Question 1 **(2 marks)**

The absolute scale of temperature is defined in terms of the pressure of a fixed volume of an ideal gas. State the fixed points of the Kelvin scale.

- Absolute zero
- Triple point of water (273.16 K)

Question 2 **(3 marks)**

A pan of water is heated from 25.0°C to 80.0°C. Calculate the change in temperature in the Kelvin scale.

$$\Delta T = T_f - T_i \quad (1)$$
$$= 80 - 25 \quad (1)$$
$$= 55.0\ K$$

Question 3 **(3 marks)**

The length of the mercury column in an uncalibrated 'liquid-in-glass' thermometer is 12.0 mm in ice water and 237 mm in boiling water. When placed in a liquid with an unknown temperature it is 57.0 mm long. Calculate the value of the unknown temperature.

$$\frac{\theta}{100} = \frac{X_\theta - X_0}{X_{100} - X_0} \quad (1)$$
$$\frac{\theta}{100} = \frac{57 - 12}{237 - 12} \quad (1)$$
$$\theta = 20.0^\circ C \quad (1)$$

Question 4 **(3 marks)**

Calculate the amount of energy absorbed by a 2.80 kg brick, sitting in the sun, if its temperature rises from 18.0°C to 28.0°C. (c_{brick} = 7.50 x 10^2 J kg^{-1} K^{-1}).

$$Q = mc\Delta T \quad (1)$$
$$= (2.80)(750)(28-18) \quad (1)$$
$$= 21.0kJ \quad (1)$$

Question 5 **(4 marks)**

A certain quantity of energy is supplied to both a kilogram of water (c = 4180 J kg^{-1} K^{-1}). And to a kilogram of iron (c = 470 J kg^{-1} K^{-1}). State which undergoes the greater change in temperature and explain your reasoning.

- The iron
- The specific heat capacity of a substance is the energy required to raise the temperature of 1 kg of the substance by 1°C.
- The specific heat capacity of the iron is less than that of the water,
- For the same amount of energy the water will use 9 times the energy to raise its temperature by 1°C than the iron.

Question 6 **(3marks)**

If 4.20 kJ of energy are required to vaporise 5.00 g of ethanol, calculate the specific latent heat of vaporization of ethanol.

$$Q = mL$$
$$4.20 \times 10^3 = (0.005)(L_v) \quad (1)$$
$$L_v = 840\,kJ\,kg^{-1} \quad (1)$$

Question 7 **(8 marks)**

A large bucket of water at 80.0 °C sits next to a small cup of water at 80.0 °C.

(a) Choose which has more internal energy (Circle your chosen answer) (1 mark)

(i) The bucket

(ii) The cup

(iii) They both have the same amount of internal energy

(b) Explain why you chose your answer to (a). (3 marks)

- Internal energy is the total energy of the particles in a system – their kinetic energy and potential energy associated with bonds.
- There are more particles in the bucket than in the cup due to its greater volume.
- The average translational kinetic energy of the particles is the same in each container, but as the bucket has more particles, it will have a higher total kinetic energy.
- And therefore higher total energy.

Could also look at the increased number of bonds because of the increased number of particles and hence the greater total energy.

(c) Choose which has the fastest moving molecules (Circle your chosen answer)

(1 mark)

(i) The bucket

(ii) The cup

(iii) They both have the same mean speed of particles

(d) Explain why you chose your answer to (c).

(3 marks)

- Temperature is a measure of the mean translational velocity of particles in a substance
- Both bucket and cup are at the same temperature
- Therefore both have the same mean translational velocities.

Question 8 **(8 marks)**

A 500 W copper kettle of mass 0.500 kg contains 2.00 kg of water at 20.0°C.
(c_{Cu} = 390 $Jkg^{-1}K^{-1}$)

(a) Calculate the amount of energy required to bring the water (and the copper) to its boiling point.

(4 marks)

$$Q_{total} = Q_{Cu} + Q_{H_2O} \quad (1)$$
$$= m_{Cu}c_{Cu}\Delta T + m_{H_2O}c_{H_2O}\Delta T \quad (1)$$
$$= (0.5)(390)(100-20) + (2)(4180)(100-20) \quad (1)$$
$$= 6.84 \times 10^5 J \quad (1)$$

(b) Calculate the time, in minutes, required to bring the water to boil

(4 marks)

Q = 6.84 x 10^5 J

$P = \frac{Q}{t}$ (1)

500 = $\frac{6.84\,x10^5}{t}$ (1)

t = $\frac{6.84\,x\,10^5}{500} = 1368.8\,s$ (1) $\div 60 = 22.8\,minutes$ (1)

Question 9 **(3 marks)**

Explain why is there no increase in temperature when the water undergoes the change from the liquid to the gaseous phase.

- During a ohase change, the potential energy of substances changes as distance between particles increase.
- All energy input during a phase change goes to increasing the potential energy and not kinetic.
- As kinetic energy is a measure of the temperature, the temperature does not change during this period.

Question 10 **(5 marks)**

Suppose you pour a mass of water initially at 20.0°C into a 0.500 kg aluminium pan fresh off the stove with a temperature of 145°C. Assuming that the pan is on an insulated pad and that a negligible amount of water boils off, if the final temperature of the mixture is 50.0 °C, calculate the mass of the water. (c_{Al} = 900 $Jkg^{-1}K^{-1}$)

$Q_g + Q_L = 0$ 1/2 $Q = mc\Delta T$ 1/2

$m_w c_w \Delta T_w + m_A c_A \Delta T_A = 0$ 1

$(m)(4180)(50-20) + 0.5(900)(50-145) = 0$ 1

$125400m - 42750 = 0$ 1

$m = 0.341$ kg 1

Question 11 **(6 marks)**

A calorimeter that has a mass of 1.00 kg and a specific heat capacity of 8.40 x 10^2 J kg^{-1} K^{-1} is cooled to 0.00°C and 1.40 kg of water at 0.00°C is placed in it. 2.00 kg of water at 90.0°C is then poured into the calorimeter. Calculate the resulting temperature of the mixture.

$Q_g + Q_L = 0$ 1/2 $Q = mc\Delta T$ 1/2

$m_w c_w \Delta T_w + m_c c_c \Delta T_c + m_w c_w \Delta T_w = 0$ 1

1

$(1.4)(4180)(Tf - 0) + 1(840)(Tf-0) + 2(4180)(Tf – 90) = 0$

$5852Tf - 0 + 840Tf - 0 + 8360Tf – 752400 = 0$ 1

$15052\ Tf = 752400$ 1

$Tf = 50.0\ °C$ 1

END OF TEST