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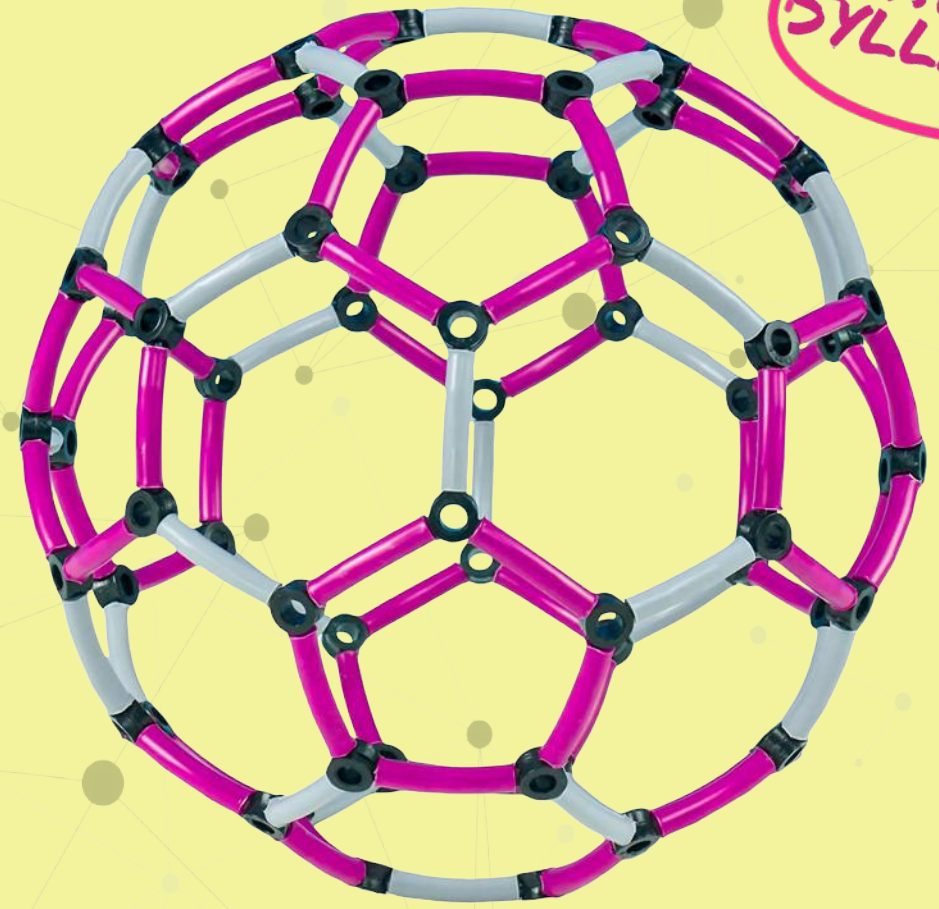
AS Chemistry

LATEST SYLLABUS



Unit 1 Classified Past Papers

SCAN ME

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

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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

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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** $PbO_2 \rightarrow PbO + ½O_2$

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)

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

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

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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

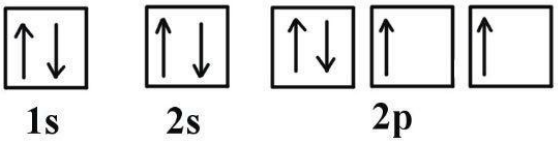
- ☑ **A** a sodium ion.
- ☐ **B** a fluoride ion.
- ☐ **C** an oxide ion.
- ☐ **D** a potassium ion.

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)

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** $Cl^-(g) \rightarrow Cl^{2-}(g) - e^-$

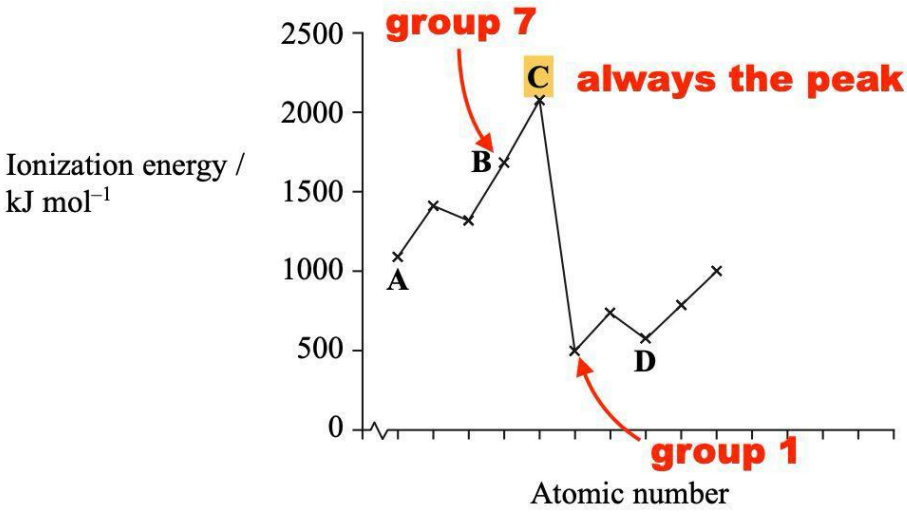
10 The electronic structures of four elements are given below. Which of these elements has the highest first ionization energy?

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**	↑↓	↑↓	↑↓	↑↓	↑↓

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**

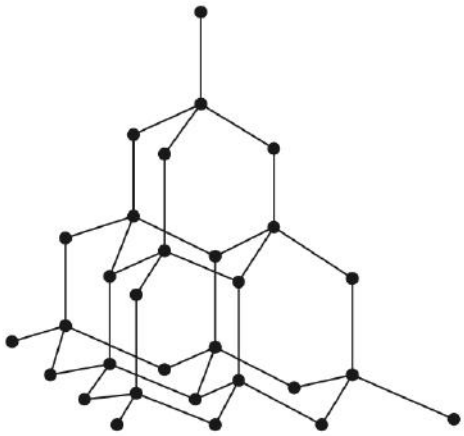
☒ **C**

COVALENT BONDING

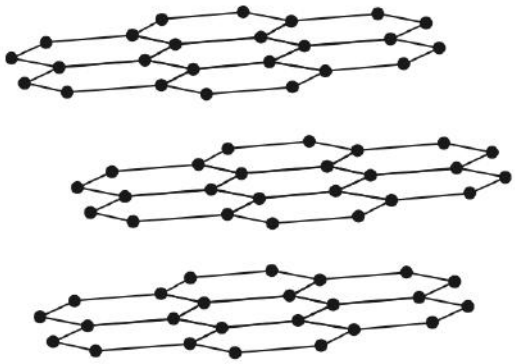
3. Diamond, graphite and graphene are all forms of carbon.

(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

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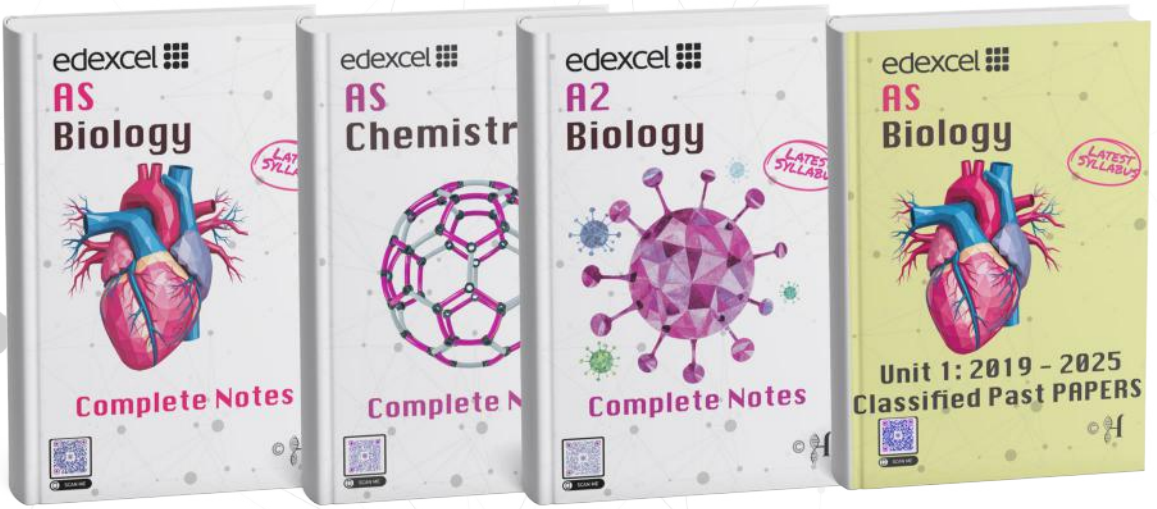

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