Energy density of ethanol and propanol fuels

Aim - To determine the energy density of ethanol and propanol by measuring the temperature rise of water heated using their combustion in a spirit burner.

Equipment

- 2 X Spirit burners (one with ethanol and one with propanol)
- 2 X 200 mL Beaker
- Tripod
- Electronic balance
- Thermometer (0-100°C)
- Two 200 mL beakers
- Distilled water
- Heat-resistant mat
- 100 mL measuring cylinder

Figure 1 – the setup of the spirit burner and beaker.

Method

1. Fill the spirit burner with ethanol fuel and record the initial mass.
2. Measure and record the mass of the spirit burner with the fuel using the electronic balance.
3. Place 100 mL of water into a 200 mL beaker. Record the initial temperature of the water.
4. Set up the spirit burner on the tripod beneath the beaker of water, as shown in the fig 1.
5. Light the burner and allow the water to heat until the temperature increases by about 40°C. Stir occasionally with the thermometer to ensure uniform heating.
6. Record the highest temperature reached by the water.
7. Extinguish the flame and allow the burner to cool.
8. Measure and record the final mass of the spirit burner.
9. Repeat steps 3 -8 two more times.
10. Repeat steps 1 – 9 for propanol fuel.

Calculations:

Use the formula $Q = mc\Delta T$ to calculate the heat energy transferred to the water, where:

- m = mass of water (in grams)
- c = specific heat capacity of water (4.18 J/g°C)
- ΔT = change in temperature of the water (°C)

Calculate the energy density by dividing Q by the mass of fuel burned (difference in burner mass).

Use the space below for the calculations.

Data Table

Trial	Fuel Type	Initial Burner Mass (g)	Final Burner Mass (g)	Mass of Fuel Burned (g)	Initial Water Temp (°C)	Final Water Temp (°C)	ΔT (°C)	Energy Transferred Q (J)	Energy Density (J/g)
1	Ethanol								
2	Ethanol								
3	Ethanol								
1	Propanol								
2	Propanol								
3	Propanol								

1. **How does measuring the change in water temperature accurately reflect the energy released by the burning fuel?**
   (Consider heat losses to the environment and incomplete combustion.)

2. **What factors could affect the validity of the calculated energy density when using the spirit burner and beaker setup?**
   (Think about heat loss, evaporation of fuel, and measurement errors.)

3. **What improvements or controls could be introduced to reduce heat loss and increase the validity of the results?**

4. **How does placing the spirit burner closer to the beaker of water, as shown in fig 2, impact the validity of the results?**

Figure 2 – Placing the spirit burner closer to the water.

5. **What is assumed when measuring the energy content of fuel using this procedure?**