TAMPINES MERIDIAN JUNIOR COLLEGE

JC2 PRELIMINARY EXAMINATION

H2 CHEMISTRY **9729/01**

Paper 1 Multiple Choice **22 September 2022**

1 hour

Additional materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Write your name, class and register number on the Answer Sheet in the spaces provided.

There are **thirty** questions in 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 use of the Answer Sheet very carefully.

You are advised to fill in the Answer Sheet as you go along. No additional time will be given for the transfer of answers once the examination has ended.

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.

Use of the Answer Sheet

Ensure you have written your name, class register number and class on the Answer Sheet.

Use a **2B** pencil to shade your answers on the Answer Sheet; erase any mistakes cleanly. Multiple shaded answers to a question will not be accepted.
For **shading of class register number** on the Answer Sheet, please follow the given examples:

If your register number is **1**, then shade **01** in the index number column.
If your register number is **21**, then shade **21** in the index number column.

1 In which species are the numbers of protons, neutrons and electrons **all** different?

A $^{19}_{9}F^{-}$ **B** $^{23}_{11}Na^{+}$ **C** $^{31}_{15}P$ **D** $^{32}_{16}S^{2-}$

2 Beams of charged particles are deflected by an electric field. When a beam of protons passes through an electric field of constant strength, the angle of deflection is +12 °.

In another experiment under identical conditions, particle Y is deflected by an angle of – 4 °.

What could be the composition of particle Y?

	protons	neutrons	electrons
1	1	2	2
2	3	3	5
3	4	5	1

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

3 *Use of the Data Booklet is relevant to this question.*

In which pair of compounds does the first molecule have a smaller bond angle than the second molecule?

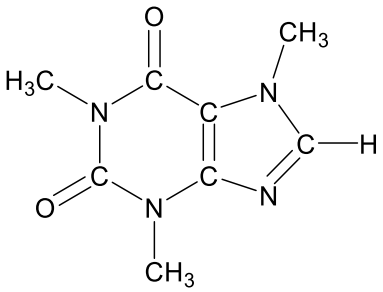
A BF_3, NH_3

B H_2O, H_2S

C $BeCl_2$, SCl_2

D XeF_4, $SiCl_4$

4 To produce decaffeinated coffee, pure liquid CO_2 is sometimes used to extract caffeine from coffee beans.



caffeine

It was discovered that the solubility of caffeine greatly increased when a mixture of ethanol and liquid CO_2 was used.

Which interaction best explains why caffeine is more soluble in the ethanol-CO_2 mixture as compared to liquid CO_2?

A instantaneous dipole - induced dipole interactions

B permanent dipole - permanent dipole interactions

C hydrogen bonding

D dative covalent bond

5 Which graph does **not** share the same general shape as the other three graphs according to the ideal gas law for a fixed mass of gas with pressure *p*, volume V and temperature T in Kelvin?

A *p* against $\frac{1}{V}$ (at constant T)

B *p*V against *p* (at constant T)

C *p*V against V (at constant T)

D $\frac{V}{T}$ against T (at constant *p*)

6 Which statements about Group 2 elements are correct?

1 The charge density of cations increases down the Group.

2 The reducing strength of the elements increases down the Group.

3 The minimum temperature needed for the thermal decomposition of Group 2 carbonates increases down the Group.

4 The melting point of MgO is higher than CaO due to the higher polarising power of Mg^{2+}.

A 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

7 Due to its radioactive nature, the properties of astatine, At, have to be estimated based on its position in the Periodic Table.

Which prediction concerning At or its compounds is correct?

A Astatine is a weaker oxidising agent than iodine.

B Astatine is a liquid at room temperature.

C Astatine forms diatomic molecules which dissociate into atoms less readily than iodine molecules.

D Hydrogen astatide has a higher decomposition temperature than hydrogen iodide.

8 Sodium thiosulfate ($Na_2S_2O_3$) is used in the textile industry to remove any excess chlorine from bleaching processes by reducing it to chloride ions.

10 cm^3 of 0.20 mol dm^{-3} of sodium thiosulfate requires 192 cm^3 of chlorine gas for complete reaction at room temperature and pressure.

Which of the following is a possible formula of the sulfur-containing product?

A H_2S **B** S **C** SO_2 **D** HSO_4^-

9 Aqueous solutions of **P**, **Q** and **R** react according to the following equation:

$$\mathbf{P} + 3\mathbf{Q} + 2\mathbf{R} \longrightarrow \mathbf{T} + \mathbf{U}$$

The kinetics of the above reaction was studied and the experimental results obtained are shown in the table below.

experiment	volume of **P** / cm^3	volume of **Q** / cm^3	volume of **R** / cm^3	volume of water / cm^3	relative initial rate
1	20	20	20	20	16
2	20	10	40	10	32
3	10	10	20	40	4
4	20	10	20	30	8

What is the rate equation for the above reaction?

A Rate = k[**P**][**Q**]

B Rate = k[**P**][**Q**][**R**]

C Rate = k[**P**][**Q**][**R**]^2

D Rate = k[**P**][**Q**]^2[**R**]^2

10 The following data may be useful for this question.

$\Delta H_f^{\ominus}(N_2H_4(l)) = +50.6$ kJ mol^{-1}

$\Delta H_f^{\ominus}(N_2O_4(g)) = +9.2$ kJ mol^{-1}

$\Delta H_f^{\ominus}(H_2O(g)) = -241.8$ kJ mol^{-1}

Hydrazine, $N_2H_4(l)$, reacts with dinitrogen tetroxide, $N_2O_4(g)$, to form nitrogen gas and water vapour.

$$2N_2H_4(l) + N_2O_4(g) \longrightarrow 3N_2(g) + 4H_2O(g)$$

What is the enthalpy change for this reaction?

A +1078 kJ mol^{-1}

B –1078 kJ mol^{-1}

C +1754 kJ mol^{-1}

D –1754 kJ mol^{-1}

11 Travellers to countries with cold climate may sometimes use heat packs to keep warm.

The heat pack is made up of a supersaturated solution of sodium ethanoate and a small metal disc containing very small crystals of sodium ethanoate.

When the disc is broken, small crystals of sodium ethanoate are released into the solution to catalyse the crystallisation reaction of sodium ethanoate.

What are the correct signs for ΔH and ΔS in this reaction?

	ΔH	ΔS
A	+	–
B	+	+
C	–	+
D	–	–

12 When 0.20 mol of hydrogen gas and 0.15 mol of iodine gas are heated at 723 K until equilibrium is established, the equilibrium mixture is found to contain 0.02 mol of iodine gas. The equation for the reaction is as follows:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

What is the correct numerical value for the equilibrium constant, K_c?

A 12.1 **B** 48.3 **C** 92.9 **D** 185.7

13 Which of the following gives the correct relative strengths of the acids and bases in the reaction?

$$HPO_4^{2-}(aq) + H_2BO_3^{-}(aq) \rightleftharpoons H_2PO_4^{-}(aq) + HBO_3^{2-}(aq) \qquad K_c > 1$$

	acids	**bases**
A	$H_2PO_4^- > H_2BO_3^-$	$HBO_3^{2-} > HPO_4^{2-}$
B	$H_2PO_4^- > HPO_4^{2-}$	$HBO_3^{2-} > H_2BO_3^-$
C	$H_2BO_3^- > H_2PO_4^-$	$HPO_4^{2-} > HBO_3^{2-}$
D	$H_2BO_3^- > HBO_3^{2-}$	$HPO_4^{2-} > H_2PO_4^-$

14 The table below shows the values of the ionic product of water, K_w, at two different temperatures.

temperature / ^oC	K_w / $mol^2\ dm^{-6}$
25	1.00×10^{-14}
62	1.00×10^{-13}

Which statements are correct for pure water?

1 At 62 ^oC, pH < 7.

2 At 62 ^oC, pH = 14 – pOH.

3 The ionic dissociation of water is an exothermic process.

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

15 An acidified solution contains 0.10 mol dm^{-3} of $ZnSO_4$ and 0.10 mol dm^{-3} of $CuSO_4$. Hydrogen sulfide gas, H_2S, is blown through the solution until it is saturated with H_2S at 15 ^oC. The concentration of S^{2-}(aq) in the solution reaches 10^{-35} mol dm^{-3}.

The solubility product of ZnS at 15 ^oC is 10^{-24} $mol^2\ dm^{-6}$ and that of CuS is 10^{-40} $mol^2\ dm^{-6}$.

Which statement describes what happens in the solution?

A No precipitate is formed.

B ZnS only is precipitated.

C CuS only is precipitated.

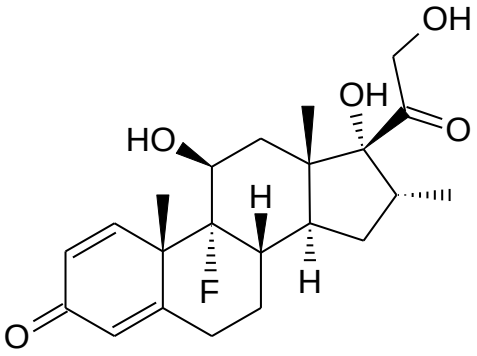
D Both ZnS and CuS are precipitated.

16 $(CH_3CH_2)_3CH$ can react with limited chlorine under *uv* light to produce monochloro-compounds.

How many possible isomers (including stereoisomers) of monochloro-compounds can $(CH_3CH_2)_3CH$ produce?

A 3 **B** 4 **C** 5 **D** 6

17 *Dexamethasone* is a corticosteroid commonly used to treat many inflammatory and autoimmune disorders. It received prominence as it showed high efficacy for patients with severe COVID-19 symptoms who need either mechanical ventilation or supplemental oxygen.



dexamethasone

How many possible stereoisomers exist for *dexamethasone*?

A 2^7 **B** 2^8 **C** 2^9 **D** 2^{10}

18 Which compounds may be a possible product of the reaction of $C_6H_5OCOCHBrCH_3$ with sodium hydroxide under different conditions?

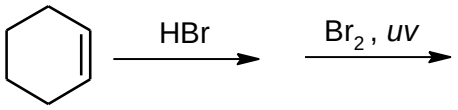
1 $C_6H_5CO_2Na$

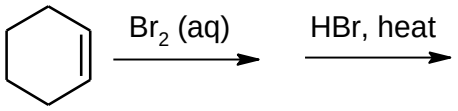
2 $CH_3CH(OH)CO_2Na$

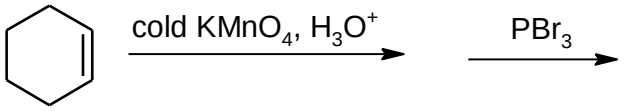
3 $C_6H_5OCOCH=CH_2$

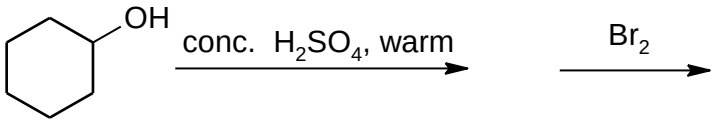
A 1, 2 and 3 **B** 1 and 2 **C** 2 and 3 **D** 3 only

19 Which reaction scheme will **not** give a good yield of 1,2-dibromocyclohexane?

A 

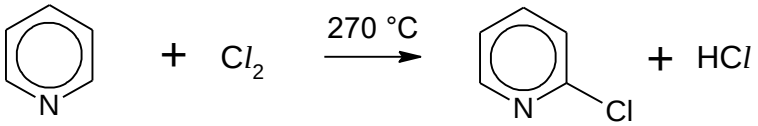
B 

C 

D 

20 Pyridine, like benzene, is an aromatic compound.

In the presence of Cl_2, cyclohexene undergoes an addition reaction at room temperature. However, unlike an alkene, pyridine undergoes a substitution reaction with Cl_2 only at high temperatures.



pyridine

Which statement does **not** help to explain for this observation?

A Pyridine is resonance stabilised.

B Chlorine is not sufficiently electrophilic.

C Pyridine is a weaker nucleophile than cyclohexene.

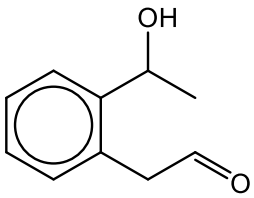
D The lone pair on N atom of pyridine increases the electron density of the π electron cloud.

21 A student carried out an experiment to study the ease of hydrolysis of a series of bromine containing compounds, and recorded the observations based on the addition of acidified silver nitrate solution.

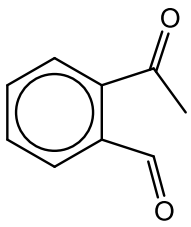
Which of the following gives the expected results?

	time taken for precipitate to appear shortest ⟶ longest		
A	C_6H_5Br	$CH_2BrCONH_2$	CH_3COBr
B	$CH_2BrCONH_2$	C_6H_5Br	CH_3COBr
C	CH_3COBr	C_6H_5Br	$CH_2BrCONH_2$
D	CH_3COBr	$CH_2BrCONH_2$	C_6H_5Br

22 Which reagent could be used to distinguish between compound **X** and compound **Y**?



X



Y

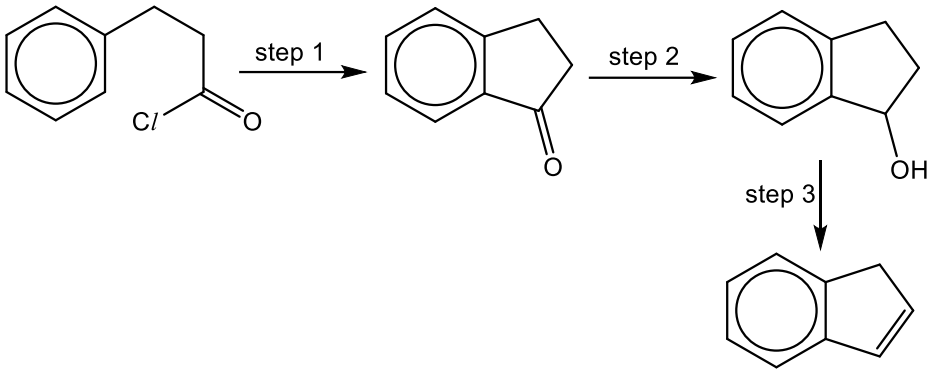
A 2,4-dinitrophenylhydrazine

B alkaline aqueous iodine

C Tollens' reagent

D Fehling's solution

23 A sequence of reactions is shown below.



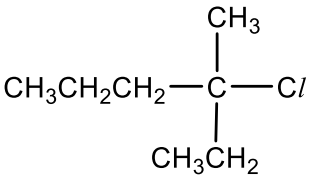
Which is the correct list of reagents and conditions for the sequence?

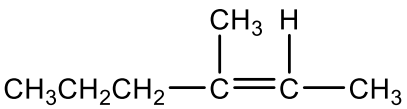
	step 1	step 2	step 3
A	A*l*C*l*$_3$(aq)	H_2, Ni	A*l*$_2$O$_3$, heat
B	A*l*C*l*$_3$(s)	LiA*l*H$_4$ in dry ether	conc. H_3PO_4, heat
C	A*l*C*l*$_3$(aq)	$NaBH_4$ in methanol	conc. H_3PO_4, heat
D	A*l*C*l*$_3$(s)	H_2, Ni	alcoholic KOH, heat

24 Which reaction will **not** form a racemic mixture of products?

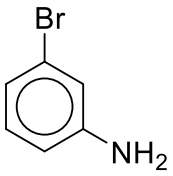
A CH_3CHO with HCN

B CH_3CH_2Br with NaOH(aq)

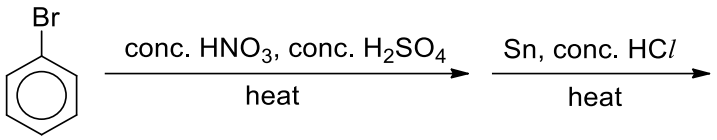
C  with alcoholic KCN

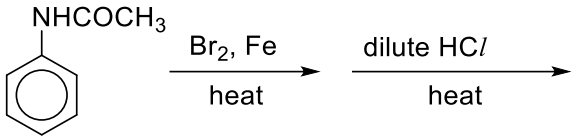
D  with HC*l*

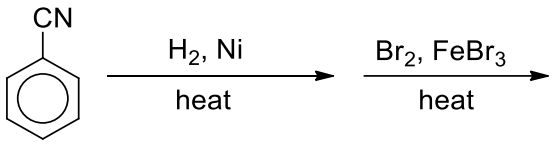
25 Which is the best sequence for synthesising 3-bromophenylamine?

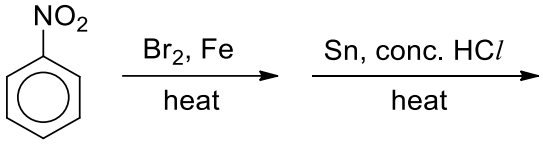


3-bromophenylamine

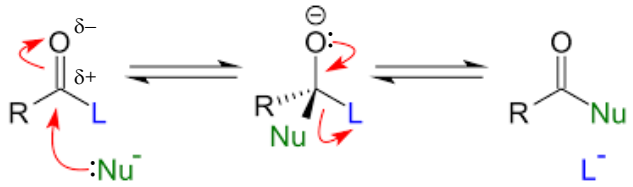
A 

B 

C 

D 

26 Carboxylic acid and their derivatives tend to undergo reactions involving a nucleophile. The mechanism of such a reaction is shown below.



R = alkyl, aryl, H
L = OH, OR, NH_2, C*l*, Br, etc
Nu = nucleophile

Which statements concerning the mechanism are correct?

1 One of the steps involves an addition reaction.

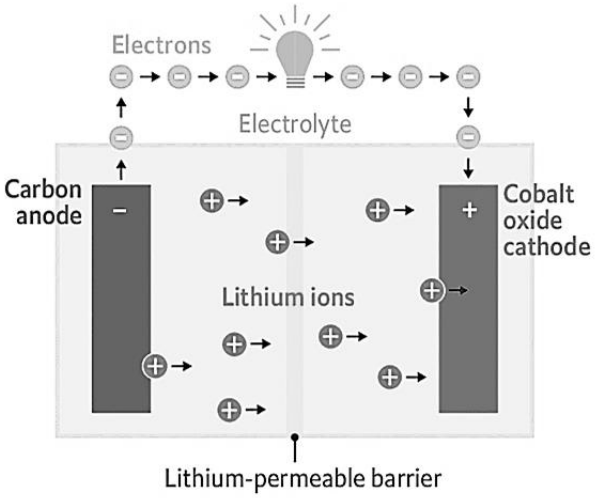
2 One of the steps involves an elimination reaction.

3 The overall reaction is nucleophilic acyl substitution.

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

27 Electric vehicles are mostly powered by lithium-ion batteries.

The diagram of a typical lithium-ion battery is given below.



The equation at the anode is given as $LiC_6 \rightarrow C_6 + Li^+ + e^-$.

The overall equation of the cell is $LiC_6 + CoO_2 \rightarrow C_6 + LiCoO_2$.

What is the equation at the cathode?

A $CoO_2 + Li^+ + e^- \rightarrow LiCoO_2$

B $Co^{2+} + O_2 + 2e \rightarrow CoO_2$

C $CoO_2 + e^- \rightarrow CoO_2^-$

D $Li^+ + Co + O_2 + e \rightarrow LiCoO_2$

28 An impure copper rod containing zinc and silver is purified by connecting it to the anode of an electrolytic cell. The electrolyte is a 1.0 mol dm^{-3} solution of $CuSO_4$.

A current is passed through the cell for 2 h.

Which observation is **not** correct?

A The anode decreases in mass.

B The cathode increases in mass.

C The blue electrolyte decolourises.

D The Ag impurity deposits at the bottom of the electrolyte.

29 Cadmium, Cd, is a Group 12 element in the d-block of the Periodic Table.

What is the main reason why Cd is not classified as a typical transition element?

1 Its complexes are colourless.

2 It has a low melting point of 321 ^{o}C.

3 It forms compounds with fully filled 4d orbitals.

4 It does not form compounds with variable oxidation numbers.

A 1, 2, 3 and 4 **B** 1 and 2 **C** 3 only **D** 4 only

30 The Wacker process is an industrial procedure developed to convert ethene to ethanal.

In this reaction, ethene and oxygen gas are bubbled into an aqueous solution of $[PdCl_4]^{2-}$ at high pressure.

The mechanism of the process is given below.

Step 1: $[PdCl_4]^{2-} + CH_2{=}CH_2 + H_2O \rightarrow CH_3CHO + Pd + 2HCl + 2Cl^-$

Step 2: $Pd + 2CuCl_2 + 2Cl^- \rightarrow [PdCl_4]^{2-} + 2CuCl$

Step 3: $2CuCl + ½\ O_2 + 2HCl \rightarrow 2CuCl_2 + H_2O$

Which statement concerning the reaction is correct?

A $[PdCl_4]^{2-}$ is a homogeneous catalyst.

B Pd is a heterogeneous catalyst.

C $CuCl_2$ is an intermediate.

D $CuCl$ is a side product.

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