NATIONAL JUNIOR COLLEGE
SH2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
SUBJECT CLASS		REGISTRATION NUMBER	

CHEMISTRY **9729/01**
Paper 1 Multiple Choice **15 September 2021**
1 hour

Additional Materials: Optical Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, subject class and registration number on the Answer Sheet in the spaces provided unless this has been done for you.
There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

Instructions on how to fill in the Optical Mark Sheet
Shade the index number in a 5 digit format on the optical mark sheet:
1st digit and the last 4 digits of the Registration Number.

Example:

Student	Examples of Registration No.	Shade:
	2005648	**25648**

This document consists of **12** printed pages.

1 A sample of element sulfur contains four isotopes of the following composition.

relative isotopic mass	relative abundance
32	95.02
33	0.76
34	4.20
36	0.02

What is the relative atomic mass of sulfur in this sample?

A 32.07 **B** 32.08 **C** 32.09 **D** 32.10

2 When 15 cm^3 of a gaseous organic compound were completely burnt in an excess of oxygen, 30 cm^3 of carbon dioxide and 15 cm^3 of nitrogen were formed, all volumes being measured at the same temperature and pressure.

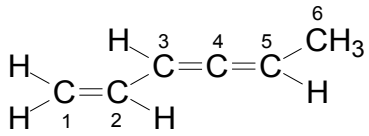
Which could be the formula of the organic compound?

A $C_2H_4N_2$ **B** C_2H_7NO **C** C_3H_7NO **D** $C_3H_6N_2$

3 Which ion has less electrons than neutrons and less neutrons than protons?

	ion	neutrons	nucleons
A	A^-	18	37
B	B^{2+}	17	34
C	C^{3+}	16	33
D	D^{3-}	16	31

4 Covalent bonds are formed by orbitals overlap.



Which statement does **not** describe the molecule above?

A The σ bond between C1–C2 is formed by $2sp^2$–$2sp^2$ overlap.

B The σ bond between C2–C3 is stronger than that between C5–C6.

C The π bond between C4–C5 is formed by $2sp$–$2sp^2$ overlap.

D The σ bond between C6–H is formed by $2sp^3$–1s overlap.

5 Which options contain a polar and a non-polar molecule?

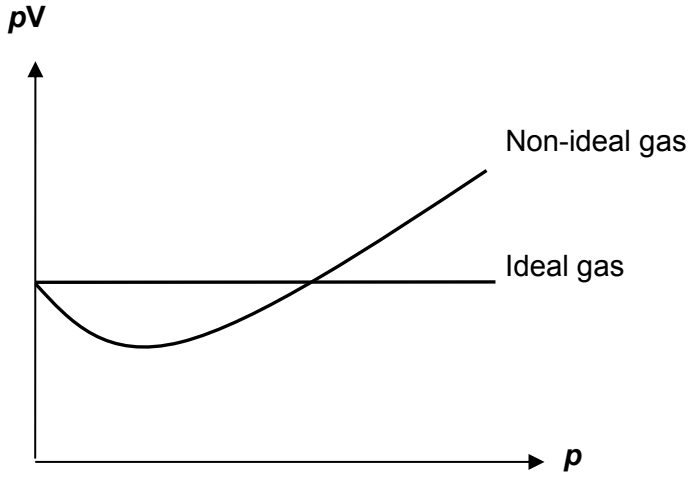
1 CO_2, H_2O

2 SO_2, PCl_5

3 CH_2Cl_2 , $SiCl_4$

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only

6 The value of *p*V is plotted against *p* for two gases, an ideal gas and a non-ideal gas, where *p* is the pressure and V is the volume of the gas.



Which gas shows the greatest deviation from ideal gas behaviour at 200 °C?

A CO_2 **B** Cl_2 **C** CH_3OH **D** N_2H_4

7 Astatine is an element in Group 17. Which statements are correct?

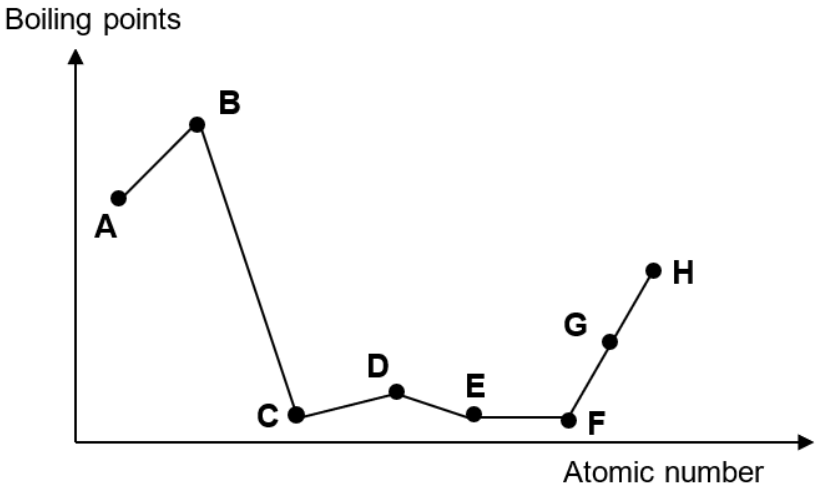
1 Silver astatide is insoluble in aqueous ammonia.

2 Hydrogen astatide is less stable to heat than hydrogen iodide.

3 Astatine is more electronegative than iodine.

A 1, 2 and 3 **B** 2 and 3 only **C** 1 and 2 only **D** 1 only

8 The graph below shows the variation in the boiling point for 8 consecutive elements in the Periodic Table, all with atomic number ≤ 20.



What can be deduced from the graph?

A The ions of **A** and **E** are isoelectronic.

B The chlorides become less acidic from **A** to **C**.

C When the oxide of **D** is added to water, the resulting solution has a pH greater than 7

D The oxide of **A** reacts with excess aqueous sodium hydroxide to form a soluble complex.

9 Given the following data:

Lattice energy of magnesium chloride	–2526 kJ mol^{-1}
Standard enthalpy change of hydration of chloride	–384 kJ mol^{-1}
Standard enthalpy change of hydration of magnesium	–1890 kJ mol^{-1}

What would be the change in temperature measured when 0.49 g of magnesium chloride was dissolved in 50 g of water?
[Molar mass of $MgCl_2$ = 95.3 g mol^{-1}]

A − 6.2 °C **B** − 3.3 °C **C** + 3.3 °C **D** + 6.2 °C

10 Combustion of carbon monoxide to form carbon dioxide is an exothermic reaction.

What can be deduced from this information?

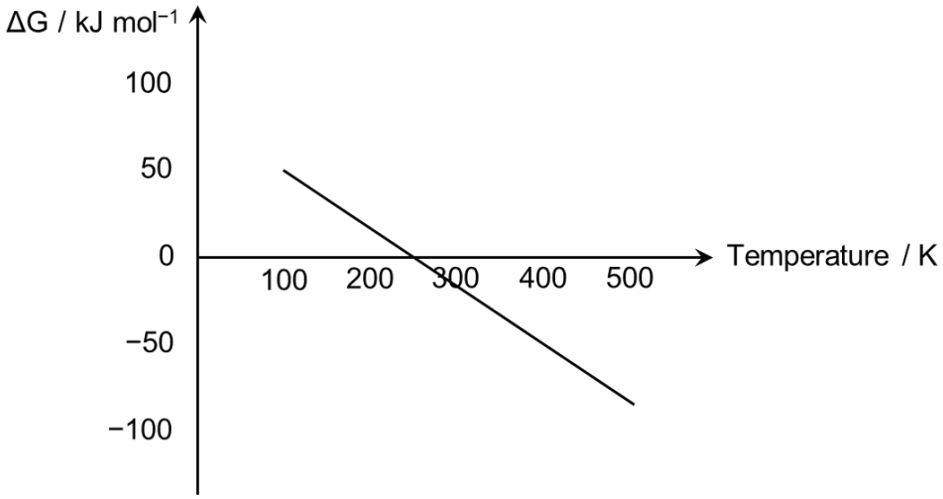
1 CO_2 is more stable than CO.

2 The standard enthalpy change of formation of carbon dioxide is more exothermic than the standard enthalpy change of formation of carbon monoxide.

3 Combustion of CO has a low activation energy.

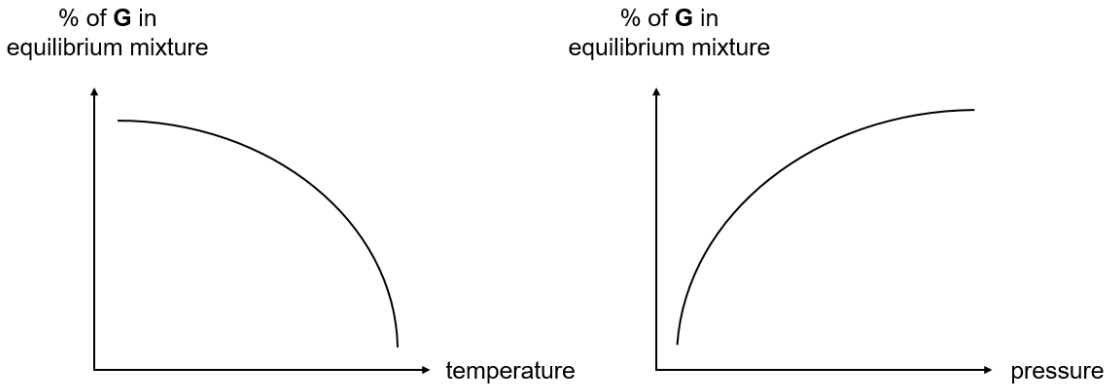
A 1, 2 and 3 **B** 2 and 3 only **C** 1 and 2 only **D** 1 only

11 What can be concluded about the values of ΔH and ΔS from this graph?



	ΔH	ΔS
A	positive	positive
B	positive	negative
C	negative	positive
D	negative	negative

12 Compound **G** is formed during a reaction involving only gaseous particles.
The graphs below show how the percentage of compound **G** at equilibrium varies with temperature and pressure.



Which equation represents the formation of compound **G**?

	equation	ΔH
A	**E**(g) + 3**F**(g) ⇌ 2**G**(g)	negative
B	2**E**(g) ⇌ **F**(g) + 2**G**(g)	positive
C	4**D**(g) + 3**E**(g) ⇌ 2**F**(g) + 6**G**(g)	negative
D	**E**(g) + **F**(g) ⇌ 2**G**(g)	positive

13 Which reactions show NH_3 behaving as a Lewis base?

1 $HNO_3 + NH_3 \longrightarrow NH_4NO_3$

2 $2NH_3 \longrightarrow NH_2^- + NH_4^+$

3 $BH_3 + NH_3 \longrightarrow BH_3NH_3$

A 1, 2 and 3 **B** 2 and 3 only **C** 1 and 2 only **D** 1 only

14 The auto-ionisation of H_2O is an endothermic process.

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq) \qquad K_w = 1.0 \times 10^{-14} \text{ at } 25\,^\circ\text{C}$$

Which option is correct about water at 60 °C?

A pH < 7 **B** pH = 7 **C** $[H^+] > [OH^-]$ **D** $[H^+] < [OH^-]$

15 A 1 dm^3 solution contains 2×10^{-4} mol dm^{-3} each of magnesium, strontium, iron(II) and silver(I) ions.

Which carbonate will be precipitated first when 1 mol dm^{-3} sodium carbonate is added dropwise into the solution?

	compound	K_{sp}
A	Magnesium carbonate	1.3×10^{-7} mol^2 dm^{-6}
B	Strontium carbonate	9.3×10^{-10} mol^2 dm^{-6}
C	Iron(II) carbonate	2.1×10^{-11} mol^2 dm^{-6}
D	Silver(I) carbonate	8.1×10^{-12} mol^3 dm^{-9}

16 Ethyl ethanoate undergoes an acid-catalysed hydrolysis in water where the concentration of acid in the solution remains constant.

$$CH_3CO_2CH_2CH_3 + H_2O \xrightarrow{H^+} CH_3CO_2H + CH_3CH_2OH$$

The rate equation is found to be rate = $k[CH_3CO_2CH_2CH_3][H^+]$

In an experiment, when 0.01 mol dm^{-3} HC*l* was reacted with 0.10 mol dm^{-3} ethyl ethanoate, the half-life was found to be 42 min.

In a second experiment, 0.02 mol dm^{-3} HC*l* was reacted with 0.40 mol dm^{-3} ethyl ethanoate.

What is the half-life of the second experiment?

A 6.25 min **B** 10.5 min **C** 21 min **D** 42 min

17 What is the rate equation for the reaction with the mechanism shown?

$$2A \rightleftharpoons A_2 \quad \text{fast}$$
$$A_2 + B \longrightarrow A_2B \quad \text{slow}$$
$$A_2B + B \longrightarrow A_2B_2 \quad \text{fast}$$

A Rate = $k[A]^2$

B Rate = $k[A][B]$

C Rate = $k[A_2][B]$

D Rate = $k[A]^2[B]$

18 Which species is the weakest oxidising agent under standard conditions?

A Ag^+ (aq) **B** Cu^{2+} (aq) **C** Fe^{2+} (aq) **D** H^+ (aq)

19 Each gold medal awarded in the Olympic Games weighs 500 g. The gold plating constitutes 1.2% by mass of the gold medal.

The core of the medal is immersed in a solution of gold(III) chloride and connected to a power source with a current of 0.10 A.

What is the time required to electroplate the desired mass of gold?

A 1.76×10^4 s **B** 2.94×10^4 s **C** 8.81×10^4 s **D** 7.35×10^6 s

20 It has been estimated that for every atom of chlorine or bromine generated from a halogenoalkane in the stratosphere, one hundred thousand molecules of ozone may be destroyed.

Which organic compound would cause the most destruction to ozone?

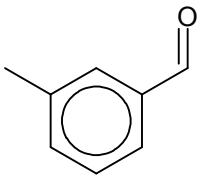
A $CF_2Cl CH_2CF_2Cl$

B CCl_2BrCH_2Br

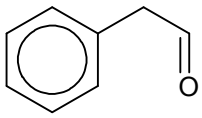
C $CHCl_2CBr_3$

D CCl_4

21 Compounds **X** and **Y** are isomers with the molecular formula C_8H_8O.



Compound **X**



Compound **Y**

Which reagent can be used to distinguish between **X** and **Y**?

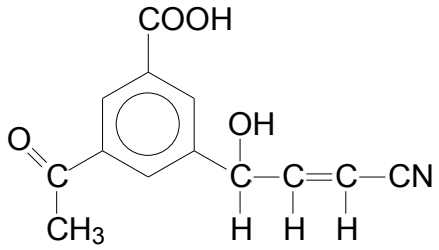
A Hot acidified $K_2Cr_2O_7$

B Hot acidified $KMnO_4$

C $[Ag(NH_3)_2]^+$, heat

D I_2, NaOH(aq), warm

22 How many moles of H_2 will react with 1 mole of the following compound in the presence of platinum catalyst?



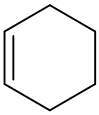
A 2 **B** 3 **C** 4 **D** 5

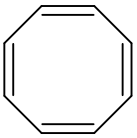
23 In 1931, the German chemist Erich Hückel formulated a theory to help determine if a species would be considered aromatic. This rule became known as Hückel's rule.

The compound must meet all the following four criteria to be considered as aromatic:
- a cyclic structure (a ring of atoms)
- a planar ring structure (all atoms in the ring must lie in the same plane)
- a fully conjugated ring structure (continuous lateral overlap of p orbitals at every atom in the ring)
- a ring structure has (4n+2) π electrons (n = 0 or any positive integer)

Which molecules are aromatic?

1 

2 

3 

A 1 only

B 2 and 3 only

C 1 and 3 only

D None of the above

24 Which molecule **cannot** be used to synthesise propanoic acid in less than 3 steps?

A $CH_3CH_2COCH_3$

B $CH_3CH_2CONH_2$

C $CH_3CH_2CH_2CH_2Br$

D $CH_3CH_2OCOCH_3$

25 During the preparation of many organic compounds, by-products are formed. This usually occurs because the reagents can react in more than one way depending on the conditions used or because the products formed may react with the reactants.

Propanol is produced by the reaction between bromopropane and aqueous sodium hydroxide.

$$CH_3CH_2CH_2Br + NaOH \rightarrow CH_3CH_2CH_2OH + NaBr$$

What could be a by-product of this reaction?

1 $CH_3CH{=}CH_2$

2 $CH_3CH(OH)CH_3$

3 $CH_3CH_2CH_2ONa$

A 1, 2 and 3

B 1 and 3 only

C 1 only

D None of the above

26 The hydride ion, H^-, is a strong reducing agent, a good nucleophile and a good base.

Which conversion **cannot** be carried out by the hydride ion?

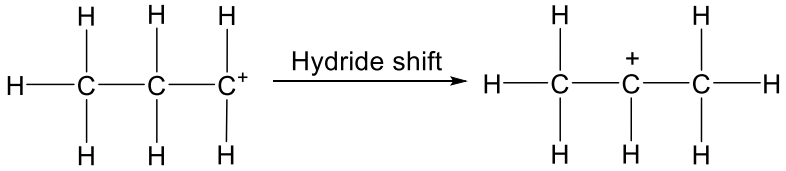
A C_3H_7Br to C_3H_8

B $CH_2{=}CH_2$ to CH_3CH_3

C C_6H_5OH to $C_6H_5O^-$

D CH_3CN to $CH_3CH_2NH_2$

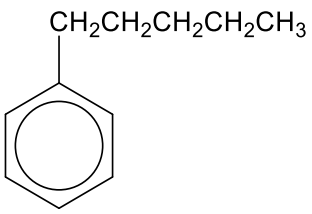
27 Hydride shift is a rearrangement process which produces a more stable carbocation. For example, after removing the halogen from $CH_3CH_2CH_2Cl$, a hydride shift will take place as shown.



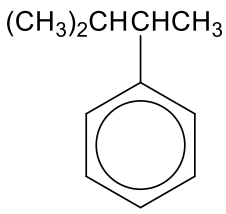
In another experiment, $(CH_3)_2CHCHClCH_3$ reacts with benzene in the presence of $FeCl_3$.

Which product would most likely be formed?

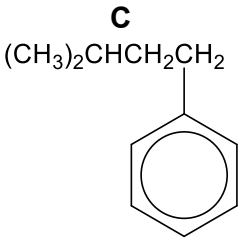
A



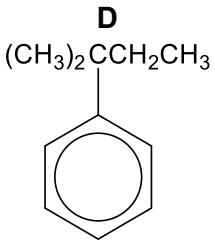
B



C



D



28 Which reaction yields a carbon compound incorporating deuterium, D? [D = ^2_1H]

A $CH_3CHO \xrightarrow[\text{dry ether}]{LiAlD_4}$

B $CH_3CH_2CN \xrightarrow[D_2O]{NaOD}$

C $(CH_3)_3COH \xrightarrow[\text{heat}]{\text{conc. } D_2SO_4}$

D $CH_3CD(OD)CH_3 \xrightarrow[\text{heat}]{\text{acidified } KMnO_4}$

29 What is the predominant form of glycine, NH_2CH_2COOH, in a solution of pH 3? (Given pK_{a1} = 2.3 and pK_{a2} = 9.6).

A $^{+}NH_3CH_2CO_2H$

B $^{+}NH_3CH_2CO_2^{-}$

C $NH_2CH_2CO_2H$

D $NH_2CH_2CO_2^{-}$

30 Transition metals like platinum and rhodium are found in catalytic converters fitted into cars. Which statement best explains the role of transition metals in this use?

A Transition metals can exhibit variable oxidation states in their compounds as 3d and 4s electrons have similar energies.

B Transition metals have available and partially filled 3d orbitals for the adsorption of reactant molecules.

C Transition metals have very high melting points because both 3d and 4s electrons are involved in forming strong metallic bonds.

D Transition metals form coloured ions due to absorption of energy in the visible light region to promote an electron from a lower to a higher energy 3d orbitals.