Thermal Properties of Materials

Mark Scheme 4

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Thermal Properties of Materials
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 4

Time Allowed: **64 minutes**

Score: **/53**

Percentage: **/100**

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

1 **(a** e.g. fixed mass/ amount of gas
ideal gas
(*any two, 1 each)* B2 **[2]**

(b) (i) $n = pV / RT$ C1
$= (2.5 \times 10^7 \times 4.00 \times 10^4 \times 10^{-6}) / (8.31 \times 290)$ C1
$= 415$ mol A1 **[3]**

(ii) volume of gas at 1.85×10^5 Pa $= (2.5 \times 10^7 \times 4.00 \times 10^4) / (1.85 \times 10^5)$
$= 5.41 \times 10^6$ cm^3 C1
so, $5.41 \times 10^6 = 4.00 \times 10^4 + 7.24 \times 10^3 N$ C1
$N = 741$ A1 **[3]**
(answer 740 or fails to allow for gas in cylinder, max 2/3)

2 **(a** correct statement, words or symbols …..……..….. B1 **[1]**

(b)(i) $w = p\Delta V$ …….. C1
$= 1.03 \times 10^5 \times (2.96 \times 10^{-2} - 1.87 \times 10^{-5})$
$= (-)\ 3050$ J ……..…….……..…… A1 **[2]**

(ii) $q = 4.05 \times 10^4$ J ……. B1 **[1]**

(iii) $\Delta U = 4.05 \times 10^4 - 3050 = 37500$ J …no e.c.f. from **(a)**…… **[1]**
penalise 2 sig.fig. once only

(c) number of molecules = N_A ……. C1
energy $= 37500 / (6.02 \times 10^{23})$
$= 6.2 \times 10^{-20}$ J (accept 1 sig.fig.) ……..…. A1 **[2]**

CHEMISTRY ONLINE
— TUITION —

3	**(a)**	(thermal) energy/heat required to convert unit mass/1 kg of solid to liquid	**M1**	
		with no change in temperature/at melting point	**A1**	**[2]**
	(b) (i)	energy required to warm ice = $24 \times 10^{-3} \times 2.1 \times 10^{3} \times 15$ (= 756 J)	**C1**	
		energy required to melt ice at 0 °C = $24 \times 10^{-3} \times 330 \times 10^{3}$ (= 7920 J)	**C1**	
		total energy = 8700 J	**A1**	**[3]**
	(ii)	energy lost by warm water = $200 \times 10^{-3} \times 4.2 \times 10^{3} \times (28 - T)$	**C1**	
		$200 \times 4.2 \times (28 - T) = 24 \times 4.2 \times T + 8676$	**C1**	
		T = 16 °C	**A1**	**[3]**
		[allow 2 marks if ΔT calculated]		
		[allow 2 marks if (24 x 4.2 x T) omitted]		
		[allow 1 mark for 224 x 4.2 x (28 - T) = 8676, T - 19 °C]		

4	0	-	+	(-1 for each error)	B2	
	+	+	0	(-1 for each error)	B2	
	+	+	0	(-1 for each error)	B2	**[6]**
				Total		**[6]**

5	**(a)**	pV/T = constant	C1	
		T = (6.5 x 10^{6} x 30 x 300)/(1.1 x 10^{5} x 540)	C1	
		= 985 K	A1	[3]
		(*if uses °C, allow 1/3 marks for clear formula*)		
	(b) **(i)**	$\Delta U = q + w$		
		symbols identified correctly	M1	
		directions correct	A1	[2]
	(ii)	q is zero	B1	
		w is positive OR $\Delta U = w$ and U increases	B1	
		ΔU is rise in kinetic energy of <u>atoms</u>	M1	
		and mean kinetic energy $\propto T$	A1	[4]
		(*allow one of the last two marks if states 'U increases so T rises'*)		

6 **(a)** ✗
✗
✓
✓ (-1 for each error or omission) ..... B2 [2]

(b) heat lost by liquid gold = 0.95*m* x 129 x Δ*T*..... C1
heat gained (silver) = 0.05*m* x 235 x (1340 – 300) + 0.05*m* x 105 000..C1, C1
122.5*m*Δ*T* = 17 470*m*
Δ*T* = 143 K.....C1
temperature = 143 + 1340 = 1483 K.....A1 [5]

(c) e.g. thermocouple/resistance thermometer ..... B1 [1]

7 (a) (i) *Q* = *mc/10* Cl
2300 = 0.75 x *c* x (100 - 20) / 120 ...(if uses ±273, then -2)..... Cl
c = 4600 J kg^{-1} K^{-1} ... (allow 1 sf)..... Al

(ii) *Q* = ***ml*** C1
2300 = (0.375 / 420) x ***L***
L = 2.6 x I0^{6} J kg^{-1} ...(alow 1 sf)..... Al [5]

(b) e.g. heat losses, .power not constant etc ..... Ml
(do not allow if releated to s.h.c., rather than l.h.c.)
effect of value for ***L*** ..... AI. [2]