Topic 3 – Guidance for Practical 1

Determining the specific heat capacity (SHC) of a metal using a calorimeter

Safety

Although great care has been taken in checking the accuracy of the information provided in this guidance, Cambridge University Press shall not be responsible for any errors, omissions or inaccuracies.

Teachers and technicians should always follow their school and departmental safety policies. You must ensure that you consult your employer's model risk assessments and modify them as appropriate to meet local circumstances before starting any practical work. Risk assessments will depend on your own skills and experience, the skills and experience of your students, and the facilities available to you. Everyone has a responsibility for his or her own safety and for the safety of others. The notes below should not be regarded as a risk assessment.

You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties your students may encounter.

Guidance

Students will practice a calorimetric technique.

Students sometimes mix up their mass measurements and forget to subtract the mass of the container to calculate the mass of the water. Some students ignore the heat transferred to the copper container and stirrer; you might need to remind them.

Apparatus and materials

Each group will need:

- insulated copper calorimeter (inner cooper can + insulation + outer can)
- thermometers or temperature sensors
- block of metal (known metal, dimensions suitable to fit in the calorimeter, string of insulating material attached)
- beaker
- top-pan balance
- copper stirrer
- Bunsen burner
- lighter
- tripod and gauze
- heat-proof tile

Answers to questions

1 Time to transfer metal block (some heat transferred to surroundings), amount of hot water transferred to calorimeter with metal block, water used not being deionised, some heat lost to surroundings through calorimeter.

2 In this case an extra term in the equation relevant to the heat gained by the air would have been ignored and the determined value for the SHC of water would be smaller than the accepted one.

Topic 3 – Guidance for Practical 2

Determining the specific latent heat of ice using a calorimeter

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Guidance

Students will practice a calorimetric technique.

Students often forget that a substance is involved in the exchange of heat, or confuse whether the heat is gained or lost, resulting in an incorrect formula and calculation of latent heat.

It is common for students to take some time to take temperature readings from traditional thermometers.

Apparatus and materials

Each group will need:

- insulated copper calorimeter (inner cooper can + insulation + outer can)
- copper stirrer
- thermometers or temperature sensors
- beaker
- water
- ice
- cloth
- hammer
- top-pan balance
- Bunsen burner
- lighter
- tripod and gauze
- heat-proof tile
- tongs

Answers to questions

1 To increase its surface area and maximise its contact with the water, thus minimising the time it takes to reach the final temperature and any heat exchange with the surroundings.

2 Water used not being deionised, some heat transferred to the surroundings, reading the thermometer incorrectly, mass of ice less than the value used because of melting during the duration of the practical, uneven distribution of temperature.

Topic 3 – Guidance for Practical 3

Boyle's law

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Guidance

Students will practice using a pressure sensor, possibly data logging and drawing graphs of inverse relationships.

Even though the apparatus is simple, students need to make sure that there are no air leaks.

Apparatus and materials

Each group will need:

- syringe (100 cm^3)
- sealing lubricant
- pressure sensor
- rubber tube

Setting up the practical

If laptops are available, a simulation of this experiment can be done using the 'Gas properties' simulation on the phET website – http://phet.colorado.edu/en/simulation/gas-properties (See Practical **5**, Topic **3**).

Answers to questions

1 Curve demonstrating inverse proportionality.

2 P vs $\frac{1}{V}$

Topic 3 – Guidance for Practical 4

Charles' law

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You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties your students may encounter.

Guidance

Students will practice using a temperature sensor, possibly data logging and drawing graphs of proportional relationships.

Sometimes the piston gets stuck; it needs to be properly greased, twisted and slightly pushed, before taking the reading of the volume.

If a large water bath is used, it will take a long time for the temperature of the water to increase and the practical will take a long time. You could reduce the number of different temperature values.

Apparatus and materials

Each group will need:

- conical flask
- rubber stopper with hole
- syringe
- water bath
- water
- temperature sensor
- stand and clamp (× 2)

Setting up the practical

If laptops are available, a simulation of this experiment can be done using the 'Gas properties' simulation on the phET website – http://phet.colorado.edu/en/simulation/gas-properties.

Answers to questions

1 Graph of V vs T should be linear, representing a directly proportional relationship.

2 A shift of the line to the right, not going through the origin of the graph.

Topic 3 – Guidance for Practical 5

Gas laws – Simulation experiments

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You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties your students may encounter.

Guidance

Students will verify all gas laws, practice simulation experiments and drawing graphs of proportional and inversely proportional relationships.

Apparatus and materials

Each student will need:

- laptop with internet access

Setting up the practical

Students can experiment and make further observations by:

– introducing and varying the strength of gravity
– using light or heavy species or a combination of the two
– particle behaviour without collisions between them.

Answers to questions

1 **a** To confirm Boyle's law the line should be a curve representing an inverse relationship,

$PV = \text{constant}$ or $P \propto \frac{1}{V}$

b P vs $\frac{1}{V}$

c The pressure continues to increase until the container explodes.

2 To confirm Charles' law the graph should be a straight line going through the origin, representing a directly proportional relationship between V and T.

3 **a** To confirm the pressure law the graph should be a straight line, representing a proportional relationship between P and T.

b Absolute zero