Mark Scheme (Results)

October 2019

Pearson International Advanced Level
In Chemistry (WCH11)
Paper 01 Structure, Bonding and Introduction to Organic Chemistry

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

October 2019
Publications Code WCH11_01_1910_MS

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the <u>meaning</u> of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Section A (Multiple Choice)

Question number	Answer	Mark
1	**The only correct answer is C** (iron) ***A*** *is incorrect because argon is in the p-block* ***B*** *is incorrect because chlorine is in the p-block* ***D*** *is incorrect because sodium is in the s-block*	**(1)**

Question number	Answer	Mark
2	**The only correct answer is C** ($Al^{2+}(g) \rightarrow Al^{3+}(g) + e^-$) ***A*** *is incorrect because ionisation energies are successive so only one electron is lost at a time* ***B*** *is incorrect because the state symbols are incorrect and ionisation energies are successive so only one electron is lost at a time* ***D*** *is incorrect because the state symbols are incorrect*	**(1)**

Question number	Answer	Mark
3	**The only correct answer is B** (6200) ***A*** *is incorrect because successive ionisation energies always increase* ***C*** *is incorrect because this is too big an increase* ***D*** *is incorrect because this very large value indicates a new quantum shell*	**(1)**

Question number	Answer	Mark
4	**The only correct answer is B** (600) ***A*** *is incorrect because the first ionisation energy of aluminium is greater than that of sodium* ***C*** *is incorrect because the first ionisation energy of aluminium is less than that of magnesium* ***D*** *is incorrect because the first ionisation energy of aluminium is less than that of magnesium*	**(1)**

Question number	Answer	Mark
5	**The only correct answer is D** (shielding of the outer electron from the nuclear charge) ***A*** *is incorrect because the force of attraction between the nucleus and outer electron decreases* ***B*** *is incorrect because neutrons do not affect ionisation energy* ***C*** *is incorrect because if this were the only reason, the ionisation energies would increase*	**1**

Question number	Answer	Mark

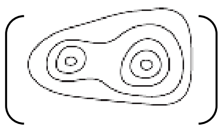
6	**The only correct answer is D** (392) ***A*** *is incorrect because this does not include 6*H_2O ***B*** *is incorrect because this only includes one* H_2O ***C*** *is incorrect because this includes 6*H_2 *but only one O*	**(1)**

Question number	Answer	Mark
7	**The only correct answer is D** (3.612×10^{24}) ***A*** *is incorrect because this is the number of molecules in 0.5 mol of water* ***B*** *is incorrect because this is the number of molecules of water* ***C*** *is incorrect because this is the answer if there are 2 atoms in a molecule*	**(1)**

Question number	Answer	Mark
8	**The only correct answer is A** (sodium fluoride) ***B*** *is incorrect because the strongest ionic bonding is between the smallest ions* ***C*** *is incorrect because the strongest ionic bonding is between the smallest ions* ***D*** *is incorrect because the strongest ionic bonding is between the smallest ions*	**(1)**

Question number	Answer	Mark
9	**The only correct answer is A** (Ca^{2+} and S^{2-}) ***B*** *is incorrect because K^+ has 18 electrons and Br^- has 36 electrons* ***C*** *is incorrect because Li^+ has 2 electrons and F^- has 10 electrons* ***D*** *is incorrect because Mg^{2+} has 10 electrons and Cl^- has 18 electrons*	**(1)**

Question number	Answer	Mark
10	**The only correct answer is B** (covalent and dative covalent bonding) ***A*** *is incorrect because there is a dative bond between the nitrogen atom and H^+ ion* ***C*** *is incorrect because dative bonding is missing and ionic bonding is between ions, not within an ion* ***D*** *is incorrect because ionic bonding is between ions, not within an ion*	**(1)**

Question number	Answer	Mark
11	**The only correct answer is C**  ***A*** *is incorrect because this is the electron density map showing two ions* ***B*** *is incorrect because this is the electron density map with a polarised anion* ***D*** *is incorrect because this is the electron density map of a covalent molecule with two identical atoms*	**(1)**

Question number	Answer	Mark
12	**The only correct answer is C** (polar bond, non-polar molecule) ***A*** *is incorrect because the Al-Cl bond is polar* ***B*** *is incorrect because the Al-Cl bond is polar and the molecule is symmetrical so the bond polarities cancel* ***D*** *is incorrect because the molecule is symmetrical so the bond polarities cancel*	**(1)**

Question number	Answer	Mark
13	**The only correct answer is B** (45.8 %) ***A*** *is incorrect because the relative atomic mass of Fe on the right-hand side has not been multiplied by 2* ***C*** *is incorrect because the relative atomic mass of Fe has not been multiplied by 2 and the relative molecular mass of* CO_2 *has not been multiplied by 3* ***D*** *is incorrect because the relative molecular mass of* CO_2 *has not been multiplied by 3*	**(1)**

Question number	Answer	Mark
14	**The only correct answer is A** (8×10^{-2}) ***B*** *is incorrect because 2000 has been divided by 40 instead of 40 by 2000* ***C*** *is incorrect because 2 kg has not been converted to 2000 g* ***D*** *is incorrect because 2 kg has not been converted to 2000 g and 2 has been divided by 40*	**(1)**

Question number	Answer	Mark
15	**The only correct answer is B** (2)	**(1)**

	A *is incorrect because the ratio of $CaSO_4$ to H_2O is the wrong way round* ***C*** *is incorrect because this is 3.405 x 0.900 to the nearest whole number and masses have not been converted to moles* ***D*** *is incorrect because this is 3.405 /0.900 to the nearest whole number and masses have not been converted to moles*	

Question number	Answer	Mark
16	**The only correct answer is B** (C_6H_{14}) ***A*** *is incorrect because this would show the loss of two ethane molecules* ***C*** *is incorrect because this would show the loss of one ethane molecule* ***D*** *is incorrect because this would show the loss of one ethene molecule*	**(1)**

Question number	Answer	Mark
17	**The only correct answer is D** (a pair of electrons from a bond to an atom, forming ions) **A** *is incorrect because movement of an electron is represented by a curly arrow with a half arrow-head and ions are formed when a pair of electrons moves* ***B*** *is incorrect because movement of an electron is represented by a curly arrow with a half arrow-head* ***C*** *is incorrect because ions are formed when a pair of electrons moves*	**(1)**

Question number	Answer	Mark
18	**The only correct answer is C** (9 σ bonds and 2 π bonds) ***A*** *is incorrect because all single bonds are σ bonds, one of each double bond is a σ bond and one of*	**(1)**

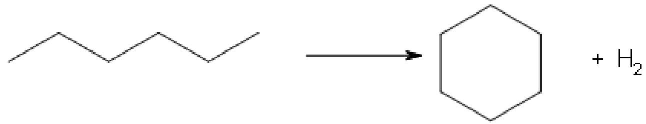
	each double bond is a π bond ***B*** *is incorrect because all single bonds are σ bonds, one of each double bond is a σ bond and one of each double bond is a π bond* ***D*** *is incorrect because all single bonds are σ bonds, one of each double bond is a σ bond and one of each double bond is a π bond*	

Question number	Answer	Mark
19	**The only correct answer is D** (a secondary carbocation is more stable than a primary carbocation) ***A*** *is incorrect because the stability of the compound does not determine which product is formed* ***B*** *is incorrect because the stability of the compound does not determine which product is formed* ***C*** *is incorrect because the secondary carbocation is more stable*	**(1)**

Question number	Answer	Mark
20	**The only correct answer is A** (2.04 (g)) ***B*** *is incorrect because this is the mass when the yield is 100%* ***C*** *is incorrect because this is just the masses expressed as a percentage without converting them into moles* ***D*** *is incorrect because this is the mass of propene formed with the molar masses reversed*	**(1)**

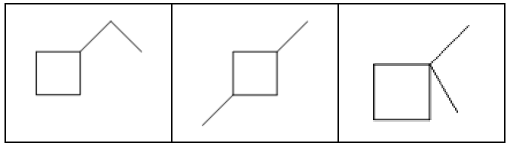
Section B

Question number	Answer	Additional guidance	Mark

21(a)	• 2 correct skeletal formulae (1) • balanced equation (1)	Example of equation:  Ignore molecular, displayed or structural formulae as working for M1 Allow balanced equation using molecular, displayed or structural formulae e.g. $C_6H_{14} \rightarrow C_6H_{12} + H_2$ Allow TE on any other C_6H_{12} cycloalkane Ignore state symbols / conditions	**(2)**

Question number	Answer	Additional guidance	Mark
21(b)(i)	• 1,3-dimethylcyclopentane	Allow 1,3 dimethylcyclopentane 1 3-dimethylcyclopentane 1 3 dimethylcyclopentane cyclopentane-1,3-dimethyl Allow methy / methly for methyl Do not award 1,3-dimethylpentane	**(1)**

Question Number	Answer	Additional guidance	Mark
21(b)(ii)	• C_7H_{14}	Allow $H_{14}C_7$ / C7H14 / H14C7 Ignore any other symbols as working e.g. $CH_2CHCH_3CH_2CH_2CHCH_3$ Do not award superscripts e.g. C^7H^{14}	**(1)**

Question number	Answer	Additional guidance	Mark
21(c)	• All 3 correct (2) • Any 2 correct (1)	Examples of isomers:  Allow isomers in any order Allow CH_3 and C_2H_5 for side chains Ignore bond angles and bond lengths Do not award any structure with 2 or more rings	**(2)**

Question number	Answer	Additional guidance	Mark
21(d)	• (**E** is) C_9H_{18}	Allow $H_{18}C_9$ Allow large numbers Ignore working Do not award superscripts	**(1)**

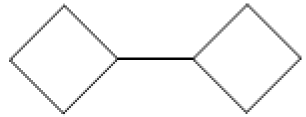
Question number	Answer	Additional guidance	Mark
21(e)	• calculation of volume of CO_2(g) **and** H_2O(g) (1) • calculation or working of volume of O_2(g) used (1) • calculation of volume of O_2(g) left (1)	Example of calculation: 25 cm^3 of C_5H_{10} produces $\frac{25 \times 10}{2}$ = 125 (cm^3) CO_2 **and** 125 (cm^3) H_2O(g) 25 cm^3 of C_5H_{10} needs $\frac{25 \times 15}{2}$ = 187.5 (cm^3) O_2 Volume of O_2 left = 250 − 187.5 = 62.5 (cm^3) TE on volume of O_2 reacted (volume of C_5H_{10} = 0) Correct answers with no working scores (3) Allow volumes in dm^3 provided unit is given Penalise rounding to 1 or 2 SF once only Penalise correct volumes not linked to specific gases once only Penalise incorrect units e.g. cm once only	**(3)**

Question number	Answer	Additional guidance	Mark
21(f)(i)	• (free) radical (1) • substitution (1)	Allow words in either order Mark independently Ignore homolytic (fission) / initiation / propagation / termination / photochemical Do not award heterolytic / electrophilic / nucleophilic for M1 only Ignore halogenation / S_N1 / S_N2 Do not award addition / elimination for M2 only	**(2)**

Question number	Answer	Additional guidance	Mark
21(f)(ii)	• both curly half-arrows (1) • two chlorine (free) radicals with dot (1)	Example of equation:  Ignore two dots shown to represent electrons above and below the Cl−Cl bond Full arrow loses M1 only Penalise missing • once only in (f)(ii), (iii), (iv)	**(2)**

Question number	Answer	Additional guidance	Mark

21(f)(iii)	• first propagation step (1) • second propagation step (1)	Example of equations: $C_4H_8 + Cl\bullet \rightarrow C_4H_7\bullet + HCl$ $C_4H_7\bullet + Cl_2 \rightarrow C_4H_7Cl + Cl\bullet$ Allow equations in either order Allow displayed or skeletal formulae Ignore curly arrows and state symbols, even if incorrect Do not award any equations involving H•	**(2)**

Question number	Answer	Additional guidance	Mark
21(f)(iv)	An explanation that makes reference to the following points: • correct skeletal formula (1) • (two) C_4H_7• / cyclobutyl radicals join together (1)	Mark independently Example of skeletal formula:  Allow any 2 squares joined by a bond Ignore bond lengths and bond angles No TE on incorrect radicals Allow $2C_4H_7• \rightarrow C_8H_{14}$ Allow cyclobutane / hydrocarbon radicals join together Ignore just '(two) radicals join together'	**(2)**

(Total for Question 21 = 18 marks)

Question number	Answer	Additional guidance	Mark
22(a)(i)	• 17 protons (1) • 18 neutrons (1)	Any reference to electrons scores (1) for an answer that includes 17 protons **and** 18 neutrons	**(2)**

Question number	Answer	Additional guidance	Mark
22(a)(ii)	• $(1s^2)2s^2 2p^6 3s^2 3p^6$	Allow $2p_x^2 2p_y^2 2p_z^2$ and/or $3p_x^2 3p_y^2 3p_z^2$ Allow numbers of electrons written as subscripts or large numbers Ignore repeated $1s^2$	**(1)**

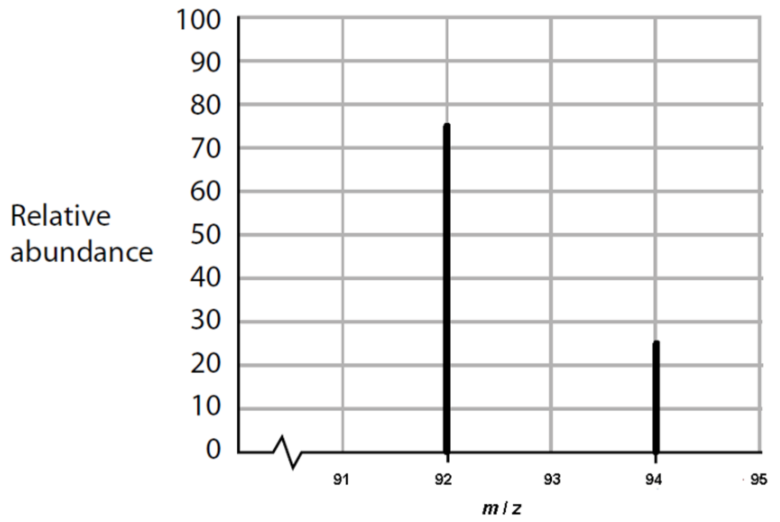
Question number	Answer	Additional guidance	Mark

22(a)(iii)	• correct working (1) • answer given to 2 dp (1)	Example of calculation: $\frac{(35 \times 75.53) + (37 \times 24.47)}{100}$ (= 35.4894) or (35 x 0.7553) + (37 x 0.2447) (= 35.4894) 35.49 TE on working involving two different species Correct answer to 2 dp with no working scores (2) 35.50 with no working scores (0) Ignore units, even if incorrect	**(2)**

Question number	Answer	Additional guidance	Mark
22(b)(i)	• dot-and-cross diagram showing three pairs of electrons between one Cl and three F atoms (1) • rest of diagram correct conditional on M1 (1)	Example of dot-and-cross diagram:  Allow overlapping circles Allow all dots / all crosses Allow 4 non-bonded electrons on Cl shown as: 2 lone pairs together or 2 lone pairs between any two of the bonded pairs or 1 lone pair and 2 unpaired electrons or 3 electrons and 1 electron Ignore inner shell electrons / lines for bonds Penalise a charged species in M2 only	**(2)**

Question number	Answer	Additional guidance	Mark
22(b)(ii)	• there are 10 electrons / 5 pairs of electrons in the outer / valence shell of chlorine	Allow there are more than 8 electrons in the outer / valence shell of chlorine Allow there are 3 bond pairs and 2 lone pairs (in the outer shell of chlorine) Allow chlorine has expanded its octet Allow chlorine does not have a noble gas electronic structure / does not have 8 electrons in the outer / valence shell Allow just 'chlorine has 10 electrons' / 'more than 8 electrons' Ignore chlorine is the central atom Ignore just 'chlorine has 2 lone pairs' Do not award incorrect numbers of electrons / orbitals	**(1)**

Question number	Answer	Additional guidance	Mark

22(b)(iii)	• a peak at *m/z* = 92 (1) • a peak at *m/z* = 94 (1) • peaks at 92 and 94 are in the ratio 3:1 approximately (1)	Example of mass spectrum:  Allow any 3:1 ratio for the peaks e.g. 100:33, 30:10 Ignore any labels on the peaks M3 is a stand alone mark for peaks at 92 and 94 only	**(3)**

Question number	Answer	Additional guidance	Mark
22(b)(iv)	• conversion of temperature to K (1) • rearrangement of Ideal Gas Equation (1) • evaluation to give volume (1) • conversion of volume to cm^3 **and** answer given to 2 or 3 SF (1)	Example of calculation: temperature = 60 + 273 = 333 K $V = \frac{nRT}{P}$ or $V = \frac{0.0200 \times 8.31 \times 333}{1.28 \times 10^5}$ $V = 4.3238 \times 10^{-4}$ (m^3) TE on temperature volume = $4.3238 \times 10^{-4} \times 1 \times 10^6$ = (432.38) = 432 / 430 / 4.32×10^2 / 4.3×10^2 (cm^3) TE on volume in M3 Penalise rounding to 1SF once only in M1, M2 and M3 Correct answer with no working scores full marks	**(4)**

(Total for Question 22 = 15 marks)

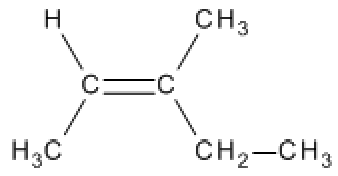
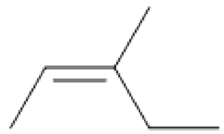
Question number	Answer	Additional guidance	Mark

23(a)	A description that makes reference to the following points: • (propane) yellow (solution) (1) • (propene) colourless (solution) (1)	 Allow brown or orange or any combination of yellow, orange and brown Allow no (colour) change / no change in bromine water / remains yellow / turns yellow Allow upper layer / both layers are yellow / orange / brown etc Ignore just 'no reaction' Do not award any mention of red Do not award lower layer is yellow / orange / brown etc Allow decolorises / colour disappears Allow (both) layers are colourless Ignore initial colour of red in M2 only Do not award remains colourless	**(2)**

Question number	**Answer**	**Additional guidance**	**Mark**

23(b)(i)	• steam / H_2O(**g**) **and** acid (catalyst) / phosphoric acid / H_3PO_4	In (b)(i) and (ii) allow names or formulae for reagents but if both are given, both must be correct Allow water / H_2O **and** heat for steam Do not award steam **and** room temperature Allow name or formula of any strong acid (catalyst) / H^+ Ignore concentration of acid / pressure	**(1)**

Question number	Answer	Additional guidance	Mark
23(b)(ii)	• potassium manganate((VII)) (solution)/ $KMnO_4$ **and** sulfuric acid / H_2SO_4 / acid(ified) / H^+ / sodium hydroxide / NaOH / potassium hydroxide / KOH / alkali(ne) / OH^-	Allow potassium permanganate Do not award K_2MnO_4 Ignore heat / concentration of acid or alkali Allow (1) in (ii) if reagents **and** conditions for (i) and (ii) are interchanged If no other mark is awarded: Allow (1) in (ii) if reagents for both (i) and (ii) are correct but conditions are omitted / incorrect	**(1)**

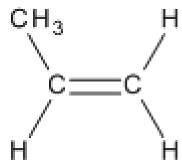
Question number	Answer	Additional guidance	Mark
23(c)	• structure of *Z*-3-methylpent-2-ene	Examples of structure:  or  Allow C_2H_5 / displayed formula Ignore connectivity of methyl and ethyl groups Ignore bond lengths and bond angles on skeletal formula	**(1)**

Question number	Answer	Additional guidance	Mark

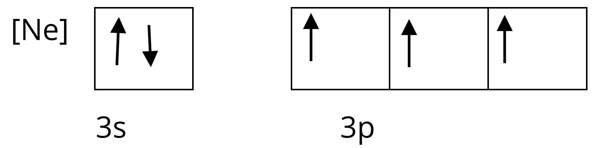
23(d)	• calculation of number of moles of hydrogen **or** calculation of volume of alkene (1) • deduction of number of double bonds (1)	Example of calculation: $\frac{720}{24\,000}$ = 0.030 or $\frac{0.72}{24}$ = 0.030 **or** volume of alkene = 0.01 x 24000 = 240 (cm^3) mole ratio alkene : hydrogen = (0.01 : 0.03 or 720/240) = 1 : 3 so there are 3 double bonds TE on mol hydrogen Correct answer with no working scores (1)	**(2)**

Question number	Answer	Additional guidance	Mark

23(e)	• the dipole on the bromine (molecule) should be the other way around (1) • the arrow should go from the double / pi / π bond to the bromine / (pair of) electrons move from the double bond to the bromine **or** the curly arrow should go from C=C to $Br^{\delta+}$ (1) • the Br ion should have a negative charge (1)	Allow the changes in any order and they may be shown on the diagram Ignore references to lone pairs Allow the top bromine should be δ+ / the bottom bromine should be δ− Allow the bromine (atom) should have a negative charge Ignore just ‘Br is not positive’ Do not award the bromine molecule should have a negative charge Do not award $Br^{\delta-}$	**(3)**

Question number	Answer	Additional guidance	Mark
23(f)	• structure of propene	Example of structure:  Allow any unambiguous structure of propene showing the double bond e.g. $CH_3CH{=}CH_2$ Ignore name, even if incorrect Ignore n / brackets Ignore connectivity of CH_3 group	**(1)**

(Total for Question 23 = 11 marks)

Question number	Answer	Additional guidance	Mark
24(a)(i)	• correct electronic configuration	Example of electronic configuration:  Allow half-arrow heads Allow three arrows pointing downwards in 3p orbitals Ignore numbers in the boxes e.g. 2	**(1)**

Question number	Answer	Additional guidance	Mark
24(a)(ii)	An explanation that makes reference to the followin points: **Phosphorus** • phosphorus has a half-filled p (sub)shell / one electron in each p orbital / the p orbitals are singly occupied (1) • more energy is required to remove an unpaired electron (than a paired electron) **or** an unpaired electron / electron removed has a lower energy (1) OR **Sulfur** • the outermost / 3p electron or the electron being removed in sulfur is paired (1) • less energy is required to remove a paired electron (than an unpaired electron) **or** repulsion between paired electrons (reduces the ionisation energy needed to remove it) **or** the paired electron has a higher energy (1)	**Both marks must come from the same pair** Allow 'electrons-in-boxes' / $3p_x 3p_y 3p_z$ to show electronic configurations Allow 'box' for orbital as this is in (i) Ignore references to shielding / nuclear charge / lone pairs Penalise 3 or more electrons in a p **orbital** once only Allow '(electron removed is from) a half-filled p orbital' Do not award just $3p^3$ Allow a half-filled subshell is (more) stable Allow sulfur is $3p^4$ Allow sulfur forms a half-filled p (sub)shell when it loses 1 electron Note – paired only needs to be mentioned once in M1 or M2 Do not award M2 if answer states more energy needed to remove electron in sulfur	**(2)**

Question number	Answer	Additional guidance	Mark
24(b)	An explanation that makes reference to the following points: • there are intermolecular forces between P_4 / phosphorus (molecules) **or** phosphorus is made up of small molecules / discrete molecules / is simple molecular (1) • there are covalent bonds between the silicon atoms **or** silicon is a giant (covalent) structure / giant lattice (1) • (much) more energy is needed to break the (covalent) bonds in silicon than overcome the intermolecular forces in phosphorus **or** the (covalent) bonds in silicon are (much) stronger than the (intermolecular) forces in phosphorus (1)	Allow London / dispersion / van der Waals' forces for intermolecular forces Allow macromolecular / giant molecule Do not award ionic / metallic Do not award breaking bonds between phosphorus **atoms**	**(3)**

Question number	Answer	Additional guidance	Mark
24(c)(i)	• number of bonding pairs **and** number of lone pairs (1) • shape (1) • **both** bond angles (1)	Example of table: Number of bonding pairs of electrons on phosphorus: 5 Number of lone pairs on electrons on phosphorus: 0 Shape of molecule: trigonal bipyramidal Cl-P-Cl bond angles: 90° / 120° Mark independently Allow bond angles in either order Ignore 180°	**(3)**

Question number	Answer	Additional guidance	Mark
24(c)(ii)	• PCl_4^+ (1) • PCl_6^- (1)	Ions can be in any order If no charges are shown or charges are incorrect, allow (1) for PCl_4 and PCl_6	**(2)**

Question number	Answer	Additional guidance	Mark
24(d)	• calculation of mol of H_3PO_4 **and** calculation of mol of NaOH (1) • mol ratio (1) • balanced equation (1)	Example of calculation: mol H_3PO_4 = $\frac{10.0 \times 0.100}{1000}$ = 0.00100 / 1.00×10^{-3} **and** mol NaOH = $\frac{8.0 \times 0.250}{1000}$ = 0.00200 / 2.00×10^{-3} mol ratio H_3PO_4 : NaOH = 1 : 2 Mol ratio mark can be awarded from equation TE on mol H_3PO_4 and NaOH Do not award M2 if the mol ratio in the balanced equation contradicts the mol ratio from the mol calculations $H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$ Allow HNa_2PO_4 Allow $H_3PO_4 + 2OH^- \rightarrow HPO_4^{2-} + 2H_2O$ Allow multiples Ignore state symbols, even if incorrect Equation TE on mol ratio provided it is 1:1 or 1:3 $H_3PO_4 + NaOH \rightarrow NaH_2PO_4 + H_2O$ $H_3PO_4 + 3NaOH \rightarrow Na_3PO_4 + 3H_2O$	**(3)**

Question number	Answer	Additional guidance	Mark
24(e)	• calculation of molar mass of hydrated magnesium phosphate (1) • calculation of **y** (1)	Examples of calculation: **Method 1** molar mass = $262.9 \times \frac{100}{78.5} = 334.9$ (g) mass of water = 334.9 – 262.9 = 72 moles of water = $\frac{72}{18} = 4$ so **y** = 4 Allow alternative methods, for example **Method 2** in 100 g of salt: mol $Mg_3(PO_4)_2 = \frac{78.5}{262.9} = 0.29859$ (mol) **and** mol $H_2O = \frac{21.5}{18} = 1.1944$(mol) (1) ratio $Mg_3(PO_4)_2$: H_2O = 0.29859 : 1.1944 = 1 : 4 so **y** = 4 (1) This could also be done using 0.785 g and 0.215 g **Method 3** $\frac{262.9}{262.9 + 18y} = 0.785$ or $\frac{262.9}{262.9 + 18y} \times 100 = 78.5$(1) 262.9 = 206.4 + 14.13 **y** so **y** = 4 (1) Correct answer with no working or working that does not involve A_r or M_r or moles scores (0) Allow TE for **y** from correct working but an incorrect number used for one of the values	**(2)**

(Total for Question 24 = 16 marks)

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom