Candidate's Name: _____

Class	Reg Number

MERIDIAN JUNIOR COLLEGE
JC 1 Promotional Examination
Higher 2

Chemistry   **9729**

27 September 2017

Section A

40 minutes

Additional Materials: OMR Sheet and *Data Booklet*

READ THESE INSTRUCTIONS FIRST

This booklet contains Section A of your paper.

Write your name, class and register number in the spaces provided at the top of this page.

There are **twenty** questions in this section. Answer **all** questions. For each question, there are four possible answers labelled **A, B, C** and **D**. Choose the one you consider correct and record your choice in soft pencil on the OMR answer sheet.

Read very carefully the instructions on the use of OMR answer sheet.

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

Use of OMR Answer Sheet

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

Use a **2B** pencil to shade your answers on the OMR sheet; erase any mistakes cleanly. Multiple shaded answers to a question will not be accepted.

For shading of class register number on the *OMR 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.

This document consists of **8** printed pages, including this cover page.

Answer all questions in this section.

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

1   Methylamine, CH_3NH_2 is a colourless gas which has a strong odour similar to fish. It burns in oxygen according to the following equation.

$$CH_3NH_2 \text{ (g)} + \frac{13}{4} O_2 \text{ (g)} \longrightarrow CO_2 \text{ (g)} + NO_2 \text{ (g)} + \frac{5}{2} H_2O \text{ (}l\text{)}$$

A sample of 10 cm^3 of methylamine was burned in 50 cm^3 of oxygen. The products were cooled to room temperature and treated with an excess of aqueous sodium hydroxide.

What would be the final volume of the resultant mixture of gases?

A   17.5 cm^3 B   20.0 cm^3 C   27.5 cm^3 D   37.5 cm^3

2   How many atoms are present in 24 cm^3 of carbon dioxide gas under room conditions?

A $\dfrac{6.02 \times 10^{23}}{10^3}$

B $\dfrac{3 \times 6.02 \times 10^{23}}{10^3}$

C $\dfrac{3 \times 6.02 \times 10^{23}}{24000}$

D $3 \times 24 \times 6.02 \times 10^{23}$

3   25.0 cm^3 of 0.05 mol dm^{-3} acidified NH_4VO_3 was reduced by sulfur dioxide to form a deep–blue solution containing V^{n+} ions.
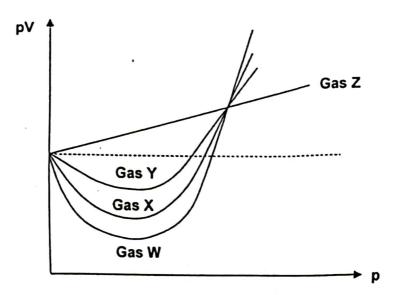
The V^{n+} ions are then re–oxidised to its original oxidation state by 12.50 cm^3 of 0.02 mol dm^{-3} acidified $KMnO_4$.

What is the oxidation state of vanadium in the deep–blue solution?

A   0   B   +3   C   +4   D   +6

4   The value of pV is plotted against p at the same temperature for four gases, where p is the pressure and V is the volume of the gas.

Which of the following statements are correct?

1   All gases deviate most from ideal gas behaviour at high pressures.

2   The intermolecular forces of attraction in Gas Y is more significant than that in Gas X.

3   Gas W is H_2O; Gas X is HF; Gas Y is CH_3F; Gas Z is Ne.

A   1 only

B   1 and 2 only

C   1 and 3 only

D   1, 2 and 3

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

The ion X^{4+} contains 28 electrons and 42 neutrons.

Which of the following statements about X^{4+} or X^{2+} is correct?

A X^{2+} has less protons than $^{59}Co^{2+}$.

B X^{4+} has the same electronic configuration as $^{58}Ni^{2+}$.

C X^{4+} has the same nucleon number as $^{75}As^{3+}$.

D X^{2+} has a lower tendency to form covalent compounds than X^{4+}.

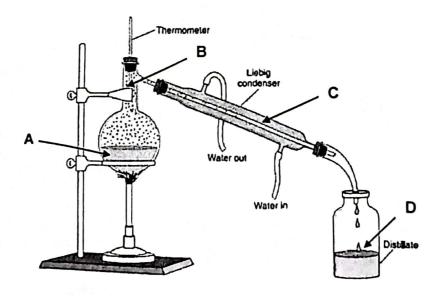**6**   The angle of deflection of a beam of $^{27}_{13}Al^{3+}$ in an electric field is +5.6 °.

What is a possible species that will give an angle of deflection of 4.2 ° when passed through the same electric field?

A $^{19}_{9}F^{-}$ B $^{24}_{12}Mg^{2+}$ C $^{32}_{16}S^{2-}$ D $^{52}_{24}Cr^{2+}$

7   1–chlorobutane can be synthesised by reacting butan–1–ol with thionyl chloride, $SOCl_2$.

1–chlorobutane

butan–1–ol

Distillation is performed to separate the 1–chlorobutane and the unreacted butan–1–ol upon completion of the reaction. A distillation set–up is shown below where the organic compound with the lower boiling point will distil out first.

Which region indicates an area where there is a higher proportion of butan–1–ol than 1–chlorobutane?

8   The melting points of two aluminium halides, AlX_3 are given below.

Compound	Formula	Melting Point/ °C
Aluminium fluoride	AlF_3	1291
Aluminium chloride	$AlCl_3$	178

Which pairs of factors provide the reasons to explain for the differences in the melting points?

1   charge density of cation

2   radius of anion

3   strength of the $Al-X$ bond

4   distortion of electron cloud

A   1 and 3 only

B   1 and 4 only

C   2 and 3 only

D   2 and 4 only

9   Nickel is a by–product formed by a series of changes in which the rate–determining step is the radioactive decay of cobalt–60, a radiation source for cancer treatment. This radioactive decay is a first–order reaction with a half–life of 5.3 years.

How long would it take for a radiation cartridge of cobalt–60, originally nickel–free, to contain a molar proportion of cobalt to nickel of 1:7?

A   0.8 years

B   14.9 years

C   15.9 years

D   37.1 years

10   The reaction between nitrogen monoxide, NO and oxygen, O_2 takes place as follows:

$2NO \rightleftharpoons N_2O_2$ (fast)

$N_2O_2 + O_2 \longrightarrow 2NO_2$ (slow)

Which of the following statement is correct?

A   The overall reaction is third order.

B   The reaction is an elementary reaction.

C   The rate equation is Rate = k [N_2O_2] [O_2].

D   The activation energy of the first step is higher than the second step.

11 A 0.0113 mol sample of ammonium nitrate is introduced into an evacuated vessel with a volume of 0.83 dm³. The vessel, of constant volume, is heated to a constant temperature such that the equilibrium below is established.

$$NH_4NO_3 (s) \rightleftharpoons NH_3 (g) + HNO_3 (g)$$

Given that the percentage dissociation of ammonium nitrate at equilibrium is 66.8%, what is the value of the equilibrium constant, K_c?

A 5.70×10^{-5} B 8.27×10^{-5}

C   0.0152 D   0.0183

12 The key stage in the manufacture of sulfuric acid is the reaction between sulfur dioxide and oxygen.

$$2SO_2 (g) + O_2 (g) \rightleftharpoons 2SO_3 (g) \qquad \Delta H = -197 \text{ kJ mol}^{-1}$$

Which of the following statements are correct for an increase in temperature?

1   The equilibrium constant increases.

2   The rate constant for the forward reaction increases.

3   The rate constant for the backward reaction increases.

4   The activation energy for the forward reaction decreases.

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

C   2 and 3 only D   3 only

13 The dihydrogen phosphate ion, $H_2PO_4^-$ can act as a base or an acid.

$$H_2PO_4^- + H_2CO_3 \rightleftharpoons H_3PO_4 + HCO_3^- \qquad K_c < 1$$
$$H_2PO_4^- + HCO_3^- \rightleftharpoons HPO_4^{2-} + H_2CO_3$$

The conjugate _____ of $H_2PO_4^-$ is _____, and H_3PO_4 is a stronger acid than _____.

A   acid; HPO_4^{2-}; H_2CO_3

B   acid; H_3PO_4; HCO_3^-

C   base; HPO_4^{2-}; HPO_4^{2-}

D   base; HPO_4^{2-}; H_2CO_3

14 Values for the ionic product of water, K_w, at two different temperatures are given below.

Temperature / °C	K_w / mol² dm⁻⁶
10	2.90×10^{-15}
25	1.00×10^{-14}

What is correct for pure water at 10 °C?

A pH = 7

B pH > 7

C $[H^+] = 2.90 \times 10^{-8}$ mol dm⁻³

D $[H^+] > [OH^-]$

15 A mixture is made by mixing equal volumes of a solution of H_2SO_4 (aq) of pH 2 and of a solution of HC*l* (aq) of pH 3.

What is the pH of the resulting solution?

A 1.67

B 1.96

C 2.26

D 2.50

16 The values of the solubility products at 25 °C of three metal sulfides are tabulated below.

Compound	Value of solubility product
CuS	8.5×10^{-45}
Ag_2S	1.6×10^{-49}
Bi_2S_3	1.1×10^{-73}

The dissolution process of these metal sulfides is endothermic.

Which statements about the metal sulfides are correct?

1 The value of the solubility products of the metal sulfides increases with temperature.
2 The value of the solubility products of the metal sulfides decreases when there is a common ion effect as the solubility decreases.
3 The molar solubility of the metal sulfides decreases in the following order: $CuS > Ag_2S > Bi_2S_3$.
4 The molar solubility of the metal sulfides increases when pH decreases.

A 1 and 2 only

B 1 and 4 only

C 2 and 3 only

D 3 and 4 only

17 Cyanopropyne has the following structure:

$$CH_3C\equiv CCN$$

Which statements about the molecule are correct?

1 There are 6 sigma bonds and 2 pi bonds.
2 All the carbon atoms lie in the same plane.
3 Only two of the carbon atoms are *sp* hybridised.
4 One of the terminal carbon atoms has a tetrahedral geometry.

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

18 How many constitutional and *cis–trans* isomers are there for dichloropropene, $C_3H_4Cl_2$?

A 5   B 6   C 7   D 8

19 Limonene is an oil formed in the peel of citrus fruits.

limonene

When limonene reacts with excess cold dilute $KMnO_4$, how many **more** chiral centres than limonene does the product possess?

A 2   B 3   C 4   D 5

20 Which two-stage process will give the greatest yield of $CH_2(Br)CH(Br)CH_2CH_3$?

A $CH_3CH(Br)CH_2CH_3$ $\xrightarrow{\text{ethanolic KOH, heat}}$ $\xrightarrow{\text{Br}_2 \text{ in organic solvent}}$

B $CH_2=CHCH_2CH_3$ $\xrightarrow{\text{HBr}}$ $\xrightarrow{\text{limited Br}_2, \text{ heat}}$

C $CH_3CH=CHCH_3$ $\xrightarrow{\text{H}_2 \text{ (g), Pt}}$ $\xrightarrow{\text{Br}_2 \text{ (g), uv light}}$

D $CH_3CH_2CH_2CH_2OH$ $\xrightarrow{\text{conc. H}_2\text{SO}_4, 170°C}$ $\xrightarrow{\text{Br}_2 \text{ in organic solvent}}$