Thermal Properties of Materials

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Thermal Properties of Materials
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 1

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 melting: solid to liquid B1
at a specific / one temperature / at the melting point B1

evaporation: liquid to vapour / gas OR molecules escape from surface of liquid B1
at all temperatures B1 [4]

2 evaporation: molecules escape from the surface B1
at all temperatures B1

boiling: takes place throughout / in the liquid B1
at the boiling point / at specific temperatures B1 [4]

3 **(a (i)** e.g. (phase) change from liquid to gas / vapour
thermal energy required to maintain constant temperature .... B1 [1]
(*do not allow 'convert water to steam'*)

(ii) e.g. evaporation takes place at surface B1
boiling takes place in body of the liquid B1
e.g. evaporation occurs at all temperatures B1
boiling occurs at one temperature .... B1 [4]

(b) (i) volume = $\left(\frac{48}{4.5} = \right)$ 10.7 cm^3 .... A1 [1]

(ii) volume = $10.7 / (6.0 \times 10^{23})$
= 1.8×10^{-23} cm^3 .... A1 [1]
2 separation = $\sqrt[3]{(1.8 \times 10^{-23})}$
= 2.6×10^{-8} cm .... A1 [1]

[Total: 8]

4	**(a)**	sum of (random) kinetic and potential energies of the atoms/molecules of the substance		M1 A1	**[2)**
	(b)	(i)	potential energy unchanged as atoms remain in same posijions allow 'reduced because atoms slightly closer together' vibrational kinetic energy reduced because temperature lower so internal energy less	M1 M1 A1	**[3)**
		(ii)	potential energy increases because separation increases kinetic energy unchanged because temperature unchanged so internal energy increases	M1 M1 A1	**[3)**

5	**(a)**	(sum of) potential energy and kinetic energy of molecules/atoms/particles	M1	
		mention of random motion/distribution	A1	[2]
	(b) (	$pV = nRT$		
		either at A, $1.2 \times 10^5 \times 4.0 \times 10^{-3} = n \times 8.31 \times 290$		
		or at B, $3.6 \times 10^5 \times 4.0 \times 10^{-3} = n \times 8.31 \times 870$	C1	
		$n = 0.20$ mol		[2]
	(ii)	$1.2 \times 10^5 \times 7.75 \times 10^{-3} = 0.20 \times 8.31 \times T$ *or* $T = (7.75/4.0) \times 290$	C1	
		$T = 560$ K	A1	[2]
		(*Allow tolerance from graph*: $7.7–7.8 \times 10^{-3}\,m^3$)		
	(c)	temperature changes/decreases so internal energy changes/decreases	B1	
		volume changes (at constant pressure) so work is done	B1	[2]

6	**(a)**	(numerically equal to) quantity of (thermal) energy/heat to change state/phase of unit mass	M1	
		at constant temperature	A1	[2]
		(*allow 1/2 for definition restricted to fusion or vaporisation*)		
	(b) (i)	at 70 W, mass $s^{-1} = 0.26\,g\,s^{-1}$	A1	
		at 110 W, mass $s^{-1} = 0.38\,g\,s^{-1}$	A1	[2]
	(ii) 1.	$P + h = mL$ or substitution of one set of values	C1	
		$(110 – 70) = (0.38 – 0.26)L$	C1	
		$L = 330\,J\,g^{-1}$	A1	[3]
	2.	*either* $70 + h = 0.26 \times 330$		
		or $110 + h = 0.38 \times 330$	C1	
		$h = 17/16/15$ W	A	[2]

7 (a) (numerically equal to) quantity of heat/(thermal) energy to change state/phase of unit mass — M1
at constant temperature — A1 [2]
(*allow 1/2 for definition restricted to fusion or vaporisation*)

(b) **(i)** constant gradient/straight line *(allow linear/constant slope)* — B1 [1]

(ii) $Pt = mL$ *or* power = gradient × L — C1

use of gradient of graph

(*or two points separated by at least 3.5 minutes*) — M

$110 \times 60 = L \times (372 - 325) \times 10^{-3} / 7.0$

$L = 9.80 \times 10^{5}\,\text{J kg}^{-1}$ (*accept 2 s.f.*) (*allow 9.8 to 9.9 rounded to 2 s.f.*) — A1 [3]

(iii) some energy/heat is lost to the surroundings *or* vapour condenses on sides — M1
so value is an overestimate — A1 [2]