CAMBRIDGE INTERNATIONAL AS & A LEVEL CHEMISTRY · 9701

CHEMISTRY



MARK SCHEME

4 STATES OF MATTER

SCORE	PERCENTAGE
/	%

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Paper 1 Multiple Choice Answers: States of Matter

Question	Paper	Q. No.	Answer
167	9701_m21_qp_12	6	D
168	9701_s21_qp_11	8	A
169	9701_s21_qp_12	5	A
170	9701_w21_qp_11	6	D
171	9701_w21_qp_12	8	A
172	9701_m20_qp_12	9	B
173	9701_s20_qp_11	9	D
174	9701_s20_qp_12	9	A
175	9701_w20_qp_12	6	A
176	9701_w20_qp_12	7	C
177	9701_m19_qp_12	6	B
178	9701_s19_qp_11	7	B
179	9701_s19_qp_11	12	D
180	9701_s19_qp_12	6	C
181	9701_s19_qp_13	7	D
182	9701_w19_qp_12	5	C
183	9701_m18_qp_12	7	C
184	9701_s18_qp_12	6	A
185	9701_s18_qp_13	6	A
186	9701_w18_qp_11	2	A
187	9701_w18_qp_11	5	C
188	9701_w18_qp_12	6	A
189	9701_m17_qp_12	6	B
190	9701_s17_qp_12	5	A
191	9701_s17_qp_13	5	D
192	9701_w17_qp_11	5	B
193	9701_w17_qp_12	5	C
194	9701_m16_qp_12	7	C
195	9701_s16_qp_12	6	C
196	9701_s16_qp_12	7	D
197	9701_s16_qp_13	2	D
198	9701_w16_qp_11	2	D
199	9701_w16_qp_11	7	D
200	9701_w16_qp_12	8	C
201	9701_s15_qp_11	3	A
202	9701_s15_qp_13	2	D
203	9701_s15_qp_13	11	A
204	9701_w15_qp_12	19	C
205	9701_m22_qp_12	7	C
206	9701_s21_qp_12	6	D
207	9701_s20_qp_11	19	A
208	9701_s20_qp_12	1	B
209	9701_s20_qp_13	3	A
210	9701_m19_qp_12	7	B
211	9701_s19_qp_12	5	C
212	9701_s19_qp_12	7	B

Paper 1 Multiple Choice Answers: States of Matter (continued)

Question	Paper	Q. No.	Answer
213	9701_s19_qp_13	4	C
214	9701_s19_qp_13	5	B
215	9701_s18_qp_11	6	A
216	9701_s18_qp_12	3	D
217	9701_s18_qp_12	9	B
218	9701_s18_qp_13	1	B
219	9701_w18_qp_11	14	B
220	9701_m17_qp_12	4	C
221	9701_w17_qp_11	4	C
222	9701_m16_qp_12	8	A
223	9701_m16_qp_12	9	C
224	9701_s15_qp_12	4	D
225	9701_s15_qp_13	14	D
226	9701_w15_qp_11	5	C
227	9701_w15_qp_12	3	D

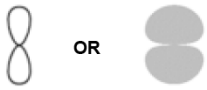
17. 9701_s21_ms_21 Q: 2

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>(a)(i)</td><td>M1 both make triple (covalent) bond / 3 shared pairs of electrons</td><td>1</td></tr>
<tr><td></td><td>M2 one bond in CO is coordinate / dative covalent / formed by donating a pair of electrons from O (to C)</td><td>1</td></tr>
<tr><td>(a)(ii)</td><td>
<table>
<tr><td></td><td>N_2</td><td>CO</td></tr>
<tr><td>number of electrons per molecule</td><td>14</td><td>14</td></tr>
<tr><td>type of van der Waals'</td><td>temporary / instantaneous dipole–induced dipole</td><td>permanent dipoles–(permanent) dipoles

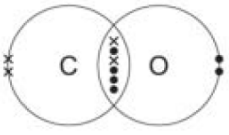
(and temporary / induced / instantaneous dipoles)</td></tr>
</table>
</td><td>2</td></tr>
<tr><td>(b)</td><td>CO / it is a polar molecule / it has a (permanent) dipole (but N_2 is non-polar)</td><td>1</td></tr>
<tr><td>(c)(i)</td><td>high temperature AND low pressure</td><td>1</td></tr>
<tr><td>(c)(ii)</td><td>M1 CO is polar / has a permanent dipole OR N_2 is non-polar</td><td>1</td></tr>
<tr><td></td><td>M2 IMF in CO are (more) significant / larger OR IMF in N_2 are smaller / less significant</td><td>1</td></tr>
<tr><td></td><td>Alternative answer
M1 (Size of) N_2 smaller than CO
OR volume of N_2 molecules / particles smaller</td><td></td></tr>
<tr><td></td><td>Alternative answer
M2 volume of N_2 molecules / particles is more negligible
ORA</td><td></td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>(d)</td><td>M1 correct conversion to consistent units
P = 101 000 V = 100 / 1 000 000 = (1×10^{-4}) T = 293</td><td>1</td></tr>
<tr><td></td><td>M2 use of all values from M1 in correct relationship, n = PV / RT</td><td>1</td></tr>
<tr><td></td><td>M3 calculation = 4.15×10^{-3} mol</td><td>1</td></tr>
</table>

18. 9701_s19_ms_21 Q: 3

(a)	$Ar^{+}(g) \rightarrow Ar^{2+}(g) + e^{(-)}$ **OR** $Ar^{+}(g) - e^{(-)} \rightarrow Ar^{2+}(g)$	**1**
(b)	at $x = 8$, within range 13000–20000	**1**
	at $x = 9$, within range 35000–45000	**1**
(c)	 **OR**	**1**
(d)(i)	**M1** *correct conversions of data to SI/consistent units* $p = 404\,000$; $V = 20 \times 10^{-6}$; $T = 298$	**1**
	M2 *calculation of n (= pV/RT) from* ***M1*** *values* $n = \frac{404000 \times 20 \times 10^{-6}}{8.31 \times 298} = 3.263 \times 10^{-3}$ mol of Cl_2	**1**
	M3 *finding the mass of* Cl_2 $= 3.263 \times 10^{-3} \times 71.0 = 0.23$ (g)	**1**
(d)(ii)	**Method 1** **M1** $= 3.263 \times 10^{-3} \times 2$ **Method 2** **M1** $= \frac{0.23}{71.0} \times 2$ **OR** 6.53×10^{-3}	**1**
	M2 $= 6.02 \times 10^{23} \times$ **M1** $= 3.93 \times 10^{21}$ atoms of Cl **M2** $= 6.02 \times 10^{23} \times$ **M1** $= 3.90 \times 10^{21}$ atoms of Cl	**1**
(d)(iii)	**M1** size / volume of **molecule / particle** becomes significant / non-negligible **OR** IMFs become significant / non-negligible	**1**
	M2 IMFs becomes significant / non-negligible / collisions are not elastic	**1**

19. 9701_s21_ms_22 Q: 2

Question	Answer	Marks
(a)(i)	Li^{+} AND S^{2-}	**1**
(a)(ii)	**M1** giant	**1**
	M2 (many) strong force(s) of attraction between oppositely charged ions OR (many) strong ionic bond(s)	**1**
(b)(i)	(covalent) bond with both electrons are provided from the same / one species OR shared pair (of electrons) are provided from the same species / one atom *owtte*	**1**
(b)(ii)	3 bonding pairs between C and O, 4 •'s AND 2×'s 1 lone pair on C, ××, AND 1 lone pair on O, ••. 	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Mark</th></tr>
<tr><td>(c)(i)</td><td>Any two assumptions about the behaviour of particles in an ideal gas from
• (particles / molecules have mass but) negligible size / volume (compared to total volume of gas / container)
• no / negligible forces / interactions (between particles / molecules)
• collisions are elastic</td><td>2</td></tr>
<tr><td>(c)(ii)</td><td>M1 IMF become larger / more significant</td><td>1</td></tr>
<tr><td></td><td>M2 volume of <u>molecules / particles</u> becomes significant / no longer negligible</td><td>1</td></tr>
<tr><td>(c)(iii)</td><td><table><tr><td>$N_2(g)$</td><td>CO(g)</td></tr><tr><td>instantaneous dipole–induced dipole ✓</td><td>instantaneous dipole–induced dipole
(and)
permanent dipole–permanent dipole ✓</td></tr></table></td><td>2</td></tr>
<tr><td>(c)(iv)</td><td>O is more electronegative than C</td><td>1</td></tr>
</table>

20. 9701_w16_ms_21 Q: 2

<table>
<tr><td>(a)(i)</td><td>Enthalpy / energy / heat change when one mole of a substance

Burns / combusts / reacts in excess oxygen
OR
Completely burns / combusts / reacts in oxygen

under standard conditions</td><td>1

1

1</td><td>3</td></tr>
<tr><td>(a)(ii)</td><td>$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$</td><td>1</td><td>1</td></tr>
<tr><td>(b)(i)</td><td>6813.4 / 6813 / 6810 / 6800 (J)</td><td>1</td><td>1</td></tr>
<tr><td>(b)(ii)</td><td>−1362.68 / −1362.7 / −1363 / −1360 / −1400 (kJ)</td><td>1</td><td>1</td></tr>
<tr><td>(b)(iii)</td><td>Any 2 from:
heat / energy losses (to air and/or to the container/surroundings)

incomplete combustion

(volatile) ethanol evaporated

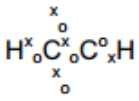
ethanol is impure

not all energy is lost as heat</td><td>
1

1</td><td>2</td></tr>
<tr><td>(c)(i)</td><td>$3C(s) + 4H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_3H_7OH(l)$
$3(-393.5)$ $4 \times (-285.8)$ -2021.0
$3CO_2 + 4H_2O$</td><td>
1+1

1</td><td>3</td></tr>
<tr><td>(c)(ii)</td><td>$\Delta H_f + (-2021.0) = 3(-393.5) + 4(-285.8)$
$\Delta H_f = -302.7$ (kJ mol^{-1})</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td>Total:</td><td></td><td>13</td></tr>
</table>

Q1.

2 **(a)** 

(1) **[1]**

(b) $n = \frac{PV}{RT} = \frac{(1515 \times 10^3) \times (76 \times 10^{-3})}{8.31 \times 298}$ **(1)**

$= 46.5$ **(1)** **[2]**

(c) **(i)** $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$ **(1)**

(ii) $n(C_2H_2) = n(CaC_2) = 100 \times 46.5$ **(1)**

mass of $CaC_2 = 100 \times 46.5 \times 64 =$

$= 297\ 570$ g

$= 297.6$ kg (accept 298 kg)

correct units necessary **(1)**

allow e.c.f. on candidate's answer in **(b)** **[3]**

Q2.

2 **(a)** there are no inter-molecular forces present between ideal gas molecules
ideal gas molecules have no volume
collisions between ideal gas molecules are perfectly elastic
ideal gas molecules behave as rigid spheres (any 2) [2]

(b) high temperature (1)
low pressure (1) [2]

(c) **most ideal** ..... neon..... nitrogen..... ammonia..... **least ideal** (1)
nitrogen has stronger van der Waals' forces than argon (1)
ammonia has hydrogen bonding as well as van der Waals' forces (1) [3]

(d) with increasing temperature,
average kinetic energy of molecules increases (1)
intermolecular forces are more easily broken (1) [2]

Q3.

(d) $n = \frac{PV}{RT} = \frac{6 \times 10^5 \times 710 \times 10^{-6}}{8.31 \times 293}$ (1)

$= 0.175$ (1) [2]

(e) $P = \frac{nRT}{V} = \frac{0.175 \times 8.31 \times 278}{710 \times 10^{-6}}$ (1)

$= 569410.5634$ Pa $= 5.7 \times 10^5$ (1)

allow ecf on **(d)** [2]

Q4.

(c) **(i)** for an ideal gas, **any four** from the following

the molecules behave as rigid spheres (1)

there are no/negligible intermolecular forces between the molecules (1)

collisions between the molecules are perfectly elastic (1)

the molecules have no/negligible volume (1)

the molecules move in random motion (1)

the molecules move in straight lines (1)

the kinetic energy of the molecules is directly proportional to the temperature (1)

the pressure exerted by the gas is due to the collisions between the gas molecules and the walls of the container (1)

not an ideal gas obeys $pV = nRT$

(max 4)

(ii) there are intermolecular forces between CO_2 molecules/ CO_2 molecules have volume (1) [5]