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!

Task 1: Recollecting Evaporation Experiences

Q1. Have you seen evaporation in your surrounding? If yes, can you write any two examples?

_____

_____

Q2. What do you observe when a liquid evaporates in a container? Do you see any change happening in liquid which indicates that evaporation is taking place?

_____

_____

_____

Fill in the blank to complete the sentence: The process of a liquid _____ _____ at the liquid surface (in contact with air or a gas) 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 2: 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*.

_____

Materials required: Conical flask (100 mL) 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. Note the smell in table below.
2. To this flask, add about 6 to 7 drops of acetone (or spirit or nail polish remover) using a 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 to detect any change in smell. (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	**Flask + Cork** **m_1 = _____ g**	**Flask + acetone + cork** **m_2 =_____ g**	**Flask + acetone vapour + cork** **m_3 =_____ g**	**Flask + cork (after opening)** **m_4 =_____ g**
Smell				

Table 1

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?

_____

_____

Q 8. 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, check if the following statement(s) is/are true or false for the above experiment.

1) Evaporation converts liquid into gaseous phase. _____
2) Gases have mass._____

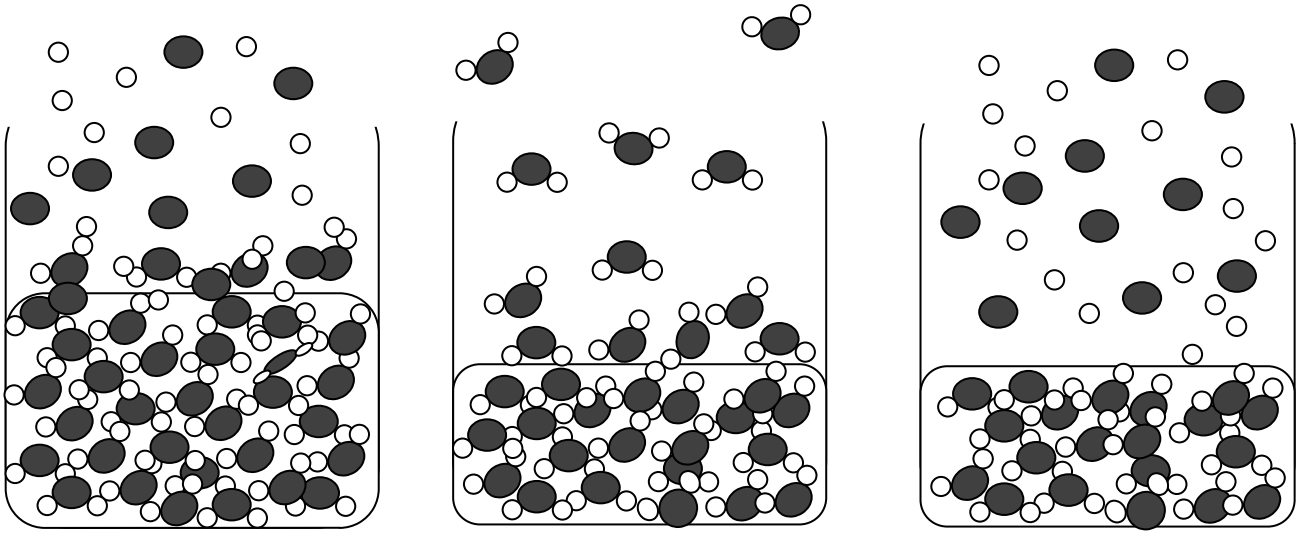
3) Gases under pressure, when released, can expand and move/travel out of flask very quickly._____
4) Movement from liquid to gaseous state decreases mass of its molecules._____

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  represents a water molecule ● represent Oxygen atom and ○ represent Hydrogen atom, then which of the following diagram represents evaporation of water? Justify your answer.



(A) (B) (C)

_____

Q 13. Can evaporation be a source of pollution? If yes, give some examples and explain.

_____
_____
_____

Task 3: Heat Transfer during Evaporation

Have you ever wondered why we sweat when our surrounding is hot or when we exercise? Sweating is a life-saving strategy that cools the body down and maintains its temperature. Without sweating, the body cannot regulate its temperature, which can lead to overheating or even heatstroke. But why does sweating have a cooling effect? In this activity you can observe this cooling power in action!

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

Q 14. Why do people sprinkle water on open ground on a hot sunny day?

_____

_____

Materials required: a thermometer (0˚C to 100˚C), cotton or paper napkin, a rubber band (small size), a small beaker or small container containing water (acetone or alcohol can also be used), 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).

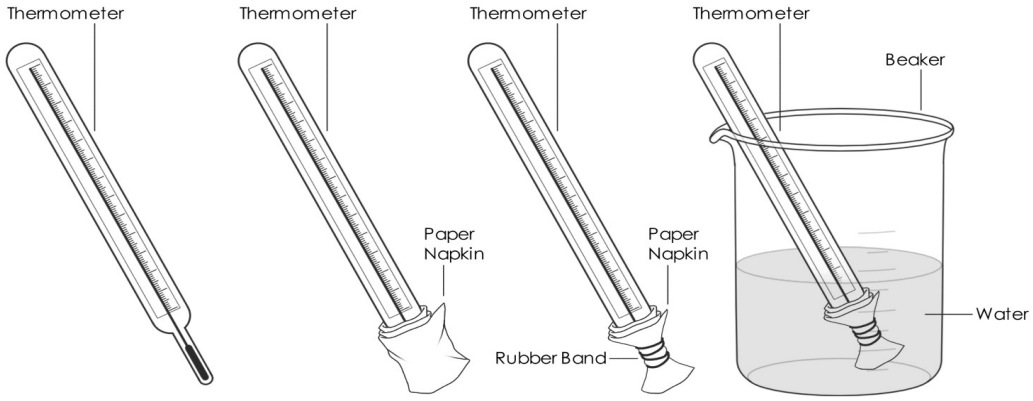


Figure 1

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).

Steps	Thermometer reading in ˚C			
		After 1 min.	After 2 min.	After 3 min.
Step 2				
Step 3 :Bulb covered with dry paper napkin or cotton				
Step 4				
Step 5 :Bulb covered with wet paper napkin or cotton				

Table 2: Observations for step 2 to step 5

Q 15. How did the temperature change in two cases? Can you explain it?

_____

_____

_____

Q 16. 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 17. 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 4: Faster and Slower Evaporation

Q 18. 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 an agricultural field

(f) A perfume sprayed on a handkerchief

(g) Drying of nail paint on nails

(h) Paint done on a wall

(i) Fresh plaster on a wall

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

Q 19. How can you make the evaporation in any situation slower or faster?

_____

_____

Q 20. Based on your past experience, arrange the following in increasing order of evaporation rate. Water, alcohol based sanitizer, kerosene, cooking oil.

_____

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

Materials required: Stop Watch or a clock, four droppers, acetone (2 mL), ethyl alcohol/ alcohol based sanitizer(2 mL), glycerine / Cooking oil (2 mL), water (2 mL), brown paper or any other absorbing paper (4 pieces of about 4 cm × 2 cm size).

Procedure:

1) Label the four small containers containing acetone, ethyl alcohol/ alcohol based sanitiser, glycerine/ cooking oil and water, as 1, 2, 3, 4 respectively.
2) On four pieces of brown paper, write on corner 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 stop watch.

Observations:

Room temperature: ……˚C

Sr. No.	Liquid	Time (Seconds) required for evaporation of the liquid
1	Acetone	
2	Ethyl Alcohol/ alcohol based sanitiser	
3	Glycerine/ cooking oil	
4	Water	

Table 3

Q 21. Which of the above four liquids evaporates faster?

_____

_____

_____

Q 22. If you were to make a paint, would you choose a fast evaporating or a slow evaporating liquid as solvent to mix the solid colour in? Why would you choose that liquid?

_____

_____

_____

Q 23. 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.

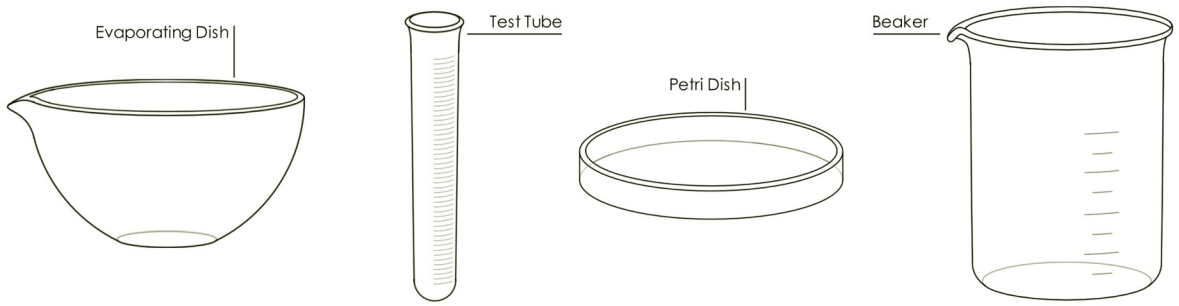


Figure 2

_____

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

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References:

1) Lohner, Science Buddies, Sevenja. (https://www.sciencebuddies.org, on Evaporation)
2) Abtew, Wossenu, Melesse, and Assefa M. (2012). Evaporation and Evapotranspiration, Measurements and Estimation. Springer, Netherlands.
3) David Brutin, Editor (2015), Droplet Wetting and Evaporation, e book, Ist ed. Academic Press.

