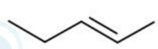
Question Number	Answer	Mark
8	**The only correct answer is D** (buckminsterfullerene C_{60}) ***A*** *is incorrect because silver has a giant metallic lattice* ***B*** *is incorrect because sodium chloride has a giant ionic lattice* ***C*** *is incorrect because carbon has giant covalent lattice*	**(1)**

Question Number	Answer	Mark
6(a)	**The only correct answer is D** ($[Ar]\ 4s^2$) ***A*** *is not correct because this is the electronic configuration for sodium* ***B*** *is not correct because this is the electronic configuration for potassium* ***C*** *is not correct because this is the electronic configuration for magnesium*	**(1)** **Computer**

Question Number	Answer	Mark
6(b)	**The only correct answer is B** ($[Ar]3d^3$) ***A*** *is not correct because the 3 electrons have been removed from the 3d orbitals* ***C*** *is not correct because this is the electronic configuration for* Cr^{2+} ***D*** *is not correct because this is the electronic configuration for* Cr^{+}	**(1)** **Computer**

Question Number	Answer	Mark
4	**The only correct answer is A** (argon) ***B*** *is incorrect because this would have a mass of 176 mg* ***C*** *is incorrect because this would have a mass of 16 mg* ***D*** *is incorrect because neon is monatomic not diatomic*	**(1)**

Question Number	Answer	Mark
18	**The only correct answer is D** () ***A*** *is incorrect because this molecule has two methyl groups at one end of the carbon to carbon double bond* ***B*** *is incorrect because this molecule has two methyl groups at one end of the carbon to carbon double bond* ***C*** *is incorrect because this molecule has two methyl groups at each end of the carbon to carbon double bond*	**(1)**

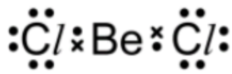
Question Number	Answer	Mark
16	**The only correct answer is A** (*E* | *E*) ***B*** *is incorrect because double bond 2 is an E configuration* ***C*** *is incorrect because double bond 1 is an E configuration* ***D*** *is incorrect because both double bonds are E configuration*	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(a)(i)	an explanation that makes reference to the following points: • (there is) an (overall) **increase** (in first ionisation energy) as the nuclear charge / number of protons increases (across the period) **(1)** • but the electron removed comes from the same (main quantum) shell / level of shielding is unchanged **(1)**	Ignore just 'charge increases' Allow same (main) energy level / number of (quantum) shells stays the same / number of electron shells stays the same Allow subshell for shell Ignore references to atomic radius and distance from the nucleus	**(2)**

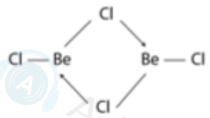
Question Number	Answer	Additional Guidance	Mark
18(a)(ii)	an answer that makes reference to the following points: • 1314 (kJ mol^{-1}) **(1)** • as electrons pair up (in p orbital) / has a full p orbital **(1)** • which leads to repulsion (causes a lower ionisation energy for oxygen) **(1)** Alternative for M2 and M3 • Allow (2p3) half-filled subshell is stable **(1)** • So oxygen loses an electron more readily to reach this configuration **(1)**	Allow any value or range or values between 1200 and 1350 (kJ mol^{-1}) Allow reverse argument for M2 and M3 e.g. nitrogen has unpaired electrons / half filled subshell so less repulsion Comment : pairing of electrons in M2 could be shown via 'electrons in boxes' diagram Ignore any references to shielding	**(3)**

Question Number	Answer	Additional Guidance	Mark
18(b)(i)	• correct species in equation (1) • state symbols (1)	$Li^{+}(g) \rightarrow Li^{2+}(g) + e^{(-)}$ Accept $Li^{+}(g) - e^{(-)} \rightarrow Li^{2+}(g)$ Allow $Li^{+}(g) + e^{(-)} \rightarrow Li^{2+}(g) + 2e^{(-)}$ Ignore **any** state symbols on $e^{(-)}$ Accept '=' instead of '→' Allow state symbols mark on any correct ionisation energy equations removing 1 electron	(2)

Question Number	Answer	Additional Guidance	Mark
18(b)(ii)	an explanation that makes reference to the following points: (2^{nd} ionisation is greater because) • (second) electron removed is in a lower (main) energy level / from the inner (main) energy level (1) • removal of an electron reduces electron-electron repulsion causing the ion to contract OR electron removed is closer to the nucleus (1)	Allow shell for energy level Allow second electron removed is from the 1s (orbital / shell / subshell) Allow 'first electron is removed from 2^{nd} shell, 2^{nd} electron is removed from first' Ignore 'new shell' Allow needs more energy to remove an electron from a positive ion / stronger (forces of) attraction to a positive ion / needs more energy to remove an electron as there are now more protons than electrons Allow net charge is greater / effective nuclear charge is greater / nuclear charge is greater as there are more protons than electrons Allow lower / less / low shielding Ignore just 'nuclear charge is greater'	(2)

Question Number	Answer	Additional Guidance	Mark
18(c)(i)	an answer that makes reference to the following point: • dot-and-cross diagram	 Allow all dots or all crosses Allow bonding electrons / electron pairs shown horizontally Do not award ions / ionic bonds	**(1)**

Question Number	Answer	Additional Guidance	Mark
18(c)(ii)	an answer that makes reference to the following points: • linear **(1)** • 180° **(1)** • 2 bond pairs / pairs of electrons (around central atom) **(1)** • (linear shape adopted to) minimise repulsion (between electron pairs) **(1)** mark independently	Allow TE from (c)(i) Allow TE from (c)(i) e.g. 2bp, 1lp allow 118-120, e.g. 2bp, 2lp 103 - 106 Allow two regions of electron density Allow TE from (c)(i) Allow maximise separation (between electron pairs) Allow 'minimise repulsion / maximise separation between bonds'	**(4)**

Question Number	Answer	Additional Guidance	Mark
18(c)(iii)	an answer that makes reference to the following points: • diagram of dimer including two arrows **(1)** • dative (covalent bond) **(1)**	 Arrow heads in correct direction needed for M1 Ignore bond angles / shapes in diagram Accept correct dot-and-cross diagram with correct arrows Ignore just covalent (bond) / sigma bond Do not award ionic (bond)	**(2)**

(Total for Question 18 = 16 marks)

Question Number	Answer		Additional Guidance	Mark
22(a)			Example of calculation	(5)
	• conversion of dm^3 to m^3	(1)	$1 \div 1000 = 0.0010$ / 1.0×10^{-3} (m^3)	
	• conversion of temperature to K	(1)	$273 + 20 = 293$	
	• rearrangement of ideal gas equation	(1)	$n = \frac{pV}{RT}$	
	• evaluation to give number of moles	(1)	$\frac{101000 \times 1.0 \times 10^{-3}}{8.31 \times 293} = 0.04148$ / 4.148×10^{-2} (mol)	
	• calculation of molar mass	(1)	$\frac{0.656}{0.04148} = 15.81 = 16$ (g mol^{-1}) Ignore SF except 1SF Allow TE throughout Allow conversion of Pa to kPa and use of dm^3 Do not award a TE on a molar mass less than 2 Correct answer with some working scores 5	
	Alternative method • conversion of any volume in dm^3 to m^3 by dividing by 1000 (e.g. 24 in this case)		$24 \div 1000 = 0.024$ (m^3)	
	• conversion of temperature to K		$273 + 20 = 293$	
	• rearrangement of ideal gas equation		$n = \frac{pV}{RT}$	
	• evaluation to give number of moles		$\frac{101000 \times 0.024}{8.31 \times 293} = 0.99556$ (mol)	
	• calculation of mass in volume chosen in M1 (eg 24 dm^3 as shown) **and** calculation of molar mass		$0.656 \times 24 = 15.744$ (g) **and** $15.744 \div 0.99556$ (mol) $= 15.81$(g mol^{-1})	

Question Number	Answer	Additional Guidance	Mark
22(b)	An answer that makes reference to the following point: • methane/CH_4	TE on a hydrocarbon that fits the molar mass from (a)	(1)

(Total for Question 22 = 6 marks)