**COMET BAY COLLEGE**

**Physics - Unit 1 – Task 5**

**Heating and Cooling Test**

**Name: SOLUTIONS Total Marks /55**

**Question 1:**

People who have not studied Physics often use the word *heat* when they actually mean *temperature* or even *internal energy (thermal energy)* of the object*.* Explain the difference between the three (words underlined). **(3 marks)**

Either (1 mark)

Heat is the transfer of energy from one object to another caused by a difference in temperature.

OR

Heat is the transfer of energy from an object at a higher temperature to one at a lower temperature until thermal equilibrium is reached.

Temperature is a measure of the average kinetic energy of an object.(1 mark)

Thermal or Internal energy is the sum of the kinetic and potential energy of an object. (1 mark)

**Question 2:**

Explain why supermarket bucket freezers still manage to keep the contents frozen despite often having no lids. Also explain what the advantage of having a lid would be? **(3 marks)**

Lids prevent the layers of cool air being replaced by “fresher” layers of room temperature air, hence adding to the kinetic energy in the bucket fridge. (1 mark)

This is due to convection.Heat is removed from the air surrounding the food in the freezer making the air more dense and cold. Any warm air rises (less dense) and is replaced by the colder, denser air. (1 mark)

The “cold” air through conduction keeps the food frozen. (1 mark)

**Question 3:**

A large 2.50 × 103 W kettle uses 1.65 × 106 J to completely boil away the contents of a kettle. Calculate the time (in minutes) that it would take for this to occur. **(3 marks)**

P = 2500 W

P = = t = = (1 mark)

= 660 s (1 mark)

=

t = 11 minutes (1 mark)

**Question 4:**

What is the specific heat of an alloy if it requires 5.10 × 104 J of energy to heat 2.20 kg of the alloy from 15.0 0C to 92.5 0C? **(2 marks)**

Q = mcΔT

5.10 × 104= 2.20 × c × (92.5 – 15) (1 mark)

5.10 × 104 = 170.5× c

c = 299 J kg-1 K-1 (1 mark)

**Question 5:**

A laboratory technician was trying to find the latent heat of fusion of an alloy she had created. She found that she needed to add 4.9× 105 J of energy to 0.95 kg of the alloy to fully melt it without changing the temperature. Find the latent heat of fusion of the alloy. **(2 marks)**

Q = mL

4.9 x 105 = 0.95 × L(1 mark)

L = 5.16×105 J kg-1 (1 mark)

**Question 6:**

Explain how a calorimeter works, by considering all the compartments that make up the calorimeter, comparing the specific heat of each and what their purposes are. **(2 marks)**

The metal in the calorimeter has low specific heat hence is quick to transfer heat and hence reduce the effect of temperature change.**(1 mark)** Low energy to change temperature to match contents.

The air cushion in the calorimeter has high specific heat hence it takes a long time to transfer heat and hence contains the heat within the calorimeter and reduces the effect of temperature change.**(1 mark)** no air flow due to wool holding air in place

**Question 7:**

A small espresso coffee machine contains 0.500 kg of water at 20.00 C. How much energy is required to heat the water to 100.00 C and boil all of the water away? **(3 marks)**

Q = heat water + boil water away

= mcΔT + mL

= (0.5 × 4180 ×(100 – 20)) + (0.5 × 2.26 × 106)

(1 mark) (1 mark)

= 167200 + 1130000

Q = 1297200(1 mark)

Q = 1.30 × 106 J

**Question 8:**

An ice-block tray holding 0.250 kg of water at 18.0 0C is placed in the freezing compartment of a refrigerator. If it takes 1.50 hours for all the water to form into ice-blocks (at 0.00 0C), find the power that the refrigerator is using to extract heat from the water?

**(4 marks)**

Q = cool water + freeze water

= (0.25 × 4180 × 18) + (0.25 × 3.34 × 105) (1 mark)

= 18810 + 83500

Q = 102310 J (1 mark)

Rate = = (1 mark)

= 18.95 W (1 mark)

Rate = 19.0 W

**Question 9:**

Alan wants to add the exact amount of ice (made of pure water) to his 250.0 mL drink (the drink has a specific heat 3.99 × 103 J kg-1 K-1) to cool it from 36.0 0C to 7.00 0C. The ice comes from the freezer where it is kept at a temperature of -6.00 0C. Assuming the cup used is fully insulated, how much ice must he add?  **(5 marks)**

Heat lost = heat gained (1 mark concept)

mcΔT = mcΔT ice + mL + mcΔT water (1 mark of all L and c)

(0.25 × 3990 × (36 – 7)) =(m × 2100 × (0 – (-6))) + (m × 3.34 × 105) + (m × 4180 × (7 – 0))

(1 mark) (1 mark)

(0.25 × 3990 × 29) = (m × 2100 × 6) + (m × 3.34 × 105) + (m × 4180 × 7)

28927.5 = 12600m + 334000m + 29260m

28927.5 = 375860m

m = 0.0769635 kg (1 mark)

mass = 7.70 × 10-2 kg ice

**Question 10:**

A 2.3 kW kettle holds 1.8 litres of water, initially at 16.0 0C. How long will it be before a quarter the water has boiled away, assuming that there are no heat losses? **(5 marks)**

To boil away 0.45 kg of the water (1 mark)

Q = mwcwΔT + mLv  (1 mark)

= 1.8× 4180 × 84 + 0.45 × 2 250 000 (1 mark)

= 1644516 J (1 mark)

Power = Energy ÷ time

time = Energy ÷ Power = 1644516÷ 2300 = 715 seconds (1 mark)

**Question 11:**

MetALwerx wants to decrease energy usage during its smelting of low grade bauxite to extract aluminium. They usually achieve this by raising the temperature of the bauxite ore to 2600o C at standard atmospheric pressure. This turns the aluminium to a gaseous state, allowing it to be separated from the hydroxide molecules. Using mathematical expressions, find the temperature required to achieve gaseous state if the pressure was decreased to two thirds standard atmospheric pressure. Since the pressure decrease is so small there is no volume change. **(3 marks)**

P1V1 = P2V2

T1 T2

2/3 × P1 = P2 (1 mark)

T1 = 2600 + 273 = 2873 K

V1 = V2 = V

P1 × V = 2/3 × P1 × V

2873 T (1 mark)

T = 2/3 × P × V× 2873

P × V

T = 1642o C (1915 K) (1 mark)

**Question 12:**

The two disk brakes of a 600 kg motorbike each have a mass of 1 kg. The motorbike brakes to a stop from 30 m s-1. If 50% of the bike’s Kinetic energy is transferred to the disk brakes and transformed into heat, calculate their change in temperature.

Specific heat capacity of the disk brakes: c = 500 J kg-1 K-1? **(4 marks)**

50% of Ek of bike = Heat energy of brakes (1 mark)

50% × ½ × m × v2 = m × c × ∆T

50% × ½ × 600 × 302 = 2 × 500 × ∆T

(1 mark) (1 mark)

∆T = 135 K (1 mark)

**Question 13:**

A 0.680 kg solid sample of an unknown substance is heated slowly while inside an insulated container. The graph below illustrates the heating curve of this substance.



**E**

**D**

**C**

1. State the temperature at which

84 oC (1 mark)

22 oC (21 – 23) (1 mark)

(i) the substance boils. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **(1 mark)**

(ii) the substance melts. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **(1 mark)**

1. What state or states is/are present between

liquid

liquid and gas

1. B and C? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **(1 mark)**
2. C and D? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **(1 mark)**
3. Explain on a molecular level why the temperature doesn’t change between A and B although heat is still being added to the substance. **(3 marks)**

Between A and B the substance is changing phase. (1 mark)

In phase change bonds are being broken and particles moving further apart. This involves an increase in potential energy and not kinetic energy. (1 mark)

Temperature is the measure of the average kinetic energy so if the kinetic energy is not increasing, the temperature remains the same. (1 mark)

1. Explain why section AB is shorter than section CD. **(2 marks)**

In AB the substance is changing from a solid to a liquid. While bonds are being broken, the particles are not moving much further apart. (1 mark)

In CD, the substance is changing from a liquid to a gas. After the bonds have been broken, extra energy is needed to move the particles much further apart in the gas and therefore much more energy is needed for particles to gain the extra potential energy to move further apart and the section is longer. (1 mark)

1. Calculate the latent heat of vaporisation of this substance, and give the correct units.

**(3 marks)**

Latent heat; Q = m L

Q = 13 × 104 – 8 × 104 = 5 × 104 J (1 mark)

Q = m L

5 × 104 = 0.68 × L (1 mark)

L =

L = 73500 J kg-1 (1 mark)

Latent heat of vaporisation = 7.35 × 104 J kg-1(1 mark)

1. Calculate the specific heat capacity of this substance in the liquid phase. **(4 marks)**

Specific heat; Q = m c ΔT

Q = 8 × 104 – 4 × 104 = 4 × 104 J (1 mark)

ΔT = 84 – 22 = 62 oC (1 mark)

Q = m c ΔT

4 × 104 = 0.68 × c × 62 (1 mark)

c =

c = 949

Specific heat capacity = 949 J kg-1 K-1  (1 mark)