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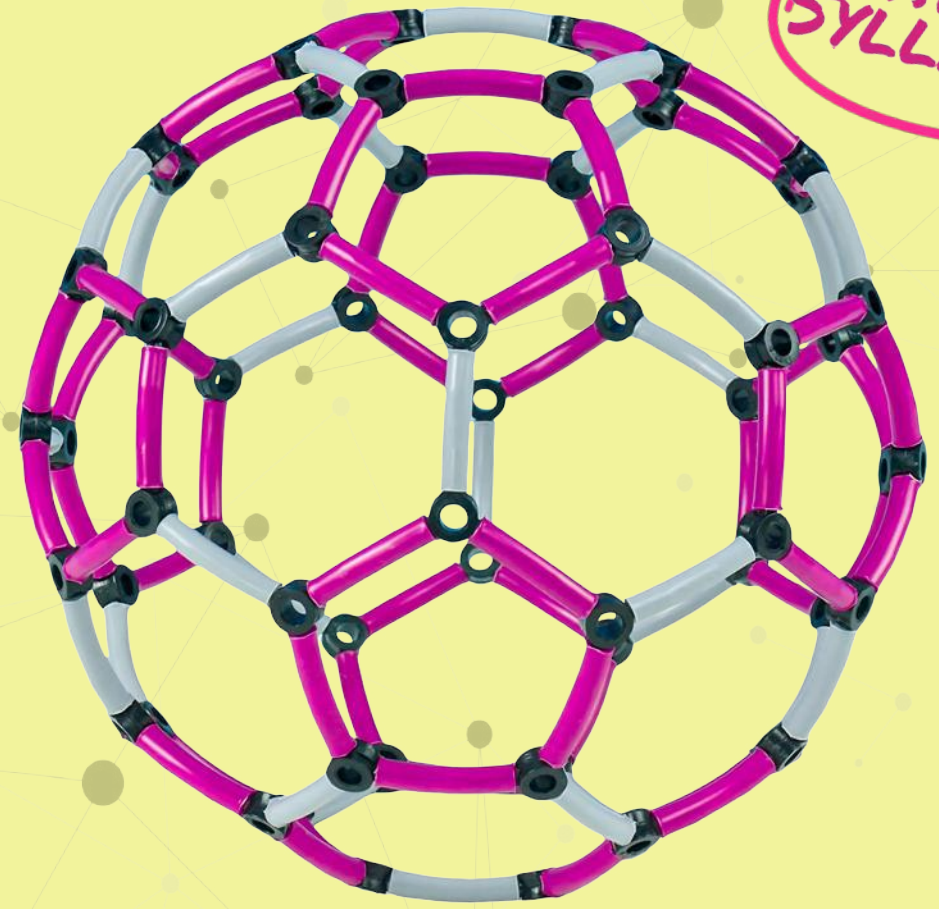
AS Chemistry

LATEST SYLLABUS



Unit 1 Classified Past Papers

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Edexcel IAL - Solved Past Paper

January 2026 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question

hard medium easy

7

Select · [1 mark]

Which is NOT a neutralisation reaction?

Answer

- [x] **A** $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$
- [ ] **B** $CuO + 2HCl \longrightarrow CuCl_2 + H_2O$
- [ ] **C** $NH_3 + HNO_3 \longrightarrow NH_4NO_3$
- [ ] **D** $CaCO_3 + 2CH_3COOH \longrightarrow Ca(CH_3COO)_2 + H_2O + CO_2$

The logic

✓ A neutralisation is acid + base ⟶ salt (with water and/or CO_2 where a carbonate or oxide is involved).

✓ In A a metal displaces hydrogen from the acid and releases H_2 gas – that is a redox/displacement reaction, not neutralisation.

Why the others fail

B acid + metal oxide (base) ⟶ salt + water: a neutralisation
C acid + ammonia (base) ⟶ ammonium salt: a neutralisation
D acid + carbonate ⟶ salt + water + CO_2: a neutralisation

Revise from your notes

- Successive ionisation energies - notes p. 11 5.3
- Essential definitions - notes p. 1 1.1
- Percentage composition - notes p. 1 1.3
- Counting particles - notes p. 2 1.6

ATOM ECONOMY

4 An example of an equation to illustrate the cracking of an alkane from crude oil is

	$C_{15}H_{32}$	→	$2C_2H_4$	+	C_3H_6	+	C_8H_{18}
	pentadecane		ethene		propene		octane
Molar masses / g mol^{-1}			28		42		114

(a) What is the atom economy for this reaction in terms of production of alkenes?

Use the expression

$$\text{Atom economy} = \frac{\text{Total mass of desired product(s)}}{\text{Total mass of all products}} \times 100\%$$

(1)

☒ **A** 26%

☒ **B** 33%

☒ **C** 38%

☒ **D** 46%

(28 x 2 + 42)/ 212

---

5 Phosphoric(V) acid, H_3PO_4, can be made from phosphorus in two stages.

$$P_4 + 5O_2 \rightarrow P_4O_{10}$$

$$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$$

Data

Formula	P_4	O_2	P_4O_{10}	H_2O	H_3PO_4
Molar mass / g mol^{-1}	124	32	284	18	98

The percentage atom economy, by mass, for the production of phosphoric(V) acid from phosphorus is

☒ **A** 58.0

☒ **B** 69.0

☒ **C** 72.4

☒ **D** 100

Reactants: 124 + 5x32 + 6x18 = 392

Product: 4x98 = 392

---

6 Oxygen can be prepared using several different reactions. Which of those given below has the highest atom economy by mass?

☒ **A** $NaNO_3 \rightarrow NaNO_2 + ½O_2$

☒ **B** $H_2O_2 \rightarrow H_2O + ½O_2$

☒ **C** $Cl_2 + H_2O \rightarrow 2HCl + ½O_2$

☒ **D** $PbO_2 \rightarrow PbO + ½O_2$

Edexcel IAL - Solved Past Paper

June 2019 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question 24

hard medium easy

24 (a)

Write · [1 mark]

Airbags inflate when solid sodium azide (NaN_3) decomposes into nitrogen gas and sodium as the only products. Write an equation for this decomposition. State symbols are not required.

Model answer

✓ $2NaN_3 \longrightarrow 2Na + 3N_2$

Mark scheme 1 mark

✓ correct balanced equation (1)

Accept: $NaN_3 \longrightarrow Na + 1½N_2$ and multiples

Ignore: state symbols even if wrong

Do not accept: Na_2

Where marks are lost

Leaving the equation unbalanced, writing nitrogen as N instead of N_2, or inventing an Na_2 molecule.

Examiner's insight

Answered well - and a correct 2 : 3 ratio here feeds the mark for the ratio step in (b).

24 (b)

Calculate · [6 marks]

A passenger airbag requires 120 dm^3 of gas. Calculate, using the ideal gas equation, the mass of sodium azide required to fill the airbag under standard conditions (101 000 Pa, 25 °C). Give your answer to an appropriate number of significant figures. [pV = nRT, R = 8.31 J K^{-1} mol^{-1}]

Working

✓ convert volume: V = 120 dm^3 = 0.12 m^3

pV = nRT needs SI units: Pa, m^3, K

✓ convert temperature: T = 25 + 273 = 298 K

✓ rearrange and substitute: n = pV / RT = (101 000 x 0.12) / (8.31 x 298)

✓ $n(N_2)$ = 12 120 / 2476.4 = 4.89 mol

✓ from $2NaN_3 \longrightarrow 2Na + 3N_2$: $n(NaN_3)$ = 4.89 x 2/3 = 3.26 mol

✓ $M(NaN_3)$ = 23.0 + (3 x 14.0) = 65.0 g mol^{-1}; mass = 3.26 x 65.0 = 212 g

mass of NaN_3 = 212 g (3 SF; 210 g at 2 SF)

Mark scheme 6 marks - the correct answer scores all 6; transfer errors carried throughout

COUNTING PARTICLES

1 What is the total number of **atoms** in 1.8 g of water, H_2O?

DATA
- The molar mass of H_2O is 18 g mol^{-1}
- The Avogadro Constant is 6.0×10^{23} mol^{-1}

☒ **A** 6.0×10^{22}

☒ **B** 6.0×10^{23}

☒ **C** 1.8×10^{23}

☒ **D** 1.8×10^{24}

mol = mass ÷ Mr
Mr water = 18
mol = 1.8 ÷ 18 = 0.1
number of atoms per water = 3
count of atoms = 3 x 0.1 x L

(Total for Question 12 = 1 mark)

2 Calculate the total number of **ions** in 7.41 g of calcium hydroxide, $Ca(OH)_2$.

The molar mass of calcium hydroxide is 74.1 g mol^{-1}.

The Avogadro constant is 6.0×10^{23} mol^{-1}.

☒ **A** 6.0×10^{22}

☒ **B** 1.2×10^{23}

☒ **C** 1.8×10^{23}

☒ **D** 3.0×10^{23}

mol = mass ÷ Mr
mol = 7.41 ÷ 74.1 = 0.1
number of ions per molecule = 3
count of atoms = 3 x 0.1 x L

(Total for Question = 1 mark)

3 Which of the following statements is true? The Avogadro constant is the number of

☒ **A** grams of any element which contains 6.02×10^{23} atoms of that element.

☒ **B** atoms contained in one mole of any element.

☒ **C** atoms contained in one mole of any monatomic element.

☒ **D** particles (atoms, molecules or ions) required to make one gram of a substance.

(Total for Question = 1 mark)

Where marks are lost

Giving 34 or 36 electrons - a neutral atom has electrons EQUAL to protons (29), whatever the mass number.

Examiner's insight

Most scored well. Remember the neutral atom has as many electrons as protons; only the neutron count differs between isotopes.

20 (b)(ii)

Explain · [2 marks]

Explain the term isotopes, using the information in the table.

Model answer

✓ Isotopes are atoms of the same element with the same number of protons – here both have 29 protons. ✓ but they have different numbers of neutrons – ^{63}Cu has 34 and ^{65}Cu has 36.

Mark scheme 2 marks

- ✓ same number of protons / same proton number (1)
- ✓ different numbers of neutrons (1)

Accept: 'same atomic number but different mass number' scores 1 if protons and neutrons are not both mentioned

Do not accept: atomic MASS used for mass number

Where marks are lost

Answering in terms of mass number and atomic number when the question says to USE the table - refer directly to the protons and neutrons.

Examiner's insight

Well known, but the question said to use the table, so name the actual particles (protons and neutrons), not just atomic and mass number.

20 (b)(iii)

State · [1 mark]

State why the two isotopes of copper have the same chemical reactions.

Model answer

✓ They have the same electronic configuration – chemistry is decided by the electrons, and both isotopes have the same 29 electrons arranged identically.

Mark scheme 1 mark

- ✓ same electronic configuration / electron arrangement (1)

Accept: the same number of electrons

Ignore: same number of OUTER-shell electrons only - this does not score

Where marks are lost

Saying 'same number of outer electrons' or 'same number of protons' - the mark is for the same electron configuration overall.

IDEAL GAS LAW

6 Airbags protect occupants by inflating when a car crashes.

Airbags rely on chemical reactions to produce large volumes of gases quickly.
In some airbags, solid sodium azide (NaN_3) decomposes forming nitrogen gas and sodium as the only products.

(a) Write an equation for the decomposition of sodium azide.
State symbols are not required.

(1)

2NaN 3 → 2Na + 3N 2

(b) A passenger airbag requires 120 dm^3 of gas to fill it.

Calculate, using the ideal gas equation, the mass of sodium azide required to fill a passenger airbag in this reaction under standard conditions (101 000 Pa, 25°C).

Give your answer to an appropriate number of significant figures.

[$pV = nRT$ $R = 8.31\ J\,K^{-1}\,mol^{-1}$]

(6)

conversion of volume m3 **V = 0.12m 3**

conversion of temperature to K **T =298 K**

calculation of n for N2

n = PV/RT

n =101000X 0.12/ 8.31 X 298

n = 4.89

calculation of n for NaN3 (2:3)

n = 4.89X 2/3 = 3.26

Mr (NaN3) = 65

m = 3.26X 65 = 212

Edexcel IAL - Solved Past Paper

October 2022 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question

hard medium easy

3

Deduce · [1 mark]

An atom of $^{15}_{7}N$ forms a nitride ion, N^{3-}. What are the numbers of protons, neutrons and electrons in this ion?

Answer

- [ ] **A** protons 7, neutrons 8, electrons 7
- [ ] **B** protons 7, neutrons 8, electrons 4
- [x] **C** **protons 7, neutrons 8, electrons 10**
- [ ] **D** protons 8, neutrons 7, electrons 10

How to get there

✓ protons = atomic number = 7

✓ neutrons = mass number − protons = 15 − 7 = 8

✓ electrons = 7 + 3 = 10 (the 3− charge means three electrons gained)

7 protons, 8 neutrons, 10 electrons

Why the others fail

A these are the particles in the neutral N atom (7 electrons, not the ion)

B this is the N^{3+} ion - electrons removed instead of added

D protons and neutrons have been swapped over

Revise from your notes

- Reaction types - notes p. 1 1.1
- The atom and isotopes - notes p. 5 2.1 2.2
- Writing electron configurations - notes p. 8 4.2 4.3
- The E-Z naming system - notes p. 36 19.2

PERCENT YIELD

1 Ammonia is manufactured from hydrogen and nitrogen in the Haber process.

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

If 60 tonnes of hydrogen produces 80 tonnes of ammonia, what is the percentage yield in the reaction?

- ☒ **A** $\frac{80}{170} \times 100\%$
- ☒ **B** $\frac{80}{340} \times 100\%$ (actual / max)
- ☒ **C** $\frac{30}{80} \times 100\%$
- ☒ **D** $\frac{60}{80} \times 100\%$

mol H2 = mass ÷ Mr

mol H2 = 60 ÷ 2 = 30

mol NH3 = 30 x 2/3 = 20

mass NH3= mol x Mr

Max mass NH3 = 20 x (14+3) = 340

---

2 Phenol, C_6H_5OH, is converted into trichlorophenol (known as TCP), $C_6H_2Cl_3OH$, according to the equation below.

$$C_6H_5OH + 3Cl_2 \rightarrow C_6H_2Cl_3OH + 3HCl$$

If 50.0 g of phenol produces 97.6 g of TCP, what is the percentage yield of the TCP?

[Molar masses: phenol = 94 g mol^{-1}; TCP = 197.5 g mol^{-1}]

- ☒ **A** 47.6%
- ☒ **B** 49.4%
- ☒ **C** 51.2%
- ☒ **D** 92.9%

mol of C6H5OH = mass ÷ Mr

mol of C6H5OH = 50 ÷ 94 = 0.53

mol of C6H2Cl3OH = 0.53

mass = mol x Mr

mass = 0.53 x 197.5 = 104.675

%Y = 97.6 / 104.675 x 100 = 93%

---

3 If the price of one tonne (1000 kg) of sulfur, S, is £160, what is the cost (to the nearest pound) of the sulfur needed to make one tonne of sulfuric acid, H_2SO_4?

- ☒ **A** £52
- ☒ **B** £98
- ☒ **C** £160
- ☒ **D** £490

S → H2SO4

mol H2SO4 = mass ÷ Mr

mol H2SO4 = 1000 ÷ (1x2 + 32 + 4x16) = 10.2

mol of S = mol of H2SO4 = 10.2

mass S = mol x Mr

mass S = 10.2 x 32 = 326.4 kg

1000 kg cost 160

326.2 will cost x

x = 326.2 x 160 / 1000 = 52

6 Which one of the following elements undergoes the change in electronic configuration shown when it forms the stated ion?

Atom $1s^2 2s^2 2p^6 3s^2 3p^3$ Ion $1s^2 2s^2 2p^6 3s^2 3p^6$

- ☐ **A** B to B^{3+}
- ☐ **B** Al to Al^{3+}
- ☐ **C** N to N^{3-}
- ☑ **D** P to P^{3-}

it gained 3 electrons

(Total for Question = 1 mark)

7 The chemical properties of an element are determined by its

- ☑ **A** electronic structure.
- ☐ **B** number of neutrons.
- ☐ **C** relative atomic mass.
- ☐ **D** number of protons plus neutrons.

(Total for Question = 1 mark)

8 A particle with a **single** positive charge and with the electronic configuration $1s^2\ 2s^2\ 2p^6$ is

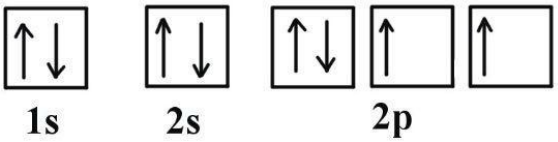
- ☑ **A** a sodium ion.
- ☐ **B** a fluoride ion.
- ☐ **C** an oxide ion.
- ☐ **D** a potassium ion.

originally Na is: 1s2 , 2s2 , 2p6 , 3s1

lost when forming a cation

9 In which of the following electronic configurations are only two of the electrons unpaired?

- ☐ **A** $1s^2\ 2s^2$
- ☐ **B** $1s^2\ 2s^2\ 2p^3$
- ☑ **C** $1s^2\ 2s^2\ 2p^4$
- ☐ **D** $1s^2\ 2s^2\ 2p^5$



(Total for Question = 1 mark)

Edexcel IAL - Solved Past Paper

October 2024 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question

hard medium easy

9 (a)

Calculate · [1 mark]

Using the particle masses given, what is the mass in grams of one atom of ^{1}H? [electron 0.0009×10^{-24}, neutron 1.6748×10^{-24}, proton 1.6725×10^{-24}]

Answer

- [ ] **A** 1.6725×10^{-24}
- [x] **B** 1.6734×10^{-24}
- [ ] **C** 3.3473×10^{-24}
- [ ] **D** 3.3482×10^{-24}

How to get there

✓ ^{1}H has mass number 1, so it is 1 proton + 1 electron and NO neutron

✓ mass = $1.6725 \times 10^{-24} + 0.0009 \times 10^{-24} = 1.6734 \times 10^{-24}$ g

1.6734×10^{-24} g

Why the others fail

A 1.6725×10^{-24} is the proton alone - it leaves out the electron

C 3.3473×10^{-24} adds a neutron, but ^{1}H has no neutron

D 3.3482×10^{-24} adds proton + neutron + electron - one neutron too many

9 (b)

Select · [1 mark]

Which particles would be deflected by an electric field?

Answer

- [ ] **A** electrons only
- [x] **B** electrons and protons only
- [ ] **C** neutrons and protons only
- [ ] **D** electrons, neutrons and protons

The logic

✓ An electric field deflects any charged particle, and the size of the charge here is what matters.

✓ Electrons (1-) and protons (1+) are both charged and deflect; neutrons are neutral, so they pass straight through.

Why the others fail

IONISATION ENERGY

8 The first five ionization energies of an element, **X**, are shown in the table.

Ionization energy	1st	2nd	3rd	4th	5th
Value / kJ mol^{-1}	631	1235	2389	7089	8844

a gap here so it is 3+

What is the mostly likely formula of the oxide that forms when **X** burns in oxygen?

- ☒ **A** X_2O
- ☒ **B** XO
- ☑ **C** X_2O_3 **oxygen's valency is 2**
- ☒ **D** XO_2

9 Which of the following equations represents the **second** ionization energy of chlorine?

- ☑ **A** $Cl^+(g) \rightarrow Cl^{2+}(g) + e^-$
- ☒ **B** $Cl(g) \rightarrow Cl^{2+}(g) + 2e^-$
- ☒ **C** $Cl(g) \rightarrow Cl^{2-}(g) - 2e^-$
- ☒ **D** $Cl^-(g) \rightarrow Cl^{2-}(g) - e^-$

10 The electronic structures of four elements are given below. Which of these elements has the highest first ionization energy?

noble gases have the highest IE in their period because they have the highest number of protons per period

	1*s*	2*s*	2*p*		
☒ **A**	↑↓	↑↓	↑	↑	
☒ **B**	↑↓	↑↓	↑	↑	↑
☒ **C**	↑↓	↑↓	↑↓	↑↓	↑
☑ **D**	↑↓	↑↓	↑↓	↑↓	↑↓

number – it cannot carry extra decimal places.

Mark scheme 1 mark

- ✓ the number of protons and neutrons / nucleons must be an integer / whole number (1)

Ignore: the values in the table having 2 s.f.

Where marks are lost

Answering about the precision of the table data, or naming only protons OR only neutrons rather than both (nucleons).

Examiner's insight

Very few scored. A mass number is a count of protons plus neutrons, so it has to be a whole number.

23 (b)

Compare · [4 marks]

Germanium-76 decays to selenium-76. Compare and contrast the atomic structure of an atom of germanium-76 with an atom of selenium-76.

Model answer (one similarity, three differences)

✓ Similarity: both atoms have the same total number of nucleons (the same mass number, 76 – protons plus neutrons add up the same). ✓ Difference: germanium has 2 fewer protons than selenium (32 vs 34). ✓ Difference: germanium has 2 more neutrons than selenium (44 vs 42). ✓ Difference: germanium has 2 fewer electrons than selenium (32 vs 34).

Mark scheme 1 similarity + 3 differences - 4 marks

- ✓ same total of protons and neutrons (same mass number) (1)
- ✓ germanium has 2 fewer protons / selenium has 2 more (32 vs 34) (1)
- ✓ germanium has 2 more neutrons / selenium has 2 fewer (44 vs 42) (1)
- ✓ germanium has 2 fewer electrons / selenium has 2 more (32 vs 34) (1)

Accept: the difference marks must be quantitative (state '2', or the actual counts 32/34, 44/42)

Accept: if none of the quantitative marks score, 1 mark for any two of: Ge has more neutrons, Ge has fewer protons, Se has more electrons

How to reach full marks

Work systematically through protons, neutrons and electrons giving numbers each time, and do not miss the shared mass number as the similarity.

Where marks are lost

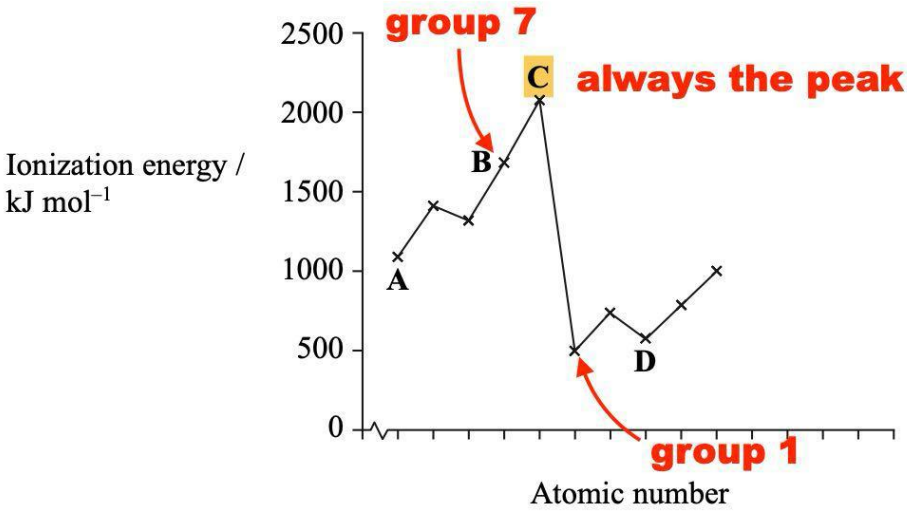
Drifting into bonding, reactivity or ionisation energy, or giving qualitative 'more/fewer' without the numbers for the difference marks.

Examiner's insight

Read the question - it asks about atomic STRUCTURE. Tabulate protons, neutrons and electrons with numbers, and state the identical mass number.

IONISATION ENERGY

11 The sketch graph below shows the trend in first ionization energies for some elements in Periods two and three.



Select, from the elements **A to D**, the one that

(a) has atoms with five p electrons.

so group 7

(1)

☐ **A**

☑ **B**

☐ **C**

☐ **D**

(b) is a member of Group 3.

(1)

☒ **A**

☒ **B**

☒ **C**

☑ **D**

(c) is likely to be very unreactive.

noble gas

(1)

☒ **A**

☒ **B**

☑ **C**

☒ **D**

(d) normally forms four covalent bonds per atom.

(1)

☑ **A**

☒ **B**

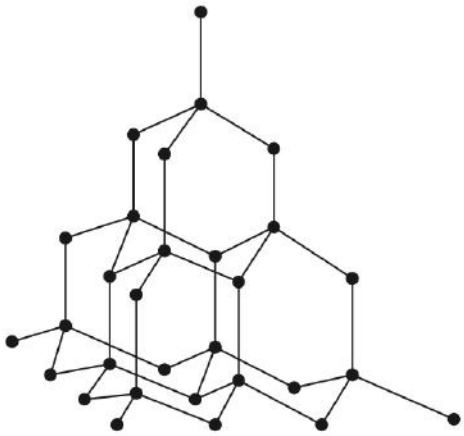
☒ **C**

COVALENT BONDING

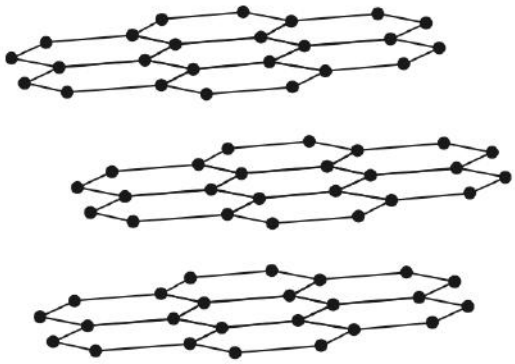
3. Diamond, graphite and graphene are all forms of carbon.

(i) Explain **two** ways in which the physical properties of diamond and graphite differ. Refer to their structure and bonding in your answer.

(4)



diamond



graphite

diamond is hard and graphite is soft

because diamond has covalent bonds in a 3D structure
while graphite has weak forces between the layers

graphite conducts electricity and diamond does not
because only graphite has delocalised electrons

(ii) State how the structure of graphene is related to the structure of graphite.

(1)

Graphene is made only of a single layer

while graphite is made of many layers

(iii) State a use for graphene, identifying the property that makes it suitable for that use.

(2)

Bullet proof clothing & body armor

Coating of space crafts

Micro-electrodes & electricalwires

Nanotubes

Non-stick coatings in frying pans

Strong and durable

oxidation resistant + reduces friction

Good electrical conductor

Flexible and durable

reduces friction between surfaces

Working

% of chlorine-37 = 100 − 75.53 = 24.47%

the two isotope abundances must add to 100%

✓ A_r = (35 x 75.53 + 37 x 24.47) / 100 = 35.4894

✓ to two decimal places: 35.49

A_r = 35.49

Mark scheme 2 marks - the correct answer to 2 dp with no working scores both

- ✓ correct working (weighted mean of the two isotopes) (1)
- ✓ answer given to 2 decimal places (1)

Accept: transfer error if two different species are used consistently

Ignore: units, even if incorrect

Do not accept: 35.50 with no working scores 0

Where marks are lost

Only using the chlorine-35 data - you must first find the 24.47% of chlorine-37 - and rounding to 35.5.

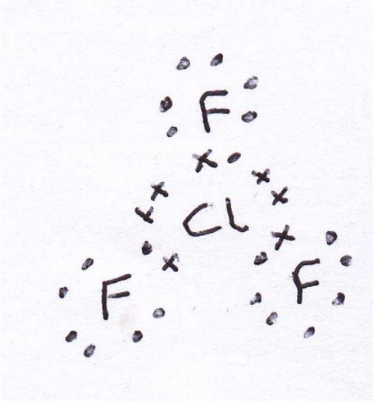
Examiner's insight

Some candidates never worked out the chlorine-37 percentage and lost both marks.

22 (b)(i)

Draw · [2 marks]

Chlorine and fluorine react to form chlorine trifluoride, ClF_3. Draw a dot-and-cross diagram to show the bonding in a molecule of ClF_3. Show outer shell electrons only.



Cl centre: 3 bonding pairs (dot + cross) to the three F atoms, plus 2 lone pairs on Cl; each F keeps 3 lone pairs

Model answer

✓ Three shared pairs, each with one dot and one cross, between the central chlorine and the three fluorine atoms. ✓ The rest of the outer shells complete: TWO lone pairs left on chlorine (7 − 3 bonding electrons = 4) and three lone pairs on every fluorine.

Mark scheme 2 marks - the second mark depends on the first

- ✓ three bonding pairs shown between one Cl and three F atoms (1)
- ✓ the rest of the diagram correct (2 lone pairs on Cl, 3 on each F) (1)

Edexcel IAL - Solved Past Paper

January 2020 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question

hard medium easy

2

Select · [1 mark]

A sample of element X contains only the isotopes shown. What is the relative atomic mass of X to three decimal places in this sample?

Isotope	Percentage abundance
^{58}X	68.077
^{60}X	26.223
^{61}X	1.140
^{62}X	3.634
^{64}X	0.926

The five isotopes and their percentage abundances

Answer

- [x] **A** 58.760
- [ ] **B** 58.8
- [ ] **C** 59.4
- [ ] **D** 59.440

How to get there

✓ A_r = sum of (isotope mass x fractional abundance), using the MASS NUMBER of each isotope.

✓ A_r = (58 x 68.077 + 60 x 26.223 + 61 x 1.140 + 62 x 3.634 + 64 x 0.926) / 100

✓ = (3948.466 + 1573.38 + 69.54 + 225.308 + 59.264) / 100 = 5875.958 / 100

A_r = 58.760 (to 3 decimal places)

Why the others fail

- **B** 58.8 is correct arithmetic but rounded to 3 significant figures, not 3 decimal places
- **C** uses 59 for the first isotope AND rounds to 3 significant figures
- **D** uses a mass of 59 instead of 58 for the first isotope

Where marks are lost

Read '3 decimal places' carefully - two of the wrong options are just the right method rounded wrongly.

Model answer

✓ $S(g) \longrightarrow S^+(g) + e^-$ One mole of gaseous atoms loses one mole of electrons — both species must be gaseous, and only ONE electron leaves.

Mark scheme 2 marks

- ✓ correct species and balancing (1)
- ✓ correct state symbols on S and S^+ (1)

Do not accept: multiples, e.g. $2S(g) \longrightarrow 2S^+(g) + 2e^-$

Ignore: a (g) written on the electron

Where marks are lost

Omitting the (g) state symbols, or writing the electron on the wrong side (that is electron affinity, not ionisation).

Examiner's insight

Some confused ionisation with electron affinity or with electron bombardment in the mass spectrometer - learn the definition equation by heart.

18 (c)

Explain · [3 marks]

Explain why the first ionisation energy of sulfur is less than the first ionisation energies of both phosphorus and chlorine.

Model answer

✓ P, S and Cl all lose their outer electron from the same 3p subshell, so the shielding from inner shells is essentially the same for all three. ✓ Chlorine has more protons than sulfur, so its nuclear charge pulls the 3p electrons in more strongly — the electron is harder to remove from Cl than from S. ✓ In sulfur, two of the 3p electrons are paired in the same orbital; the repulsion between this pair makes one of them easier to remove than an electron from phosphorus's half-full 3p subshell of unpaired electrons.

Mark scheme 3 marks

- ✓ outer electrons in the same subshell / same shell (so similar shielding) (1)
- ✓ Cl has more protons than S (greater nuclear charge) (1)
- ✓ repulsion between the paired electrons in a 3p orbital of S (1)

Accept: similar or same electron shielding; correct full electron configurations

Do not accept: just 'Cl has the greatest charge'; 'S has the greatest atomic radius'

Do not accept: 'shell' used where 'orbital' is needed for the repulsion point

Where marks are lost

Vague talk about 'stability of a half-full subshell' without naming the paired-electron repulsion in a p ORBITAL, and trying to compare shielding within the outer subshell.

Examiner's insight

Shielding comes almost entirely from INNER shells - state 'same subshell, similar shielding' first, then protons, then the 3p pair repulsion.

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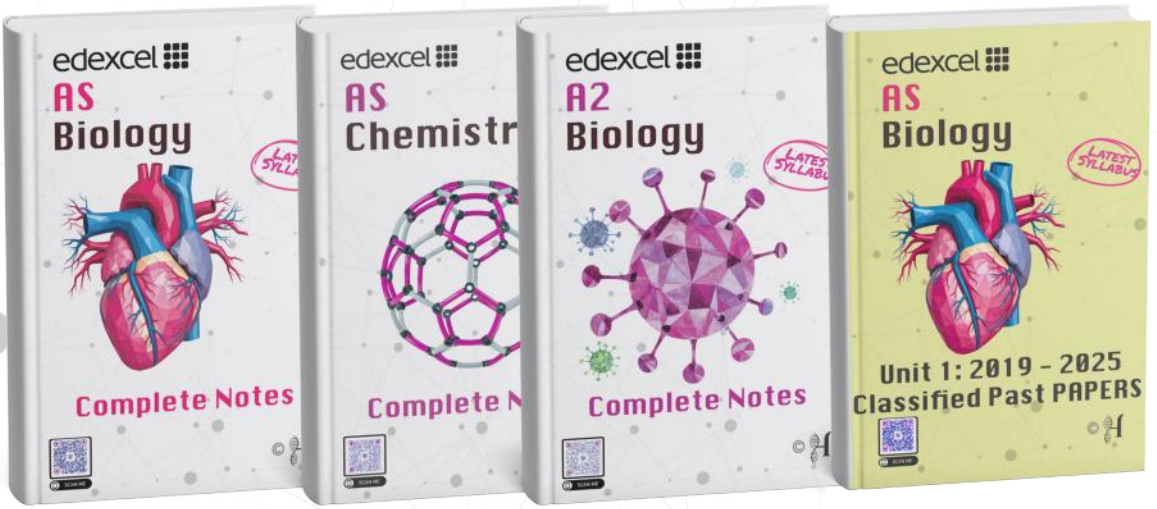

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