Teacher's Copy

2014 Sec 4 Physics Practical 12
Rate of cooling of water in different containers

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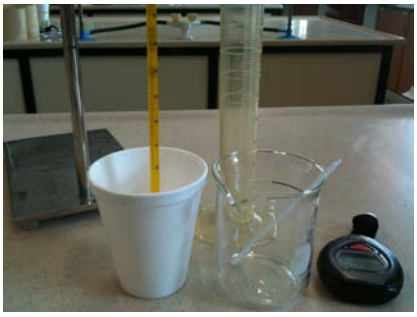
Name: _____ **( ) Class: 4/** ___ **Date:** _____



Objectives:
At the end of this lesson you should be able to:
- identify factors affecting the rate of cooling of a liquid, and
- compare the rates of cooling of a liquid using its cooling curves.

Grouping: Pair work

Apparatus: beaker, Styrofoam cup, thermometer, retort stand with bosshead and clip, stopwatch, hot water supply, plastic jug, 100 cm^3 measuring cylinder, stirrer

Procedure
1. Set up the thermometer in the retort stand with its bulb in the beaker.
2. Measure 100 cm^3 of hot water with a measuring cylinder and pour the water into a beaker.

Precaution:	Handle the hot water and mercury thermometer with extreme care!

3. Ensure the bulb of the thermometer is fully immersed in the hot water.
4. Measure and record the temperature θ of the hot water and start timing immediately.
5. Stir the water continuously with the stirrer.
6. Obtain temperature readings at 30 s intervals until t = 300 s.
7. Repeat steps 1 to 6 using a Styrofoam cup, and the same starting temperature.
8. Tabulate all measurements of θ and t.
9. Plot cooling curves of θ against t for the hot water placed in the beaker and the Styrofoam cup on the same axes.
10. Make a suitable conclusion by comparing the graphs.

Measurements ~~[2]~~ [4]

t / s	θ / °C	
	beaker	**Styrofoam cup**
0		
30		
60		
90		
120		
150		
180		
210		
240		
270		
300		

- labeling of temperature, units
- temperature recorded to precision of 0.5 **°C**

Adapted from Activity B7 (Physics Insights 2007) by Ang JL (2010, 2011)

Graphs [4]

- Scale : 30 s in 2 cm interval - odd scale!
  2.5 degC - odd scale!
- Points
- Lines (axes, curves)
- Axes labeling, labeling of cooling curves

Conclusion [1]

- From the cooling curves, the hot water in the beaker loses thermal energy faster than that in the Styroforam cup.

/ glass is a better conductor of heat than Styrofoam

Questions

Suggested answers:

1. State ~~and explain~~ **two** ~~**other**~~ ways in which the hot water may lose heat to the environment. Note: Name & briefly describe the processes. [2]

Note: conduction less for water/air!

Stating any two:

- By convection currents *in the air above the container*
- By radiation to the *environment* (Note: can pass through materials here!)
- By evaporation of water, such that *latent heat is lost*

- By conduction through the walls of the beaker and styrofoam cup.

2. Is the cooling rate of water greater or smaller at the beginning of the experiment? Explain your answer clearly.(based on observations rather than theory?) [2]

- The cooling rate is greater at the beginning of the experiment.
- The gradient of each cooling curve is steeper at the beginning, showing that temperature falls rapidly at the beginning.

/ the temperature difference between the water and the surrounding air is higher at the beginning.

3. State **one** possible source of error in this experiment ~~and explain how it~~ that may affect your conclusion. ~~[2]~~ [1]

Any one: Unfair comparison?

- The container with a larger surface area will have a higher rate of heat loss through radiation.
- The rate of heat loss by evaporation would be higher for the container which has a larger exposed surface area.

- two containers have different shapes and sizes.

Note: stirring required by question, difference not significant.

4.5. State **one** improvement to reduce the source of error stated in your answer to **Question 3**. [1]

Any one:

- Use containers of the same shape and size.
- Cover each container with a cover of the same material to minimize the rate of evaporation. (lid)