| 1.  | D | 11. | Α | 21. | Α | 31. | С |
|-----|---|-----|---|-----|---|-----|---|
| 2.  | С | 12. | В | 22. | Α | 32. | С |
| 3.  | С | 13. | В | 23. | Α | 33. | Α |
| 4.  | С | 14. | Α | 24. | В | 34. | В |
| 5.  | В | 15. | Α | 25. | D | 35. | D |
|     |   |     |   |     |   |     |   |
| 6.  | D | 16. | С | 26. | В | 36. | В |
| 7.  | Α | 17. | С | 27. | В | 37. | В |
| 8.  | D | 18. | D | 28. | С | 38. | Α |
| 9.  | Α | 19. | D | 29. | D | 39. | В |
| 10. | С | 20. | D | 30. | В | 40. | В |



JURONG JUNIOR COLLEGE PRELIMINARY EXAMINATION 2008

# H2 CHEMISTRY PAPER 1 9746 / 1

Wednesday

27<sup>th</sup> August 2008

1 hour

# **INSTRUCTIONS TO CANDIDATES:**

## Do not open this question booklet until you are told to do so.

Write your name and class on the answer sheet in the spaces provided.

There are **40** 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.

## **INFORMATION FOR CANDIDATES:**

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.

A Data Booklet is provided.

This question booklet consists of 16 printed pages, including this page.

[Turn over

## SECTION A (30 MARKS)

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

**1.** Potassium iodate(V) can be used as a standard in iodine-thiosulfate titrimetry since it reacts with iodide ions according to the equation:

$$IO_3(aq) + 5I(aq) + 6H(aq) \rightarrow 3I_2(aq) + 3H_2O(I)$$

How many moles of sodium thiosulfate,  $Na_2S_2O_3$ , is needed to react with the iodine produced by 1 mole of iodate(V) ions?

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

2. The successive ionisation energies of two elements, **M** and **N**, are given.

| lonisation<br>energy /<br>kJ mol <sup>-1</sup> | 1 <sup>st</sup> | 2 <sup>nd</sup> | 3 <sup>rd</sup> | 4 <sup>th</sup> | 5 <sup>th</sup> | 6 <sup>th</sup> | 7 <sup>th</sup> | 8 <sup>th</sup> |
|--|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| М  | 1090            | 2350            | 4610            | 6220            | 37800           | 47000           | -               | -               |
| Ν  | 1251            | 2298            | 3822            | 5158            | 6542            | 9362            | 11018           | 33604           |

What is the formula of the compound that **M** and **N** are likely to form?

| Α | MN | В | $M_2N_2$ | С | MN <sub>4</sub> | D | $M_4N$ |
|---|----|---|----------|---|-----------------|---|--------|
|---|----|---|----------|---|-----------------|---|--------|

3. Ions of two isotopes of the transition metal nickel are shown below.

 ${}^{58}_{28}$ Ni<sup>2+</sup>  ${}^{60}_{28}$ Ni<sup>2+</sup>

Which one of the following statements is correct?

- **A** The  ${}^{60}_{28}$ Ni<sup>2+</sup> ion has more protons than the  ${}^{58}_{28}$ Ni<sup>2+</sup> ion.
- **B** The electronic configuration of both  $Ni^{2+}$  ions is  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$ .
- **C** These Ni<sup>2+</sup> ions have the same number of electrons but a different number of neutrons.
- **D** The  ${}^{60}_{28}$ Ni<sup>2+</sup> ion will be deflected more than the  ${}^{58}_{28}$ Ni<sup>2+</sup> ion under the same magnetic field.
- **4.** A certain mass of an ideal gas occupies a volume of 1 dm<sup>3</sup> at 20 °C. If the pressure remains unchanged, at what temperature will its volume be 2 dm<sup>3</sup>?

| Α | 40 °C | В | 293 °C | С | 313 °C | D | 586 °C |
|---|-------|---|--------|---|--------|---|--------|
|---|-------|---|--------|---|--------|---|--------|

- **5.** Which one of the following, in the solid state, has a crystalline structure of simple molecules held together by van der Waals' forces?
  - A ice
  - B iodine
  - **C** graphite
  - D silicon dioxide
- 6. In which pair is the bond angle in Species I greater than that in Species II?

|   | Species I         | Species II        |
|---|-------------------|-------------------|
| Α | $BrF_3$           | $SF_6$            |
| В | $SF_6$            | XeF <sub>4</sub>  |
| С | XeF <sub>4</sub>  | CO3 <sup>2-</sup> |
| D | CO3 <sup>2-</sup> | $BrF_3$           |

7. You are given the following standard enthalpy changes.

|             |   |                       |        | <u>∆H<sup>,</sup>/kJ mol<sup>−1</sup></u> |
|-------------|---|-----------------------|--------|---|
| C(graphite) | + | $2H_2(g) \rightarrow$ | CH₄(g) | -75                                       |
|             |   | $H_2(g) \rightarrow$  | 2H(g)  | +436                                      |

By using any other relevant data from the *Data Booklet*, what is the standard enthalpy change of atomisation of graphite?

**A** +693 kJ mol<sup>-1</sup>

- **B** +1129 kJ mol<sup>-1</sup>
- **C** -2151 kJ mol<sup>-1</sup>
- **D** -2587 kJ mol<sup>-1</sup>

8. A student used the apparatus below to heat a can containing 300 g of water.



The following data were recorded:

| Mass of propan-1-ol bur   | nt                     | = | <i>m</i> g                                   |
|---------------------------|------------------------|---|--|
| Change in temperature of  | of water               | = | ΔT°C   |
| You are given that:       |                        |   |  |
| Relative molecular mass   | of propan-1-ol         | = | 60.0   |
| Enthalpy change of com    | bustion of propan-1-ol | = | –2021 kJ mol <sup>-1</sup>                   |
| Specific heat capacity of | water                  | = | <i>c</i> kJ kg <sup>-1</sup> K <sup>-1</sup> |

What is the efficiency of this heating process?

| Α | $\frac{m \times 2021 \times 1000}{300 \times c \times \Delta T \times 60.0} \times 100$   | % C | $\frac{300 \times c \times \Delta T \times 60.0}{m \times 2021} \times 100\%$             |
|---|---|-----|---|
| В | $\frac{m \times c \times \Delta T \times 60.0}{300 \times 2021 \times 1000} \times 100\%$ | 6 D | $\frac{300 \times c \times \Delta T \times 60.0}{m \times 2021 \times 1000} \times 100\%$ |

- **9.** Ammonia gas and hydrogen chloride gas react to form ammonium chloride as shown in the equation below:
  - $NH_{3}(g) + HCl(g) \rightarrow NH_{4}Cl(s) \qquad \Delta H' = -176 \text{ kJ mol}^{-1}$

The standard entropy change of this reaction is  $-284 \text{ J K}^{-1} \text{ mol}^{-1}$ .

Which of the following statements is not correct?

- **A** At room temperature,  $\Delta G' = +84.4 \text{ kJ mol}^{-1}$ .
- **B** The reaction is spontaneous at 500 K.
- **C** The reaction becomes non-spontaneous at temperatures higher than 620 K.
- **D** There is an increase in order due to the formation of a solid from gases.

**10.** The following equilibrium exists in a system containing carbon monoxide and hydrogen gases.

$$CO(g) + 2H_2(g) = CH_3OH(g)$$
  $\Delta H^2 < 0$ 

Which of the following actions would result in an increase in the yield of methanol gas?

- **A** adding a catalyst
- **B** heating the system
- **C** liquefying the product by cooling
- **D** lowering the pressure of the system
- **11.** The electrolysis of aqueous sodium sulfate, Na<sub>2</sub>SO<sub>4</sub>, was carried out using inert electrodes in the apparatus below. It is observed that bubbles of colourless gases were liberated at the end of each electrode.



Which of the following could give the correct volumes of the gases collected, in  $dm^3$ , at the end of the experiment?

| at positive electrode | at negative electrode                                    |
|-----------------------|--|
| 3.0                   | 6.0  |
| 6.0                   | 3.0  |
| 4.0                   | 6.0  |
| 6.0                   | 4.0  |
|                       | <b>at positive electrode</b><br>3.0<br>6.0<br>4.0<br>6.0 |

**12.** The titration curve below shows the reaction between a solution of a weak monoprotic acid, **HX**, and aqueous sodium hydroxide.



What is the value of  $K_a$ , in mol dm<sup>-3</sup>, for this acid **HX**?

- $\textbf{A} \quad 1.0\times 10^{-3}$
- $\textbf{B} \qquad 1.0\times 10^{-5}$
- $\bm{C} \qquad 1.0\times 10^{-6}$
- $\textbf{D} \qquad 1.0\times 10^{-9}$
- **13.** The solubility product values of two Group II fluorides, at 25 °C, are given in the table below.

| Group II fluorides | $K_{\rm sp}$ / mol <sup>3</sup> dm <sup>-9</sup> |  |
|--------------------|--|--|
| CaF <sub>2</sub>   | 3.9 x 10 <sup>−11</sup>                          |  |
| $BaF_2$            | 1.7 x 10 <sup>-6</sup>                           |  |

A solution L contains 0.100 mol  $dm^{-3}$  of calcium chloride and 0.100 mol  $dm^{-3}$  of barium chloride.

What would happen when equal volumes of solution L and 0.00500 mol dm<sup>-3</sup> of sodium fluoride are mixed together?

- A No precipitate is formed.
- **B** Only a precipitate of  $CaF_2$  is formed.
- **C** Only a precipitate of BaF<sub>2</sub> is formed.
- **D** Both precipitates of  $CaF_2$  and  $BaF_2$  are formed.

14. The rate equation for this reaction  $W + 2X + Y \rightarrow Z$  is given below:

Rate =  $k[\mathbf{X}]^2[\mathbf{Y}]$ 

If the concentration of W is tripled, the concentration of X is halved and the concentration of Y is doubled, by what factor is the rate of reaction being changed?

- **A** 0.5 **B** 1.0 **C** 2.0 **D** 4.0
- **15.** Which of the following elements has the same oxidation number in all of its known compounds?
  - A aluminium
  - **B** nitrogen
  - **C** carbon
  - D chlorine
- **16.** The following graphs show how three properties of the elements, Na to P, and their compounds, vary with proton number.



What properties are shown by the three graphs?

|   | Graph 1                   | Graph 2                   | Graph 3                   |
|---|---------------------------|---------------------------|---------------------------|
| Α | Melting point of oxide    | Melting point of chloride | Conductivity of element   |
| В | Melting point of oxide    | Melting point of element  | Melting point of chloride |
| С | Melting point of chloride | Conductivity of element   | Melting point of oxide    |
| D | Melting point of element  | Melting point of chloride | Conductivity of element   |
|   |                           |                           |                           |

**17.** A 24.62 g sample of a nitrate of a Group II metal is heated until there is no further change. A white residue of 8.42 g remained at the end of the experiment.

Identify the Group II metal involved.

- A beryllium
- **B** magnesium
- **C** calcium
- D barium
- **18.** A compound of chromium with the general formula  $CrCl_{3.6}H_2O$  forms an aqueous solution. When this solution is treated with an excess of aqueous silver nitrate, only one third of the total chloride present is precipitated as AgC*l*.

What represents the structure of the chromium-containing ion present in the original compound?

- A Cr<sup>3+</sup>
- **B**  $Cr(H_2O)_6^{3+}$
- **C**  $[Cr(H_2O)_5Cl]^{2+}$
- $\mathbf{D} \quad \left[ Cr(H_2O)_4 Cl_2 \right]^+$
- **19.** Ethane reacts with chlorine gas in the presence of ultraviolet light to form a mixture of products via free radical substitution. Which statement is true about this reaction?
  - A Homolytic fission occurs only in the initiation step.
  - **B** Chloroethane is formed only in the propagation step.
  - **C** Bond formation occurs only in the termination step.
  - **D** Butane is formed only in the termination step.
- 20. Which one of the following statements about the molecule below is correct?



- A It has a pair of geometric isomers.
- **B** It has an empirical formula of  $C_5H_8Cl$ .
- **C** It gives off  $CO_2$  gas upon oxidation with hot KMnO<sub>4</sub>.
- **D** It forms a tertiary alcohol upon reaction with steam and  $H_3PO_4$  catalyst.

**21.** When ethene reacts with bromine in the presence of concentrated aqueous sodium nitrate, the product contains the following compound.



What is the intermediate formed in this reaction?



- 22. Which one of the following sequences of nitration, alkylation and bromination is expected to give the best yield for the synthesis of 2-bromo-4-nitromethylbenzene from benzene?
  - A alkylation, nitration, bromination
  - **B** alkylation, bromination, nitration
  - **C** nitration, alkylation, bromination
  - **D** nitration, bromination, alkylation
- 23. Which part in the account below is incorrect?

"An excess of aqueous bromine is shaken with aqueous phenol in a test tube. A creamy-white precipitate of 2,4,6-tribromophenol was suspended in a yellow alkaline solution."

- **A** The resultant solution is not alkaline, but acidic.
- **B** The resultant solution is not yellow, but purple.
- **C** The precipitate obtained is not creamy-white, but yellow.
- **D** The precipitate is not 2,4,6-tribromophenol, but a mixture of 2-bromophenol and 4-bromophenol.

**24.** Which diagram correctly shows the movement of electrons when ammonia reacts with a chloroalkane?



**25.** When an alkene **J** is oxidised, a diol is obtained which can be further oxidised to a diketone.

Which of the following could be J?

- **A**  $CH_3CH=C(CH_3)_2$
- **B**  $(C_6H_5)_2C=CHCH_3$
- C (CH<sub>3</sub>)<sub>2</sub>CHCH=CH<sub>2</sub>
- $D = C_6H_5CH=CHCH_3$

26. Which reagent gives a colourless homogeneous solution when added to phenol?

- A aqueous bromine
- **B** aqueous sodium hydroxide
- **C** acidified potassium manganate(VII)
- **D** aqueous sodium hydroxide and benzoyl chloride

27. In which pair of reactions would the intermediate be the same?

- A E and F
- B E and G
- C F and H
- D G and H
- **28.** Two chlorine-containing compounds can be synthesised from an organic compound **P** by the following routes:



When equal amounts of **P**, **Q** and **R** (not necessarily in that order) are added to separate portions of water, solutions with pH values of 0.5, 2.5 and 3.5 are formed.

Deduce which pH value is associated with each of the compounds P, Q and R.

|   | pH 0.5 | pH 2.5 | pH 3.5 |
|---|--------|--------|--------|
| Α | Q      | Р      | R      |
| В | Р      | Q      | R      |
| С | R      | Q      | Р      |
| D | R      | Р      | Q      |

29. Which one of the following shows the correct order of basicity?



- **30.** Partial hydrolysis of a tetrapeptide produces the following three dipeptides, as well as its individual amino acids.
  - i. NH<sub>2</sub>CH<sub>2</sub>CONHCH(CH<sub>3</sub>)COOH
  - ii. NH<sub>2</sub>CH(CH<sub>3</sub>)CONHCH<sub>2</sub>COOH
  - iii. NH<sub>2</sub>CH(CH<sub>3</sub>)CONHCHCOOH

Which one of the following represents the structural formula of the tetrapeptide showing the correct order in which the amino acids are bonded?

- A NH<sub>2</sub>CH(CH<sub>3</sub>)CONHCHCONHCH<sub>2</sub>CONHCH(CH<sub>3</sub>)COOH CH<sub>2</sub>CH<sub>2</sub>COOH
- B NH<sub>2</sub>CH(CH<sub>3</sub>)CONHCH<sub>2</sub>CONHCH(CH<sub>3</sub>)CONHCHCOOH CH<sub>2</sub>CH<sub>2</sub>COOH
- C  $NH_2CH(CH_3)CONHCHCONHCH(CH_3)CONHCH_2COOH$  $<math>H_2CH_2CH_2COOH$

# SECTION B (10 MARKS)

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct.

The responses A to D should be selected on the basis of

| A              | В                | С                | D         |
|----------------|------------------|------------------|-----------|
| 1, 2 and 3 are | 1 and 2 only are | 2 and 3 only are | 1 only is |
| correct        | correct          | correct          | correct   |

No other combination of statements is used as a correct response.

31. Which of the following statements are true?



**32.**  $P_{\text{He}}$  is the partial pressure of helium and  $P_{\text{Ne}}$  is the partial pressure of neon.

*P* is the total pressure of a mixture of the two gases.

Given that the  $A_r$  of helium is 4 and the  $A_r$  of neon is 20, for a mixture of 20 g of helium and 20 g of neon, which of the following are correct?

1  $P_{\rm He} = 0.5P$ 

$$2 \qquad P_{\rm He} + P_{\rm Ne} = P$$

$$3 \qquad P_{\rm He} = 5P_{\rm Ne}$$

| Α              | В                | С                | D         |
|----------------|------------------|------------------|-----------|
| 1, 2 and 3 are | 1 and 2 only are | 2 and 3 only are | 1 only is |
| correct        | correct          | correct          | correct   |

**33.** A cell involving aqueous potassium iodide and acidified potassium manganate(VII) is shown.



Which observations about this arrangement are correct?

- 1 The voltmeter shows a reading of about 0.98 V.
- 2 The potassium iodide solution turns brown.
- **3** The purple colour of the potassium manganate(VII) solution becomes less intense.
- **34.** The graph below shows the Boltzmann distribution of molecular energies at a given temperature.



As temperature increases, which statements are correct?

- 1 The maximum of the curve is displaced to the right.
- 2 The proportion of molecules with energies above any given value increases.
- **3** The proportion of molecules with any given energy increases.

| Α              | В                | С                | D         |
|----------------|------------------|------------------|-----------|
| 1, 2 and 3 are | 1 and 2 only are | 2 and 3 only are | 1 only is |
| correct        | correct          | correct          | correct   |

- **35.** Which of the following increases down Group VII?
  - 1 The strength of the halide ion as a reducing agent.
  - 2 The magnitude of the lattice energy of the sodium halide.
  - 3 The polarity of the hydrogen-halide bond.
- **36.** With reference to the two half equations below, which of the following statements are true?

$$[Fe(CN)_6]^{3-}(aq) + e^- = [Fe(CN)_6]^{4-}(aq)$$
  $E^{3+}(aq) + e^- = Fe^{2+}(aq)$   $E^{3+}(aq) + e^- = Fe^{2+}(aq)$ 

- 1  $[Fe(CN)_6]^{3-}(aq)$  is more stable than  $Fe^{3+}(aq)$ .
- 2  $[Fe(CN)_6]^{4-}(aq)$  is a stronger reducing agent than  $Fe^{2+}(aq)$ .
- **3** Both  $[Fe(CN)_6]^{3-}(aq)$  and  $Fe^{3+}(aq)$  can oxidise  $MnO_4^{2-}(aq)$  to  $MnO_4^{-}(aq)$ .
- **37.** When halogens are dissolved in water, low concentration of hypohalous acids, HOX, and HX are produced as shown in the following reaction:

 $X_2 + H_2O = HX + HOX$  (where X = Cl, Br or I)

The hypohalous acids are weak acids, and have the following  $pK_a$  values:

|      | р <i>К</i> а |
|------|--------------|
| HOCl | 7.43         |
| HOBr | 8.70         |
| HOI  | 10.52        |

Which of the following statements are true?

- 1 Adding more  $X_2$  will increase the yield of the hypohalous acids.
- 2 The order of increasing acidity is HOI < HOBr < HOC*l*.
- **3** The order of increasing acidity is HI < HBr < HC*l*.

| Α              | В                | С                | D         |
|----------------|------------------|------------------|-----------|
| 1, 2 and 3 are | 1 and 2 only are | 2 and 3 only are | 1 only is |
| correct        | correct          | correct          | correct   |

**38.** Alkanes can be prepared from iodoalkanes by heating under reflux with sodium (in ether) according to the equation:

 $2RI + 2Na \rightarrow R-R + 2NaI$ 

Which alkanes will be produced if a mixture containing equal amounts of  $CH_3CH_2I$  (iodoethane) and  $CH_3CHICH_3$  (2-iodopropane) is used?

- **3** CH<sub>3</sub>-CH<sub>2</sub>-CH<sub>2</sub>-CH<sub>3</sub>
- **39.** Which compounds below release a gas when treated with aqueous sodium carbonate?
  - 1 CH<sub>3</sub>COOH
  - **2**  $Cr_2(SO_4)_3$
  - **3** C<sub>6</sub>H<sub>5</sub>OH
- **40.** Which of the following molecules are able to react with *both*  $SOCl_2$  and dilute  $HNO_3$ ?

