Question 1

(*d*) The *U*-value of the material in a double-glazed window in a house is 2.8 W m^{-2} K^{-1}. The window has an area of 3.0 m^2. How much energy is lost through the window in one hour if the temperature inside the house is 20 °C and the outside temperature is 11 °C?

(*e*) List a pair of complementary colours of light.

Question 2

(*c*) Define specific latent heat. (6)

A drinking glass contains 500 g of water at a temperature of 24 °C. Three cubes of ice, of side 2.5 cm, are removed from a freezer and placed in the water. The temperture of the ice is –20 °C.

Calculate the mass of the ice. (6)

Calculate the minimum temperature of the water when the ice has melted. (16)

density of ice	= 0.92 g cm^{-3}
specific heat capacity of water	= 4200 J kg^{-1} K^{-1}
specific heat capacity of ice	= 2100 J kg^{-1} K^{-1}
specific latent heat of fusion of ice	= 3.3×10^5 J kg^{-1}

Question 3

(*d*) Storage heaters are frequently used to heat buildings. State the principle that underlies the operation of an electrical storage heater.

Question 4

(*c*) The graph shows the variation in temperature θ of 150 g of crushed ice when it was supplied with energy ΔE at a constant rate.

(i) Explain the shape of the graph. (12)

(ii) Describe how energy could have been supplied at a constant rate. (6)

(iii) Using the graph, estimate the specific latent heat of fusion of ice. (10)

Question 5

2. In an experiment to measure the specific latent heat of vaporisation of water, a student used a copper calorimeter containing water and a sensitive thermometer. The water was cooled below room temperature before adding dry steam to it.

The following measurements were recorded.

Mass of copper calorimeter	=	34.6 g
Initial mass of calorimeter and water	=	96.4 g
Mass of dry steam added	=	1.2 g
Initial temperature of calorimeter and cooled water	=	8.2 °C
Final temperature of calorimeter and water	=	20.0 °C

How was the water cooled below room temperature? (6)

How was the steam dried? (6)

Describe how the mass of the steam was determined. (6)

Why was a sensitive thermometer used? (6)

Using the data, calculate the specific latent heat of vaporisation of water. (16)

(specific heat capacity of water = 4180 J kg^{-1} K^{-1}; specific heat capacity of copper = 390 J kg^{-1} K^{-1})

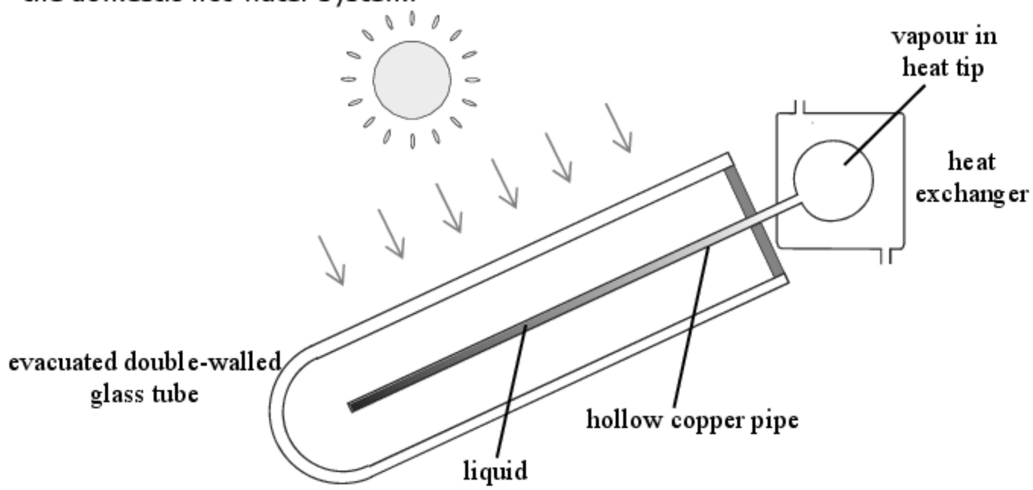
Question 6

11. Read the following passage and answer the accompanying questions.

The sun is a major source of 'green' energy. In Ireland solar heating systems and geothermal systems are used to get energy from the sun.

There are two main types of solar heating systems, flat-plate collectors and vacuum-tube collectors.

- A flat-plate collector is usually an aluminium box with a glass cover on top and a blackened plate on the bottom. A copper pipe is laid on the bottom of the box, like a hose on the ground; water is passed through the pipe and transfers the absorbed heat to the domestic hot water system.



- In a vacuum-tube collector, each tube consists of an evacuated double-walled silvered glass tube in which there is a hollow copper pipe containing a liquid. The liquid inside the copper pipe is vaporised and expands into the heat tip. There the vapour liquefies and the latent heat released is transferred, using a heat exchanger, to the domestic hot water system. The condensed liquid returns to the copper pipe and the cycle is repeated.

In a geothermal heating system a heat pump is used to extract solar energy stored in the ground and transfer it to the domestic hot water system.

(*a*) What is the maximum energy that can fall on an area of 8 m^2 in one hour if the solar constant is 1350 W m^{-2}? (7)

(*b*) Why is the bottom of a flat-plate collector blackened? (7)

(*c*) How much energy is required to raise the temperature of 500 litres of water from 20 °C to 50 °C? (7)

(*d*) The liquid in a vacuum-tube solar collector has a large specific latent heat of vaporisation. Explain why. (7)

(*e*) Name the three ways that heat could be lost from a vacuum-tube solar collector. (7)

(*f*) How is the sun's energy trapped in a vacuum-tube solar collector? (7)

(*g*) Describe, in terms of heat transfer, the operation of a heat pump. (7)

(*h*) Give an advantage of a geothermal heating system over a solar heating system. (7)

(specific heat capacity of water = 4200 J kg^{-1} K^{-1}; density of water = 1000 kg m^{-3}; 1 litre = 10^{-3} m^3)

Question 7

2. The specific heat capacity of water was found by adding hot copper to water in a copper calorimeter. The following data was recorded.

mass of calorimeter	55.7 g
mass of calorimeter + water	101.2 g
mass of copper + calorimeter + water	131.4 g
initial temperature of water	16.5 °C
temperature of hot copper	99.5 °C
final temperature of water	21.0 °C

Describe how the copper was heated and how its temperature was measured. (9)

Using the data, calculate:

(i) the energy lost by the hot copper

(ii) the specific heat capacity of water. (16)

Give two precautions that were taken to minimise heat loss to the surroundings.

Explain why adding a larger mass of copper would improve the accuracy of the experiment. (15)

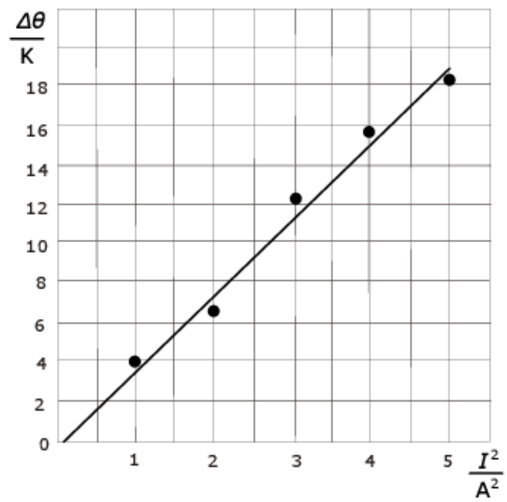
(specific heat capacity of copper = 390 J kg^{-1} K^{-1})

Question 8

(c) Why does the temperature of an athlete reduce when she perspires? (7)

Question 9

4. In an experiment to verify Joule's law a student passed a current through a heating coil in a calorimeter containing a fixed mass of water and measured the rise in temperature $\Delta\theta$ for a series of different values of the current I. The student allowed the current to flow for three minutes in each case.



Describe, with the aid of a labelled diagram, how the student arranged the apparatus. (12)

Why was a fixed mass of water used throughout the experiment? (6)

The student drew a graph, as shown. Explain how this graph verifies Joule's law. (7)

Given that the mass of water in the calorimeter was 90 g in each case, and assuming that all of the electrical energy supplied was absorbed by the water, use the graph to determine the resistance of the heating coil. The specific heat capacity of water is 4200 J kg^{-1} K^{-1}. (15)

Question 10

2. In an experiment to measure the specific latent heat of vaporisation of water, cool water was placed in an insulated copper calorimeter. Dry steam was added to the calorimeter. The following data was recorded.

Mass of calorimeter	=	50.5 g
Mass of calorimeter + water	=	91.2 g
Initial temperature of water	=	10 °C
Temperature of steam	=	100 °C
Mass of calorimeter + water + steam	=	92.3 g
Final temperature of water	=	25 °C

Calculate a value for the specific latent heat of vaporisation of water. The specific heat capacity of copper is 390 J kg^{-1} K^{-1} and the specific heat capacity of water is 4200 J kg^{-1} K^{-1}. (24)

Why was dry steam used? How was the steam dried? (10)

A thermometer with a low heat capacity was used to ensure accuracy. Explain why. (6)

Question 11

2. In an experiment to measure the specific latent heat of fusion of ice, warm water was placed in a copper calorimeter. Dried, melting ice was added to the warm water and the following data was recorded.

mass of calorimeter	60.5 g
mass of calorimeter + water	118.8 g
temperature of warm water	30.5 °C
mass of ice	15.1 g
temperature of water after adding ice	10.2 °C

Explain why warm water was used.

Why was dried, melting ice used?

Describe how the mass of the ice was found.

What should be the approximate room temperature to minimise experimental error? (22)

Calculate:
(i) the energy lost by the calorimeter and the warm water;
(ii) the specific latent heat of fusion of ice. (18)

(specific heat capacity of copper = 390 J kg^{-1} K^{-1};
specific heat capacity of water = 4200 J kg^{-1} K^{-1})

Question 12

(b) Why is a filament light bulb **not** an efficient source of light? (7)

Question 13

(c) Define (i) power, (ii) specific heat capacity. (9)

400 g of water at a temperature of 15 °C is placed in an electric kettle. The power rating of the kettle is 3.0 kW.

Calculate
(i) the energy required to raise the temperature of the water to 100 °C;
(ii) the energy supplied by the kettle per second;
(iii) the least amount of time it would take to heat the water to 100 °C. (15)

In reality, the time taken to heat the water will be greater. Explain why. (4)

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

Question 14

(*c*) On what thermometric properties are the following based: [redacted]
(*i*) the thermocouple thermometer and (*ii*) the mercury-in-glass thermometer?

Question 15

(*c*) Why is it necessary to have a standard thermometer? (7)

Question 16

(*c*) What is the thermometric property of a thermocouple? (7)