2006

Half-yearly Examination

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 1.5 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your student I.D. number on each answer sheet

Total marks   60

Section A   10 multiple choice questions worth 1 mark each
Section B   7 written response questions worth 30 marks in total
Section C   3 longer response questions worth 20 marks in total

TIC: Ms Jackson and Mr Geerling

Section A

Record your answers to the multiple choice questions by colouring in the appropriate circle below.

1 A ◯ B ◯ C ◯ D ◯
2 A ◯ B ◯ C ◯ D ◯
3 A ◯ B ◯ C ◯ D ◯
4 A ◯ B ◯ C ◯ D ◯
5 A ◯ B ◯ C ◯ D ◯
6 A ◯ B ◯ C ◯ D ◯
7 A ◯ B ◯ C ◯ D ◯
8 A ◯ B ◯ C ◯ D ◯
9 A ◯ B ◯ C ◯ D ◯
10 A ◯ B ◯ C ◯ D ◯

1. Identify the substance that is acidic.

    (A) bleach

    (B) lemon juice

    (C) laundry detergents

    (D) distilled water

2. Two solutions of hydrochloric acid were used to investigate the volumes of gas produced when reacted with magnesium. Solution P has a pH of 1 and solution Q has a pH of 2.
    Equal volumes of the solutions were reacted separately with excess magnesium.
    Choose the response that correctly compares the volumes of hydrogen gas produced under the same conditions of temperature and pressure.

    (A) Q produces twice the volume that P produces.

    (B) P produces twice the volume that Q produces.

    (C) P produces ten times the volume that Q produces.

    (D) Q produces ten times the volume that P produces.

3. The following equilibrium was carried out in a closed container at 300°C.

$$C_{(s)} + H_2O_{(g)} \leftrightarrow CO_{(g)} + H_{2(g)}$$
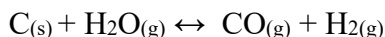
   Which alternative describes the effect of adding more $C_{(s)}$ to this equilibrium mixture 300^0C?

   (A)   There would be no change in the number of moles of $CO_{(g)}$.

   (B)   There would be an increase in the number of moles of $H_{2(g)}$.

   (C)   There would be no change in the number of moles of $C_{(s)}$.

   (D)   There would be an increase in the rate of the reaction.

4. Which statement describes the equilibrium condition in a reversible reaction?

   (A)   The reactants stop changing into products.
   (B)   The activation energy of the forward reaction equals that of the reverse reaction.
   (C)   The concentration of the reactants and the products are equal.
   (D)   The concentration of the reactants and the products are constant.

5. Identify the reason why ethanol is commonly used as a solvent.

   (A)   Ethanol contains polar and covalent bonds
   (B)   Ethanol contains ionic and covalent properties
   (C)   Ethanol has polar and non-polar properties
   (D)   Ethanol is acidic

6. Copper metal was placed into a beaker containing zinc sulfate solution. Use your knowledge of electrochemistry to predict the most likely outcome.

   (A) The copper would be oxidised and the zinc would be reduced.
   (B) The copper would be reduced and the zinc would be oxidised.
   (C) The sulfate ions would oxidise the copper.
   (D) There would be no reaction.

7. Which of the following equations correctly represents the formation of a transuranic element?

   (A) $^{238}_{92}U + ^{4}_{2}He \rightarrow ^{239}_{94}Pu + 3^{1}_{0}n$

   (B) $^{238}_{92}U \rightarrow ^{234}_{90}Pu + ^{4}_{2}He$

   (C) $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{1}H + ^{1}_{1}H$

   (D) $^{1}_{0}n + ^{238}_{92}U \rightarrow ^{88}_{38}Sr + ^{136}_{54}Xe + 12^{1}_{0}n$

8. Which statement best describes the purpose of the salt bridge in an electrochemical cell?

   (A) The salt bridge allows electrons to flow through the circuit.

   (B) The salt bridge allows the ions in the beakers to be reduced.

   (C) The salt bridge creates a pathway for ions to move.

   (D) The salt bridge maintains electrical neutrality in each beaker.

9. Identify which of the following is a product of the process of condensation polymerisation.

   (A) Water

   (B) Hydrogen

   (C) Methane

   (D) Ethanoic acid

10. Ions of which of the following metals would be displaced from solution by the addition of powdered iron?

    (A) Aluminium

    (B) Sodium

    (C) Nickel

    (D) Zinc

Section B

11. The main compound in glass is silicon dioxide (also known as silicon (IV) oxide).

    (a)   With reference to its position on the periodic table, identify the acid-base nature of silicon dioxide.   (1 mark)

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    (b)   Glass bottles are suitable for storing hydrochloric acid, but not sodium hydroxide solution. Explain why glass bottles are not suitable for storing sodium hydroxide. Clarify your answer with a relevant chemical equation.   (2 marks)

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12. An industrial process for producing hydrogen gas uses the following equilibrium reaction:

$$CH_{4(g)} + H_2O_{(g)} \leftrightarrow CO_{(g)} + 3H_{2(g)} \qquad \Delta H = +206 \text{ kJ.mol}^{-1}$$

    (a)   This reaction is carried out at high temperatures. Outline ONE reason for the use of high temperatures.   (1 mark)

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    (b)   Using Le Chatelier's principle, explain the effect increasing pressure would have on the yield of hydrogen   (3 marks)

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13. Evaluate the impact of industrial sources of sulfur dioxide on the environment, using appropriate chemical equations to clarify your answer. (4 marks)

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14. Outline the difference between destructive and non-destructive testing in chemistry, giving an appropriate example of each. (3 marks)

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15. (i)   During the course you performed a first-hand investigation to prepare and test a natural indicator.

(a)   Recount the procedure you used to prepare this indicator.   (2 marks)

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(b)   Assess its usefulness/value as an acid-base indicator.   (2 marks)

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(ii)   Write the full structural formula equations for the;

(a)   Production of ethanol by fermentation. *(Indicate the catalyst used.)*   (1 mark)

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(b)   Dehydration of ethanol. *(Indicate the catalyst used.)*   (1 mark)

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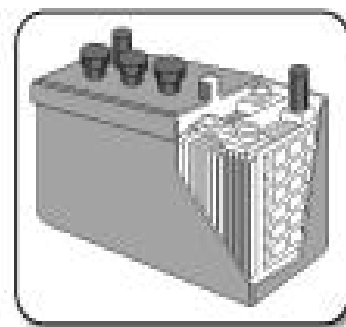
16. You have studied one of the cells shown below.

Cell X   Cell Y

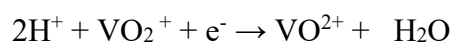(a) Describe the chemistry of the cell you have chosen.   (2 marks)

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(b) One of the half equations which occurs in a vanadium cell is

$$2H^+ + VO_2{}^+ + e^- \rightarrow VO^{2+} + H_2O$$

(i) Identify if this is an oxidation or a reduction half-equation? Justify your answer.   (1 mark)

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(ii) Identify the oxidation state of vanadium in $VO_2{}^+$.   (1 mark)

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17. Assess the potential of ethanol as an alternative fuel source.   (6 marks)

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Section C

18. A student carried out an experiment to monitor the mass changes involved when a soft drink is de-carbonated. The student weighed a sealed can of soft drink and found its mass to be 400 g. The can was then placed on an electronic balance connected to a data logger. The can was then opened and the mass of the can and its contents was recorded by the data logger every hour over a 12-hour period. The following results were obtained.

Time after opening can (hours)	Mass of can and contents (g)
0	400
1	396
2	393
3	391
4	390
5	390
6	390
7	390
8	390
9	390
10	390
11	390
12	390

(a) Assuming that all the mass loss was due to the release of carbon dioxide graph the mass of carbon dioxide released vs the time after opening.   (5 marks)
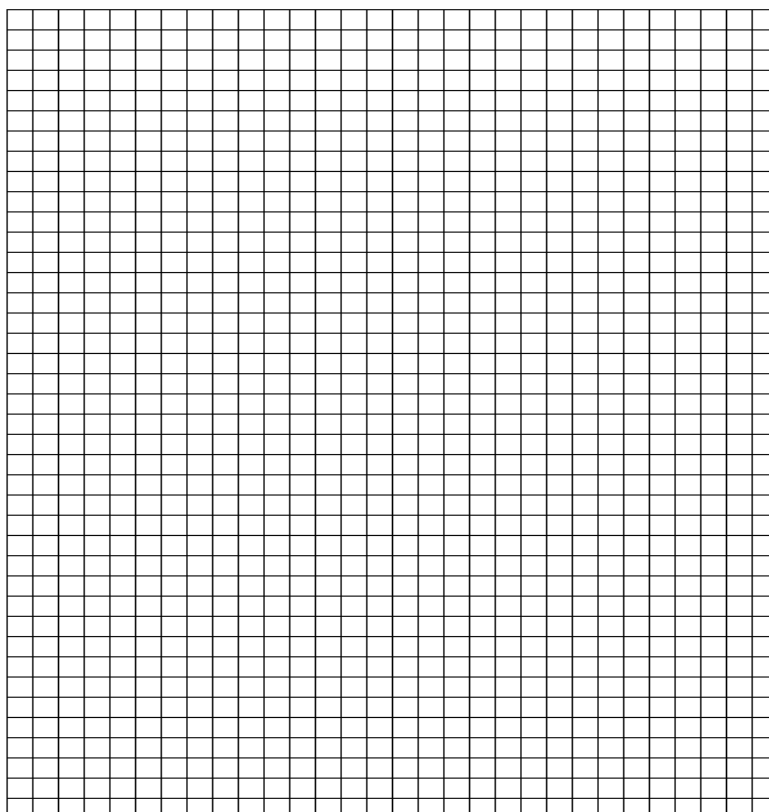
(b)   Describe what happens to the rate of production of carbon dioxide as time proceeds.   (1 mark)

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(c)   Calculate the volume that the carbon dioxide released, would occupy at 25^0C and 100kPa.(2 marks)

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(d)   In part (a), the law of conservation of mass was applied.
        Evaluate whether this investigation alone validates the law of conservation of mass.   (2 marks)

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19. Plant growth is affected by the pH of soils. Table 1 shows the pH range of a number of indicators.

Table 1

Indicator	Colour(low pH-high pH)	Approximate pH range
Thymol blue	Red/yellow	1.2-2.8
Bromocresol green	Yellow/blue	3.8-5.4
Methyl red	Pink/yellow	4.4-6.2
Bromothymol blue	Yellow/blue	6.0-7.6
Phenol red	Yellow/red	6.8-8.4
Phenolphthalein	Colourless/red	8.3-10.0
Alizarin yellow	Yellow/lilac	10.1-12.0

Table 2 shows the soil pH values below which growth of the listed plants is restricted by the pH.

Table 2

Crop	pH
Potatoes	4.9
Apples	5.0
Cabbages	5.4
Wheat	5.5
Beans	6.0
Lettuce	6.1

Describe how indicators could be used to check whether the pH of the soil in a particular area is suited for growing beans. In your answer you should identify which indicator/s could be used and justify your choice. (4 marks)

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20. Use the following abbreviated electrolytic cell to answer the following questions.

$$\text{Pt,Cl}_{2(g)} \mid \text{Cl}^{-}_{(aq)} \parallel \text{Zn}^{2+}_{(aq)} \mid \text{Zn}_{(s)}$$
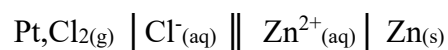
(a) Write the correct half equations for the cell   (2 marks)

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(b) Draw a scientific diagram of the cell and label the anode, cathode, salt bridge, electron flow, electrolytes, anion flow, and cation flow.   (4 marks)

Chemistry

2006 --- Half -Yearly Mark Scheme

Part A

1. B   **2.** C   **3.** A   **4.** D   **5.** C

6. D   **7.** A   **8.** D   **9.** A   **10.** C

Part B - Extended Response

11. (a)

Criteria	Marks
Identifies that silicon dioxide is an ACIDIC oxide	1

11. (b)

Criteria	Marks
Outlines that a neutralisation reaction will occur (acid + base → salt + water) which will 'dissolve' the glass bottle AND Writes an appropriate chemical equation	2
Outlines that an acid reacts with a base in a neutralisation reaction	1

12. (a)

Criteria	Marks
Outlines an appropriate reason such as increases the kinetic energy of particles thus increasing the rate of reaction or favours the forward endothermic reaction increasing yield	1

12. (b)

Criteria	Marks
States Le Chatelier's Principle AND Applies the principle to the equilibrium system, identifying that the reverse reaction will be favoured since there are fewer moles of GASEOUS molecules in the reactants AND Concludes that the yield of hydrogen will DECREASE.	3
TWO of the above points	2
ONE of the above points	1

13.

Criteria	Marks
* Makes a judgement * Demonstrates an extensive knowledge of the industrial sources of SO_2 * Demonstrates an extensive knowledge of the effects of SO_2 on the environment * Includes relevant and correct chemical equations for both the production and impacts on the environment	4
* Outlines two industrial sources of SO_2 OR outlines one industrial source of SO_2 and makes a judgement * Demonstrates a sound knowledge of the effects of SO_2 on the environment * Writes relevant and correct equations to support the information outlined.	3
* Outlines an industrial source of SO_2 * Demonstrates a limited knowledge of the effects of SO_2 on the environment * Writes a relevant and correct equation to support the information outlined.	2
Identifies an industrial source of SO_2 OR identifies an effect of SO_2 on the environment	1

14.

Criteria	Marks
Demonstrates an extensive and precise understanding of the difference between destructive and non-destructive testing AND Outlines an appropriate example of each (derived from first-hand investigations performed in chemistry)	3
Demonstrates a sound understanding of the difference between destructive and non-destructive testing AND identifies an appropriate example of either destructive testing or non-destructive testing OR Demonstrates a limited understanding of the difference between destructive and non-destructive testing AND outlines an appropriate example of each (derived from first-hand investigations performed in chemistry)	2
Identifies a characteristic of either destructive or non-destructive testing	1

OR

Identifies an example of either destructive or non-destructive testing derived from a first-hand investigation carried out in chemistry

15 (i). (a)

Criteria	Marks
Outlines a suitable method for producing a natural indicator AND Clearly identifies the materials and equipment required to do this	2
Outlines a suitable method for producing a natural indicator	1

15 (i). (b)

Criteria	Marks
Makes a judgement regarding the usefulness of the indicator AND Outlines the colours that would be expected when it is placed in an acid, a base and a neutral substance.	2
One of the above points	1

15 (ii).

Criteria	Marks
FULL STRUCTURAL FORMULA equations given for each reaction.	2
Full structural formula given for one reaction OR Correct molecular equations given for each reaction	1

16. (a)

Criteria	Marks
Two correct half-equations (oxidation and reduction)	2
One correct half equation	1

16. (b) (i)

Criteria	Marks
Identifies reaction as reduction and gives an appropriate reason (eg. because the reactants gain electrons)	1

16. (b) (ii)

Criteria	Marks
Identifies the oxidation state as +5 (not '5' – see text, p.39)	1

17.

Criteria	Marks
Extensively draws out the implications of the impact that one or two features of the use of ethanol will have on society. (For example, ethanol burns cleaner than petrol, reducing the emissions of CO and C. This will lead to improved air quality which will reduce the incidence of respiratory problems in humans. In turn, this will reduce the burden on the health system, leading to improved access to health care for emergency-care or terminally ill people).	5-6
Outlines characteristics of the use of ethanol as a fuel and weakly draws out the implications of the impact one or two characteristics will have on society	3-4
Outlines advantage(s) and/or disadvantage(s) of the use of ethanol as a fuel.	1-2

18. (a)

Criteria	Marks
Graphs correct data – mass of CO_2 produced vs time with graph fully labelled and correctly drawn	5
A mark deducted for each error - axes incompletely labelled; poor choice of scale; dependent and independent variables on wrong axis; title for graph missing; points incorrectly plotted; line of best fit imprecise; pencil not used	1-4
OR A maximum of 2 marks allocated if the wrong data is graphed ie. mass of can vs time.	2
Minus a mark for any error	1

18. (b)

Criteria	Marks
Outlines that the rate of production of CO_2 decreases until T = 4 h and then CO_2 production ceases.	1

18. (c)

Criteria	Marks
Calculates the number of moles of CO_2 released (0.22722 mol) and hence the volume released (5.633 L), showing FULL WORKING (including symbol equations)	2
Calculates the number of moles of CO_2 released	1

18. (d)

Criteria	Marks
Makes the judgement that this investigation alone DOES NOT validate the law of conservation of mass AND Gives a reason for this judgement [eg. Since there was no control set up, it can not be concluded with absolute certainty that mass loss was due only to the release of CO_2. Evaporation of water may have contributed to the mass loss (which has been assumed to be due to CO_2 release alone)].	2
Makes the judgement that this investigation alone DOES NOT validate the law of conservation of mass BUT Does not clearly justify the judgement.	1

19.

Criteria	Marks
* Identifies an indicator AND the colour it will show that will narrow the pH range to between 6 and 14 * identifies a second indicator and the colour it will show that will narrow the range further (to closer to 6) * describes a procedure that would be used * acknowledges that a number of soil samples from across the site would be used to improve reliability	4
Three of the above points	3
Two of the above points	2
One of the above points	1

20. (a)

Criteria	Marks
A correct oxidation half-equation and a correct reduction half equation that INCLUDE states	2
Two correct half equations but with states omitted OR One correct half-equation	1

20. (b)

Criteria	Marks
Fully labelled diagram of an electrochemical cell, showing the specific components identified by the short-hand cell notation given in the stem of the question	4
Minus a half mark for each incorrect or missing label or diagram component	0 – 3.5