Thermal Properties of Materials

Mark Scheme 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Thermal Properties of Materials
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 2

Time Allowed: **59 minutes**

Score: **/49**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** *either* change in volume = $(1.69 - 1.00 \times 10^{-3})$
or liquid volume $<<$ volume of vapour — M1
work done = $1.01 \times 10^5 \times 1.69 = 1.71 \times 10^5$ (J) — A1 [2]

(b) **(i)** **1.** heating of system/thermal energy supplied to the system — B1 [1]

2. work done on the system — B1 [1]

(ii) $\Delta U = (2.26 \times 10^6) - (1.71 \times 10^5)$ — C1
$= 2.09 \times 10^6$ J (*3 s.f. needed*) — A1 [2]

2 **(a** resonance — B1 [1]

(b) $Pt = mc\,\Delta\theta$ — C1
$750 \times 2 \times 60 = 0.28 \times c \times (98 - 25)$ — C1
$c = 4400\,\mathrm{J\,kg^{-1}\,K^{-1}}$ — A1 [3]

(*use of* $\Delta\theta = 73 + 273$ *max. 1/3*)
(*use of* $t = 2\,\mathrm{s}$ *not* $120\,\mathrm{s}$ *max. 2/3*)

(c) e.g. some microwave leakage from the cooker
e.e.g. container for the water is also heat — B [1]
(*any sensible suggestion*)

3 (a	(i)	sum of kinetic and potential energies of the molecules	M1	
		reference to random distribution	A1	[2]
	(ii)	for ideal gas, no intermolecular forces	M1	
		so no potential energy (only kinetic)	A1	[2]
(b)	(i)	*either* change in kinetic energy $= 3/2 \times 1.38 \times 10^{-23} \times 1.0 \times 6.02 \times 10^{23} \times 180$	C1	
		$= 2240\,J$	A	[2]
		or $R = kN_A$		
		energy $= 3/2 \times 1.0 \times 8.31 \times 180$	(C1)	
		$= 2240\ J$	(A1)	
	(ii)	increase in internal energy = heat supplied + work done on system	B1	
		2240 = energy supplied – 1500	C1	
		energy supplied = 3740 J	A	[3]

4 (a	(i)	sum of potential energy and kinetic energy of atoms / molecules / particles		
		reference to random	A1	[2]
	(ii)	no intermolecular forces	B1	
		no potential energy	B1	
		internal energy is kinetic energy (of random motion) of molecules	B1	[3]
		(*reference to random motion here then allow back credit to* ***(i)*** *if M1 scored*)		
(b)		kinetic energy $\propto$ thermodynamic temperature	B1	
		either temperature in Celsius, not kelvin so incorrect		
		or temperature in kelvin is not doubled	B1	[2]

5	**(a)**	(numerically equal to) quantity of (thermal) energy required to change the state of unit mass of a substance	M1	
		without any change of temperature	A1	[2]
		(Allow 1 mark for definition of specific latent heat of fusion/vaporisation)		
	(b)	*either* energy supplied = 2400 × 2 × 60 = 288000 J	C1	
		energy required for evaporation = 106 × 2260 = 240000 J	C1	
		difference = 48000 J		
		rate of loss = 48000 / 120 = 400 W	A1	
		or energy required for evaporation = 106 × 2260 = 240000 J	(C1)	
		power required for evaporation = 240000 / (2 × 60) = 2000 W	(C1)	
		rate of loss = 2400 – 2000 = 400 W	(A1)	[3]

6	**(a)**	sum of potential energy and kinetic energy of atoms/molecules/particles	M1	
		reference to random (distribution)	A1	[2]
	(b) (i)	as lattice structure is 'broken'/bonds broken/forces between molecules reduced (not molecules separate)	B1	
		no change in kinetic energy, potential energy increases	M1	
		internal energy increases	A1	[3]
	(ii)	*either* molecules/atoms/particles move faster/ <c^2> is increasing		
		or kinetic energy increases with temperature (increases)	B1	
		no change in potential energy, kinetic energy increases	M1	
		internal energy increases	A1	[3]

7	**(a**	+ΔU: increase in internal energy	B1	
		+q: thermal energy / heat supplied to the system	B1	
		+w: work done on the system	B1	[3]
	(b) (	(thermal) energy required to change the state of a substance	M1	
		per unit mass	A1	
		without any change of temperature	A1	[3]
	(ii)	when evaporating		
		greater change in separation of atoms/molecules	M1	
		greater change in volume	M1	
		identifies each difference correctly with ΔU and w	A1	[3]