O Level Pure Physics Structured

Thermal Properties of Matter Test 2.0

Q1

Induction cookers work on the principle of electromagnetic induction. Fig 9.1 shows an induction cooker which consists of a copper coil connected to an alternating current (a.c.) supply and a ceramic plate. When a pot made of soft magnetic material is placed on top of the cooker and the a.c. supply is turned on, electromagnetic induction leads to the pot being heated. The ceramic plate remains relatively cool.

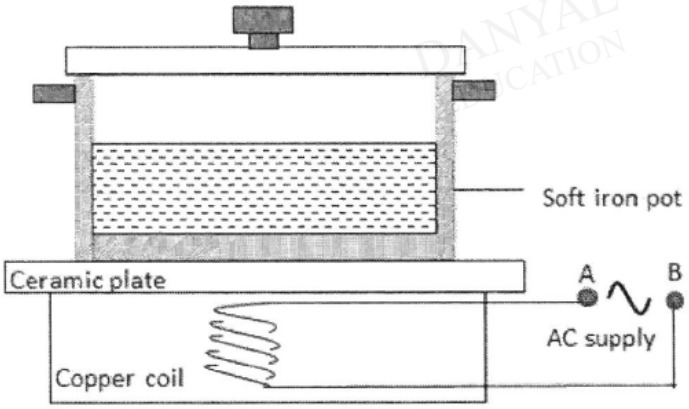

Fig. 9.1

The induction cooker has a power rating of 1800 W and contains 0.2 kg of water at a temperature of 23 °C. The pot was left on the induction cooker until all the water boiled off.

The specific heat capacity of water = 4200 J/(kg °C)
The specific latent heat of vaporization of water = 2 260 000 J/kg

Calculate the minimum time the pot was left on the induction cooker.

time =.....[3]

Q2

An experiment is conducted to determine the specific latent heat of fusion of ice. Fig. 3.1 shows the set-up. The immersion heater set 1 is connected to a 12 V power supply and the current is 10.0 A. The heater in set 2 is not connected to any power supply.

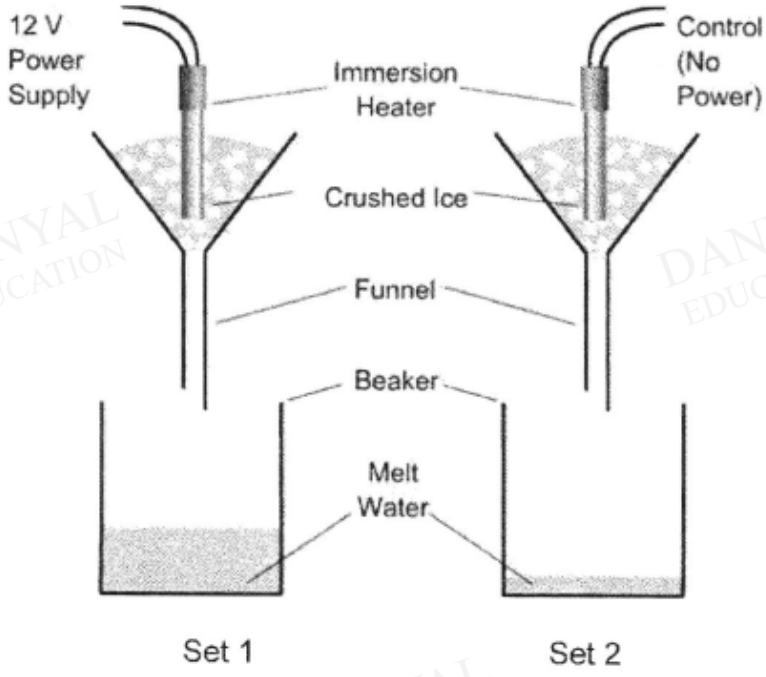

Fig. 3.1

The immersion heater in set 1 is only switched on until water flows at a steady rate from the funnel, for a duration of 5.0 minutes.

Table 3.1 shows the data collected from the experiment after 5.0 minutes.

Table 3.1

	set 1	set 2
mass of beaker/g	60	60
mass of beaker with water/g	192	85
mass of melted ice/g		

(a) Define *specific latent heat of fusion*.

.....

..... [1]

(b) Fill in the blanks for Table 3.1. [1]

(c) Set 2 is known as a control set. Explain the purpose of having a control set in the experiment.

.....

..... [1]

(d) Calculate the heat energy provided by the immersion heater for 5.0 min.

heat energy = ... [1]

(e) Hence, calculate the ideal value of the specific latent heat of fusion of ice.

specific latent heat of fusion of ice = ... [2]

Q3

Fig. 4.1 shows a container in which coffee is served at an airport kiosk.

Fig. 4.1

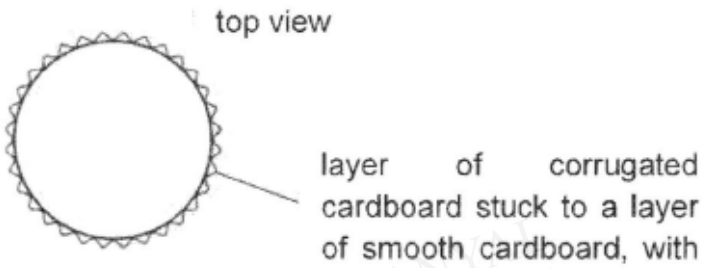

Fig. 4.2

The container itself is made of two layers of cardboard, as shown in Fig. 4.2. It has a thin plastic lid.

(a) State one reason why the layer of corrugated cardboard stops the fingers of the person holding the container from becoming uncomfortably hot.

.....

..... [1]

(b) Another airport kiosk serves coffee in pottery mugs. The mugs all have the same internal dimensions but some have a high heat capacity and some have a low heat capacity.

When hot drinks are poured into the mugs, the temperature of the drink always drops because of the thermal energy absorbed by the mug.

State which mug, high heat capacity or low heat capacity, causes the least fall in temperature of the hot drink, and explain why.

.....

.....

.....

..... [2]

Q4

500 g of water at a temperature of 16°C enters an ice-making machine and emerges as ice cubes at a temperature of –5°C. The freezing point of water is 0°C. Given that:

- specific heat capacity of water = 4.2 J/(g°C)
- specific latent heat of fusion of water = 336 J/g
- specific latent heat of vaporization of water = 2260 J/g
- specific heat capacity of ice = 2.1 J/(g°C)

Calculate the thermal energy removed from

(a) the water during freezing,

thermal energy = ... [2]

(b) the frozen water as it cools further.

thermal energy = ... [2]

(c) Using ideas about molecules, suggest why more energy is needed to change water into steam than to change the same mass of water into ice.

.....

..... [1]

Q5

a) **Fig. 6.1** shows a 100 W coffee-making machine.

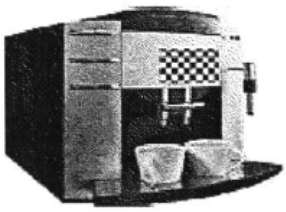

Fig 6.1

(i) In the coffee-making machine, steam at 100°C is passed into the mixture of cold milk and coffee of mass 0.20 kg in each cup at 8°C until its temperature rises to 96°C. [3]

Specific heat capacity of the coffee and milk mixture is 4000 J/kgK
Specific heat capacity of water is 4200 J/kgK
Specific latent heat of vaporisation of water is 2300000 J/kg

Find the mass of hot coffee finally produced in each cup.

Mass of hot coffee =……..

Answers

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Q1

Thermal energy required to change water from 23°C to 100 °C $Q = mc\Delta\theta$ = 0.2 x 4200 x (100 - 23) = 64 680 J	M1
Thermal energy required to change water from 100°C to steam at 100 °C $Q = ml_v$ = 0.2 x 2 260 000 = 452 000 J	M1
Total energy needed = 64 680 + 452 000 = 516 680 J	
$E = Pt$ 516 680 = 1800 x t t = 287 s	A1
*Accept 288 s (*minimum time)	

Q2

3a	Heat required to melt 1 kg of ice to water at same temperature.	1
3b		1

	Set 1	Set 2
mass of beaker/g	60	60
mass of beaker with water/g	192	85
mass of melted ice/g	132	25

3c	Heat energy supplied by the surroundings to melt the ice can be determined.	1
3d	Heat energy = VIT = 12 × 10 × 5 × 60 = 36 kJ	1
3e	energy = ml_v 36 000 = (132 – 25) × l_v l_v = 336 J/kg = 336000J/kg	1m: diff in mass 1

Q3

4a	• Air within the gaps is a poor conductor of heat from the cup to the fingers OR • The cardboard is a poor conductor of heat from the cup to the fingers.	1
4b	• Low heat capacity cup. • Less heat energy is absorbed from the drink to lower the temperature by 1 ^{0}C.	1 1

Q4

(a)	Q = ml_f = (500)(336) = **168 000 J**	[1]: W & C/F [1]: A & U
(b)	Q = $mc\Delta\theta$ = (500)(2.1)(5 – 0) = **5250 J**	[1]: W & C/F [1]: A & U
(c)	Any **one** of the following: More energy needed to completely break intermolecular forces (during vaporization) than to strengthen it (during freezing) / incomplete breaking of intermolecular forces during melting but complete breaking of such forces during boiling / work is done to push back atmosphere during boiling but not so during melting	[1]

Q5

)a) (i)

Heat lost by steam = Heat gained by coffee and milk mixture

$mL + mc\theta\square = mc\theta\square$

$m(2300000) + m(4200)(100-96) = (0.20)(4000)(96-8)$ [M1]

$2316800m = 70400$

$m = 0.030$ kg [A1]

Total mass = 0.030 + 0.20 = 0.23kg [A1]

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