2021 O Level Chem Paper 2

Section A

Answer all questions in this section in the spaces provided.

The total mark for this section is 50.

1 **(a)** (2021/O/GCSE/P2/01) all Select elements from the 11st 'O answer the following questions. You may use each element once, more than once or not all.

Potassium

Copper

Magnesium

Iodine

Aluminum

Lithium

Chlorine

(i) Which **two** elements react together most vigorously?

_____ [1]

(ii) Which element bleaches damp blue litmus paper?

_____ [1]

(iii) Which element forms positive ions with different oxidation states.

_____ [1]

(iv) Which element forms an amphoteric oxide?

_____ [1]

(v) Which two elements form ions with the electron arrangement 2, 8, 8?

_____ [1]

(b) The following are statements about groups and periods in the Periodic Table.

Put a tick (✓) in **one** box in each row to show which statement are **true** and which are

	true	**false**
The most unreactive group contains only non-metals.		
Melting point increases across Period 2.		
Atoms lose electrons more easily down Group I.		
The strongest non-metal oxidising agent is at the top of a group.		

[3]

[Total: 8 marks]

2 (2021/O/GCSE/P2/02) (organic chem – fuels, alkanes. For part d only put in energy changes) Fractional distillation is used to separate the alkanes in crude oil.
Fig. 2.1 shows where some alkanes leave the fractionating column.

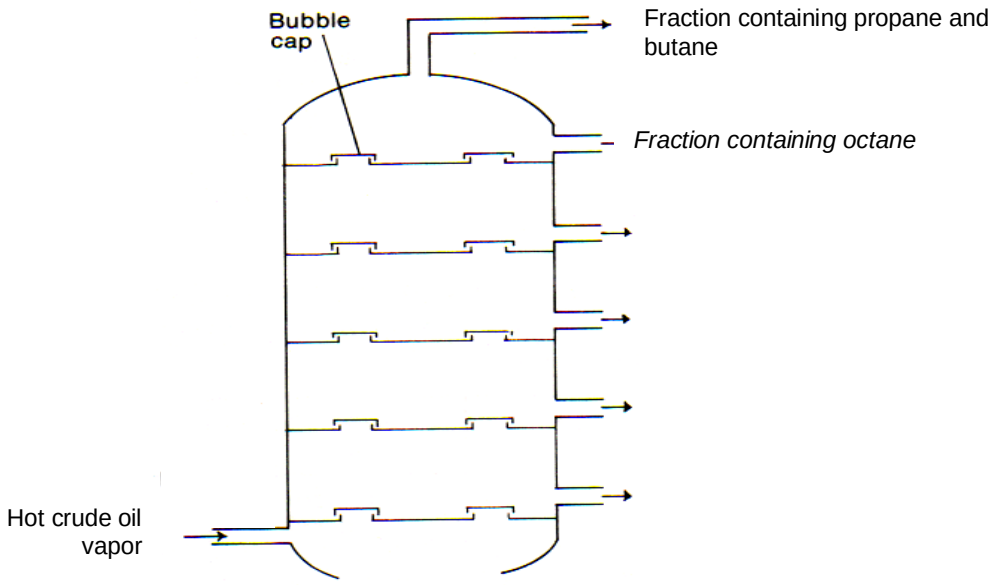


Fig. 2.1

(a) Describe how fractional distillation separates propane from octane.

[3]

(b) Explain why propane and butane leave the column in the same fraction.

_____

_____ [1]

(c) Complete Table 2.1 to show the molecular formula and empirical formula of propane and the empirical formula of octane.

Table 2.1

compound	molecular formula	empirical formula
propane		
octane	C_8H_{18}	

[2]

(d) Octane is the main component in petrol used in cars. However, some cars use LPG (Liquefied Petroleum Gas) fuel. The main component of LPG fuel is butane.
Table 2.2 shows the enthalpy change of combustion when one mole of octane and one mole of butane are completely burned.

Table 2.2

alkane	enthalpy change of combustion in kJ/mol
octane	-5470
butane	-2880

(i) Suggest reasons why the enthalpy change of combustion of octane is more negative than the enthalpy change of combustion of butane.

_____

_____ [2]

(ii) Calculate the mass of butane that gives the same amount of energy when combusted as 50.0 kg of octane.
Give your answer to **three** significant figures.

Mass of butane: ..... kg [3]

3 (2021/O/GCSE/P2/03) (electrolysis) Table 3.1 shows information about some electrolysis experiments.

Table 3.1

Experiment	Negative electrode	Positive electrode	Electrolyte	Substance formed at negative electrode	Substance formed at positive electrode
1	carbon	carbon	dilute aqueous sodium chloride		
2	carbon	carbon	concentrated aqueous sodium chloride		
3	silver	silver	Dilute aqueous copper(II) sulfate	copper	oxygen
4	copper	copper	Dilute aqueous copper(II) sulfate		

(a) Complete Table 3.1 by filling in the missing information.

[2]

(b) Use examples from the table to explain the difference between an inert electrode and an electrode that is not inert.

[2]

(c) **(i)** **Describe the** change that would be **seen** at the negative electrode during experiment 3.

[1]

(ii) Write an ionic equation for the reaction at the positive electrode in experiment 3.

[1]

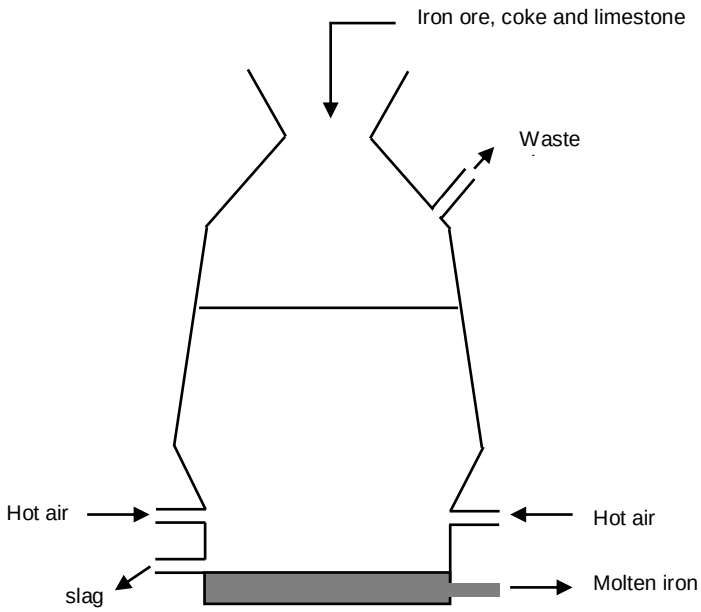
(iii) Describe and explain the colour change of the solution during experiment 3.

[2]

[Total: 8 Marks]

4 (2021/O/GCSE/P2/04) (metals – iron. For part bi, put in moles) Iron is extracted from iron ore in a blast furnace.

Fig. 4.1 shows the substances that enter and leave a blast furnace.



(a) Give the name and the formula for the main compound in the slag.

Name: ……

Formula: ……

[1]

(b) Iron ore contains iron(III) oxide, Fe_2O_3.

(i) Calculate the maximum mass of iron that could be produced from 14,000 tonnes of iron(III)oxide.

1 tonne = 1000kg

[3]

(ii) 14000 tonnes of iron are produce much less iron than the value calculate in (b)(i).
Suggest reasons why.

[2]

(c) Table 4.1 shows the composition of the main waste gases that leave the furnace.

Table 4.1

gas	percentage composition
nitrogen	55
carbon dioxide	21
carbon monoxide	20

Describe and explain the source of each these gases.

[3]

(d) Molten iron from the blast furnace contains carbon. The carbon is removed from the iron.

Carefully controlled amounts of carbon are then added to make steel.

Explain why carbon is added to iron and why the amounts added must be carefully controlled.

[2]

[Total: 11 Marks]

5 (2021/O/GCSE/P2/05) (air) A new system for treating the exhaust emissions of diesel cars has been developed.

The system injects **a** fluid called DEF (Diese1 Exhaust Fluid) into the hot exhaust gases. DEF contains an aqueous solution of urea, $(NH_2)_2CO$.

(a) Draw a 'dot-and cross' diagram for urea, $(NH_2)_2CO$.

Show outer electrons only.

[3]

(a) When the DEF is injected into the hot exhaust gases, the high temperature causes the reaction shown in equation 1.

Equation 1 $(NH_2)_2CO + H_2O \rightarrow 2NH_3 + CO_2$

The ammonia formed reacts with nitrogen oxides in the exhaust gases.

Equation 2 $4NH_3 + 4NO + O_2 \rightarrow 4N_2 + 6H_2O$

Equation 3 $8NH_3 + 6NO_2 \rightarrow 7N_2 + 12H_2O$

(i) The DEF is stored in a tank in the car away from the hot engine.

If this tank becomes too hot, it could cause an explosion.

Use equation 1 to explain why.

[1]

(ii) State with reasons, two benefits to the environment of using DEF to treat exhaust gases.

Refer to the reactants and products of equation 2 and equation 3 in your answer.

[2]

(iii) Suggest and explain one reason why using DEF does not solve all environmental problems caused by the exhaust gases.

[2]

(iv) Write an overall equation for the reaction of urea with NO_2.

[2]

(b) A motorist buys a 500 cm^3 bottle of DEF.

The label says that the bottle contains 160 g of urea.

Calculate the concentration of urea in mol/dm^3.

Concentration of urea: ……..mol/dm^3 [2]

[Total: 12 Marks]

Section B

Answer all three questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

6 (2021/O/GCSE/P2/06) (acids) Acids and pH

Solution of different acids of the same concentration (in mol/dm3) have different properties. The concentration of hydrogen ions, the pH and the rate of reaction with metals and carbonates may be different, even when the initial concentration of the acid is the same.

Table 6.1 gives information about solutions of acids at different concentrations.

Table 6.1

Name of acid	Concentration of acid in mol/dm^3	Concentration of hydrogen ions in solution in mol/dm^3	pH
Hydrochloric acid	0.01	0.01	2.0
	0.10	0.10	1.0
Sulfuric acid	0.01	0.02	0.7
	0.02	0.04	1.7
Ethanoic acid	0.05	0.0009	3.0
	0.10	0.0013	2.9

General Equations for **Reactions** of Acids

Some sources, such as text books and websites, represent the general formula of an acid as HA, **where A** ls an anion. HA can be used to give general equations for the reactions of acids.

For example, the reaction of acids with Group II metal hydroxides may be shown as:

equation 1 $2HA + M(OH)_2 \rightarrow MA_2 + 2H_2O$

And the reaction of acids with any metal can be shown as:

equation 2 $\boldsymbol{x\,HA + M^{-} \rightarrow MA_x + \frac{x}{2}H_2}$

where x is the value of the positive charge on the metal ion.

(a) **(i)** Which acids in Table 6.1 fit the general formula of HA and which do not? Explain your reasoning with reference to the ions present in each acid.

[2]

(ii) Construct a general equation for the reaction of an acid with group I carbonates.

Use HA as the general formula for an acid and M as the symbol for a Group I metal.

[1]

(iii) Write an equation for the reaction of calcium with ethanoic acid.
Show, with reference to the value of x, why equation 2 agrees with your equation.

[2]

(b) **(i)** A student looks at the data in Table 6.1 and suggests the following relationship.

$$\text{pH } \alpha \frac{1}{/\text{initial concentration of the acid}}$$

Use the data to show that this relationship is incorrect.

[2]

(c) **(ii)** State and explain the factors that affect the pH of an acid using information from Table 6.1.

[3]

(iii) Complete Table 6.2.

Use the data in Table 6.1 to help you.

Table 6.2

Name of acid	Concentration of acid in mol/dm^3	Concentration of hydrogen ions in solution in mol/dm^3	pH
Hydrochloric acid	0.04		
Sulfuric acid	0.05		

[2]

[Total: 12 Marks]

7 **(a)** (2021/O/GCSE/P2/07) (organic chemistry polymers) Molecule **A** and molecule **B** react together to make a condensation polymer.

(i) What is the relative molecular mass of the repeating unit of the polymer formed from molecules **A** and **B**?

Show your working.

[2]

(ii) Molecule A has two alcohol groups. Each alcohol group can be oxidized by acidified potassium manganate(VII).

[2]

(b) Fig. 7.1 shows how molecule C polymerises to make another condensation polymer.

(i) The polymer formed from molecule **C** is a type of polyester.

Explain how the structure of the polymer that it is a polyester.

[1]

The condensation polymerization of molecule C can be compared with the addition polymerization of ethane.

Outline **one** similarity and **two** differences between the condensation polymerization of molecule **C** and the addition polymerization of ethene.

[3]

[Total: 8 Marks]

8 (2021/O/GCSE/P2/08) (metals reductionand alloy) Either

Some cars have components made from an alloy of aluminum and silicon.

Silicon is extracted from silicon dioxide in sand by heating the sand to 2000°C in a furnace with carbon. The reaction is shown.

$$SiO_2 + 2C \rightarrow Si + 2CO$$

Sand also contains small amounts of aluminum oxide. Aluminum oxide remains in the silicon after the reaction with carbon and further processes are needed to remove it.

(a) What conclusions can you make from this information about the relative reactivity of carbon, silicon and aluminum?

Use ideas about reduction to explain your answer.

[2]

(b) Table 8.1 shows information about some oxides of carbon, silicon and aluminum.

Table 8.1

oxide	melting point/°C	boiling point/°C	density at room temperature and pressure in g/cm^3	electrical conductivity
carbon monoxide	-205	-192	0.002	Does not conduct in any state
silicon dioxide	1600	2230	2.65	Does not conduct in any state.
aluminum oxide	2000	2980	3.99	Conducts when molten.

Use ideas about bonding and structure to explain the differences between the properties of the oxides of carbon, silicon and aluminum.

[5]

(c) Aluminum-silicon alloys contain aluminum mixed with silicon and other elements.

Table 8.2 shows information about the composition of some aluminum-silicon alloys.

Table 8.2

alloy	percentage by mass of silicon	percentage by mass of elements other than silicon and aluminum
X	<16	7
y	16-19	8
z	22-24	6

100g of an aluminum-silicon alloy is analysed and found to contain 2.8 mol of aluminum.

Identify the alloy **X, Y** or **Z** using the information in Table 8.2.

Show your working.

[3]

[Total: 10 Marks]

9 (2021/O/GCSE/P2/09) (rate of reaction) OR)

The 'iodine clock' reaction is an experiment that is used to investigate rates of reaction.

Aqueous iodine ions are mixed with other reactions and a series of reactions takes place to produce iodine.

The solution turns blue-black when a fixed amount of iodine has been produced.

The conditions of the reaction are changed by changing the concentration of iodine ions are temperature or by adding a catalyst.

These changes affect the time taken for the solution to turn blue-black.

Table 8.3 shows the conditions and results for s series of experiments.

Table 8.3

experiment	concentration of iodide ions used in mol/dm^3	temperature /°C	catalyst added to reaction mixture	time taken for blue-black colour to appear/s
1	0.1	20	none	50
2	0.2	20	none	27
3	0.2	40	none	15
4	0.2	20	Cu^{2+} ions	20

One of the experiments is used as a reference to compare the effect of the variables.

Which experiment is used as a reference?

Explain how you made your choice.

[2]

Use ideas about collisions between particles to explain why changing the conditions shown in Table 8.3 changes the time taken for the blue-black colour to appear.

[5]

(a) The equation shows the reaction that produces iodine.

$2I^-(aq) + H_2O_2(aq) + 2H^+(aq) – I_2(aq) + 2H_2O(l)$

In every experiment the volume of aqueous iodine ions used is $10cm^3$ and acid is added in excess.

In every experiment $30cm^3$ of $0.05mol/dm^3$ aqueous hydrogen peroxide is used.

Which is the limiting reactant at the start of each experiment?

Show your working.

[3]

[Total: 10 Marks]