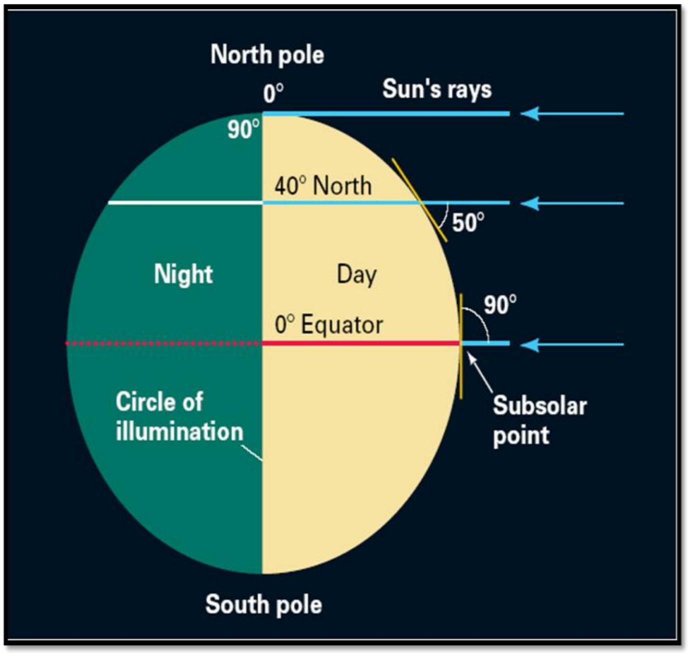
On any given Date:

SUN ANGLE VARIATION =f(   )

- **DATE (of diagram) =** ______________________
  (i.e., Solar Declination = ______________________)



- **On an EQUINOX:**
  Max. Noon Insolation ⟹ ______________________
  Min. Noon Insolation ⟹ ______________________
- **The "General Statement":**
  Max. Noon Insolation $\xrightarrow[\text{AT THE...}]{\text{ALWAYS}}$
  ____



DATE:

SOLAR DECLINATION:

DAYLENGTH
South Pole:

32°S:

0°:

San Diego (32°N):

Seattle (47°N):

North Pole:

Majority Energy Distribution:

DATE:

SOLAR DECLINATION:

DAYLENGTH
South Pole:

32°S:

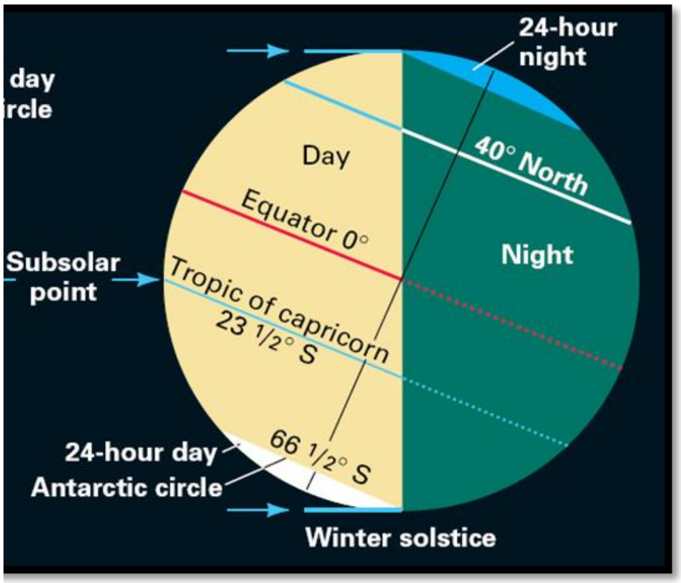
0°:

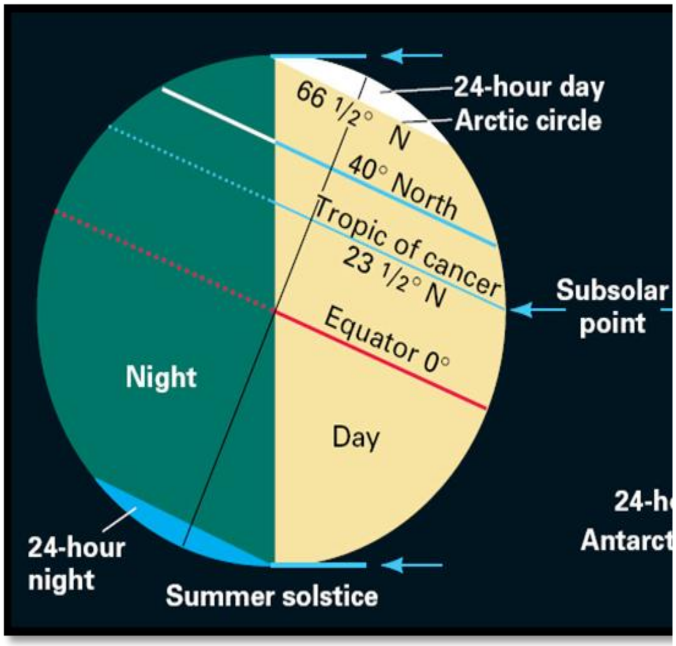
San Diego (32°N):

Seattle (47°N):

North Pole:

Majority Energy Distribution:





DATE:

SOLAR DECLINATION:

DAYLENGTH
South Pole:

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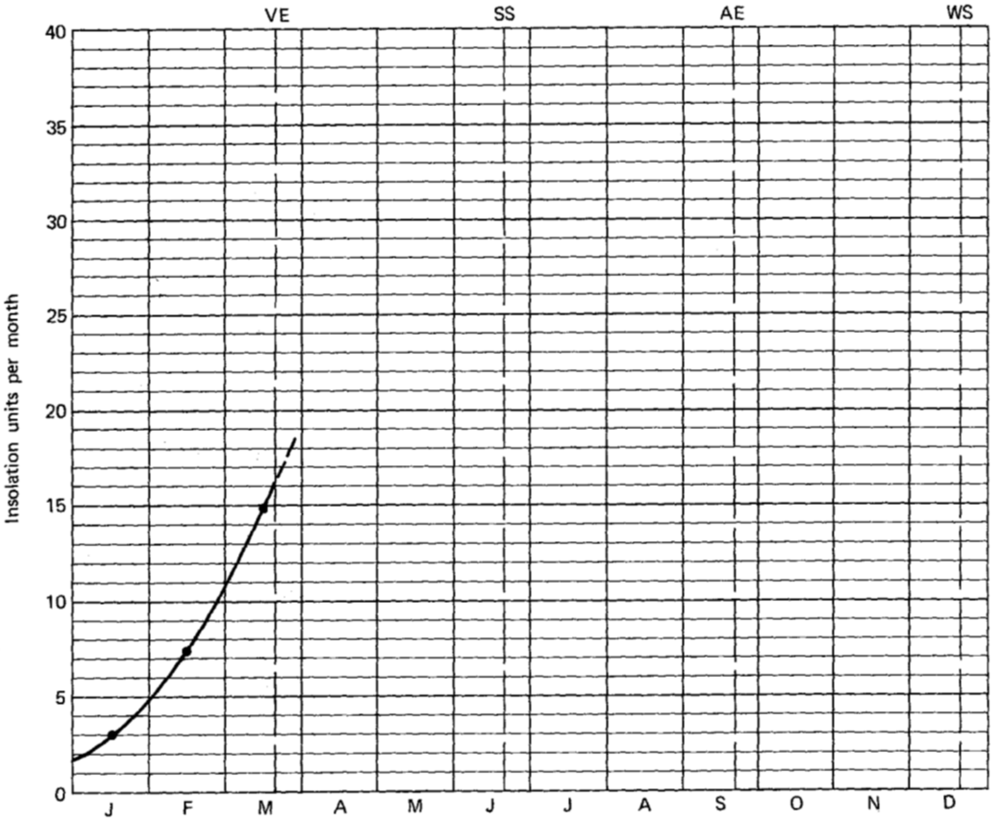
Majority Energy Distribution:



Conclusions:

SENSIBLE HEAT VS LATENT HEAT

Sensible Heat: __________ amount of molecular scale random ___________

- ✓ Quantity of _________ that can be sensed by touching or feeling (or ___________ with a thermometer)
- ✓ Heat that _________ ____ ___________ in temperature in an object

Sensible Heat Transfer:

Conduction: _________ transfer of heat (energy) from one object to another-- in direction of ____________ energy.

Convection: ______________ transfer of heat (energy). (i.e. when a warmer substance moves into the space of a cooler substance thus warming that space)

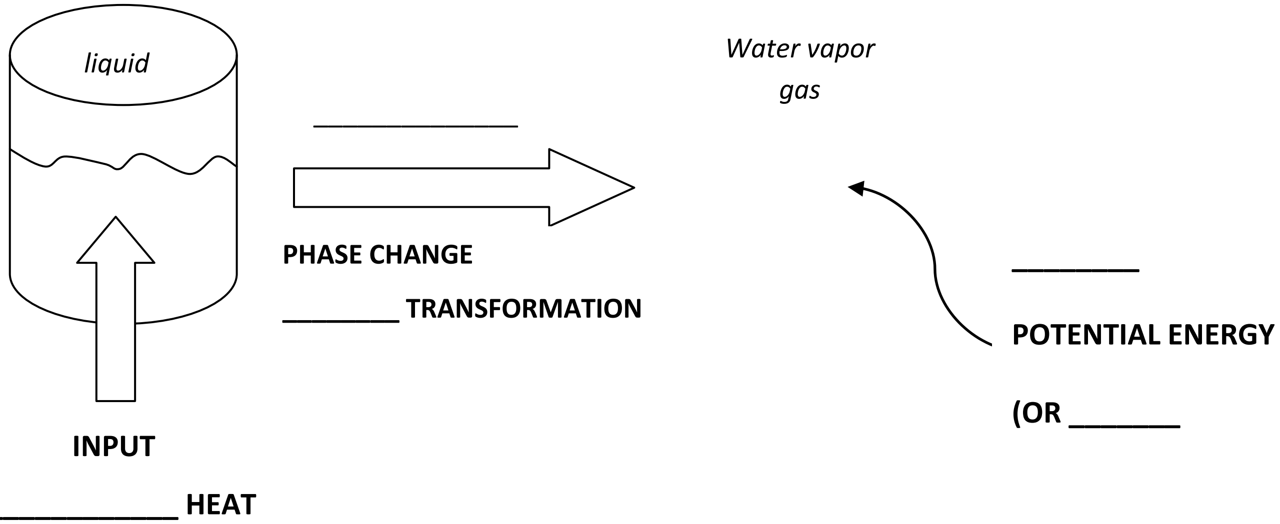
EXAMPLES:

Latent Heat: Energy that is released or absorbed during a change of state of a substance

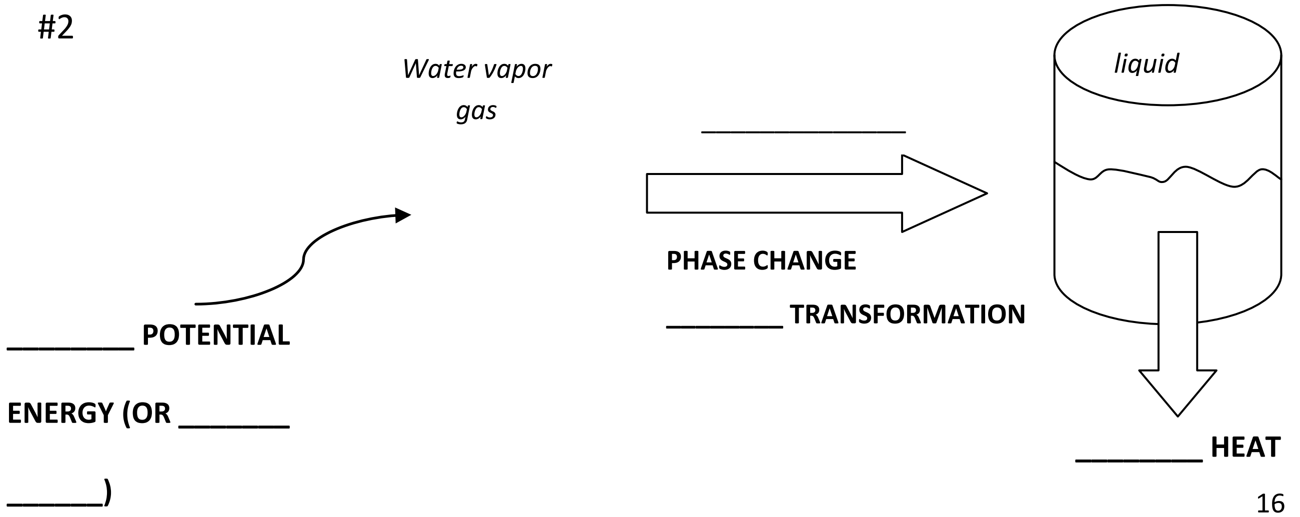
- ✓ Stored in the form of _____________ _____________
- ✓ ___________ be measured with a thermometer

**__________ transformation is required for any __________ change

#1



#2



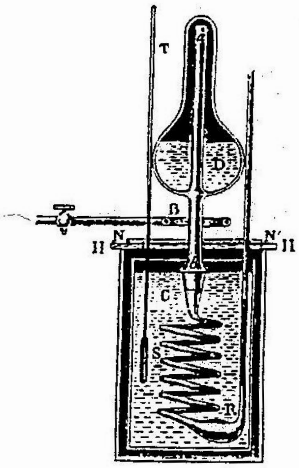
ENERGY TRANSFORMATIONS

GLOBAL ENERGY TRANSFER:

45

The Mystery of Disappearing Heat

by Richard Williams



Elegant 19th-century apparatus used to measure latent heat.

One of the most primitive human skills is our ability to tell whether an object is hot by touching it. It feels hot because of its energy content, called "sensible" heat.

Sensible heat has a lot to do with weather and climate—for example, the heat from the Gulf Stream warms the British Isles. But there is a more subtle form of heat, discovered relatively recently, that also plays a major role in shaping weather and climate. We can't detect it by touch, yet evidence of its existence is all around us.

Melting ice, for example, absorbs a large amount of heat without any increase in temperature. The evaporation of water absorbs even more without a temperature change; indeed, the heat needed to evaporate a given quantity of water is about *seven times* that required to warm it from room temperature to the boiling point! When the process is reversed and water freezes or vapor condenses, this "latent" heat returns to the environment. The latent heat stored in ice and transported by water vapor in the atmosphere has a profound effect on our weather and climate.

Early scientists were unable to grasp the concept of latent heat, which seems to disappear and then reappear later, somewhere else. To make matters worse, the distinction between heat (energy associated with molecular motion) and temperature (the degree of hotness or coldness) was poorly understood, and the instruments available to measure them were crude and unreliable. Finally, however, in a brilliant leap of scientific intuition, the bizarre behavior of latent heat was unmasked by a modest eighteenth century Scottish scientist named Joseph Black, who discerned a profound truth hidden in poorly understood and seemingly unrelated observations—even though it seemed to defy common sense.

The Dog That Did Not Bark

Black's attention was drawn to the latent heat puzzle by an observation on supercooled water made by physicist Gabriel Daniel Fahrenheit (of Fahrenheit temperature-scale fame). The latter reported the now well-known fact that water can be "supercooled" or chilled below the freezing point without turning to ice. When shaken, however, the supercooled water instantly turns to ice and the temperature rises to the freezing point.

We see this process in freezing rain, when fine, misty raindrops enter a zone of below-freezing air near the earth's surface and become supercooled. When the droplets impact trees and power lines, the supercooled water freezes immediately, forming a thick, heavy glaze of shimmering ice.

Black meditated on Fahrenheit's experiment and on his own observations of the slow melting of ice. Taken together, the two suggested that a large quantity of heat was absorbed as ice melts, and a corresponding quantity released by the freezing of water. Starting from this simple insight, he soon realized that a form of heat must exist that mysteriously disappears and reappears as water changes phases.

Black based his reasoning in part on the fact that something expected to happen did not. (Sherlock Holmes used similar logic to solve a puzzling case by noting that a dog at the crime scene had not barked.) In Black's time, the prevailing scientific opinion was that if you warmed very cold ice to the freezing point and then supplied a very small amount of additional heat, all the ice would melt. Eventually, Black would disprove this conventional wisdom experimentally, by showing that a container of ice at 32°F warmed to room temperature very much more slowly than a similar container of water at 32°F. Even before these experiments, however, he used the absence of the expected effect, "the dog that did not bark," to argue his case in his lecture notes:

"If the complete change of [ice and snow] into water required only the further addition of a very small quantity of heat, the mass, though of considerable size, ought all to be melted in a very few minutes or seconds more....Were this really the case, the consequences...would be dreadful in many cases; for even as things are at present, the melting of great quantities of snow and ice occasions violent torrents, and great inundations in cold countries, or in the rivers that come from them. But, were the ice and snow to melt...suddenly...the torrents would be incomparably more...dreadful."

Fortunately, the latent heat Black discovered provides a buffering effect that greatly slows the melting of ice and snow. This spares us many natural disasters. Imagine, for example, the catastrophic consequences if all the ice in the Arctic

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or Antarctic should suddenly melt one relatively warm summer day!

Having established the existence of latent heat in the melting of ice, Black turned to the vaporization of water. He was confident of a similar finding for vaporization, and even described the process in his lectures before demonstrating it experimentally. By analogy with the melting of ice, he reasoned that "the effect of heat...consists, not in warming the surrounding bodies, but in rendering the ice fluid; so, in the case of boiling, the heat absorbed does not warm surrounding bodies, but converts the water into vapor."

Again, Black used the "barking dog" argument: if a small quantity of heat added to boiling water could convert it all into vapor, the water would vaporize instantly with the explosive violence of gunpowder. Since this does not happen, he concluded that a large amount of heat must be added to convert boiling water into vapor, even though there is no change in its temperature. The extra heat is needed to break up the molecular cohesion of the water and, to a lesser degree, to expand the vapor against atmospheric pressure.

The concept of latent heat was essential to the full development of the steam engine. Crude steam engines already existed, but they were to be radically improved by James Watt. Watt knew Black, understood his ideas, and gave him generous credit for his scientific insights, which indicated there was seven times more energy available in steam at the boiling point than in an equal weight of water at the same temperature. This new scientific concept greatly advanced the practical use of steam power, transforming daily life in the industrializing nations.

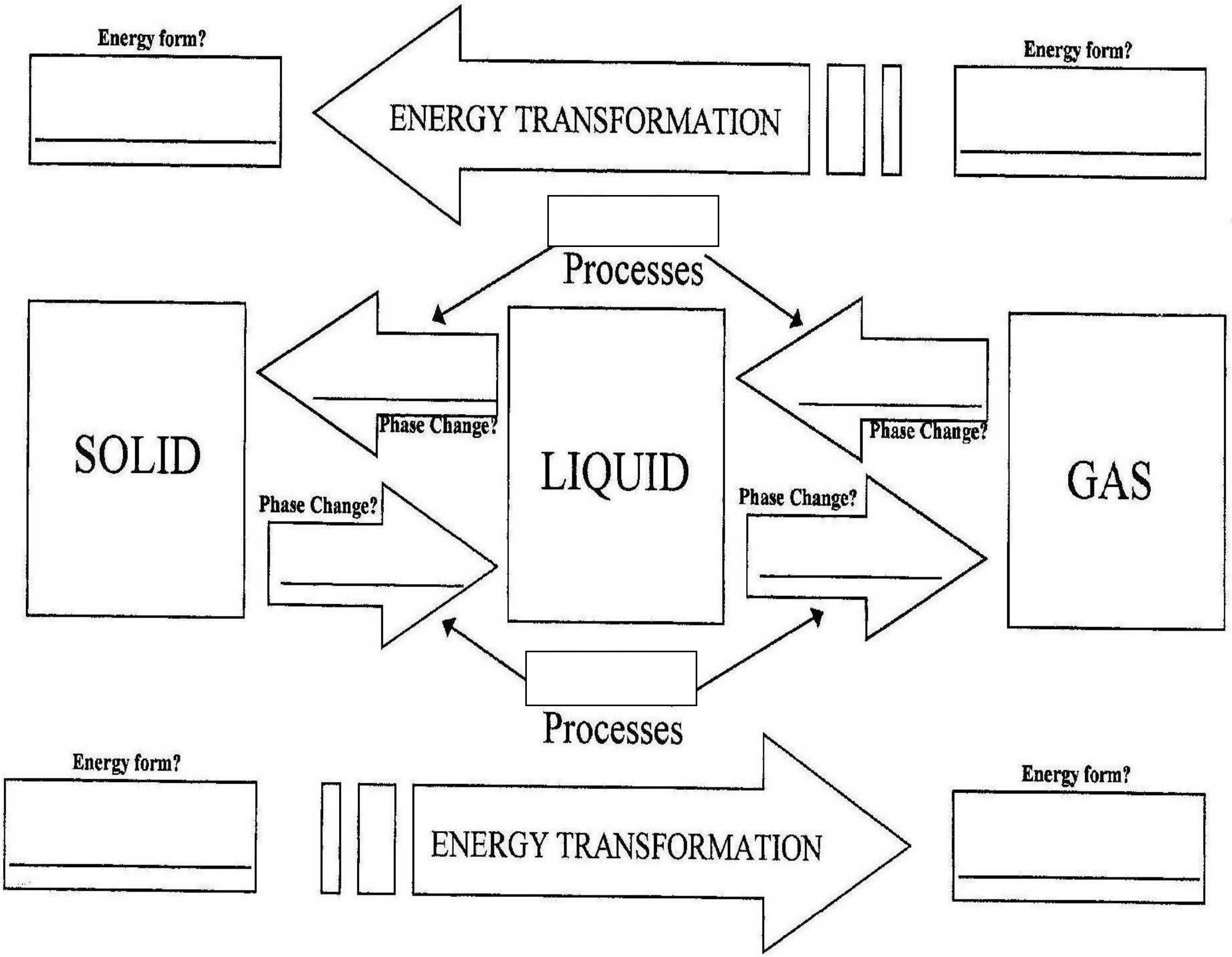
Some of Black's experiments on water vapor were related to distillation, then as now a traditional art in Scottish culture. Indeed, Black went to a distiller for practical advice on how to achieve the uniform heating of liquid needed to measure the latent heat of vaporization. Later, it would be recognized that the concept of latent heat applies not only to vaporization at the boiling point, but also to the evaporation and condensation of water in the atmosphere.

For the latent heat of vaporization shapes the meteorological world—both the daily weather and the longer-term climate. Indeed, a little over half the solar energy absorbed at the earth's surface is quickly transformed into latent heat by converting water to vapor; the heat reappears when the vapor condenses to form clouds and rain. Solar energy absorbed near the equator produces energy-rich water vapor that is transported to temperate regions by global atmospheric circulation. The heat released as the vapor condenses smooths out extreme climatic contrasts between different latitudes.

Latent heat is also released during a developing thunderstorm, as rising air at the center of the cumulonimbus cools and causes water vapor to condense. The amount of heat released can be enormous. If a thunderstorm deposits one-half inch of rain over a square mile, for example, the total latent heat released is about equal to the energy of a Hiroshima-size atomic bomb. Fortunately, the energy of the storm is usually spent renewing the earth, rather than destroying it. ⌶

CHEMICAL HERITAGE DATION

Joseph Black (1728-1799) discovered and explained the concept of latent heat.


Energy form?
ENERGY TRANSFORMATION
Energy form?
Processes
SOLID
Phase Change?
LIQUID
Phase Change?
GAS
Phase Change?
Phase Change?
Processes
Energy form?
ENERGY TRANSFORMATION
Energy form?

REVIEW QUESTIONS FOR TEST NUMBER ONE:

Rewrite and answer the following questions in detail for extra credit.

Introductions

1. What is physical geography? How does it differ/relate to human geography?

2. What are the "four great spheres?" How are they related?

The Geographic Grid

1. What is the "geographic grid"?

2. What is the logic behind lines of latitude and lines of longitude?

3. Where is the starting line for lines of longitude located? Why there?

4. Compare and contrast lines of latitude and lines of longitude (names, start, max, etc.)?

5. Make sure you can find locations when given coordinates and coordinates when given locations – practice using the map provided on page 2 of this handout.

6. Explain what "minutes" and "seconds" are in relation to the geographic grid.

7. Which is a more accurate representation of the earth, a map or a globe? Explain why.

8. What are Isolines? (isotherms, isobars, isohytes, contour lines). What is a gradient?

9. What are contour lines? What are they used for? Why are they important?

10. What is a topographic map?

11. Practice visualizing contour lines and the representation of profile views of landforms on a map and vice versa.

12. What are geographic information systems?

13. Explain the basics of how geographic information systems work and provide examples of varied uses for GIS.

THE UNDERPINNINGS OF SCIENCE

1. Explain what the ultimate goal of science is. How do scientists go about accomplishing that goal?

2. What is the scientific method?

3. What is scientific theory? Explain the “hallmarks” of scientific theory.

4. Why are the foundational laws we discussed in class important for this course?

5. Explain the law of conservation of mass.

6. Explain the 1st law of thermodynamics.

7. List and explain the different forms of energy.

8. Explain the 2nd law of thermodynamics? What is entropy? What is work? Provide some real world examples.

9. Explain all of the energy transfers that take place (as we did in class with the pen) when you bounce a ball.

THE EARTH AS A PLANET

1. Describe the earth’s place in the universe (age, theory of formation, locations, etc.)

2. What direction does the Earth rotate (as describe while looking at the equator and looking down from the north pole)?

3. How can you tell that the earth rotates in this direction?

4. Practice determining the time in these locations using the information provided (show all work)
    - ✓ 10pm in San Diego (120°W), what is the time in Philidelphia(75°W)
    - ✓ 1 am in Greenwhich, what is the time and day in Taiwan 120°E
    - ✓ Noon in San Diego, what is the time and day in Delhi (80°E)

5. What is the difference between “sun time” and “political time?” Why is there a difference/why was political time developed?

6. What is the international dateline? What happens when you cross it going in each direction (i.e. from east to west…)?

7. How many time zones exist? How wide is each?

8. Time zones are divided for two types of reasons. What are the reasons one time zone may be separated from another?

9. What were the principles of the Aristotelian-Ptolemaic model we discussed in class?

10. What idea did Copernicus introduce on his death bed?

11. How did Galileo further Coperinicus' idea? What new claims did he make? What evidence did he have to support them? And what happened to him as a result?

12. What contribution did Kepler make to our Earth-Sun understanding?

13. How did Newton finish everything off?

14. What were the four key characteristics of Earth's revolution that these historical findings led to?

15. Explain what is meant by "earth's elliptical orbit." What is the plane of the ecliptic?

16. How is the distance between the Earth and the Sun related to the seasons we experience on Earth?

17. <u>Sketch</u> and describe Earth's axial *inclination*.

18. <u>Sketch</u> and describe Earth's axial *orientation*.

19. What is solar declination? Why is it important?

20. Use figure 3.20 from your book (pg. 53) to estimate where the solar declination is on the following dates: Jan *30, Feb 30, Mar 21, Apr 15, May 15, June 21, Aug 1, Sep 21, Nov 15, Dec 21*

21. Draw from memory the Earth-Sun relationship on the four important days of the year we discussed in class as well as where the earth is TODAY in the diagram (list the names, dates and solar declination on those days).

22. Describe what conditions on Earth look like on each of the important days discussed above (i.e. where is the hottest spot in the world, where is it summer/winter, daylight hours, etc.)

23. Where are the Tropics of Cancer and Capricorn; why are they important?

24. Explain in detail (referring to the key ideas explained above) exactly why we have seasons on Earth and what is happening within the Earth-Sun relationship as the Earth revolves around the sun.

EARTH'S GLOBAL ENERGY BALANCE

1. What is the Electromagnetic Spectrum?

2. What is Radiation? What types of things emit radiation?

3. What is a wavelength? What is the difference between different forms of radiation?

4. Draw and label the electromagnetic spectrum. Add the following in the ranges they belong: Near Infrared, thermal infrared, radio waves, ultraviolet light, the visible portion of the spectrum and x-rays.

5. What is the difference between visible radiation (the light we can see) and all the other types of radiation that we cannot see?

6. What did the Stefan-Boltzmann radiation law explain to us?

7. What did Wien's law explain? Sketch the earth-sun example from class

8. Over the long term what is the relationship between insolation and outgoing radiation?

9. What is insolation?

10. What are the two variables that contribute to annual insolation variation throughout the Earth (before any of the atmospheric variables are accounted for)?

11. How is solar declination related to sun angle?

12. How does sun angle vary *daily*? What does this mean in relation to energy receipt at a given spot and why is this important? Sketch a diagram illustrating this.

13. How does sun angle vary *seasonally*? What does this mean in relation to energy receipt at a given spot and why is this important? Sketch a diagram illustrating this.

14. Why is day length important in understanding Energy receipt on Earth?

15. How do the hours of daylight received at different latitudes (ex. The ones we discussed in class) vary as the Earth revolves around the sun? Where are the drastic changes in day length/the least drastic, etc.

16. What do day lengths look like on the four important days we have repeatedly discussed?

17. Interpret the insolation graph from our notes and figure 4.8 in your book. What conclusions did we draw from this graph? Use your answers from Q9-15 above to explain why insolation the way it does at different latitudes on different dates.

18. What is the atmosphere? Where is the most of it located?

19. What is the composition of the atmosphere (refer to both constant and variable gases)?

20. What is "ozone?" Why is it important? What happened to the ozone layer in the past and what is currently happening to it? (sketch a diagram)

21. What is the greenhouse effect (use the specific terms when explaining it: longwave, shortwave radiation, greenhouse gases, absorb, emit, etc.)? Why is it important? Why do some people think it is a bad thing? (<u>sketch a diagram</u>)

22. Sketch and explain the global energy balance in terms of units of incoming solar radiation. Where do they all go? How are they distributed? What happens in the big and little picture?

23. What is albedo? How does it vary? What types of things have high/low albedos? What is the average albedo of earth?

24. What types of mechanisms work to correct this imbalance in energy between the surface and the atmosphere?

25. What is sensible heat?

26. In what two ways is sensible heat transferred? Explain these and give examples of each.

27. What is latent heat? Why is it important? Explain this concept in detail.

28. Explain in detail the molecular action that occurs when substances (ex. Water) change states (Where is heat released/absorbed/stored; in what form, etc.)

29. What is latent heat transfer? When does it occur? How does it occur. <u>**Sketch and explain the flow chart from class.**</u>

30. What is net radiation? How does it vary and how does this influence physical processes.

31. What are some mechanisms for global heat transfer?

32. Explain energy, radiation, insolation, thermodynamics, and the earth-sun relationship. Why are these concepts important? Why did we begin with these in this course (i.e. what other major course concepts do these influence)?