Name ______________________________ Date __________

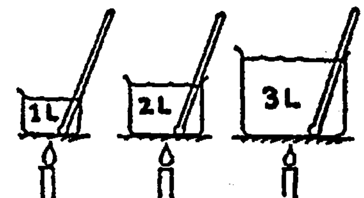
CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 15 Temperature, Heat, and Expansion
Measuring Temperatures

1. *Complete the table.*

TEMPERATURE OF MELTING ICE	0 °C	32 °F	273 K
TEMPERATURE OF BOILING WATER	100 °C	212 °F	373 K

2. Suppose you apply a flame and warm 1 liter of water, raising its temperature 10°C. If you transfer the same heat energy to 2 liters, how much will the temperature rise? For 3 liters? Record your answers on the blanks in the drawing at the right.

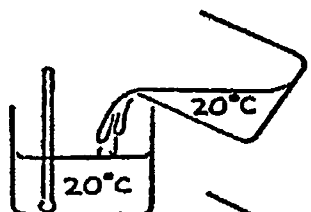


ΔT = 10°C ΔT = 5 °C ΔT = 3.3°C

3. A thermometer is in a container half-filled with 20 °C water.

a. When an equal volume of 20 °C water is added, the temperature of the mixture will be

[10 °C] [20 °C] [40 °C].

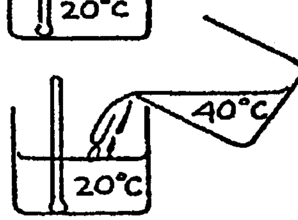


b. When instead an equal volume of 40 °C water is added, the temperature of the mixture will be

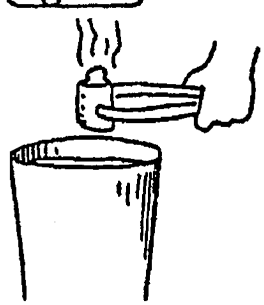
[20 °C] [30 °C] [40 °C].

c. When instead a small amount of 40 °C water is added, the temperature of the mixture will be

[20 °C] [between 20 °C and 30 °C] [30 °C] [more than 30 °C].



4. A small red-hot piece of iron is put into a bucket of cool water. (Ignore the heat transfer to the bucket.)

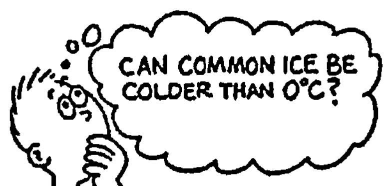


a. [True] [False] The decrease in iron temperature equals the increase in the water temperature.

b. [True] [False] The quantity of heat lost by the iron equals the quantity of heat gained by the water.

c. [True] [False] The iron and water both will eventually reach the same temperature.

d. [True] [False] The final temperature of the iron and water is halfway between the initial temperatures of each.



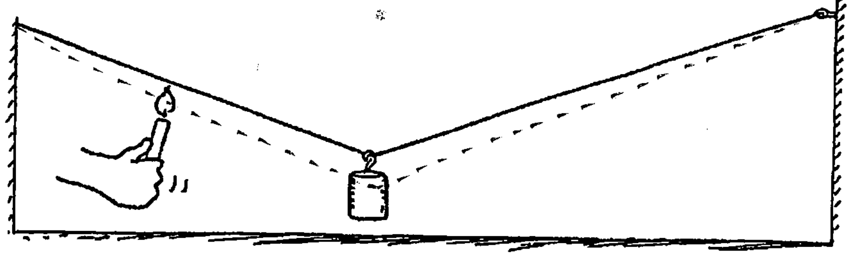
Hewitt Drew it!

Chapter 15 Temperature, Heat, and Expansion

Thermal Expansion

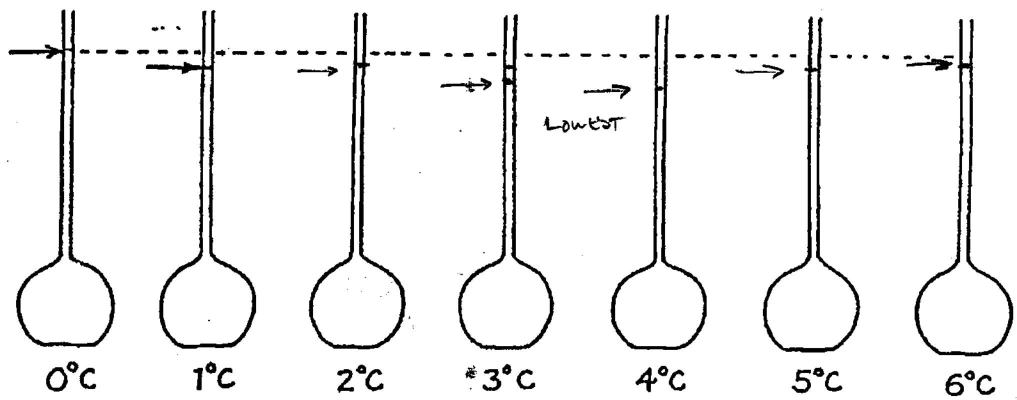
1. The weight hangs above the floor from the copper wire. When a candle is moved along the wire and heats it, what happens to the height of the weight above the floor? Why?

   THE HEIGHT DECREASES BECAUSE THE MOLECULES GET EXCITED AND MOVE MORE, ALLOWING LENGTH OF WIRE TO EXPAND

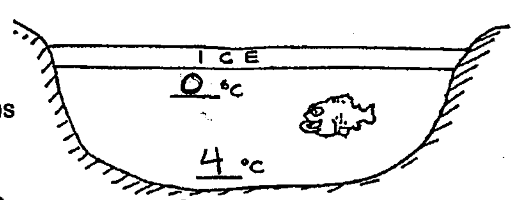


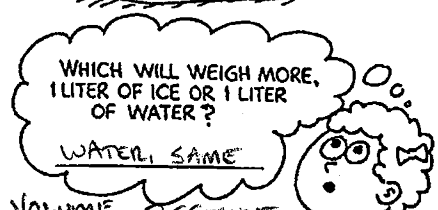
2. The levels of water at 0 °C and 1 °C are shown below in the first two flasks. At these temperatures there is microscopic slush in the water. There is slightly more slush at 0 °C than at 1 °C. As the water is heated, some of the slush collapses as it melts, and the level of the water falls in the tube. That's why the level of water is slightly lower in the 1 °C tube. Make rough estimates and sketch in the appropriate levels of water at the other temperatures shown. What is important about the level when the water reaches 4 °C?

   ALL THE SLUSH HAS MELTED @ 4°C



3. The diagram at the right shows an ice-covered pond. Fill in the blanks for likely temperatures of the water at the top and bottom of the pond and answer the questions below.





VOLUME, DIFFERENT DENSITY (ICE LESS DENSE THAN H_2O, WHILE LIQUIDS OF MOST MATERIALS WILL WEIGH LESS THAN SOLIDS.

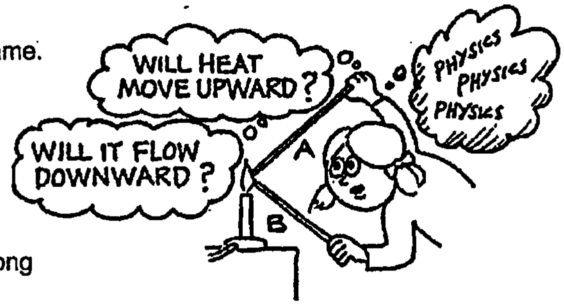
Hewitt Drew it!

Name ______________________ Date __________

CONCEPTUAL *Physics* PRACTICE PAGE

Chapter 16 Heat Transfer
Transmission of Heat

1. The tips of both brass rods are held in the gas flame.



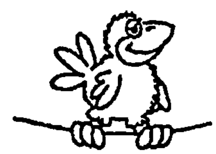
   a. [True] [False] Heat is conducted only along Rod A.

   b. [True] [False] Heat is conducted only along Rod B.

   c. [True] [False] Heat is conducted equally along both Rod A and Rod B.

   d. [True] [False] The idea that "heat rises" applies to heat transfer by *convection*, not by *conduction.*

2. Why does a bird fluff its feathers to keep warm on a cold day?



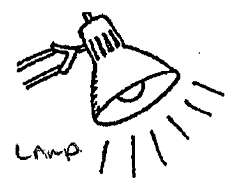
TRAPS AIR TO CREATE AN INSULATING LAYER.

3. Why does a down-filled sleeping bag keep you warm on a cold night? Why is it useless if the down is wet?

AIR IN THE DOWN IS TRAPPED - PREVENT CONVECTION

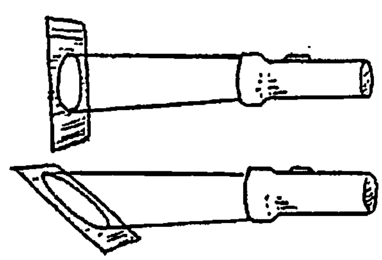
AIR PREVENTS CONDUCTION - WATER WOULD PROMOTE THIS.

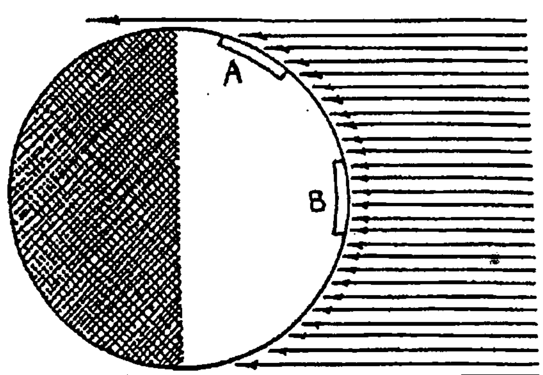
4. What does *convection* have to do with the holes in the shade of the desk lamp?



AIR FLOWS THROUGH VENTS, BY CONVECTION, COOLS LAMP

5. The warmth of equatorial regions and coldness of polar regions on Earth can be understood by considering light from a flashlight striking a surface. If it strikes perpendicularly, light energy is more concentrated as it covers a smaller area; if it strikes at an angle, the energy spreads over a larger area. So the energy per unit area is less.





The arrows represent rays of light from the distant Sun incident upon Earth. Two areas of equal size are shown, Area A near the North Pole and Area B near the equator. Count the rays that reach each area, and explain why B is warmer than A.

6 RAYS @ B ∴ MORE LIGHT/HEAT ENERGY

3 RAYS @ A

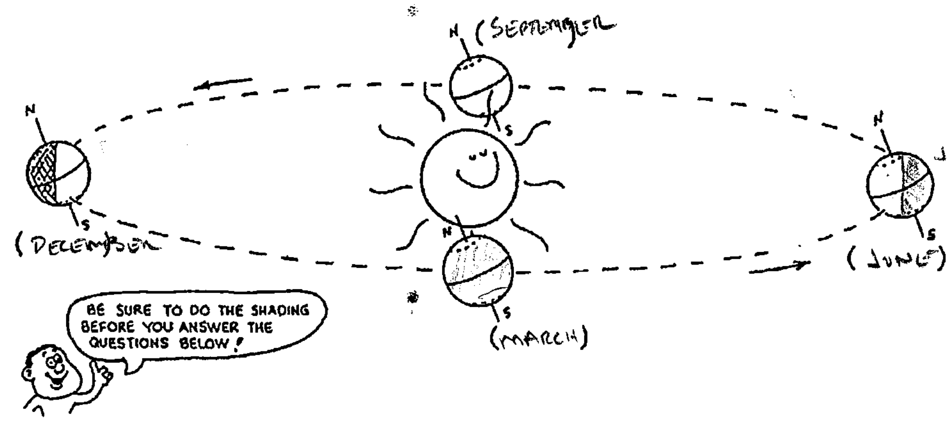
Hewitt Drew it!

CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 16 Heat Transfer
***Transmission of Heat**—continued*

6. Earth's seasons result from the 23.5-degree tilt of Earth's daily spin axis as it orbits the Sun. When Earth is at the position shown on the right in the sketch below (not to scale), the Northern Hemisphere tilts toward the Sun, and sunlight striking it is strong (more rays per area). Sunlight striking the Southern Hemisphere is weak (fewer rays per area). Days in the north are warmer, and daylight is longer. You can see this by imagining Earth making its complete daily 24-hour spin.

   Do two things on the sketch:
   i. Shade the part of Earth in nighttime darkness for all positions, as is already done in the left position.
   ii. Label each position with the proper month—March, June, September, and December.



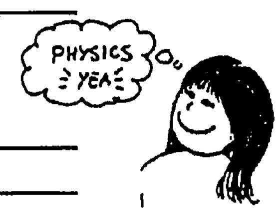
   a. When Earth is in any of the four positions shown, during one 24-hour spin a location at the equator receives sunlight half the time and is in darkness the other half of the time. This means that regions at the equator always receive about __12__ hours of sunlight and __12__ hours of darkness.

   b. Can you see that in the June position regions farther north have longer daylight hours and shorter nights? Locations north of the Arctic Circle (dotted line in Northern Hemisphere) always face toward the Sun as Earth spins, so they get daylight __24__ hours a day.

   c. How many hours of light and darkness are there in June at regions south of the Antarctic Circle (dotted line in Southern Hemisphere)?
   MORE THAN 12 HOURS OF LIGHT LESS THAN 12 DARKNESS

   d. Six months later, when Earth is at the December position, is the situation in the Antarctic Circle the same or is it the reverse?
   REVERSE

   e. Why do South America and Australia enjoy warm weather in December instead of June?
   THEY ARE IN SOUTHERN HEMISPHERE



Name ______________________________ Date __________

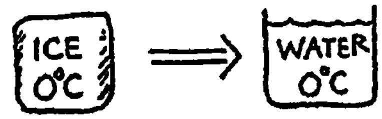
CONCEPTUAL Physics PRACTICE PAGE

Chapter 17 Change of Phase
Ice, Water, and Steam

All matter can exist in the solid, liquid, or gaseous phases. The solid phase normally exists at relatively low temperatures, the liquid phase at higher temperatures, and the gaseous phase at still higher temperatures. Water is the most common example, not only because of its abundance but also because the temperatures for all three phases are common. Study "Energy and Changes of Phase" in your textbook and then answer the following:

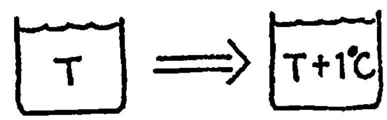
1. How many calories are needed to change 1 gram of 0 °C ice to water?

   80 calories



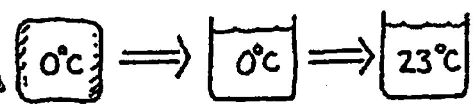
2. How many calories are needed to change the temperature of 1 gram of water by 1 °C?

   1 calorie



3. How many calories are needed to melt 1 gram of 0 °C ice and turn it to water at a room temperature of 23 °C?

   80 calories + 23 calories = 103 calories



4. A 50-gram sample of ice at 0 °C is placed in a glass beaker that contains 200 g of water at 20 °C.

   a. How much heat is needed to melt the ice?

   4000 calories

   50g of ice
   80 cal/g → $50\text{g} \times \frac{80\text{cal}}{\text{g}} = 4000\text{ cal}$

   b. By how much would the temperature of the water change if it gave up this much heat to the ice?

   By 20°C

   1g → 1 cal per 1°C   200g → 200 cal per 1°C

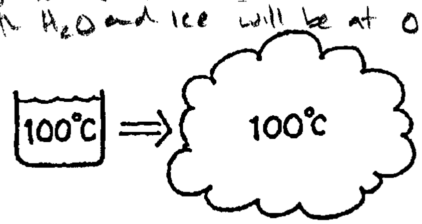
   $4000\text{cal} \cdot \frac{1\,°\text{C}}{200\text{cal}} = 20°\text{C}$

   c. What will be the final temperature of the mixture? (Disregard any heat absorbed by the glass or given off by the surrounding air.)

   0°C If the heat needed to melt the ice all comes from the cooling of the water, (4000cal) the water will cool from 20°C to 0°C, so both H_2O and ice will be at 0°C

5. How many calories are needed to change 1 gram of 100 °C boiling water to 100 °C steam?

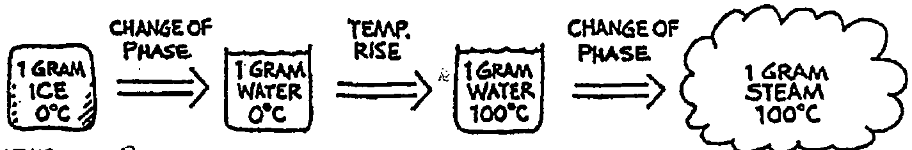
   540 calories



Hewitt Drew it!

Chapter 17 Change of Phase
Ice, Water, and Steam—continued

6. Fill in the number of calories at each step below for changing the phase of 1 gram of 0°C ice to 100°C steam.

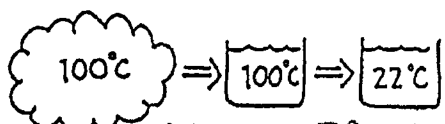


HEAT NEEDED = 80 CAL + 100 CAL + 540 CAL = 720 CAL

7. How many calories are given up by 1 gram of 100°C steam that condenses to 100°C water?

540 cal

8. How many calories are given up by 1 gram of 100°C steam that condenses and drops in temperature to 22°C water?



540cal + 78 cal = 618 cal.

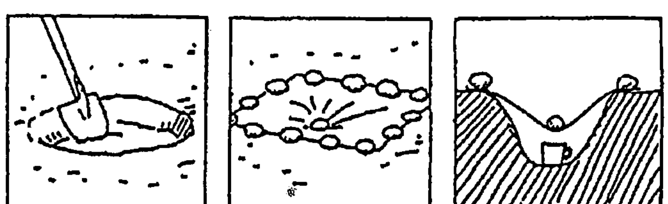
9. How many calories are given to a household radiator when 1000 grams of 100°C steam condenses and drops in temperature to 90°C water?

$\left[540\text{ cal} + 10\text{ cal}\right] 1000\text{ g} \cdot \frac{1\text{ cal}}{1\text{ g}} = 550{,}000$ Calories

10. Why is it difficult to make tea on the top of a high mountain?

Water boils at a lower temperature, as it can get no hotter than its boiling temperature

11. To get water from the ground, even in the hot desert, dig a hole about a half meter wide and a half meter deep. Place a cup at the bottom. Spread a sheet of plastic wrap over the hole and place stones along the edge to hold it secure. Weight the center of the plastic with a stone so it forms a cone shape.
Why will water collect in the cup? (Physics can save your life if you're ever stranded in a desert!)

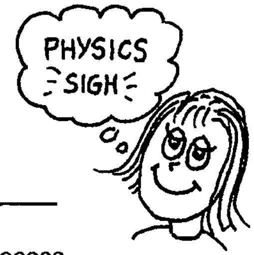


Evaporated vapor from the heated ground cannot escape so it will condense on the plastic wrap. (Air on other side is cool.) It will run down the plastic and drip into the cup. At night, moisture will condense on outside of plastic and run into lowest part. Hewitt Drew it!

Name ______________________ Date __________

CONCEPTUAL **Physics** PRACTICE PAGE

Chapter 17 Change of Phase
Evaporation



1. Why do you feel colder when you swim in a pool on a windy day?

   Water evaporates from your body more quickly and cools you faster.

2. Why does your skin feel cold when a little rubbing alcohol is applied to it?

   RUBBING ALCOHOL EVAPORATES RAPIDLY AND HEAT FROM YOUR SKIN IS USED TO EVAPORATE IT.

3. Briefly explain from a molecular point of view why evaporation is a cooling process.

   THE FASTER, THUS MORE ENERGETIC, MOLECULES ESCAPE INTO THE AIR TAKING THEIR ENERGY WITH THEM. THIS REDUCES THE AVERAGE KINETIC ENERGY OF THE SYSTEM THAT THEY LEFT.

4. When hot water rapidly evaporates, the result can be dramatic. Consider 4 g of boiling water spread over a large surface so that 1 g rapidly evaporates. Suppose further that the surface and surroundings are very cold so that all 540 calories for evaporation come from the remaining 3 g of water.

   a. How many calories are taken from each gram of water that remains?

   $\frac{540 \text{ cal}}{3} = 180$ calories

   b. How many calories are released when 1 g of 100°C water cools to 0°C?

   100 calories

   c. How many calories are released when 1 g of 0°C water changes to 0°C ice?

   80 calories

   d. What happens in this case to the remaining 3 g of boiling water when 1 g rapidly evaporates?

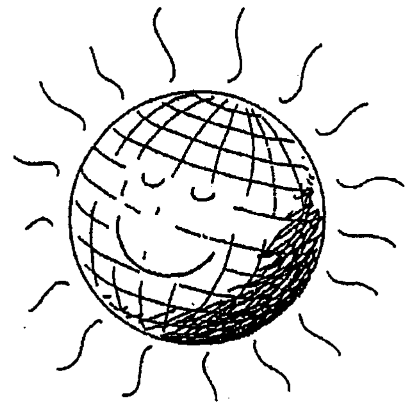
   Each gram of water releases 180 calories, thus using 100 calories to drop to 0°C then 80 calories to become ice. THUS IT FREEZES.

Hewitt Drew it!

CONCEPTUAL *Physics* PRACTICE PAGE

Chapter 17 Change of Phase
Our Earth's Hot Interior

A major puzzle faced scientists in the 19th century. Volcanoes showed that Earth is molten beneath its crust. Penetration into the crust by bore holes and mines showed that Earth's temperature increases with depth. Scientists found that heat flows from the interior to the surface. They assumed that the source of Earth's internal heat was primordial, the afterglow of its fiery birth. Measurements of cooling rates indicated a relatively young Earth—some 25 to 30 millions years in age. But geological evidence indicated an older Earth. This puzzle wasn't solved until the discovery of radioactivity. Then it was learned that the interior is kept hot by the energy of radioactive decay. We now know the age of Earth is some 4.5 billion years—a much older Earth.

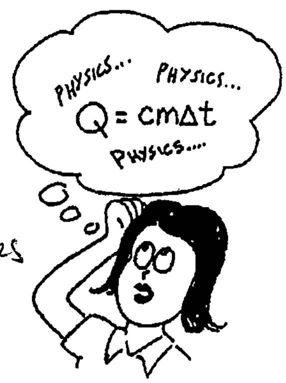


All rock contains trace amounts of radioactive minerals. Those in common granite release energy at the rate of 0.03 joule/kilogram·year. Granite at Earth's surface transfers this energy to the surroundings as fast as it is generated, so we don't find granite warm to the touch. But what if a sample of granite were thermally insulated? That is, suppose the increase of internal energy due to radioactivity were contained. Then it would get hotter. How much? Let's figure it out, using 790 joule/kilogram·kelvin as the specific heat of granite.

Calculations:

1. How many joules are required to increase the temperature of 1 kg of granite by 1000 K?
   $(1\ kg)\left(\frac{790\ J}{kg \cdot K}\right)(1000\ K) = 790{,}000\ J$

2. How many years would it take radioactive decay in a kilogram of granite to produce this many joules?
   $790{,}000 / 0.03\ J/kg \times 1\ kg = 26.3$ million years

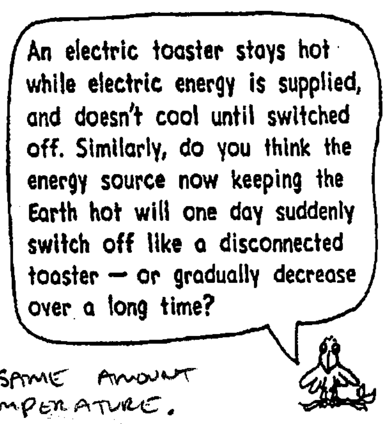


Questions:

1. How many years would it take a thermally insulated 1-kg chunk of granite to undergo a 1000 K increase in temperature?
   Same, 26.3 million years

2. How many years would it take a thermally insulated one-million-kilogram chunk of granite to undergo a 1000 K increase in temperature?
   Same (more mass, more radiation)

3. Why are your answers to the above the same (or different)?
   THE SAME. THE ENERGY RELEASED PER KILOGRAM IS THE SAME FOR BOTH. A BIGGER CHUNK GIVES MORE RADIATION AND REQUIRES THE SAME AMOUNT OF ENERGY PER KILOGRAM FOR A CHANGE IN TEMPERATURE.



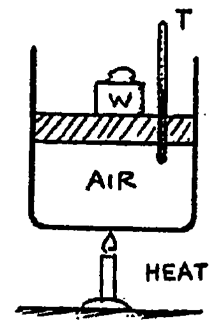
4. [True] [False] Energy produced by Earth radioactivity ultimately becomes terrestrial radiation.

Hewitt Drew it!

Name ______________________________ Date ____________

CONCEPTUAL Physics PRACTICE PAGE

Chapter 18 Thermodynamics
Absolute Zero

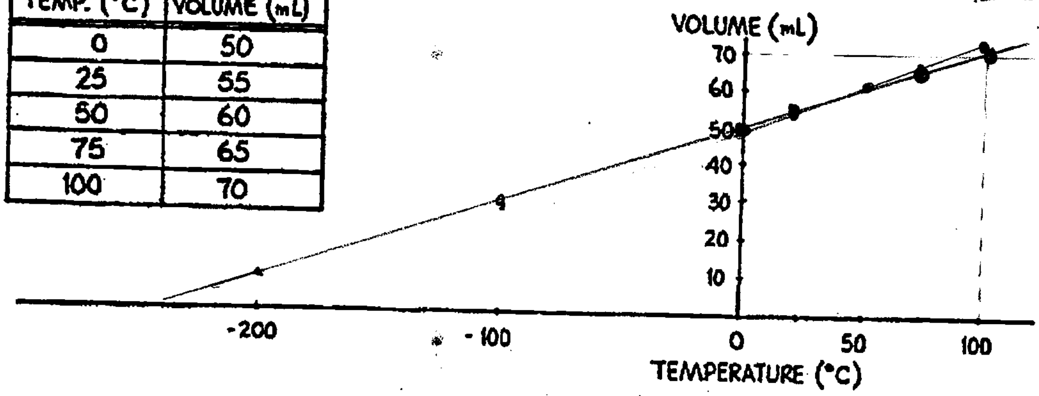


A mass of air is contained so that the volume can change while the pressure remains constant. Table I shows air volumes at various temperatures when the air is warmed slowly.

1. Plot the data in Table I on the graph and connect the points.

TABLE I

TEMP. (°C)	VOLUME (mL)
0	50
25	55
50	60
75	65
100	70

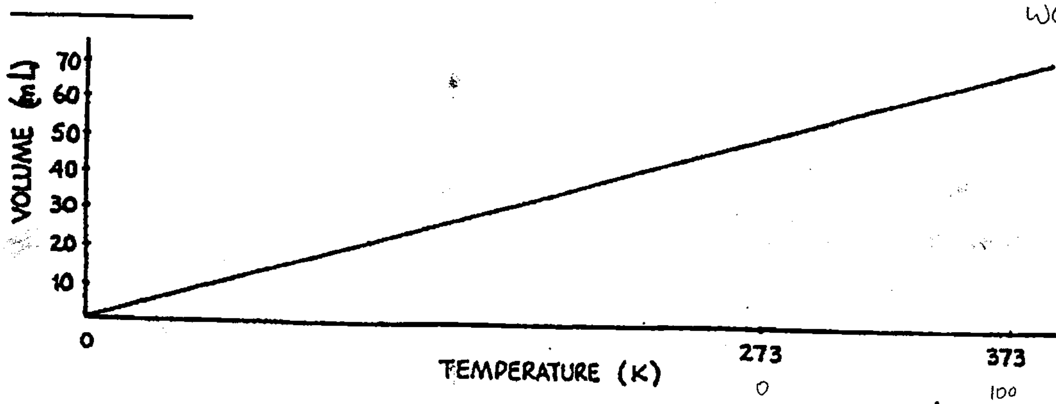


2. The graph shows how the volume of air varies with temperature at constant pressure. The straightness of the line means that the air expands uniformly with temperature. From your graph you can predict what will happen to the volume of air when it is cooled.

   Extrapolate (extend) the straight line of your graph to find the temperature at which the volume of the air would become zero. Mark this point on your graph. Estimate this temperature: 250°

3. Although air would liquefy before cooling to this temperature, the procedure suggests that there is a lower limit to how cold something can be. This is the absolute zero of temperature. Careful experiments show that absolute zero is -273 °C.

4. Scientists measure temperature in *kelvins* instead of degrees Celsius, where the absolute zero of temperature is 0 kelvins. If you relabeled the temperature axis on the graph in Question 1 so that it shows temperature in kelvins, would your graph look like the one below? yes... Wow..



Hewitt Drew it!