O Level Pure Physics Structured

Thermal Properties of Matter Test 3.0

Q1

Fig. 6.2 shows a baby's milk bottle containing some milk being heated in a bottle warmer. The bottle warmer has a foam-filled plastic wall and a smooth shiny casing.

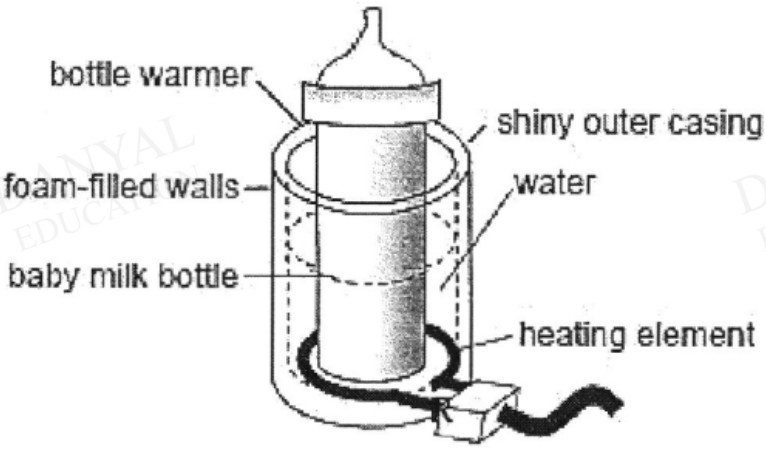


Fig 6.2

(ii) During heating, the student notices that some of the water evaporates from the warmer. Describe and explain, using ideas about molecules of water, what happens during evaporation. [2]

……

……

……

……

(iii) The student finds that the rate of evaporation increases when the temperature of the water is higher. [2]

State and explain one other change that **increases** the rate of evaporation.

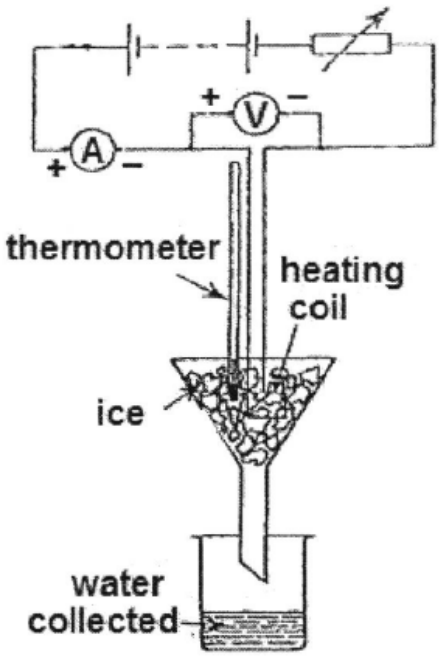
……

……

……

Q2

A student performed an experiment using the apparatus as illustrated in the figure below.



A heating coil was placed in a filter funnel and surrounded by lumps of ice. The potential difference V across the heater and mass m of water collected in time t of 500 s were measured for various values of the heater current, I.

The values were recorded and a spreadsheet was used to make calculations as shown in table below.

	A	B	C	D	E
No	potential difference, V	Current, I	Mass of water collected, m	Time taken, t	Thermal energy supplied
	/ V	/ A	/ g	/ s	/ J
1	4.0	2.0	14.9	500	4000
2	6.0	3.0	29.8	500	9000
3	7.0	3.5	39.5	500	12250
4	8.0	4.0	50.6	500	

(a) Explain how the values for the thermal energy supplied by the heating coil in column **E** were calculated from the relevant columns in the table.

_____

_____ [1]

(b) Calculate the thermal energy supplied when the mass of the water collected was 50.6 g.

thermal energy = _____ [2]

(c) The student wishes to find out the value of the *specific latent heat of fusion of ice*.

(i) State what is meant by *specific latent heat of fusion of ice*.

_____

_____ [2]

(ii) The student chose the values from row 4 to do the calculation. Write down the equation that will help him get started. (You should define symbols that are used in the equation.)

_____

_____ [1]

(iii) Hence, determine the value of the specific latent heat of fusion of ice.

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

(d) Later, the student discovered that all four values of the specific latent heat of fusion of ice calculated from each row of data were less than actual value of 336J/g. Suggest a reason to explain the discrepancy.

_____

_____

_____

_____ [2]

Q3

Fig. 10.1 shows the structure of a 1200 W electric kettle.

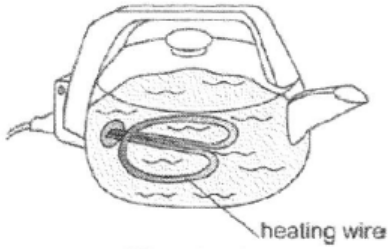


Fig. 10.1

(a) Explain why the heating wire must be at the base of the kettle.

.....

.....

..... [2]

Sammy uses the kettle in Fig. 10.1 to boil 1 litre of water at 20 °C. [1 ml = 1 cm^3]

(b) Given that the specific heat capacity of water is 4.2 J g^{-1} $°C^{-1}$ and the density of water is 1 g cm^{-3},

(i) calculate the time it takes for the water to reach 100 °C.

time = ... [2]

(ii) Explain what it means by *specific heat capacity of water is 4.2 J g^{-1} $°C^{-1}$.*

.....

..... [2]

(iii) State one assumption you made for your calculation in **(b)**.

..... [1]

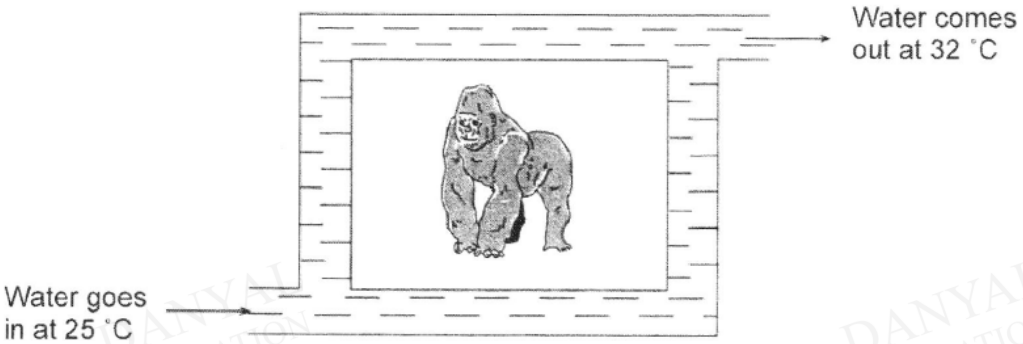
Sammy then uses 200 ml of 100 °C water to make a cup of milo. Since the milo is too hot, she adds 50 g of 0°C ice cubes into the milo.

(c) Given that the specific latent heat of fusion of ice is 334 kJ kg^{-1} and the specific heat capacity of the milo is 4.2 J g^{-1} $°C^{-1}$, calculate the final temperature of the mixture.

temperature = ... [3]

Q4

In order to determine the rate at which a monkey loses thermal energy, it is placed in a chamber through which water is circulated as shown.



The steady outlet temperature was recorded as 32 °C when the rate of flow of water was 3.0 kg h^{-1} and the inlet temperature was 25 °C.

When another monkey was added to the same chamber, the rate of flow of water had to increase to 7.0 kg h^{-1}, in order to achieve the same inlet and outlet temperatures.

Assume that each monkey lost thermal energy at the same constant rate, and the rate of loss of thermal energy from the chamber by other means remains constant.

(a) Define *temperature*.

..... [1]

(b) The main process of heat transfer from the monkey is thermal radiation. Describe **two** factors, in general, that could increase the rate of thermal radiation from an object.

1. .....

.....

2. .....

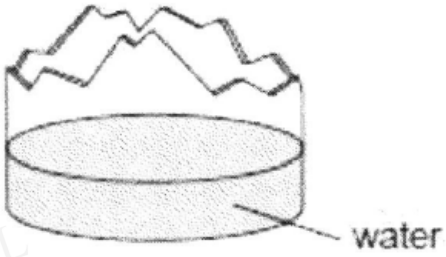
..... [2]

(c) Calculate the rate of loss of thermal energy of the second monkey .
(Specific heat capacity of water = 4 200 J kg^{-1} K^{-1})

Rate of loss of thermal energy of the second monkey = ... [4]

Q5

A broken glass bottle containing a small quantity of water was found in the waste basket, as shown in the figure below.



As the sun shines on it, the volume of water slowly decreases.

i. State the name of the process causing this decrease.

[1]

ii. In terms of the effect of the sun's rays on the water molecules, explain your answer to (b)(i).

[1]

Answers

Thermal Properties of Matter Test 3.0

Q1

(ii) The molecules at the surface gain energy and overcomes forces of attraction and changes into vapour. This leaves behind the slower moving particles in the water, which causes a decrease in its temperature.	A2

(iii) Increase the exposed surface area (any other answers) This allows more molecules at the surface to gain energy, overcomes forces of attraction and changes into vapour.	A1 A1

Q2

(a) Thermal energy = V I t , values from column A, B D are multiplied **[1]**

(b) energy = 8 x 4 x 500 **[1]**
= 16000 J **[1]**

(c) **(i)** Amount of energy needed to change 1kg of ice to water or water to ice **[1]**
without a change in temperature. **[1]**

(ii) Energy needed = mass x specific latent heat of fusion **[1]**

(iii) $50.6 \times l_f = 16000$ **[1]**
$l_f = 316$ J/g **[1]**

(d) Heat was absorbed from the surrounding by the ice. **[1]**
As such, more mass of ice was melted causing calculated value of l_f to be lesser than 336 J/g. **[1]**

Q3

Ia	Hot water being less dense will rise. So that convection can take place in the kettle to heat up the water	B1 B1
bi	$Q = mc\Delta\theta$ or 1200*t = 1000 *4.2*(100-20) t = 280 s	M1 A1
bii	It takes 4.2 J of energy to raise the temperature of 1g of water by 1 degree	B1 B1
biii	There is no heat loss to the environment / no electrical losses	B1
c	Q = ml_f (energy required to melt 50g of ice) Q = 0.05 *334 000 = 16 700 J Let final temp be T Heat loss by boiling water = heat gain melt ice + raise temp 200 *4.2 (100 – T) = 16 700 + 50*4.2*(T-0) 84000 - 840T=16700 + 210T T = 67300 / 1050 T = 64.1 °C	 M1 M1 A1

Q4

a	Temperature is the measure of the hotness and coldness of a body. *OR* Temperature is a measure of the average kinetic energy of the particles in the body.	[1]
b	**1.** The darker the colour of the body, the higher the rate of thermal radiation. **2.** The duller the surface of the body, the higher the rate of thermal radiation. **3.** The larger the surface area of the object, the higher the rate of thermal radiation. **4.** The higher the surface temperature of the surface of the object relative to the surrounding, the higher the rate of thermal radiation. **Any 2, **[1]** each*	[2]
c	Rate of heat loss by chamber and a monkey = $\frac{m_{water} c_{water} \Delta\theta}{t}$ $= \frac{3.0 \times 4200 \times (32 - 25)}{3600}$ = 24.5 W **[1]** Rate of heat loss by chamber and 2 monkeys = $\frac{m_{water} c_{water} \Delta\theta}{t}$ $= \frac{7.0 \times 4200 \times (32 - 25)}{3600}$ ≈ 57.17 W **[1]** Rate of loss of thermal energy of the 2nd monkey = 57.17 – 24.5 ≈ 33 W **[2]** (2 or 3 s.f)	Working [3] Ans [1]

Q5

i. State the name of the process causing this decrease.

[1]

evaporation *A1*

ii. In terms of the effect of the Sun's rays on the water molecules, explain your answer to (b)(i).

[1]

When the water molecules at the surface of the water gain sufficient amount of kinetic energy, *A1/2*
They will be able to break the intermolecular forces and escape into the surrounding as air particles. *A1/2*