NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CHEMISTRY

9729/01

Paper 1 Multiple Choice

24 September 2018

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, class and tutor's name 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.

This document consists of **16** printed pages and **0** blank page.

[Turn over

For each question there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider to be correct.

1 Which of the following contains the smallest number of stated atoms at r.t.p.?

A oxygen atoms in 48 dm^3 of NO_2
B sulfur atoms in 48 dm^3 of SO_2
C carbon atoms in 44 g of CO_2
D nitrogen atoms in 44 g of N_2O

2 An isolated gaseous species has paired electrons in at least one of its 3d orbitals and a fully filled 4s subshell.

What could be the identity of the species?

A Cu B Fe^{3+} C Ni^{2+} D Sr^{2+}

3 Which one of the following species is **not** planar?

A BrF_3
B ICl_4^-
C PCl_4^+
D XeF_4

4 Hydrazine, N_2H_4, and hydrogen peroxide, H_2O_2, are both used as rocket propellants because they can produce large volumes of hot gases from a small volume of liquid.

Which of the following statements about these two compounds is correct?

1 The bond angle in N_2H_4 is larger than that in H_2O_2.
2 The N–H bond is shorter than the O–H bond.
3 Hydrazine forms stronger intermolecular hydrogen bonds than hydrogen peroxide.
4 There are σ bonds formed by sp^3 – s orbital overlap in both molecules.

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

5 Which factor is the most significant in explaining the non-ideal behaviour of the gases present in the reaction chamber in the Haber process?

A strong bonds between the atoms in the molecule
B the presence of a catalyst
C the high temperature of 450 °C
D the high pressure of 150 atm

6 A student mixed 25.0 cm^3 of 3.00 mol dm^{-3} hydrochloric acid with an equal volume of 6.00 mol dm^{-3} sodium hydroxide. The initial temperature of both solutions was 15.0 °C. The maximum temperature recorded was 24.5 °C. It was found that 15% of the heat produced during the experiment was lost to the surrounding.

Using these results, what is the enthalpy change of neutralisation?

A -15.6 kJ mol^{-1}
B -22.5 kJ mol^{-1}
C -31.1 kJ mol^{-1}
D -57.3 kJ mol^{-1}

7 A student calculated the lattice energy for calcium oxide using the data in the table below, and relevant data from the *Data Booklet*.

energy change	value / kJ mol^{-1}
standard enthalpy change of atomisation of calcium	+178
first electron affinity for oxygen	–141
second electron affinity for oxygen	+798
standard enthalpy change of formation of calcium oxide	–635

However, the value calculated by the student for the lattice energy was more exothermic than the correct value.

Which error could have been made in the calculation?

A omitting the second electron affinity for oxygen
B omitting the standard enthalpy change of formation of calcium oxide
C using the 1st and 2nd ionisation energies of magnesium instead of calcium
D using the standard enthalpy change of combustion of calcium rather than the standard enthalpy change of formation of calcium oxide

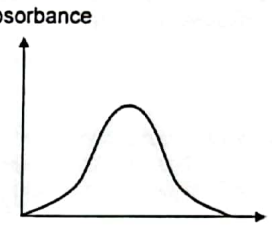
8 A student investigates the kinetics of the following reaction by using a spectrometer. The spectrometer is able to measure the concentration of iodine by measuring the absorbance of the solution.

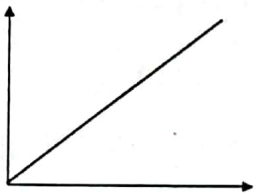
$$H_2O_2(aq) + 2H^+(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2H_2O(l)$$

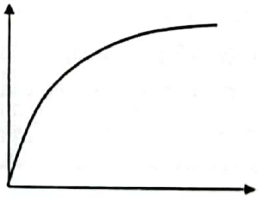
The time taken for the absorbance of the reaction mixture to reach a fixed value is measured over a range of hydrogen peroxide concentrations.

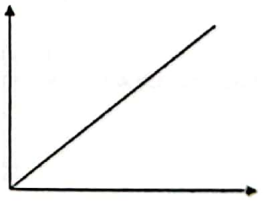
Based on the data obtained, the student correctly drew a graph to prove that order of reaction is one with respect to H_2O_2.

Which graph did the student draw?

A


B


C


D


9 The decomposition of hydrogen peroxide follows first order kinetics. A certain solution of hydrogen peroxide undergoes complete decomposition to liberate 96 cm^3 of oxygen gas. It is found that at 25 °C, 48 cm^3 of oxygen was collected in 35 min.

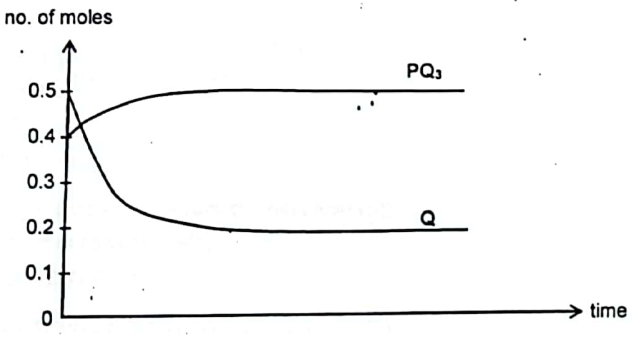
How long will it take for 80 cm^3 of the gas to be produced?

A 87.5 min
B 90.5 min
C 97.5 min
D 105 min

10 The system containing P, Q and PQ_3 is allowed to reach equilibrium in a 5 dm^3 vessel at a temperature of 1000 K.

$$P(g) + 3Q(g) \quad PQ_3(g)$$

The diagram below shows the change in number of moles of PQ_3 and Q with time. The initial number of moles of P was 0.2.



What is the equilibrium constant K_c for the reaction?

A $\frac{0.5}{0.1\times(0.2)^3}$ B $\frac{0.5}{0.2\times(0.2)^3}$ C $\frac{0.5\times5^3}{0.1\times(0.2)^3}$ D $\frac{0.5\times5^3}{0.2\times(0.2)^3}$

11 Which statement is correct about a reaction for which the equilibrium constant is independent of temperature?

1 The rate constants for the forward and reverse reactions are both independent of temperature.
2 Temperature has no effect on the position of equilibrium.
3 The forward and reverse reactions have equal activation energies.
4 The entropy change is zero.

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

12 The two simplest carboxylic acids are formic acid and acetic acid. Formic acid is present in the venom of ant and bee stings while acetic acid is the major characterising component of vinegar. The pK_a values of the two acids is given in the table below.

Acid	Formula	pK_a
Formic acid	HCOOH	3.74
Acetic acid	CH_3COOH	4.76

Which solution has the lowest pH?

A 100 cm^3 of 0.10 mol dm^{-3} acetic acid
B 100 cm^3 of 0.10 mol dm^{-3} sodium acetate
C 100 cm^3 of 1.0 mol dm^{-3} formic acid and 50 cm^3 of 1.0 mol dm^{-3} aqueous sodium hydroxide
D 100 cm^3 of 1.0 mol dm^{-3} formic acid and 75 cm^3 of 1.0 mol dm^{-3} aqueous sodium hydroxide

13 Deuterium oxide, D_2O consists of an oxygen atom bonded to two atoms of the hydrogen isotope, deuterium ^2_1D. It is known as 'heavy water' and is used for research into chemical reactions.

Like H_2O, pure D_2O is weakly ionised.

$$2D_2O \quad D_3O^+ + OD^-$$

For D_2O, we use the terms K_D instead of K_w and pD instead of pH.
At 25 °C, $pK_D = 14.8$

Which statements about D_2O at 25 °C is correct?

1 pD of D_2O is 7.4
2 D_2O is not a neutral liquid.
3 D_2O dissociates to a smaller extent than H_2O.

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

14 W, X, Y and Z are four consecutive elements in Period 3 but not necessarily in the order presented.

- Chloride of W dissolves in water and turns blue litmus red.
- X is a good conductor of electricity but is insoluble in water.
- Oxide of Y has the highest melting point.
- Z has the highest first ionisation energy and largest ionic radius.

Which of the following is the correct sequence of the four elements in order of increasing atomic number?

A X, Y, Z, W
B X, Y, W, Z
C Y, X, W, Z
D Y, X, Z, W

15 M is a Group 2 metal. The carbonate of M decomposes when heated in a Bunsen flame to give carbon dioxide and a white solid residue as the only products. This white solid residue is sparingly soluble in water. Even when large amounts of the solid residue are added to water the pH of the saturated solution is less than that of limewater.

What could be the identity of M?

A magnesium
B calcium
C strontium
D barium

16 A white powder is a mixture of sodium chloride and sodium iodide. It is dissolved in water in a test-tube. Excess aqueous silver nitrate is added to the test-tube. A precipitate, X, is observed.

Excess concentrated ammonia is then added to the test-tube containing X. After the test-tube has been shaken, a precipitate, Y, is observed.

Which statement about X or Y is correct?

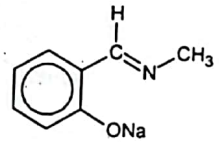
A X is a pure white colour.
B X is pure silver iodide.
C Y is pure silver chloride.
D Y is yellow.

17 Which of the following statements is correct?

1 Enthalpy change of vaporisation of halogens increases down the group.
2 Bond energy of hydrogen halides increases down the group.
3 Oxidising power of halogens increases down the group.
4 Thermal stability of hydrogen halides increases down the group.

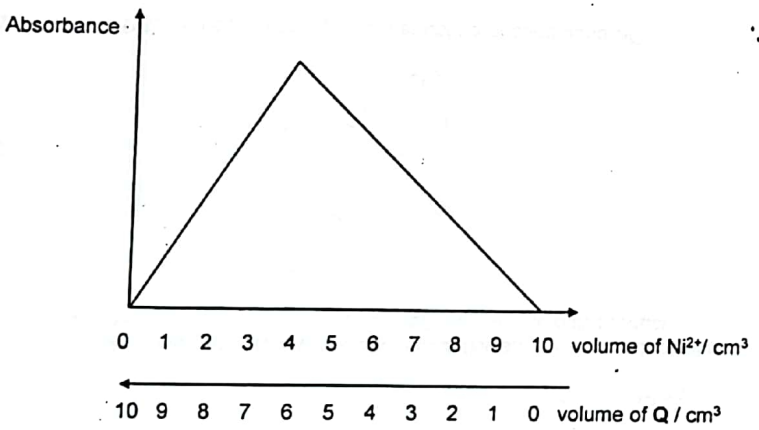
A 1 only
B 1 and 3
C 2 and 4
D 3 and 4

18 The complex of nickel with ligand **Q** (shown below) is thermochromic, being coloured red at room temperature but changing to yellow-green when heated to 170 °C.



Q

The following graph was obtained when the colour intensities of mixtures of a 4.0×10^{-3} mol dm^{-3} solution of **Q** and a 3.0×10^{-3} mol dm^{-3} solution of nickel(II) chloride were measured using a colorimeter at room temperature.



Which of the following statements is correct for the nickel(II) complex ion?

A The complex ion absorbs red light at room temperature.
B The co-ordination number of nickel(II) complex is 4.
C The overall charge of the nickel(II) complex is 2+.
D The shape of the nickel(II) complex ion is linear.

19 If a molecule contains two non-identical chiral carbon atoms, four optical isomers exist.

How many isomers are there with

- molecular formula $C_7H_{14}O$ and
- a five-membered ring and
- a tertiary alcohol group?

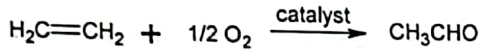
A 7 **B** 8 **C** 9 **D** 10

20 Which of the following trends are incorrect?

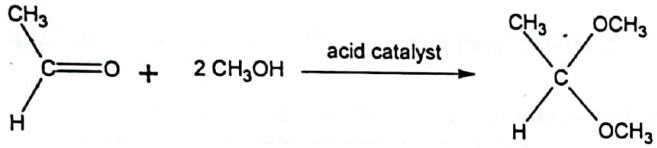
1 The boiling points of alcohols with the same molecular formula increases from primary to secondary to tertiary.
2 The pH values of the aqueous solutions increases from CH_3CH_2COCl to CH_3CH_2COOH to $CH_3CH_2CONH_2$ to $CH_3CHClCH_2NH_2$.
3 The ease of hydrolysis of the chlorine atoms decreases from chlorobenzene to chloroethane to ethanoyl chloride.
4 The pK_b values increases from ethanoate ion to phenoxide ion to ethoxide ion.

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

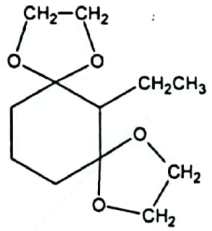
21 Alkenes undergo catalytic oxidation to produce aldehydes and ketones, for example



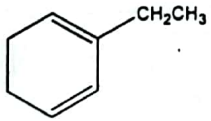
Acetals (molecules that contain 2 –OR groups bonded to the same carbon) can be formed from aldehydes and ketones in an acid catalysed process, for example

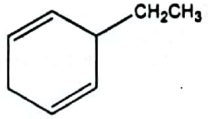


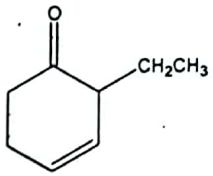
Compound **W** undergoes catalytic oxidation, followed by an acid catalysed reaction with $HOCH_2CH_2OH$ to produce the following as the only product.

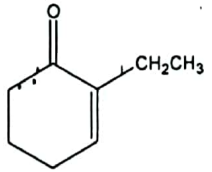


Which of the following best represents the structure of compound **W**?

A 

B 

C 

D 

22 The molecular formula of compound **X** is $C_5H_{12}O$.

Compound **X**:
- reacts with alkaline aqueous iodine
- can be dehydrated to form two alkenes only.

What could be the identity of compound **X**?

A $CH_3CH_2CH(CH_3)CH_2OH$
B $(CH_3)_2C(OH)CH_2CH_3$
C $(CH_3)_2CHCH(OH)CH_3$
D $CH_3CH_2CH_2CH(OH)CH_3$

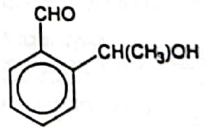
23 $H_2NNHC_6H_3(NO_2)_2$ is the structural formula of 2,4-DNPH.

Many but not all, organic reactions need to be heated before reaction occurs.

Which reaction cannot occur at a good rate at room temperature (20 °C)?

A $CH_3OH + PCl_5 \rightarrow CH_3Cl + POCl_3 + HCl$
B $CH_3CH_2OH + KBr \rightarrow CH_3CH_2Br + KOH$
C $CH_3COCl + CH_3CH_2OH \rightarrow CH_3COOCH_2CH_3 + HCl$
D $(CH_3)_2CO + H_2NNHC_6H_3(NO_2)_2 \rightarrow (CH_3)_2C{=}NNHC_6H_3(NO_2)_2 + H_2O$

24 Compound **X** is heated under reflux with an excess of acidified $K_2Cr_2O_7$ to form compound **Y**.



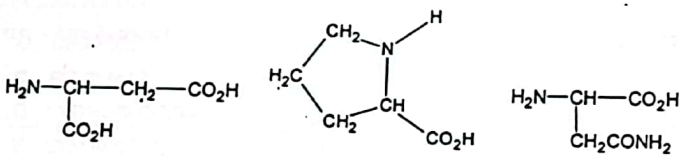
compound **X**

Both **X** and **Y** are separately warmed with Fehling's solution and the observations noted.

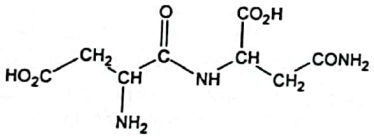
What are the observations?

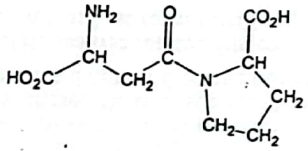
A Both **X** and **Y** give a red precipitate.
B Only **X** gives a red precipitate.
C Only **Y** gives a red precipitate.
D Neither **X** nor **Y** gives a red precipitate.

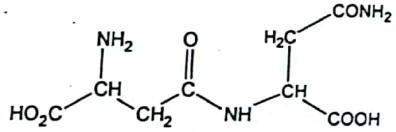
25 The following are structures of 3 amino acids.

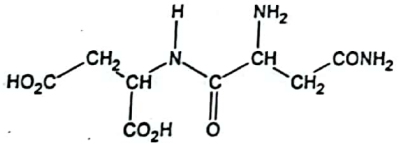


Which of the following represents dipeptides formed from these amino acids?

1 

2 

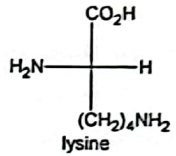
3 

4 

A 1 only
B 1 and 4 only
C 3 and 4 only
D All are correct

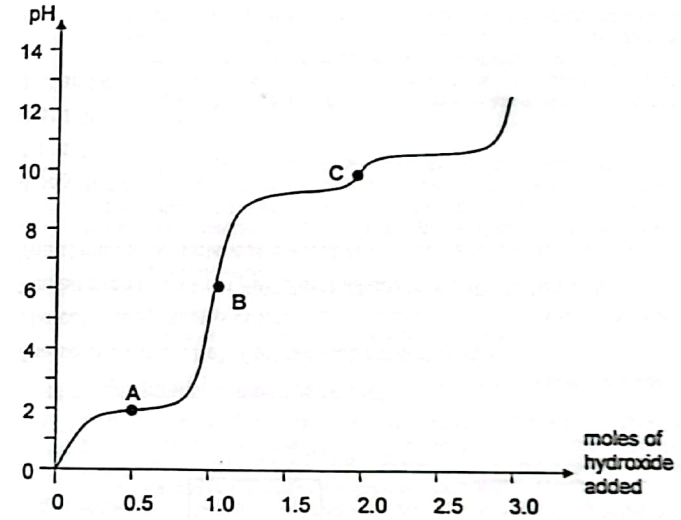
[Turn over

26 Lysine is an essential amino acid found in the body. It has three pK_a values associated with it: 2.2, 9.0 and 10.5



lysine

When one mole of protonated lysine was titrated against hydroxide ions, the following pH curve is obtained:



Which of the following statements are true with respect to the curve above?

1 The α-amino group has a pK_a value of 10.5.
2 Equal amounts of $H_3N^+CH(CO_2H)(CH_2)_4NH_3^+$ and $H_3N^+CH(CO_2H)(CH_2)_4NH_2$ are present at point A.
3 The major species present at point C has no net charge.
4 The major species present at point B will migrate towards the cathode of an electrolytic cell.

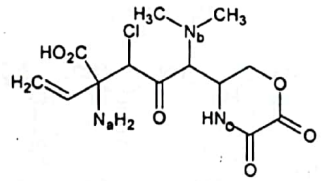
A 1 and 3 only
B 2 and 4 only
C 3 and 4 only
D All are correct

27 A carboxylic acid, P, has no possible chain isomers. It reacts with an alcohol, Q, that has only one other positional isomer.

What could be the ester formed from a reaction between P and Q?

A butyl propanoate
B ethyl butanoate
C pentyl ethanoate
D propyl pentanoate

28 Which of the following statements about compound W is correct?



compound W

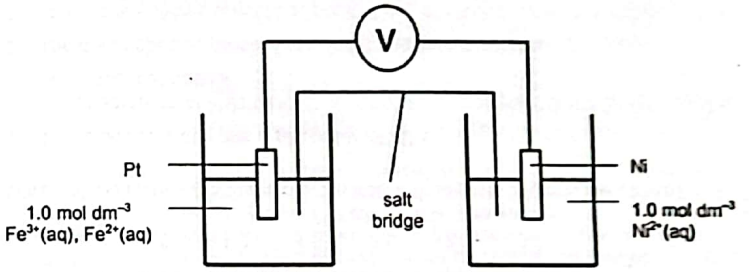
A In the gaseous phase, N_b is a stronger Lewis base than N_a but in the aqueous phase, N_b is a weaker Bronsted-Lowry base than N_a.
B When 96 dm^3 of H_2 gas was reacted with one mole of compound W, followed by excess sodium metal, at room conditions, the gas volume expanded by 48 dm^3.
C The reduction of W by $LiAlH_4$ will cause the oxidation state of any carbon involved in the reduction to decrease from +3 to −1.
D W will require 3 moles of NaOH(aq) for complete reaction if the reaction is to take place with heating.

29 Which of the following changes represent an oxidation process?

A CO_2 to $C_2O_4^{2-}$
B CrO_4^{2-} to $Cr_2O_7^{2-}$
C Br_2 to BrF_3
D Cl_2 to ICl_3

30 *The use of Data booklet is relevant to this question.*

A Fe^{3+}/Fe^{2+} half-cell was connected to a Ni^{2+}/Ni half-cell as shown in the diagram below under standard conditions.



Which of the following statements is correct?

1 The solution in the Fe^{3+}/Fe^{2+} half-cell turns red-brown.
2 The cathode increases in size.
3 The electron flows from Fe^{3+}/Fe^{2+} half-cell to the Ni^{2+}/Ni half-cell.
4 The standard cell potential is +1.02 V.

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