

## THE PHYSICAL PROPERTIES AND PHYSICAL CHANGES OF SUBSTANCES

Key

- .. A beaker of water contains some water that is at  $87^{\circ}\text{C}$ . Describe the temperature of the water
- in a "qualitative" way - hot
  - in a "quantitative" way -  $87^{\circ}\text{C}$
2. Say whether the following statements describe physical properties or chemical properties.
- |   |   |
|---|---|
| a) $\text{C}_3\text{H}_8$ burns in $\text{O}_2$ <u>chemical</u> | b) gold does not rust <u>chemical</u>               |
| c) glass is brittle <u>physical</u>                             | d) $\text{NaCl}$ dissolves in water <u>physical</u> |
3. Fill in the blank. Spelling counts.
- diffusion is the intermingling of fluids as a result of molecular motion.
  - viscosity is the resistance of a fluid to flow.
  - malleability is the ability to be rolled or hammered into thin sheets.
4. Give a scientific explanation of each of the following terms:
- substance - matter with a unique set of properties
  - boiling point - temp. at which the vapour pressure of a liquid equals the air pressure.
  - chemical property - the ability of a substance to undergo chem. reaction
5. If the boiling point of acetone is  $56^{\circ}\text{C}$ , should the gaseous form of acetone be called a "gas" or a "vapour"? Vapour Explain your reasoning.

The B.P. of acetone is above room temperature so in gas form it is a "vapour".

6. When some water at room temperature is placed in a bell jar and the air is removed with a vacuum pump, the water starts to boil. Explain why this happens.

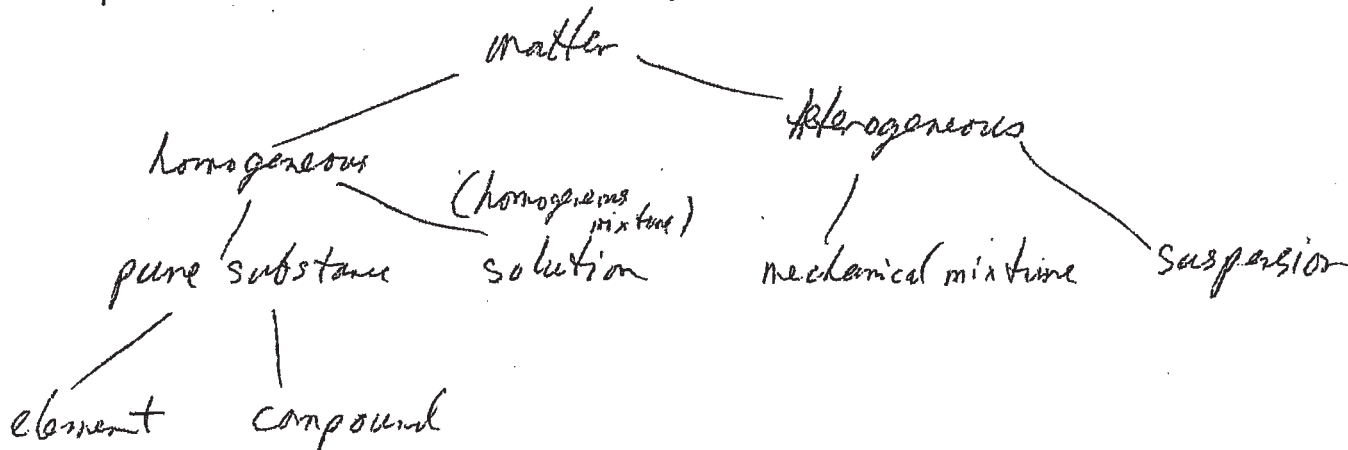
When air and its pressure on the water is removed, water is able to boil at a much lower temperature.

The temperature needed to boil is actually a measure of the energy required to allow water molecules to jump into the air. If the pressure exerted by the air's mass is removed, then the energy required by the water to jump into the air, will dramatically decrease. As such, it can now jump into the air at a much lower energy amount (temperature).

7. Acetone has a <sup>vapour</sup> pressure of 31 kPa at room temperature. Butanol has a vapour pressure of 0.9 kPa at the same temperature. Which of these liquids has the lower boiling point?

acetone

8. Complete a chart to show how chemists classify matter. Spelling counts.



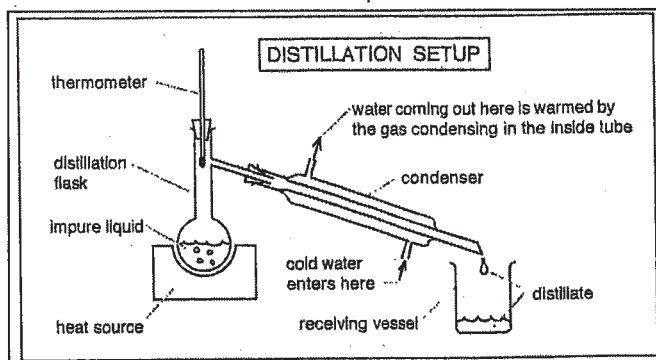
9. According to the information given, classify the following materials as completely as possible. Note: You will be using the classifications from the chart completed for question 8.

- a) a clear yellow liquid has an increasing boiling point. solution
- b) a white liquid slowly clears at the top. suspension
- c) a pale blue solid has white crystals and blue crystals. mechanical mixture
- d) a clear blue liquid leaves a blue residue after evaporation. solution
- e) the boiling point of this clear liquid rises slowly until all of the liquid has evaporated. solution
- f) a green solid when heated to 311°C turns black and gives off a colourless gas. compound
- g) a colourless liquid boils at a steady 62°C. pure substance
- h) a reddish solid melts at 1085°C and boils at 2563°C. Neither additional heat nor electricity will create new substances from it. element

10. Name one separation method (from our list of 8 methods) that could be used to easily separate the following mixtures. Spelling counts.
- a solution of methanol in water distillation
  - sawdust particles floating around in water filtration (gravity  $\pm$ ) (distillation) <sup>hand sep</sup> way
  - a mixture of  $I_2$  (soluble in  $CCl_4$ ) and NaCl (soluble in  $H_2O$ ) solvent extraction
  - brass pellets mixed with glass pellets hand separation or (gravity)

11. Explain how recrystallization is able to purify many solid substances. You may include a diagram but you must also explain in writing.

- Pour mixture into an erlenmeyer flask.
  - Find a solvent in the "big chem book" that will dissolve both parts of mixture (usually water).
  - Add 10% by weight of the solvent to the mixture and heat until mixture is fully dissolved.
  - Remove flask from heat and let cool.
  - Product should recrystallize out of solution first (most cases).
  - Pour off water/impurity solution.
  - Recrystallize again until desired level of purity has been attained.
12. Sketch and label the apparatus that you would use in a science lab to do a distillation.

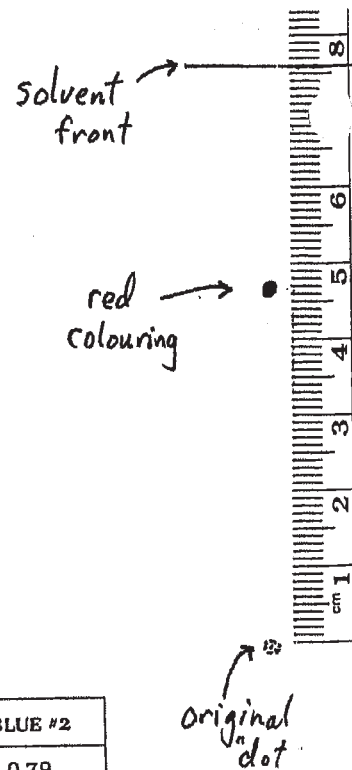


13. a) What is the name for the separation technique wherein a mixture of food colourings can be separated using a strip of filter paper and some water? chromatography
- b) Explain, by describing what is happening with the particles, how this technique is able to cause the separation to occur.

Separation is caused by a tug-of-war between the solvent (water) and the paper. The chemical dye is pulled into the solvent as it is dissolved, and then carried up the paper by the attractive forces between the solvent (water) and the chemical dye. Over time the dye will be pulled out of the solvent (water) by the attractive force from the paper. It is the difference in affinities between the solvent (water) and the paper that allows the chemical dye to travel varying amounts for different chemicals.

c) For the separation shown on the right, make the appropriate measurements and then calculate the R<sub>f</sub> value for the red food colouring (solute).

$$R_f = \frac{4.7 \text{ cm}}{7.6 \text{ cm}} = 0.62$$



d) Using the chart, determine the identity of the red food dye from question 13c. Red # 4

Table 4 Some of the Dyes Approved for Food Colorings

DYE	RED #2	RED #3	RED #4	YELLOW #5	YELLOW #6	BLUE #1	BLUE #2
R <sub>f</sub>	0.81	0.41	0.62	0.95	0.77	1.0	0.79

14. Classify each of the following as primarily a physical change or a chemical change.

a) distilling petroleum physical

b) burning wood chemical

c) tarnishing of silver chemical

d) dissolving salt in water physical

15. Fill in the blanks: a)  $-22^{\circ}\text{C} = \underline{251} \text{ K}$

b)  $289\text{K} = \underline{16}^{\circ}\text{C}$

16. What happens to the particles of a material when

a) their potential energy is increased? — move farther apart

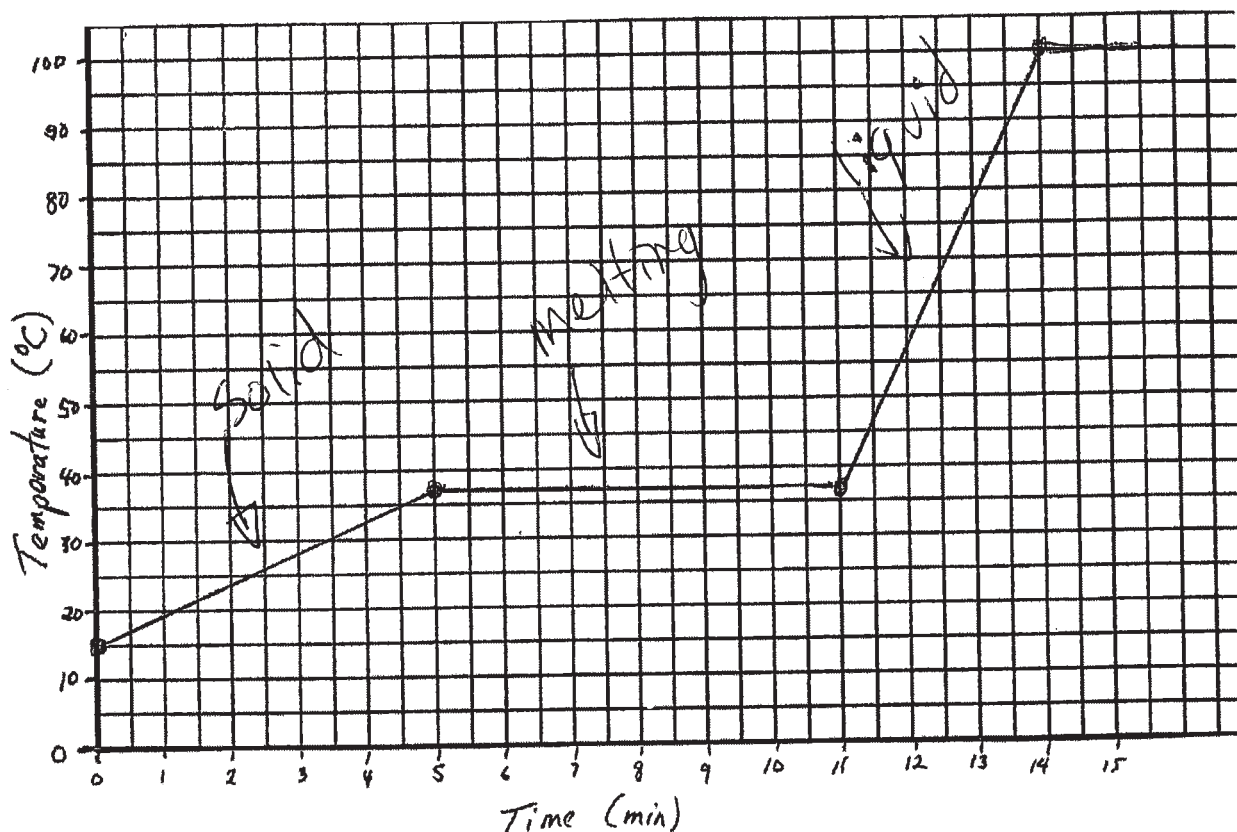
b) their kinetic energy is decreased? — move more slowly

17. Fill in the blank with either **increasing**, **decreasing**, or remaining relatively **constant**.

a) During the process of freezing (solidification), the kinetic energy is constant and the potential energy is decreasing.

b) While heating a liquid from  $27^{\circ}\text{C}$  to  $56^{\circ}\text{C}$ , the kinetic energy is increasing and the potential energy is constant.

18. Substance X has a melting point of  $37^{\circ}\text{C}$  and a boiling point of  $279^{\circ}\text{C}$ . When a sample at  $15^{\circ}\text{C}$  is placed in a large beaker of boiling water at  $100^{\circ}\text{C}$ , liquid starts to form after 5 minutes. After a total of 11 minutes, the sample is completely liquid. After a total of 14 minutes, no noticeable changes are taking place. As accurately as possible, graph the heating curve.



19. Substance Y melts at  $31^{\circ}\text{C}$  and boils at  $74^{\circ}\text{C}$ . Plot a graph showing the temperature vs time behaviour of substance Y as its temperature is cooled from  $85^{\circ}\text{C}$  to  $15^{\circ}\text{C}$ . Label the axes. No scale needs to be specified for the time axis.

