Changes during Evaporation

About 500 years ago, an Italian artist and engineer Leonardo da Vinci showed that water bodies are crucial resources of any country and by stopping flow of river one country can even harm its neighbours. Yet he argued that evaporation takes away the water from one country and passes it on to another country. It ensures that....no one can really own the water!

Q 1. Have you seen evaporation in your surrounding? If yes, can you write any two examples?

_____
_____
_____

Q 2. What do you observe when a liquid evaporates in a container? Do you see any change happening which indicates evaporation is taking place?

_____
_____
_____

Fill in the blank to complete the sentence: The process of a liquid _____ _____ at the liquid gas interface is called *evaporation*.

Q 3. What are the factors that you know which affect evaporation?
_____

_____

_____

Q 4.

a) When do you sweat?
b) If you don't wipe it, how can you dry it?
c) What happens to that sweat when it dries?
d) After it has dried where can you find it?

_____

_____

_____

_____

Task 1: Matter Transfer in Evaporation

Q5. If you take a liquid in a sealed flask and mass of this flask with the liquid is *m*. After some time, the liquid in the sealed flask evaporates. Predict if the mass of this flask will be still same as *m*, greater than *m* or less than *m*.

What you need: Conical flask (100 cm^3) with rubber cork, a dropper, digital weighing Balance (least count 10 mg or 1 mg), Acetone (or Spirit or Nail polish remover, 2 mL).

Procedure:

1. Take a clean and dry conical flask and place a cork on it. Use a balance to measure its mass, and write it as m_1. Open the cork and smell the flask gently.
2. To this flask, add about 6 to 7 drops of acetone (or spirit or nail polish remover) using dropper and smell gently (do not take it near your nostrils and breathe heavily). Place the cork on the flask and seal it tightly. Use a balance to measure its mass and write it as m_2.
3. Warm the conical flask with hands and shake it till the liquid in it evaporates (do not invert the conical flask). Measure its mass again and write it as m_3.
4. Open the flask and smell gently. (Do not take it near your nostrils and breathe heavily), keep the flask open for 5 minutes. Close the flask by replacing the cork. Measure the mass of flask now and write it as m_4.

Record your observations in table below.

	Step 1	**Step 2**	**Step 3**	**Step 4**
Mass	**m_1 = _____ gm**	**m_2 =_____ gm**	**m_3 =_____ gm**	**m_4 =_____ gm**
Smell				

Q 6. Was the smell of the conical flask content before closing (Step 1) and after opening the cork (Step 4) same or different? What does this tell about the changes in air inside the flask?

Q 7. What does the flask contain after step 3 and before step 4? What physical state is it in?

_____

_____

Q8. What happened to the air that was in the flask initially?

_____

_____

Q 9. Is m_3 same as m_1 or m_2? Can you explain your result?

_____

_____

_____

Q 10. Is m_4 same as m_1 or m_2? Can you explain your result?

_____

_____

_____

Q 11a. Based on your results; which of the following statement(s) is/are true and which is /are false?

1) Evaporation converts liquid into gaseous phase. _____
2) Gases have mass._____
3) Gases can diffuse through air within few seconds._____
4) Movement from liquid to gaseous state decreases mass of its molecules._____

Q 11b. Give evidences to support your answer for each of the above answers.

_____

_____

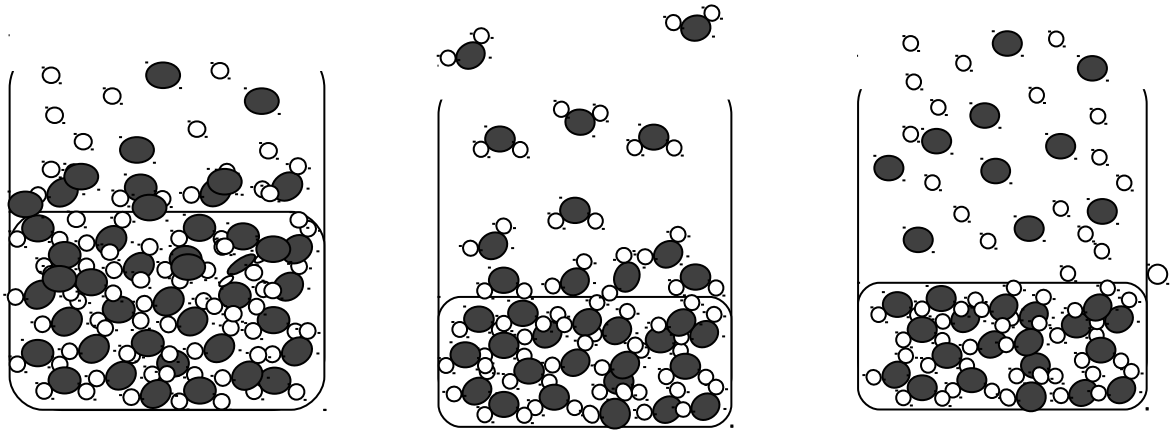
_____

_____

Our modern understanding of liquids suggest that molecules of a liquid are always moving. Even at a fixed temperature and pressure, different molecules have different amount of

kinetic energy. In liquids, some molecules at the surface always have more kinetic energy than the others. Even at temperature much below its boiling point, some of its molecules have enough energy to break the forces of attraction and escape from the surface liquid in the form of vapour (or gas).

Q 12. If  is water molecule then which of the following diagram represents evaporation of water? Justify your answer.



(A) (B) (C)

Task 2: Heat Transfer in an Evaporation

When a liquid keeps on evaporating from its surface, the molecules remaining in liquid have lower average energy. This cools down the remaining liquid.

Q13. Why do people sprinkle water on open ground on a hot sunny day?

Requirement: a thermometer (0˚C to 100˚C), cotton or paper napkin, a rubber band (small size), water in a small beaker or small container, blower (optional).

Procedure:

1. Cover thermometer bulb with paper napkin or cotton from all sides (including bottom), put the rubber band to fix the paper napkin or cotton at place (As shown in Fig. I).

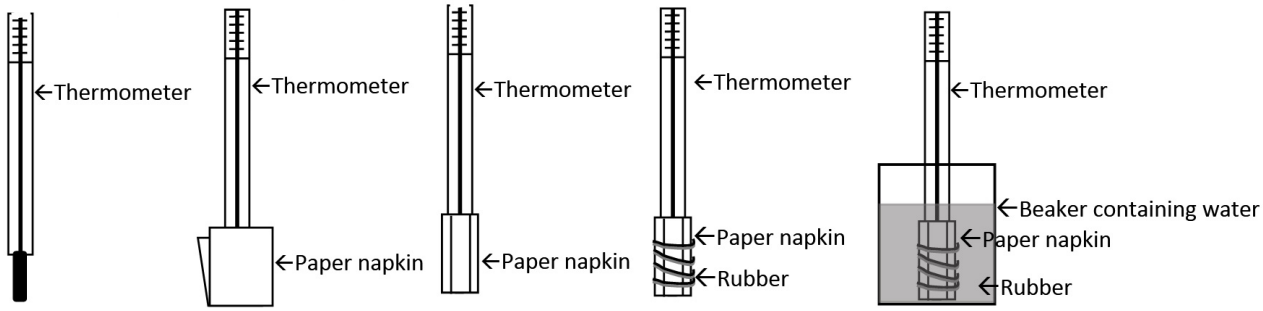


Fig. I

2. Note down the thermometer reading._____ **˚C.**

3. Hold the thermometer in a hand, keeping the cotton / paper napkin on the thermometer bulb at a distance of 1 inch from your mouth, and blow air for about three minutes by rotating thermometer very slowly (use blower if required). Note down the thermometer reading after every one minute (do not keep the thermometer aside while noting down the temperature reading).
4. Wet the thermometer bulb covered with paper napkin or cotton, just by dipping it in water for few seconds (as shown in Fig I). Note down the thermometer reading:_____ **˚C**.
5. Blow air at the cotton or paper napkin on thermometer bulb holding it in a hand and keeping it at a distance of 1 inch from your mouth for about three minutes by rotating thermometer very slowly (use blower if required). Note down the thermometer reading after every one minute (do not keep the thermometer aside while noting down the temperature reading).

Observations: For Step 3 and 5

		Thermometer reading in ˚C		
		After 1 min.	After 2 min	After 3 min
Step 3	Bulb covered with dry paper napkin or cotton			
Step 5	Bulb covered with wet paper napkin or cotton			

Q 14. How did the temperature change in two cases? Can you explain it?

_____

_____

_____

Q 15. In summer days if electricity is cut off for two days, then how can you keep food cool (to prevent its spoilage) without a refrigerator?

_____

_____

_____

Q 16. Suppose you have to walk outside on a hot sunny day, how can you maintain your body temperature and protect yourself from sun stroke by utilizing the phenomena of evaporation?

_____

_____

_____

Task 3: Faster and Slower Evaporation

Q17. Following situations involve evaporation of a liquid. In which case we want the evaporation to happen fast and in which case we want it to happen slowly:

(a) Drying of clothes
(b) Drying of papads
(c) Evaporation of water in a lake
(d) Evaporation of water in puddles after rains
(e) Drying of soil in a field
(f) A perfume sprayed on a handkerchief
(g) Drying of Nail polish on nails
(h) Paint done on a wall
(i) Fresh plaster on a wall

Above cases show that in some situations we want evaporation be as fast as possible and in some situations, we want to slow down the evaporation.

Q18. How can you make the evaporation in any situation slower or faster?

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_____

Q19. Arrange the following in increasing order of evaporation rate.
Water, spirit, kerosene, coconut oil.

_____

Now we will study evaporation of different liquids at the same conditions of temperature and pressure.

What we need: Stop Watch or a clock, four droppers, acetone (2 mL), ethanol/spirit (2 mL), glycerine (2 mL), water (2 mL), brown paper or any other absorbing paper (4 pieces of about 4 cm × 2 cm size).

Procedure:

1) You are given four small containers labelled 1, 2, 3, 4 containing acetone, alcohol, glycerine and water, respectively.
2) On the corners of four pieces of brown paper, write the names of four liquids.
3) Using a dropper, place one drop of each liquid on the piece of brown paper having its name.
4) Note down the time required for complete evaporation of the liquid on each paper with the help of a stop watch.

Observations:

Room temperature: .....˚C

Sr. No.	Liquid	Time (Seconds) required for evaporation of the liquid
1	Acetone	
2	Ethyl Alcohol	
3	Glycerine	
4	Water	

Q 20. Which of the above four liquids evaporates faster? Can you explain why?

_____

_____

_____

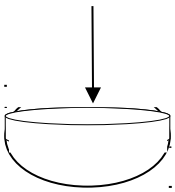
Q 21. If you were to make a paint, which of the above liquids would you choose to mix the solid colour in? Why would you chose that liquid?

_____

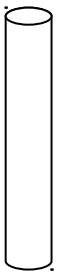
_____

Q 22. 10 mL of ethanol if placed in different containers, like evaporating dish, test tube, petri dish, beaker. Arrange the containers in the increasing order of evaporation rate of ethanol.

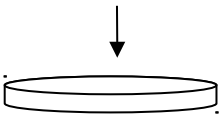
Evaporating dish



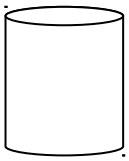
Test tube→



Petri dish



Beaker →



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Q 23. Can evaporation be a source of pollution? If yes, give some examples and explain.

_____

_____

Q 24. Explain the statement of Leonardo da Vinci given in the beginning of this Unit.

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References:

1) Lohner, Science Buddies, Sevenja. (https://www.sciencebuddies.org, search for Evaporation).

2) Evaporation and Evapotranspiration , Measurements and Estimation by Abtew, Wossenu, Melesse, Assefa M.

3) Droplet Wetting and Evaporation , e book,, Ist ed. Edited by David Brutin.