1 A large copper saucepan has a mass of 1.08 kg and is filled with 2.85 kg of raspberries. The pan is heated at a constant rate of 650 W.

(a) The pan and raspberries are initially at a temperature of 22 °C.

Calculate the theoretical rise in temperature of the raspberries after being heated for 5 minutes.

specific heat capacity of copper = 386 J kg^{-1} K^{-1}

specific heat capacity of raspberries = 3890 J kg^{-1} K^{-1}

(3)

Rise in temperature =

(b) State why the actual rise will be less than this.

(1)

(Total for Question = 4 marks)

2 The table shows data for a number of metals.

Metal	Specific heat capacity / J kg^{-1} K^{-1}	Atomic mass / u
Aluminium	910	27.0
Copper	386	63.5
Silver	233	108

It is stated in a textbook that the specific heat capacity of a metal is inversely proportional to its atomic mass.

(a) Show that this statement is approximately correct.

(2)

(b) A simple model suggests that, at a given temperature, the internal energy per atom should be the same in all metals.

Explain how this accounts for the relationship between specific heat capacity and atomic mass.

(2)

(Total for Question = 4 marks)

3 (a) Explain what is meant by internal energy of a liquid.

(2)

(b) A cup of tea contains 175 g of water at a temperature of 85.0 °C. Milk at a temperature of 4.5 °C is added to the tea and the temperature of the mixture becomes 74.0 °C.

(i) Show that the internal energy of the water decreases by about 8 kJ as its temperature decreases.

Specific heat capacity of water = 4200 J kg^{-1} K^{-1}

(2)

(ii) Calculate the mass of milk that was added to the tea. State an assumption that must be made.

Specific heat capacity of milk = 3900 J kg^{-1} K^{-1}

(3)

Mass of milk =

Assumption

(Total for Question = 7 marks)

4 The heating element of an electric shower has a power of 6.0 kW.

(a) The shower is operated from a 230 V mains supply.

Calculate the resistance of the heating element.

(2)

Resistance =

(b) Water enters the shower at a temperature of 7.5 °C.

Calculate the water flow rate required to give an output temperature of 37.5 °C.

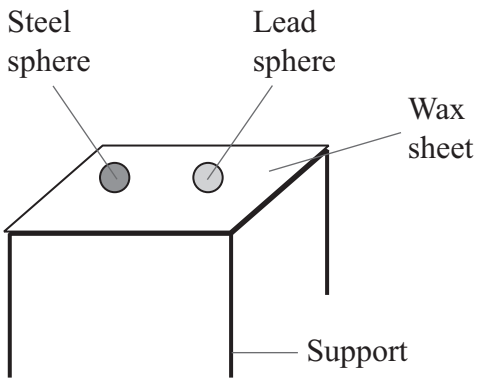
specific heat capacity of water = 4200 J kg^{-1} K^{-1}

(3)

Flow rate =

(Total for Question = 5 marks)

5 Two metal spheres of the same size are heated to a temperature of 100 °C in a water bath. One of the spheres is made of lead and the other of steel. The spheres are then placed onto a sheet of paraffin wax as shown. Paraffin wax melts at 55 °C.



	Mass / g	**Specific heat capacity /J kg ^{1} K ^{1}**
Lead sphere	50	130
Steel sphere	34	490

(a) The steel sphere melts through the wax sheet and drops to the floor. The temperature of the steel sphere when it reaches the floor is 53 °C.

Calculate the thermal energy lost by the steel sphere from the time when it was removed from the water bath.

(2)

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Thermal energy lost .....

(b) The lead sphere is only able to partially melt the wax, so does not drop to the floor.

Explain this observation.

(2)

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(Total for Question 4 marks)

6 The heating element of a hair dryer supplies 2.1 kW to the air flowing past it.

(a) The hair dryer is connected to a 230 V supply.

Calculate the minimum current in the heating element.

(2)

Current =

(b) (i) The fan in the hair dryer blows air at 20 °C across the heating element at a rate of 0.068 kg s^{-1}.

Calculate the temperature of the air emerging from the hair dryer.

specific heat capacity of air = 1.01×10^3 J kg^{-1} K^{-1}

(2)

Exit temperature =

(ii) Describe the energy changes that occur as air is blown past the heating element.

(2)

(Total for Question = 6 marks)

7 A washing machine uses 15 litres of water in a hot-wash cycle in which the machine is set to wash at 60 °C.

1.0 litre of water has a mass of 1.0 kg

specific heat capacity of water 4200 J kg ^{1} K ^{1}

(a) On a particular day the inlet temperature of the water is 15 °C. Show that the energy that must be supplied in order to bring the water to the correct temperature is about 3 MJ.

(2)

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(b) (i) The power of the heater is 2.5 kW. Calculate the minimum time it takes for the water to be brought to the correct temperature.

(2)

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Minimum time .....

(ii) State an assumption you made in your calculation.

(1)

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(c) The washing machine is connected to a 230 V supply. What current is drawn from the supply by the heater?

(2)

Current .....

(Total for Question 7 marks)