States of Matter

Mark Scheme 1

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	States of Matter
Sub-Topic	
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **65 minutes**

Score: **/54**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 **(a (i)**	Straight line drawn horizontally from same intercept	[1]	[1]
(ii)	T_1 because it shows greatest deviation/furthest from ideal	[1]	[1]
(iii)	reducing T (reduces KE of particles) so intermolecular forces of attraction become more significant	[1]	[1]
(iv)	greatest deviation is at high pressure increasing pressure decreases volume so volume of particles becomes more significant ora	[1] [1]	[2]
(b)	Mass of air = 100 × 0.00118 = 0.118 g Mass of flask = 47.930 – 0.118 = **47.812** g Mass of **Y** = 47.989 – 47.812 = **0.177** g $pV = nRT = \frac{m}{M_r} RT$ $M_r = \frac{mRT}{pV} = \frac{0.177 \times 8.31 \times 299}{1 \times 10^5 \times 100 \times 10^{-6}}$ = **44.0** (43.979 to 2 or more sf)	[1] [1] [1] [1]	[4]
(c) (i)	strong <u>triple</u> bond	[1]	
(ii)	high temperature (needed for reaction between N_2 and O_2)	[1]	[1]
(iii)	$2NO + 2CO \rightarrow N_2 + 2CO_2$ **OR** $2NO + C \rightarrow N_2 + CO_2$	[1]	[1]
(iv)	$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$	[1]	[1]
(v)	$NO + ½O_2 \rightarrow NO_2$ $NO_2 + SO_2 \rightarrow NO + SO_3$ **OR** $NO_2 + SO_2 + H_2O \rightarrow NO + H2SO_4$	[1] [1]	[2]
			[15]

2 **(a** *any two from*: molecules have negligible volume
negligible intermolecular forces *or* particles are not attracted to each other *or* to the walls of the container
random motion
no loss of **kinetic** energy during collisions *or* elastic collisions (NOT elastic molecules) 2 × [1]

[2]

(b) low temperature ***and*** high pressure both required [1]

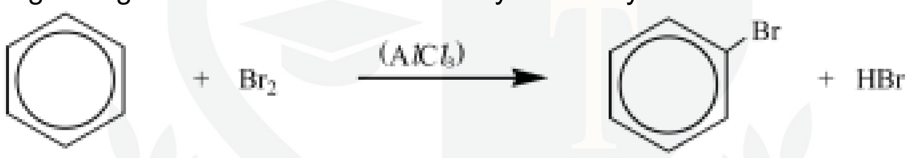
(ii) (at low T) forces between particles are more important, [1]

(at high P) volume of molecules are significant [1]

[3 max 2]

(c) endothermic; because the equilibrium moves to the right on heating *or* with increasing temperature *or* because bonds are broken during the reaction [1]

(ii) e.g. halogenation *or* Friedel-Crafts alkylation / acylation



reactants [1]
products [1]

other possibilities: Cl_2, I_2, R–Cl, RCOCl etc.

[3]

[Total: 7]

3 **(a)** diamond and graphite [1]

(ii) any three from

	graphite	**diamond**
colour	black	transp /colourless
electrical conductivity	good conductor	non-conductor
hardness	soft / slippery	/ non slippery
density	less dense than diamond	more dense than graphite
melting point	lower	h

3 × [1]

[4]

(b) Because each carbon is only bonded to 3 others *or* is unsaturated / doubly-bonded / sp^2 *or* has 3 bonding locations
(NOT forms only 3 *bonds*) [1

$C_{60}H_{60}$ [1]

[2]

(c) Number of atoms carbon present = $0.001 \times 6.02 \times 10^{23} / 12 = \mathbf{5.02 \times 10^{19}}$ [1]

(ii) Number of hexagons present = $5.02 \times 10^{19} / 2 = 2.51 \times 10^{19}$

Area of sheet = $690 \times 2.51 \times 10^{19} = \mathbf{1.73 \times 10^{22}\ nm^2}$ [1]

(iii) Graphene: Yes, since it has free / delocalised / mobile electrons [1]

Buckminsterfullerene: No, (although there is delocalisation within each sphere)
it consists of separate / simple / discrete molecules / spheres / particles,
(so no delocalisation from one sphere to the next)
or electrons are trapped within each molecule / sphere

[4]

[Total: 10]

4 **(a** alkanes/paraffins
not hydrocarbon (1) [1]

(b) **2** $C_{14}H_{30}$ + **43** $O_2 \rightarrow$ **28** CO_2 + **30** H_2O **or**

$C_{14}H_{30}$ + $^{43}/_2O_2 \rightarrow$ **14** CO_2 + **15** H_2O (1 [1]

(c) **(i)** **mass of $C_{14}H_{30}$ burnt**

$\frac{8195 \times 10.8}{1000} = 88.506 = 88.5$ t (1)

(ii) **mass of CO_2 produced**

M_r of $C_{14}H_{30}$ = (14 x 12 + 30 x 1) = 198 (1)

2 x 198 t of $C_{14}H_{30} \rightarrow$ 28 x 44 t of CO_2

88.5 t of $C_{14}H_{30} \rightarrow \frac{28 \times 44 \times 88.5}{2 \times 198}$ (1)

= 275.3 t of CO_2 (1)

allow 275.4 t if candidate has used 88.506
allow ecf on wrong value for M_r of $C_{14}H_{30}$ [4]

(d) $n = \frac{PV}{RT} = \frac{6 \times 10^5 \times 710 \times 10^{-6}}{8.31 \times 293}$ (1)
= 0.175 (1)

(e) $P = \frac{nRT}{V} = \frac{0.175 \times 8.31 \times 278}{710 \times 10^{-6}}$ (1)
= 569410.5634 Pa = 5.7×10^5 (1)

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

[Total: 10]

5 **(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) **mo 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]

(e) 18 (1)

(f) **(** both have very similar/same van der Waals' forces (1)

(ii) CH_3F has permanent dipole (1) [2]

[Total: 12]