Test on Kinetic Theory and Thermal Energy (Answers)

1 Jun 2012 PHYA5 Q 1

1	a		$\Delta T = (\frac{\Delta Q}{mc} =) \frac{8.5 \times 10^8}{4200 \times 0.12}$ ✓ 17 K ✓	2

1	b		$\left(\frac{\Delta T}{\Delta t} = \frac{\frac{\Delta Q}{\Delta t}}{mc}\right) = \frac{100-26}{\Delta t} = \frac{8.5 \times 10^8}{0.41 \times 4200}$ ✓ t = 15 s ✓	2

4

2 Jun 2012 PHYA5 Q4

4	a	i	$n = PV/RT = 3.2 \times 10^5 \times 1.9 \times 10^{-3}/8.31 \times 285$ n = 0.26 mol ✓ (0.257 mol)	1

4	a	ii	$P_2 = \frac{T_2}{T_1} \times P_1 = \frac{295}{285} \times 3.20 \times 10^5$ ✓ 3.31×10^5 Pa ✓(allow 3.30-3.35 $\times 10^5$ Pa) 3 sig figs ✓sig fig mark stands alone even with incorrect answer	3

4	b		similar -(rapid) **random** motion - range of speeds different - **mean** kinetic energy - root **mean** square speed - **frequency** of collisions	2

6

3 Jun 2008 PA02 Q5

Question 5			
(a)	(i)	(use of $pV = nRT$) V = 6.7 × 8.31 × (273 + 25)/110000 ✓ V = 0.15 m^3 ✓	5
	(ii)	(use of average kinetic energy = 3/2 kT) average kinetic energy = 3/2 × 1.38 × 10^{-23} × (273 + 25) = 6.2 × 10^{-21} J ✓ **if not** used Kelvin then no marks for (a) (i) or (ii)	
	(iii)	(if the average kinetic energy is doubled then) temperature is doubled ✓ (hence) pressure is doubled (as volume and amount of gas is constant) ✓ n.b. can be shown by calculation	
(b)	(i)	molecules have no preferred directions ✓ with a range of speeds ✓ (**or** different speeds) **or** average velocity = 0 **or** no forces between molecules (except during collisions)/molecules move freely	3
	(ii)	a collision in which (momentum and) kinetic energy is conserved ✓	
		Total	8

8

4 (Jun 2007 PA02 Q4)

Question 4			
(a)	(i)	(use of $\Delta Q = mc\Delta\theta$ gives) thermal energy = .022 × 2100 × 12 ✓ thermal energy = 55(4) J ✓	3
	(ii)	(use of $\Delta Q = mL$ gives) thermal energy = 0.022 × 3.3 × 10^5 = 7260 J	
(b)	(i)	(use of $\Delta Q = mc\Delta\theta$ gives) m × 4200 × (22 – 8) ✓ = 7260 + 554 + 0.022 × 4200 × 8 ✓ m = 8553.2 ÷ 58800 = 0.14(5) kg ✓	4
	(ii)	no heat loss/gain from surroundings ✓ **or** no heat transferred to cup **or** all ice melted **or** all water in cup at 8 °C **or** heat lost by water is equal to heat gained by ice	
		Total	7

8

5 June 2007 PA02 Q3

Question 3			
(a)	(i)	(use of $pV = nRT$ gives) $4.2 \times 10^5 \times 8.2 \times 10^{-3} = n \times 8.31 \times 295$ ✓ $n = 1.4$ (moles) ✓	**3**
	(ii)	(use of $E_k = 3/2kT$ gives) average $E_k = 3/2 \times 1.38 \times 10^{-23} \times 295 = 6.1 \times 10^{-21}$ J ✓	
(b)	(i)	mean (square) speed decreases ✓ since mean E_k decreases ✓	**4**
	(ii)	decreases ✓ since molecular collisions with walls less frequent ✓ **or** rate of change of momentum is less	
(c)		as same number of molecules (**or** moles) ✓ (and) same increase or change in (average) E_k ✓	**2**
		Total	**9**

9

Total = 35 marks