Teacher's Copy

2014 Sec 4 Physics Practical 11
Temperature of a Bunsen Flame

10

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

Objectives:
At the end of this lesson you should be able to:

- apply the law of conservation of energy,
- apply the formulae for specific heat capacities,
- calculate thermal energy gained or lost by a body, and
- estimate the temperature of a Bunsen burner.

Grouping: Pair work

Apparatus: iron washer, a pair of tongs, thermometer, retort stand with bosshead and clip, stopwatch, stirrer, Bunsen burner, bamboo container, 100 cm^3 measuring cylinder, electronic balance

Procedure

1. Measure 100 cm^3 of water with a measuring cylinder and pour the water into a bamboo container.
2. Assume the density of water is 1.0 g/cm^3, and record the mass of the water.
3. Measure and record the mass of the iron washer.
4. Set up the thermometer in the retort stand with its bulb fully immersed in the water.
5. Measure and record the temperature of the water.
6. Fully open the air vent on the Bunsen burner and light the gas.
7. Hold the iron washer firmly with the tongs and insert it into the hottest part of the flame. After 2 minutes, remove the iron washer from the flame and place it immediately into the water inside the bamboo container.

Precaution: Ensure that the hot iron washer and tongs are kept at a safe distance from others!

8. Stir the water continuously with the stirrer. Measure and record the final highest temperature of the warm water.

Measurements (examples - check units, decimal place)

- Mass of water in container, m_w = 100 g
- Given specific heat capacity of water, c_w = 4200 J kg^{-1} $°C^{-1}$

- Mass of iron washer, m_{Fe} = 4.3 g [1]
- Given specific heat capacity of iron, c_{Fe} = 460 J kg^{-1} $°C^{-1}$

- Initial temperature of water, θ_i = 30.0 °C [1]

- Final highest temperature of water, θ_f = 36.0 °C [1]

Precision of thermometer = 0.5 degree (1/2 smallest division)

Adapted from Activity A7 (Physics Insights 2007) by Ang JL (2010, 2011)

9. Using the measurements and the law of conservation of energy, estimate the temperature of the Bunsen flame.

Calculations [3]

- Specific heat capacity, $c = Q / m\Delta\theta$ where Q = thermal energy
  m = mass of body
  $\Delta\theta$ = change in temperature

1. Word equation!

- Heat lost by iron washer, Q_w = Heat gained by water, Q_{Fe} [1]

Equation in symbols!

- $m_{Fe}\, c_{Fe}\, \Delta\theta_{Fe}$ = $m_w\, c_w\, \Delta\theta_w$ working [1]
- $m_{Fe}\, c_{Fe}\, (\theta_{flame} - \theta_i)$ = $m_w\, c_w\, (\theta_f - \theta_i)$
- θ_{flame} = above 700 °C [1]

(to 2 or 3 s.f.)

Note: Describe the specific processes/materials involved.

Questions

1. State **two** assumptions you made in calculating the temperature of the Bunsen flame. Note: 1. exclude assumption given in question! [2]
   2. Assume _____ is constant / negligible.

Any two:

- Temperature of the flame is constant.
- The iron washer has reached the temperature of the flame after 2 minutes
- All the heat lost by the iron washer is gained by the water.
- There is no heat loss to the surroundings.

2. Suggest **two** sources of error in this experiment. [2]

Any two:

- Some heat is lost from the water by evaporation when the iron washer is inserted.
- Mass of water decreases due to evaporation of water.
- Temperature of the flame at the location of the iron washer is not constant.
- Some heat is lost to the tongs when it is transferring the iron washer to the water. by conduction.

- Some heat is lost to the bamboo container by conduction.
- Some heat is lost to the surrounding air by convection.
- Heat is lost by the iron washer and water to the surrounding by radiation (infrared).

Note:
1. Focus on systematic errors (that affect accuracy), not reasonable precision of instruments.
2. Distinguish between temperature & heat (thermal energy).
3. Density of water = 1.0 g/cm^3 is a reasonable assumption.

State **two** assumptions you made in calculating the temperature of the Bunsen flame. [2]

The temperature of the Bunsen flame was kept constant.

The loss of temperature of the iron washer transferred from burner to the water container is negligible. ? heat

flame. temperature ?

1. The heat supplied to the iron washer is constant. ?

Suggest **two** sources of error in this experiment. by what process(es) ? [

1. Heat has lost to the environment.

1. As the precision of the thermometer is only 0.5, hence the reading taken might not be accurate. ?

↑ precision, not accuracy

Robert Wilhelm Eberhard Bunsen (30 March 1811[N1] – 16 August 1899) was a German chemist. He investigated emission spectra of heated elements, and discovered caesium (in 1860) and rubidium (in 1861) with Gustav Kirchhoff. Bunsen developed several gas-analytical methods, was a pioneer in photochemistry, and did early work in the field of organoarsenic chemistry. With his laboratory assistant, Peter Desaga, he developed the Bunsen burner, an improvement on the laboratory burners then in use. The Bunsen–Kirchhoff Award for spectroscopy is named after Bunsen and Kirchhoff.

Contents

Robert Bunsen

Born	Robert Wilhelm Eberhard Bunsen 30 March 1811[N1] Göttingen, Westphalia, Rhine Confederation (now Germany)
Died	16 August 1899 (aged 88) Heidelberg, Baden, German Empire (now Germany)
Residence	Germany
Fields	Chemistry (career)