



CHEMISTRY

Paper 1 Multiple Choice

9729/01

18 September 2020

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, civics group 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 question paper.

The use of an approved scientific calculator is expected, where appropriate.

- 1 Which of the following species will produce the largest deflection when fired with equal velocity into an electric field?

A ${}^7\text{Li}^+$ B ${}^9\text{Be}^{2+}$ C ${}^{16}\text{O}^{2-}$ D ${}^{14}\text{N}^{3-}$

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

Which of the following statements are true?

- 1 The Cr atom has an empty d-orbital.
- 2 All the electrons in the d-orbitals of a Mn^{2+} ion are unpaired.
- 3 The Fe^{2+} ion has the same electronic configuration as the Co^{3+} ion.

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

- 3 Which of the following contains one polar molecule and one non-polar molecule?

A AlCl_3 , Al_2Cl_6 B POCl_3 , PCl_3
C HOBr , Br_2O D XeF_2 , XeF_6

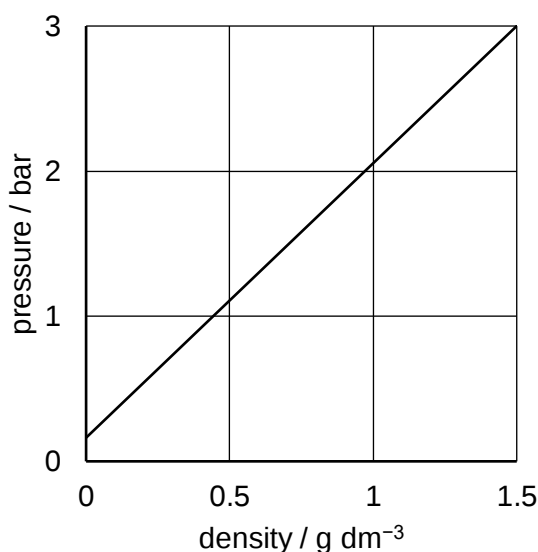
- 4 Which of the following statements about Al_2O_3 are true?

- 1 It can react with both acids and bases.
- 2 It has a higher degree of covalent character than Na_2O .
- 3 It has a more exothermic lattice energy as compared to Na_2O .

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

- 5 Use of the Data Booklet is relevant to this question.

The following graph was obtained for a sample of a gas at 500 K.



Assuming that the gas behaves ideally under the conditions at which all measurements were made, what is its likely identity?

- A He B Ne C Ar D Kr
- 6 Which of the following statements about a 20.3 g sample of $\text{Co}_2(\text{SO}_4)_3$ ($M_r = 406$) is **incorrect**?
- A It contains 1.5×10^{23} ions.
 B It contains 0.1 mol of Co^{3+} ions.
 C It contains 14.5 % of cobalt by mass.
 D It contains 47.3 % of oxygen by mass.
- 7 20.0 cm³ of 0.02 mol dm⁻³ aqueous sodium bromate(V), NaBrO_3 , was found to react completely with 80.0 cm³ of 0.01 mol dm⁻³ hydroxylamine, NH_2OH .

The half equation for the reduction of bromate(V) ion is given as shown.



Which of the following could be the nitrogen-containing product in this reaction?

- A NO B NO_2 C N_2O D NO_3^-

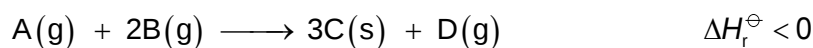
- 8 Sublimation is the process of changing a solid into a gas without passing through the liquid phase.

Which statements correctly describe the standard enthalpy change of sublimation?

- 1 The standard enthalpy change of sublimation of a metal is the same as its standard enthalpy change of atomisation.
- 2 The standard enthalpy change of sublimation is given by the sum of the standard enthalpy change of fusion (solid to liquid) and the standard enthalpy change of vapourisation (liquid to gas).
- 3 Xenon does not possess a standard enthalpy change of sublimation since xenon is a gas under standard state.

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

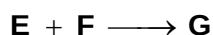
- 9 Consider a hypothetical reaction



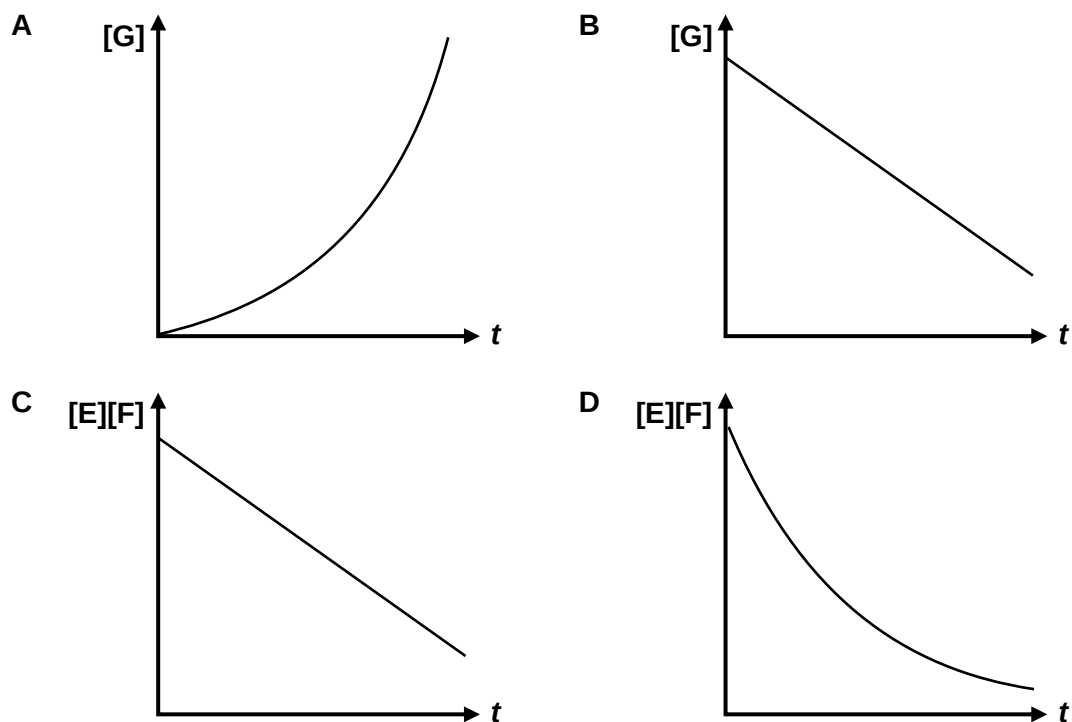
Which statement about the standard Gibbs free energy change of reaction, $\Delta G_{\text{r}}^{\ominus}$, is correct?

- A** $\Delta G_{\text{r}}^{\ominus}$ is always positive.
- B** $\Delta G_{\text{r}}^{\ominus}$ is always negative.
- C** $\Delta G_{\text{r}}^{\ominus}$ can be zero.
- D** $\Delta G_{\text{r}}^{\ominus}$ can never be zero.

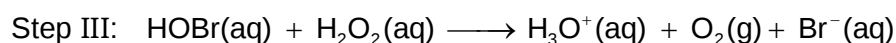
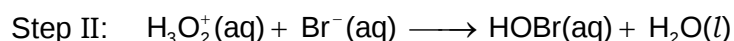
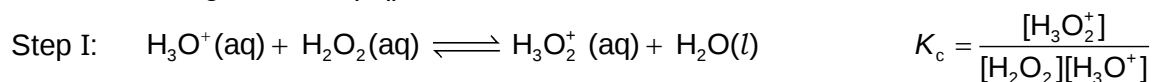
10 E and F undergo a bimolecular elementary reaction



When equal concentrations of E and F are reacted together, which of the following graphs would be obtained?



11 The following steps illustrate the decomposition of hydrogen peroxide to produce oxygen when the strong acid, $\text{HBr}(\text{aq})$ is added.



Experimental studies performed to investigate the kinetics of the reaction showed that the rate could be stated as

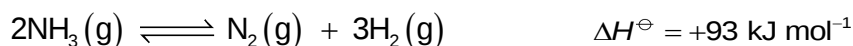
$$\text{rate} = k[\text{H}_2\text{O}_2][\text{H}_3\text{O}^+][\text{Br}^-]$$

What can be deduced from the above information?

- 1 Step III is the rate-determining step.
- 2 $\text{HBr}(\text{aq})$ served as the catalyst for the decomposition.
- 3 The decomposition of hydrogen peroxide is a pseudo-first order reaction.

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

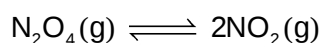
- 12 Consider the following equilibrium



Which of the following change will **not** cause the rate of backward reaction to increase?

- A Adding a catalyst.
- B Decreasing the volume of the vessel.
- C Increasing the temperature.
- D Removing gaseous NH_3 .

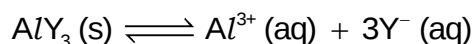
- 13 Consider the following equilibrium



0.24 atm of $\text{N}_2\text{O}_4(\text{g})$ was allowed to decompose in a 100 dm^3 container at 298 K. After the system reached equilibrium, it was found that the total pressure was 0.32 atm.

Assuming that all the gases behave ideally under the stated conditions, what is the equilibrium partial pressure of $\text{N}_2\text{O}_4(\text{g})$?

- A 0.08 atm B 0.11 atm C 0.12 atm D 0.16 atm
- 14 Which of the following aqueous solutions will considerably change in pH when relatively small volumes of strong acid or strong alkali are added?
- A A mixture of sodium benzoate and benzoic acid
 - B A mixture of ammonium sulfate and aqueous ammonia
 - C A mixture of potassium chloride and potassium ethanoate
 - D A mixture of sodium carbonate and sodium hydrogencarbonate
- 15 A sparingly soluble aluminium salt ionises in aqueous solution according to the following equation.



Given that the solubility product of AlY_3 is K , what is the concentration of $\text{Y}^{-}(\text{aq})$ in terms of K at equilibrium?

- A $(K)^{\frac{1}{2}}$ B $3(K)^{\frac{1}{2}}$ C $(3K)^{\frac{1}{4}}$ D $\left(\frac{K}{27}\right)^{\frac{1}{4}}$

16 Use of the Data Booklet is relevant to this question.

The colours of various vanadium ions in aqueous solution are given in the table below.

oxidation state of V	+5	+4	+3	+2
ion	VO_2^+	VO^{2+}	V^{3+}	V^{2+}
colour	yellow	blue	green	violet

What is the final colour of the solution when **excess** zinc powder is added to an acidified solution containing VO_2^+ ions?

- A** violet **B** green **C** blue **D** yellow

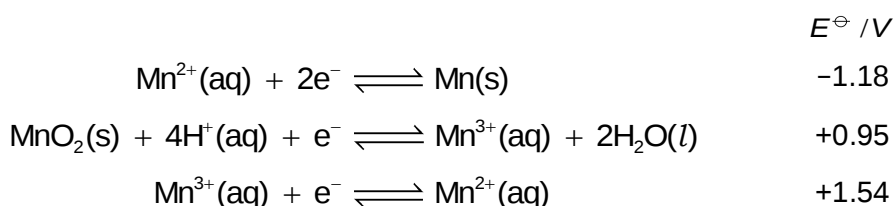
17 Use of the Data Booklet is relevant to this question.

An antique car bumper is to be chrome plated. The bumper is dipped into an acidic $\text{Cr}_2\text{O}_7^{2-}$ solution where it serves as an electrode of an electrolytic cell. Oxygen is formed at the other electrode.

Which one of the following statements is correct?

- A** Reduction of water occurs to form oxygen.
B The bumper is the anode of the electrolytic cell.
C For every 52 g of chromium plated, 3 mol of oxygen gas are evolved.
D It takes about 16 hours to plate 52 g of chromium, if the current used is 10 A.

18 The standard redox potentials of some manganese species are shown below.



Given that the reactions are carried out under standard conditions, which of the following can be deduced from the given data?

- Mn^{3+} can disproportionate.
- Mn can reduce Mn^{3+} to Mn^{2+} .
- MnO_2 cannot oxidise Mn to Mn^{2+} .

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

19 Which of the following statements is correct?

- A Electronegativity decreases across Period 3.
- B Electrical conductivity decreases across Period 3.
- C Melting point increases down Group 1.
- D First ionisation energy decreases down Group 1.

20 Which of the following statements about the Group 2 elements are correct?

- 1 The only oxidation number exhibited in their stable compounds is +2.
- 2 The reducing strength of the elements increases down the group.
- 3 The enthalpy change of hydration of magnesium ions is less exothermic than that of barium ions.

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

21 When NaBr and NaI are reacted separately with excess hot concentrated H_2SO_4 , they form different products as shown in the equations below.



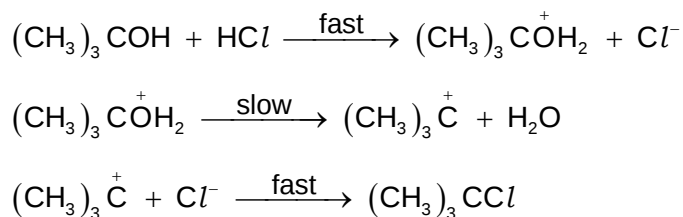
Which of the following can be deduced from the information given?

- A H_2SO_4 undergoes disproportionation.
- B H_2SO_4 is acting as an acid in both reactions.
- C NaBr is a stronger reducing agent than NaI.
- D NaCl will not be able to react with hot concentrated H_2SO_4 to form H_2S .

22 A saturated compound has the molecular formula $\text{C}_4\text{H}_7\text{Br}$. What is the number of stereoisomers it can exhibit?

- A 2 B 4 C 6 D 8

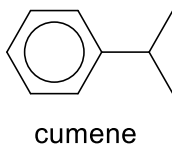
23 The mechanism for a certain reaction is given below.



Which of the following statements is **incorrect**?

- A The hybridisation state of carbon is unchanged in the slow step.
- B $(\text{CH}_3)_3\text{COH}_2^+$ and $(\text{CH}_3)_3\text{COH}$ are a conjugate acid-base pair.
- C The overall reaction is $(\text{CH}_3)_3\text{COH} + \text{HCl} \longrightarrow (\text{CH}_3)_3\text{CCl} + \text{H}_2\text{O}$
- D The above mechanism is a nucleophilic substitution reaction.

24 Cumene is an important intermediate in the industrial production of phenol.



A student synthesised cumene successfully by reacting benzene with $\text{C}_3\text{H}_7\text{Cl}$ in the presence of aluminium chloride.

Which of the following statements are correct?

- 1 Cumene does not decolourise aqueous bromine at room temperature.
- 2 Aluminium chloride is acting as a Lewis acid in the synthesis of cumene.
- 3 The electrophile which reacted with benzene in the synthesis of cumene was $\text{CH}_3\text{CH}_2\text{CH}_2^+$.

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

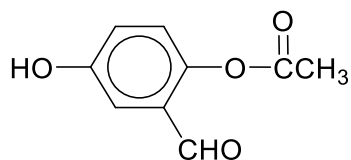
25 Which sequence correctly shows the increasing ease of hydrolysis?

- A $\text{C}_6\text{H}_5\text{CH}_2\text{Cl} < (\text{CH}_3)_2\text{C}=\text{CHCl} < \text{CH}_3\text{CH}_2\text{CH}_2\text{I} < \text{CH}_3\text{COBr}$
- B $(\text{CH}_3)_2\text{C}=\text{CHCl} < \text{CH}_3\text{CH}_2\text{CH}_2\text{I} < \text{CH}_3\text{COBr} < \text{C}_6\text{H}_5\text{CH}_2\text{Cl}$
- C $(\text{CH}_3)_2\text{C}=\text{CHCl} < \text{C}_6\text{H}_5\text{CH}_2\text{Cl} < \text{CH}_3\text{CH}_2\text{CH}_2\text{I} < \text{CH}_3\text{COBr}$
- D $(\text{CH}_3)_2\text{C}=\text{CHCl} < \text{CH}_3\text{COBr} < \text{C}_6\text{H}_5\text{CH}_2\text{Cl} < \text{CH}_3\text{CH}_2\text{CH}_2\text{I}$

26 Which of the following reagents can react with ethanol, under suitable conditions, to leave behind an organic product with the same number of oxygen atoms as the alcohol?

- A KMnO_4 B alkaline I_2 C HBr D Na

27 The following compound is a flavouring agent in food.



Which of the following reagents will **not** cause a colour change when the reagent is added to the compound?

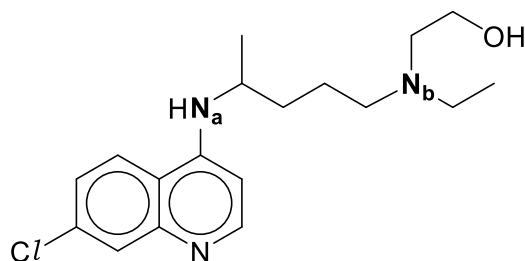
- A aqueous bromine
 B hot acidified potassium dichromate(VI)
 C neutral iron(III) chloride solution
 D hot Fehling's reagent

28 The three compounds below were treated with a warm mixture of aqueous sodium hydroxide and iodine. Which of the following compounds would give sodium ethanoate?

- 1 $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$
 2 $\text{CH}_3\text{COOCH}_2\text{CH}_3$
 3 CH_3CN

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

- 29 There has been speculative use and heightened interest in hydroxychloroquine, especially after US President Donald Trump's claim of its usefulness to ward off COVID-19 early this year. Hydroxychloroquine has always been known as a medication used to prevent and treat malaria.



hydroxychloroquine

Which of the following statements about hydroxychloroquine is true?

- A** It can liberate brown fumes with anhydrous PBr_3 .
- B** The amine group at N_a has a higher pK_a value than that at N_b .
- C** 1 mol of hydroxychloroquine can undergo condensation with 2 mol of ethanoyl chloride.
- D** 1 mol of hydroxychloroquine reacts with excess sodium metal to give 1 mol of hydrogen gas.
- 30 Upon complete hydrolysis, a polypeptide **X** gives the following amino acids.

amino acid	structure	M_r	mass of amino acid obtained from hydrolysis / g
aspartic acid	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{COOH} \\ \\ \text{CH}_2\text{COOH} \end{array}$	133	53.2
glutamine	$\begin{array}{c} \text{H} \\ \\ \text{H}_2\text{N}-\text{C}-\text{COOH} \\ \\ \text{CH}_2\text{CH}_2\text{CONH}_2 \end{array}$	146	29.2
proline		115	23.0

What is the M_r of polypeptide **X**?

- A** 358 **B** 394 **C** 473 **D** 527

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