NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 1

CHEMISTRY 8873/01

Paper 1 Multiple Choice **16 September 2024**

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.

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

20 g of ethanol and 30 g of propanoic acid are heated under reflux, 22 g of ethyl propanoate is obtained.

What is the yield of the ester?

A 50%

B 53%

C 56%

D 60%

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

0.144 g of an aluminium compound **A** react with excess water to produce a gas. This gas burns completely in oxygen to form water and 72 cm^3 of CO_2 only.

What is the molecular formula of compound **A**?

[All volumes were measured at room temperature and pressure.]

A Al_2C_3

B Al_3C_4

C Al_4C_3

D Al_5C_3

3 In this question, assume only V and Zn change oxidation numbers.

Two moles of VO_2^+ ions react with one mole of zinc atoms in the presence of dilute acid. The products include Zn^{2+} ions and an ion, **Y**. Ion **Y** contains vanadium.

What is ion **Y**?

A VO_3^-

B VO^+

C VO^{2+}

D VO_2^{2+}

4 A single ^{32}P nucleus can be produced when a single ^{32}S nucleus reacts with particle **X**. In the process a proton is emitted.

What is particle **X**?

A a deuteron,

B an electron

C a neutron

D a proton

5 Which statement about the electrons in an aluminium atom at ground state is correct?

A Electrons are present in three different energy levels.

B There are more electrons in s orbitals than there are in p orbitals in total.

C The occupied orbital of lowest energy is circular.

D The electron from the occupied orbital with the highest energy is removed first during ionisation.

6 In which process does bond angle decrease at the relevant central atom?

1 when ice melts

2 oxidation of SO_2 to SO_3

3 oxidation of a secondary alcohol by acidified $KMnO_4$

4 dimerisation of aluminium chloride

A 4 only

B 1 and 3 only

C 1 and 4 only

D 2 and 3 only

7 When two liquids are mixed, heat may be evolved if intermolecular bonds formed are stronger, than those broken, even if there is no chemical reaction.

Which pair of liquids, when mixed, will give out heat?

A CH_2Cl_2 and $(CH_3)_2CO$

B $CHCl_3$ and C_6H_{14}

C CCl_4 and $(CH_3)_2CO$

D CCl_4 and CH_3CH_2OH

8 Three substances **W**, **X** and **Y** have physical properties as shown.

substance	melting point / ^{o}C	electrical conductivity
W	1410	slight
X	3650	good
Y	– 70	poor

What could be the correct identities of **W**, **X** and **Y**?

	W	**X**	**Y**
A	Si	C(graphite)	$SiCl_4$
B	Si	C(diamond)	SiO_2
C	C(diamond)	C(graphite)	SiO_2
D	C(graphite)	C(diamond)	$SiCl_4$

9 Calcium(I) chloride, CaCl, does not exist as a stable compound but its lattice energy can be estimated.

What is the predicted order of increasing magnitude of lattice energy of CaCl, $CaCl_2$ and $MgCl_2$?

A $MgCl_2$, $CaCl_2$, CaCl

B $CaCl_2$, $MgCl_2$, CaCl

C CaCl, $MgCl_2$, $CaCl_2$

D CaCl, $CaCl_2$, $MgCl_2$

10 Which statement about the standard enthalpy change of formation of carbon dioxide is correct?

A It is equal to twice the bond energy of the C=O bond.

B It is equal to the standard enthalpy change of combustion of carbon.

C It is the same for carbon dioxide produced from graphite and from diamond.

D It is the energy change when one mole of carbon dioxide is formed from its constituent elements in their standard states at 273 K and 1 bar.

11 50.0 cm^3 of 2.00 mol dm^{-3} H_2SO_4 is added to 100 cm^3 of 1.00 mol dm^{-3} NaOH in an insulated vessel.

Both solutions are at a temperature of 20.0 °C before mixing. On mixing, the temperature rises and the highest temperature recorded is 29.0 °C.

Assume that no energy is lost to the surroundings and the density of the mixture is 1 g cm^{-3} and its specific heat capacity is 4.18 J g^{-1} K^{-1}.

What is the value of the enthalpy change of neutralisation as determined from this experiment?

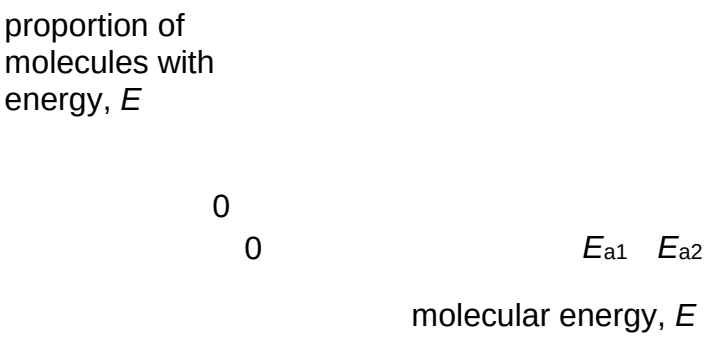
A –56.4 kJ mol^{-1}

B –28.2 kJ mol^{-1}

C +28.2 kJ mol^{-1}

D +56.4 kJ mol^{-1}

12 The diagram shows a Boltzmann distribution of the energies of gaseous molecules and the activation energies, E_a, of a reaction with and without a catalyst.



Which statement about this distribution curve is correct?

A If the temperature of the gas is increased, the maximum of the curve becomes higher.

B If the temperature of the gas is increased, the maximum of the curve moves to the left.

C The fraction of molecules that react in the presence of a catalyst is shown by .

D The fraction of molecules that react in the absence of a catalyst is shown by .

13 Which changes can be used to measure the rates of chemical reactions?

1 the decrease in concentration of a reactant per unit time

2 the rate of appearance of a product

3 the increase in total volume of gas per unit time at constant pressure

A 1 only

B 1 and 2

C 2 and 3

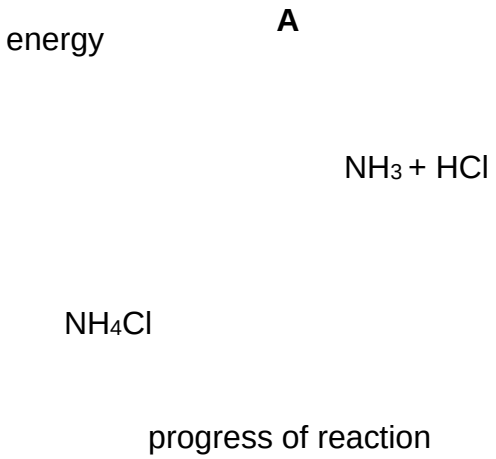
D 1, 2 and 3

14 The equation for the formation of ammonium chloride is shown.

$$NH_3(g) + HCl(g) \rightleftharpoons NH_4Cl\ (g) \qquad \Delta H = -314\ kJ\ mol^{-1}$$

Which diagram shows the correctly labelled reaction pathway diagram for the decomposition of ammonium chloride?

A



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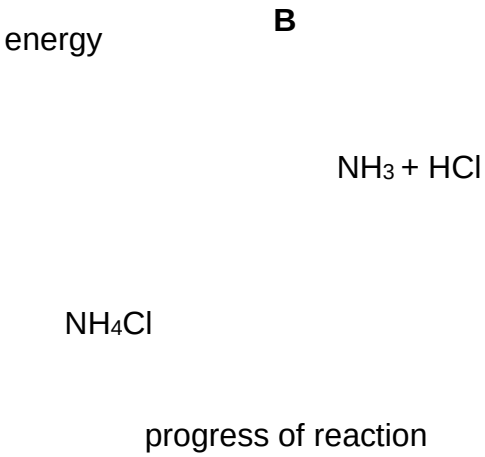

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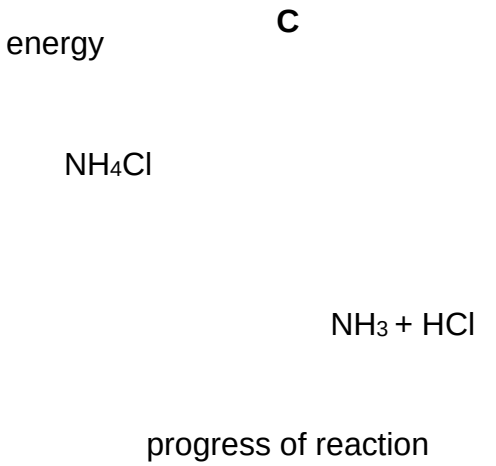

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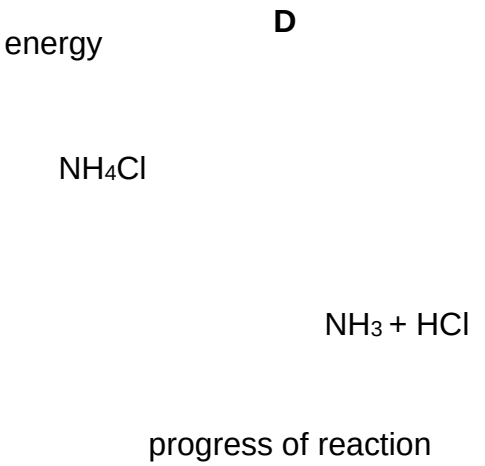


15 The Contact process to convert SO_2 into SO_3 takes place at a pressure between 100 kPa and 200 kPa and at a temperature between 400 °C and 450 °C. A catalyst is used.

$$2SO_2(g) + O_2(g) \text{ Ý } 2SO_3(g) \qquad \Delta H < 0$$

Which statement is correct?

A V_2O_5 catalyst is added to increase the equilibrium yield of the reaction.

B The higher temperature will increase the yield of the reaction.

C The higher pressure has no effect on the position of equilibrium.

D A catalyst and a high temperature will increase the rate of reaction.

16 Nitrosyl chloride, NOCl, is produced when NO and Cl_2 are reacted. The equation is shown.

$$2NO(g) + Cl_2(g) \text{ Ý } 2NOCl(g)$$

2.32 mol of NO and **X** mol of Cl_2 are mixed in a sealed container of volume 1.00 dm^3 at a temperature of 573 K. The system is allowed to reach equilibrium.

The equilibrium mixture contains 1.77 mol of NOCl. The equilibrium constant, K_c, for the reaction at 573 K is 2807.

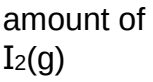
What is the value of **X**?

A 0.886 mol **B** 0.889 mol **C** 1.770 mol **D** 1.771 mol

17 The equation shows that $H_2(g)$ and $I_2(g)$ react to form an equilibrium mixture.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \quad \Delta H < 0$$

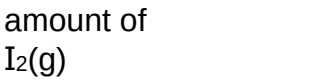
A mixture containing equal amounts of $H_2(g)$ and $I_2(g)$ is made at temperature T_1 and the composition of the mixture is monitored. A graph of the results is shown.



The experiment is repeated at a lower temperature, T_2.

Which new graph would be obtained?

A



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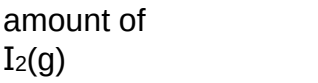

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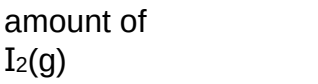

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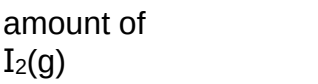


18 What is the definition of an Arrhenius acid?

A a substance that donates hydrogen ions

B a substance that accepts a lone pair of electrons

C a substance that produces hydrogen ions in aqueous solution

D a substance that readily reacts with a base to form a salt and water only

19 Four solutions, each of concentration 0.1 mol dm^{-3}, were tested with a pH meter. The results are shown.

solution	pH
acid 1	4
acid 2	1
base 1	11
base 2	13

Which statements can be deduced from these results?

1 Acid 1 dissociates to a smaller extent than acid 2.

2 Base 2 contains a lower concentration of hydrogen ions in solution than base 1.

3 Separate 25.0 cm^3 portions of acid 1 require the same volume of base 1 and base 2 for complete neutralisation.

A 1, 2 and 3

B 1 and 2 only

C 2 and 3 only

D 1 only

20 The water of Lake Nakuru in the Kenyan rift valley contains dissolved sodium carbonate, Na_2CO_3, and sodium hydrogencarbonate, $NaHCO_3$.

$$HCO_3^-(aq) \rightleftharpoons H^+(aq) + CO_3^{2-}(aq)$$

A sample of this water can resist large changes in pH when small amounts of acids or bases are added.

Which equation represents one of the reactions that will occur?

A $HCO_3^- + H^+ \rightarrow H_2O + CO_3^{2-}$

B $HCO_3^- + OH^- \rightarrow H_2O + CO_3^{2-}$

C $CO_3^{2-} + H^+ \rightarrow H_2O + CO_3^{2-}$

D $CO_3^{2-} + OH^- \rightarrow H_2O + HCO_3^-$

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

Which statements about Group 17 elements and compounds are correct?

1 Chlorine reacts with hydrogen to form a colourless gas.

2 Potassium iodide produces a purple gas after oxidising bromine.

3 Thermal stability decreases down Group 17 hydrides because the enthalpy change of decomposition of hydrogen iodide is least endothermic.

4 The boiling point of hydrogen chloride is lower than that of hydrogen bromide because the H–Cl bond is stronger than the H–Br bond.

A 1 and 3

B 1 and 4

C 2 and 3

D 2 and 4

22 **X**, **Y** and **Z** are elements all found within Groups 13, 14 and 15 of the Periodic Table.

X is in the same group in the Periodic Table as **Y**.

Y and **Z** are in Period 3.

The first ionisation energy of **X** is greater than the first ionisation energy of **Y**.
The melting point of **Z** is less than the melting point of **Y**.

Y and **Z** both form chlorides which are white solids. These white solids react with water to produce solutions with a pH of less than 4.

Which row of the table shows the possible identities of **X** and **Y**?

	X	**Y**
A	B	Al
B	Ge	Si
C	As	P
D	N	P

23 Separate 1.0 g samples of Na_2O, MgO, Al_2O_3, SiO_2, NaCl, $MgCl_2$, Al_2Cl_6 and $SiCl_4$ are added to separate beakers containing water and stirred.

The number of beakers containing a white solid is Q.

An excess of NaOH(aq) is then added to each beaker and stirred.

The number of beakers now containing a white solid is R.

Which row is correct?

	Q	R
A	3	2
B	3	3
C	4	3
D	4	4

24 Which row correctly describes the reactions of potassium and rubidium with water?

	oxidising agent	reducing agent	more vigorous reaction
A	water	potassium or rubidium	potassium + water
B	water	potassium or rubidium	rubidium + water
C	potassium or rubidium	water	potassium + water
D	potassium or rubidium	water	rubidium + water

25 Calcium behaves similarly like sodium metal.

An organic compound, **B**, will react with an excess of calcium metal to produce a salt with the empirical formula $CaC_4H_6O_4$.

What could be the identity of **B**?

A ethanoic acid

B butanoic acid

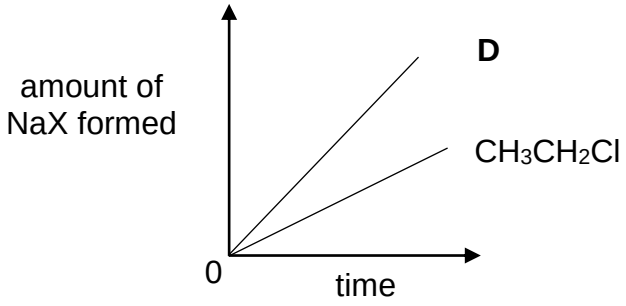
C butanedioic acid

D methylpropanediodic acid

26 When halogenoalkanes, RX, are hydrolysed with NaOH, the corresponding sodium halides, NaX, are produced.

$$RX + NaOH \rightarrow ROH + NaX$$

A student investigated the amount of NaX produced by hydrolysing CH_3CH_2Cl and another halogenoalkane, **D**. In a given time, the amount of NaX formed was greater with **D** than with CH_3CH_2Cl.



Which compound could be **D**?

1 CH_3CH_2F

2 CH_3CH_2Br

3 CH_3CH_2I

4 $ClCH_2CH_2Cl$

A 1, 2, 3 and 4

B 1, 2 and 3

C 2, 3 and 4

D 1 and 4 only

27 Compound **E** has the molecular formula $C_{10}H_{14}O$ and is unreactive towards acidified potassium dichromate(VI) solution.

What is the structure of the compound formed by dehydration of **E**?

A

B

C

D

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

A short section of the chain in the condensation polymer poly(lactic acid) is shown.

The relative molecular mass of a typical molecule of poly(lactic acid) is approximately 144 000.

How many monomers are joined together to make this typical polymer molecule?

A 1000

B 1400

C 2000

D 4200

29 The synthesis of the polymer Bakelite is shown.

Which statements are correct?

1 Bakelite can be recycled.
2 Water molecules are eliminated in step 1.
3 The reactant in step 2 is methanone.

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

30 Which statement about graphene is correct?

A It is a nanoparticle.

B All bond angles are 120°.

C The valency of each carbon atom in the lattice is 3.

D It has a layered structure with instantaneous dipoles-induced dipoles forces between the layers.