CEDAR GIRLS' SECONDARY SCHOOL
Preliminary Examination 2023
Secondary Four

CANDIDATE NAME			
CLASS	4	INDEX NUMBER	

CHEMISTRY **6092/2**

Paper 2 Section B

29 August 2023
1 hour 45 minutes

Additional Materials: NIL

For Examiner's Use	
Section B	
7	12
8	8
9 EITHER	10
9 OR	10
Total	30

[Turn over

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.

B7 The chemistry of ceramic pottery

Ceramic objects are made by combining naturally occurring raw materials such as clay and water and shaping them into different forms. Once shaped, the object is fired and glazed.

Clay

Clay is made up on aluminium silicates with alkali metals. One such example is orthosclase, whose composition is shown in Table 7.1.

Table 7.1

component in orthosclase	percentage composition / %
potassium oxide	16.9
aluminium oxide	18.3
silicon dioxide	64.8

Forming a pot

Clay is easily shaped because the layers of clay are separated by a thin layer of water molecules which are linked to neighbouring layers via intermolecular forces of attraction. These weak but useful forces enable different types of pottery vessels to be formed.

Fig. 7.1 shows the simplified structure of clay.

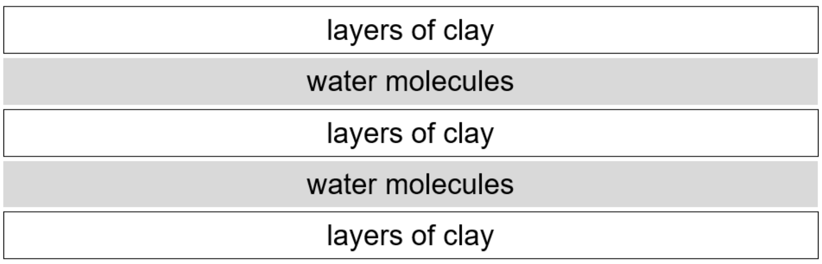

Fig. 7.1

Firing the pot

Table 7.2 gives information for each stage of the firing process in the kiln, an oven that produces high temperatures, to obtain ceramic.

Table 7.2

Stage	Temperature range / °C	Information
1	Below 100	The kiln is set to a temperature below the boiling point of water and it is held at that temperature for a few hours. The water that evaporates out of the clay readily is called 'free water'.
2	480 – 700	The water that is left after Stage 1 is called 'chemical water'. Driving off the 'chemical water' leads to the formation of new covalent bonds. This is shown in the simplified equation: [clay]−OH + HO−[clay] → [clay]−O−[clay] + H_2O
3	1100 – 1200	Non-metal compounds in clay is oxidised. Sulfur containing compounds burn in air to create a gas which irritate the eyes upon contact.
4		Quartz in the clay melts and hardens to form glass between particles in the clay. This process makes the clay less porous.
5	–	Ceramic pieces are left to cool down slowly.

Glazing the pot

The pot is then glazed for functional and decorative reasons. The main minerals (silicon dioxide and aluminium oxide) comprising glazes are colourless. However, glazes made from the oxides of transition metals are used to improve the appearance.

[Turn over

For Examiner's Use

(a) Which compound in orthosclase shows that it comprises of alkali metals?

………………………………………………………………………………………… [1]

(b) Explain why the intermolecular forces of attraction between layers of clay are considered weak **but** useful in shaping clay.

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(c) If Stage 1 is conducted above the boiling point of water, the clay object will explode.

Explain why this happens using ideas of Kinetic Particle Theory.

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(d) Explain, in terms of bonding, the difference in the temperature required for the removal of chemical water in Stage 2 compared to free water in Stage 1.

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(e) Suggest the identity of the gas produced in Stage 3 and explain why it irritates the eyes upon contact.

…………………………………………………………………………………………

………………………………………………………………………………………… [2]

For Examiner's Use

(f) Describe and explain how the melting of quartz makes the pot less porous in Stage 4.

Your answer should include:

- the change in movement of particles as quartz melts
- how this change in movement makes the pot less porous

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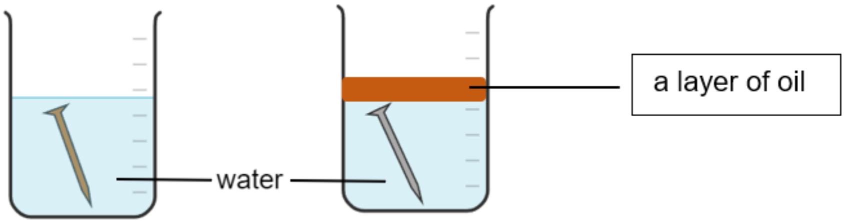
(g) State a property of the oxides of transition metals that enables it to be used for decorative reasons.

…………………………………………………………………………………………… [1]

[Total:12]

For Examiner's Use

B8 A student, Joan wanted to investigate the rate of rusting of iron nails under different conditions. She set up the experiment as shown. After 48 hours, she observed that the iron nail in beaker **1** turned slightly rusty but the iron nail in beaker **2** remained unchanged.



1 **2**

(a) Chemical analysis of the rust formed on the iron nail shows that the rust is hydrated iron(III) oxide with the formula $Fe_2O_3.nH_2O$. The '*n*' in the chemical formula of rust indicates the number of water molecules present in the compound.

With the aid of a balanced chemical equation and the information provided, describe the process of rusting of the iron nail.

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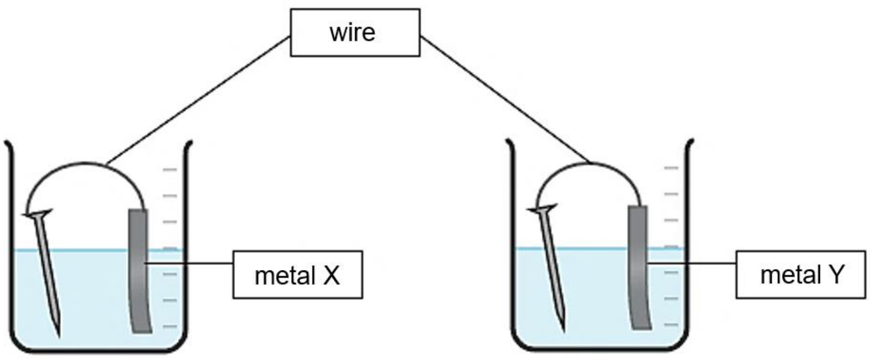
(b) Joan set up two other beakers, **3** and **4** with iron nails under similar experimental conditions, in which the iron nail is connected to metal strip X and Y respectively via a wire.



3 **4**

After 48 hours, Joan observed that for beaker **3**, the iron nail remained unchanged, whereas for beaker **4**, almost the entire iron nail turned rusty.

(i) Based on Joan's experiment, arrange the three metals (Fe, X and Y) in increasing order of reactivity.

…………………………………………………………………………………… [1]

For Examiner's Use

(ii) Explain the order of reactivity as stated in **b(i)**.

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.... [2]

(iii) Hence, suggest an identity for metal X.

.... [1]

(c) Iron is usually further processed to make steel, which is stronger.

Use ideas about the arrangement of atoms in steel to explain why. You may use a labelled diagram to support your answer.

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.... [2]

[Total: 8]

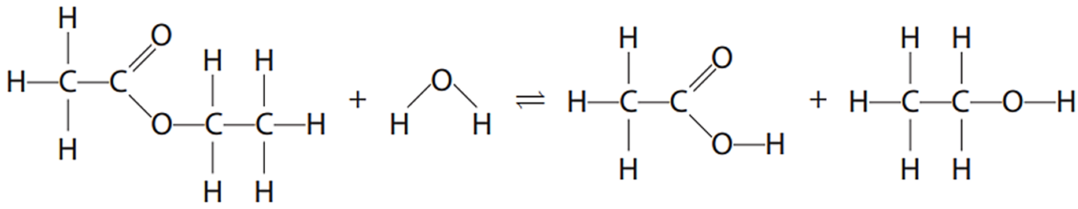
For Examiner's Use

EITHER

B9 This question is about esters.

Ester A reacts with water to form ethanoic acid and ethanol.

The displayed formulae of the reactants and products are shown in this equation:



ester A

The enthalpy change (ΔH) for the reaction is 0 kJ mol^{-1}.

(a) **(i)** Give the name of ester A.

.... [1]

(ii) Describe a chemical test, other than using an indicator, to **confirm** that the reaction mixture contains ethanoic acid.

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.... [2]

(iii) Explain why the enthalpy change (ΔH) for the reaction between ester A and water is 0 kJ mol^{-1}.

State the bonds broken and formed in your answer.

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.... [2]

(iv) State the type of reaction and the chemicals needed for the conversion of ethanol to ethanoic acid in the laboratory.

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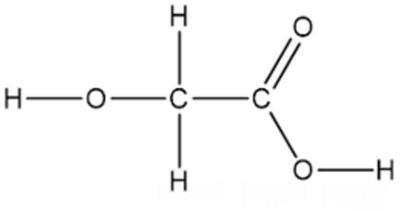
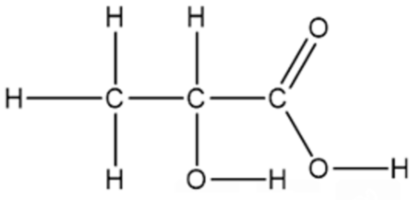
.... [2]

For Examiner's Use

(b) Ethanoic acid can be further converted to glycolic acid, $HOCH_2CO_2H$ and lactic acid, $CH_3CH(OH)CO_2H$, which are naturally occurring compounds found in the body.



glycolic acid



lactic acid

(i) When one molecule of glycolic acid reacts with one molecule of lactic acid, it is possible to form two esters with different structural formulae.

Draw the structural formula of these **two** esters.

[2]

(ii) The polyesters formed by reacting glycolic acid and lactic acid are used as material in surgery to sew up wounds inside the body, known as 'soluble stitches'.

Using information from **(a)** and **(b)**, suggest a reason why these polyesters are suitable to be used as 'soluble stitches'.

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[Total: 10]

For Examiner's Use

OR

B9 Intercontinental jet airliners use kerosene as fuel because it can combust efficiently in excess air. The formula of kerosene may be taken as $C_{14}H_{30}$.

$$2C_{14}H_{30}\ (l) + 43O_2\ (g) \rightarrow 28CO_2\ (g) + 30H_2O\ (g)$$

(a) To which homologous series does kerosene belong to?

……………………………………………………………………………………….. [1]

(b) The flight path from Singapore to London is approximately 10 700 km. A typical intercontinental jet airliner burns 10.8 kg of kerosene for each kilometre covered.

(i) Calculate the mass of kerosene burnt on a flight from Singapore to London.

[1]

(ii) Hence, calculate the mass of carbon dioxide produced during this flight.

[3]

For Examiner's Use

(c) Kerosene can be broken down in simpler hydrocarbons by passing the hot vapour over a powdered catalyst of alumina and silica as shown in the reaction below.

$$C_{14}H_{30} \xrightarrow{catalyst} E + C_5H_{10} + C_6H_{14}$$

(i) When E reacts with bromine, it forms a dibromoalkane.

The following compounds are structures of possible dibromoalkanes formed from E.

$BrCH_2CH_2CH_2Br$ $CH_3CHBrCH_2Br$ $CH_3CH_2CHBr_2$

Identify which compound is formed from E, and hence deduce the identity of E. Explain your reasoning and describe the reaction that takes place to produce dibromoalkane.

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(ii) When E is subjected to high temperature and pressure, E forms a polymeric material that is often used to make disposable food containers.

Draw the repeating unit of the polymer formed and state one possible environmental consequence of using this polymeric material.

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…………………………………………………………………………………… [2]

[Total:10]

The Periodic Table of Elements

Group

I	II											III	IV	V	VI	VII	0
							1 **H** hydrogen 1										2 **He** helium 4
3 **Li** lithium 7	4 **Be** beryllium 9											5 **B** boron 11	6 **C** carbon 12	7 **N** nitrogen 14	8 **O** oxygen 16	9 **F** fluorine 19	10 **Ne** neon 20
11 **Na** sodium 23	12 **Mg** magnesium 24											13 **Al** aluminium 27	14 **Si** silicon 28	15 **P** phosphorus 31	16 **S** sulfur 32	17 **Cl** chlorine 35.5	18 **Ar** argon 40
19 **K** potassium 39	20 **Ca** calcium 40	21 **Sc** scandium 45	22 **Ti** titanium 48	23 **V** vanadium 51	24 **Cr** chromium 52	25 **Mn** manganese 55	26 **Fe** iron 56	27 **Co** cobalt 59	28 **Ni** nickel 59	29 **Cu** copper 64	30 **Zn** zinc 65	31 **Ga** gallium 70	32 **Ge** germanium 73	33 **As** arsenic 75	34 **Se** selenium 79	35 **Br** bromine 80	36 **Kr** krypton 84
37 **Rb** rubidium 85	38 **Sr** strontium 88	39 **Y** yttrium 89	40 **Zr** zirconium 91	41 **Nb** niobium 93	42 **Mo** molybdenum 96	43 **Tc** technetium –	44 **Ru** ruthenium 101	45 **Rh** rhodium 103	46 **Pd** palladium 106	47 **Ag** silver 108	48 **Cd** cadmium 112	49 **In** indium 115	50 **Sn** tin 119	51 **Sb** antimony 122	52 **Te** tellurium 128	53 **I** iodine 127	54 **Xe** xenon 131
55 **Cs** caesium 133	56 **Ba** barium 137	57–71 lanthanoids	72 **Hf** hafnium 178	73 **Ta** tantalum 181	74 **W** tungsten 184	75 **Re** rhenium 186	76 **Os** osmium 190	77 **Ir** iridium 192	78 **Pt** platinum 195	79 **Au** gold 197	80 **Hg** mercury 201	81 **Tl** thallium 204	82 **Pb** lead 207	83 **Bi** bismuth 209	84 **Po** polonium –	85 **At** astatine –	86 **Rn** radon –
87 **Fr** francium –	88 **Ra** radium –	89–103 actinoids	104 **Rf** rutherfordium –	105 **Db** dubnium –	106 **Sg** seaborgium –	107 **Bh** bohrium –	108 **Hs** hassium –	109 **Mt** meitnerium –	110 **Ds** darmstadtium –	111 **Rg** roentgenium –	112 **Cn** copernicium –		114 **Fl** flerovium –		116 **Lv** livermorium –		

Key

proton (atomic) number **atomic symbol** name relative atomic mass

lanthanoids	57 **La** lanthanum 139	58 **Ce** cerium 140	59 **Pr** praseodymium 141	60 **Nd** neodymium 144	61 **Pm** promethium –	62 **Sm** samarium 150	63 **Eu** europium 152	64 **Gd** gadolinium 157	65 **Tb** terbium 159	66 **Dy** dysprosium 163	67 **Ho** holmium 165	68 **Er** erbium 167	69 **Tm** thulium 169	70 **Yb** ytterbium 173	71 **Lu** lutetium 175	
actinoids	89 **Ac** actinium –	90 **Th** thorium 232	91 **Pa** protactinium 231	92 **U** uranium 238	93 **Np** neptunium –	94 **Pu** plutonium –	95 **Am** americium –	96 **Cm** curium –	97 **Bk** berkelium –	98 **Cf** californium –	99 **Es** einsteinium –	100 **Fm** fermium –	101 **Md** mendelevium –	102 **No** nobelium –	103 **Lr** lawrencium –	

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).