2011

Trial HSC Examination

Chemistry

General Instructions
Reading time – 5 minutes
Working time – 3 hours

Write using blue or black pen

Draw diagrams using pencil

Approved calculators may be used

Do NOT use liquid paper or white out on this exam paper. If you make a mistake, cross it out then continue writing.
If you do use liquid paper/white out, anything written over it will NOT be remarked at a later date.

Write your student number on each section of this booklet

A data sheet and Periodic Table are provided at the back of this paper

Total marks 100

Section I
75 marks
This section has two parts, Part A and Part B.
Part A – 20 marks
Attempt Questions 1 – 20.
Allow about 35 minutes for this part.
Part B – 55 marks
Attempt Questions 21 – 32.
Allow about 1 hour and 40 minutes for this part.

Section II
25 marks
Attempt ONE question from this section.
Attempt Question 33 – Industrial Chemistry.
Allow about 45 minutes for this section.

Teacher-in-charge: Miss Jackson

Task Weighting: 40%

Section I.

Part A - 20 marks

Attempt questions 1 - 20.
Allow about 35 minutes for this part.
Record your answers on the separate multiple-choice answer sheet.

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Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ● B ⊗ C ○ D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

correct

A ⊗ B ⊗ C ○ D ○

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1. Consider the reaction:

$$Fe_2O_{3(s)} + 2CO_{(g)} \leftrightarrow 2Fe_{(s)} + 2CO_{2(g)} \qquad \Delta H = -283kJ$$

Which change in conditions will move the equilibrium position of this system to the right?

(A) A decrease in pressure
(B) The addition of a catalyst
(C) A decrease in temperature
(D) The addition of more-finely-powdered iron (III) oxide

2. Which of the following is most likely to be a stable isotope?

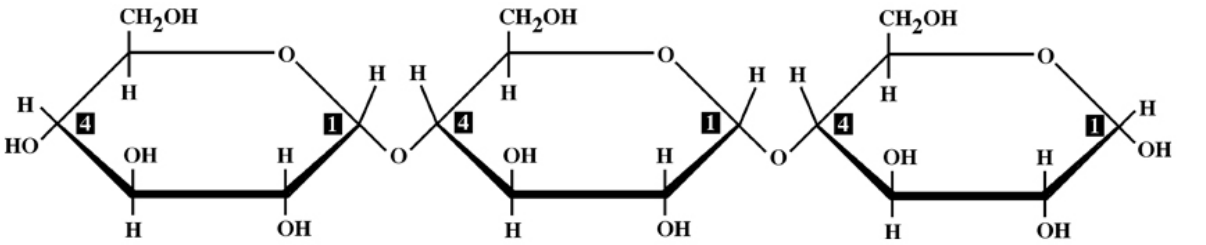
(A) hydrogen-3
(B) oxygen-19
(C) chlorine-38
(D) lead-205

3. Plutonium-241 is an unstable isotope and quickly decays to another, more stable, element by emitting a beta particle. What would be the identity of the new, more stable, element?

(A) americium-242
(B) americium-241
(C) plutonium-242
(D) neptunium-241

The next TWO questions relate to the information presented here.

Starch is an example of a condensation polymer.
A section of a starch molecule is shown below.



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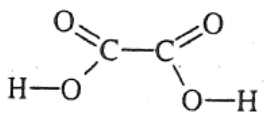
4. What does the term "condensation polymer" mean?

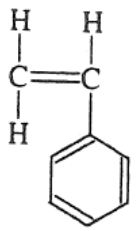
(A) Water is always used as a reactant during the polymerisation reaction
(B) Water is always released as a product during the polymerisation reaction
(C) Water is often used as a reactant during the polymerisation reaction
(D) Water is often released as a product during the polymerisation reaction

5. Cellulose is also a condensation polymer with very different properties. In what way is the structure of cellulose different from the structure of starch?

(A) Each alternate monomer is reversed
(B) Each alternate monomer is inverted
(C) Cellulose is comprised of a different monomer
(D) The number of monomer units in cellulose is much greater than in starch

6. Consider the following structural formulae.

(i)


(ii)


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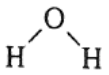
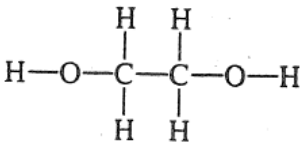


(iv)


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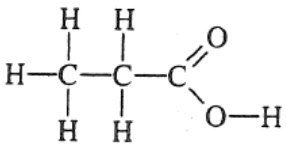
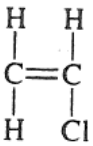


(vi)


Which compounds could be reacted together to form an addition polymer?

(A) (i) and (iv)
(B) (ii) and (iii)
(C) (iii) and (iv)
(D) (v) and (vi)

7. When hydrochloric acid reacts with magnesium metal, hydrogen gas is evolved and magnesium ions are produced. Which statement is correct?

(A) Electrons are transferred from the hydrogen ions to the metal
(B) Hydrogen ions are a strong reducing agent
(C) Hydrogen ions oxidise magnesium
(D) Chloride ions reduce magnesium

8. In which pair is the oxide of the first element more acidic than the oxide of the second element?

(A)	magnesium	sulfur
(B)	carbon	lead
(C)	tin	phosphorus
(D)	silicon	sulfur

9. The Brønsted-Lowry theory applies in both aqueous and non-aqueous systems.
The following reactions may take place in solvents other than water.
Which is NOT a Brønsted-Lowry reaction?

(A) $CO_2 + OH^- \leftrightarrow HCO_3^-$
(B) $NH_4^+ + NH_2^- \leftrightarrow 2NH_3$
(C) $HClO_4 + CH_3COOH \leftrightarrow CH_3COOH_2^+ + ClO_4^-$
(D) $CH_3CHO^- + CH_3NH_3^+ \leftrightarrow CH_3CH_2OH + CH_3NH_2$

10. What is the pH of a 5.0×10^{-5} mol/L solution of barium hydroxide?

(A) 4.00
(B) 4.30
(C) 9.70
(D) 10.00

11. Which of the following 0.1 mol/L aqueous solutions has the highest pH?

(A) Sodium chloride
(B) Ammonium nitrate
(C) Potassium carbonate
(D) Ammonium phosphate

12. The reaction of 1-hexene with bromine water is:

(A) an addition reaction that occurs spontaneously
(B) a substitution reaction that occurs spontaneously
(C) an addition reaction that occurs in the presence of a catalyst
(D) a substitution reaction that occurs in the presence of a catalyst

The next FOUR questions relate to the following information.

A student carried out a titration to determine the concentration of a hydrochloric acid.

To do this the student used sodium carbonate, a primary standard, to prepare 250 mL of a 0.2000 mol/L of sodium carbonate solution using a clean, appropriately rinsed 250 mL volumetric flask.

Exactly 25 mL of the hydrochloric acid solution was measured using a clean, appropriately rinsed pipette and placed into a clean, appropriately rinsed conical flask. Three drops of a suitable indicator was added.

The primary standard solution of sodium carbonate was placed into a clean, appropriately rinsed burette.

The sodium carbonate was run into the conical flask until the end-point was reached. The volume run out of the burette was read and recorded.

The titration was repeated 4 more times. Each time the student made sure that all equipment was appropriately rinsed.

The following results were recorded:

Titration number	Volume of sodium carbonate (mL)	Volume of hydrochloric acid (mL)
1	20.30	25.00
2	20.15	25.00
3	21.75	25.00
4	20.05	25.00
5	20.10	25.00

13. Which of the following lists properties of a primary standard that are NOT essential?

(A) It must be reasonable inexpensive and non-toxic
(B) It must be stable when exposed to air and be reasonably soluble in water
(C) It must be available in a very pure form and be stable when exposed to water
(D) Its formula must be accurately known and it should have a relatively high molar mass

14. To ensure validity of the procedure, each piece of equipment must be appropriately prepared. What should be used to carry out the final rinse of each piece of equipment?

	Volumetric flask	**Pipette**	**Conical flask**	**Burette**
A	Distilled water	Distilled water	Distilled water	Distilled water
B	Sodium carbonate	Hydrochloric acid	Hydrochloric acid	Sodium carbonate
C	Sodium carbonate	Distilled water	Hydrochloric acid	Distilled water
D	Distilled water	Hydrochloric acid	Distilled water	Sodium carbonate

15. Identify the indicator most suitable for this titration.

(A) Methyl orange
(B) Litmus solution
(C) Phenolphthalein
(D) Universal indicator

16. What should the student calculate the concentration of the hydrochloric acid to be?

(A) 0.1612 mol/L
(B) 0.3216 mol/L
(C) 0.3224 mol/L
(D) 0.3275 mol/L

17. Which of the following is NOT an industrial use of ammonia?

(A) Manufacture of explosives
(B) Manufacture of nitric acid
(C) Manufacture of amino acids
(D) Manufacture of nitrogen-rich fertilisers

18. Which of the following compounds is a CFC?

(A) fluoroethane
(B) chloromethane
(C) dichlorodifluoromethane
(D) bromodichlorofluoromethane

19. Some of the first-hand investigations a student studying the HSC Chemistry course carried out are listed below.

(1) Determining the concentration of commercial paver cleaner using a pH meter
(2) Determining the pH of a range of salt solutions using indicators
(3) Determining the reactivity of cyclohexene with bromine water
(4) Modelling the process of polymerization using molecular model kits
(5) Determining the difference in potential of different combinations of metal in a galvanic cell
(6) Preparing a natural indicator
(7) Preparing an ester

Which option in the table below best classifies two of these first-hand investigations as either destructive or non-destructive?

	destructive	***non-destructive***
(A)	(7)	(2)
(B)	(1)	(4)
(C)	(3)	(6)
(D)	(5)	(1)

20. The presence of chlorine free radicals in the stratosphere (due to the breakdown by UV energy of CFCs) causes the depletion of ozone as shown in the equation below.

$$Cl\bullet_{(g)} + O_{3(g)} \rightarrow ClO\bullet_{(g)} + O_{2(g)}$$

What volume at 25°C and 100 KPa of freon-111 (trichlorofluoromethane) would be needed to destroy exactly 50 moles of ozone?

(A) 413 L
(B) 1136 L
(C) 1240 L
(D) 3719 L

Section I (continued)

Part B - 55 marks

Attempt questions 21 – 32.
Read the whole of each question before commencing it.
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.
Allow about 1 hour and 40 minutes for this part.

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21. 45.5 mL of a 0.225 mol/L solution of sodium hydroxide is added to 60.3 mL of a 0.150 mol/L solution of hydrochloric acid and mixed. What is the pH of the resultant solution? 2M

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22. Potassium hydrogen phosphate forms an amphiprotic species in water that is involved in the buffering of living cells.

(a) Write an equation showing how the hydrogen phosphate ion can act as an acid in water. 1M

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(b) From your equation above, identify a conjugate pair. 1M

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(c) Define the term *buffer*. 1M

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23. Identify an alternative used to replace CFCs and account for its use. 2M

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24. Propanoic acid is a weak acid that gives Swiss cheese its characteristic "nutty" flavour. Its concentration is important in the quality of the cheese.
The pH of a 0.200 mol/L aqueous solution of propanoic acid is 2.78.

(a) Write an equation which shows the ionisation of this weak acid in aqueous solution. 1M

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(b) Calculate the degree of ionisation of propanoic acid molecules. Express your answer as a percentage. 2M

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25. The hardness of a sample of water was investigated using the following methods.

Method A	Method B
25.0 mL samples of water were titrated against ethyldiamine tetra-acetic acid (EDTA) with eriochrome black T indicator. On average, 21.7 mL of EDTA was required to reach end-point. The hardness was calculated to be equivalent to 17 mg/L of $CaCO_3$. A water hardness scale (as shown below) was then used to evaluate this result.	Three drops of detergent were added to separate stoppered test tubes containing 5 mL samples of distilled water, hard water and the sample. After shaking the test tubes ten times the heights of froth were compared. The procedure was repeated twice. The amount of froth in the three samples was only slightly less than in the distilled water so it was concluded that the water sample was soft.

Water Hardness Scale	
Conc. of $CaCO_3$ (ppm)	*Classification*
< 20	Soft
20 - 60	Slightly hard
60 - 120	Moderately hard
>120	Hard

ppm = parts per million

assume 1 mL of water has a mass of 1 g

(a) Identify which of the two methods is classified as qualitative. 1M

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(b) The students concluded in method B that the water sample was soft. Justify this conclusion using the results from method A. 1M

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26. Describe the chemistry of EITHER a dry cell OR a lead-acid cell. 3M

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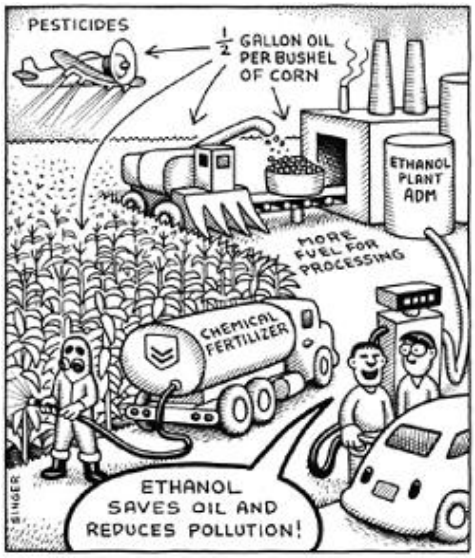
27. Ethanol is a chemical that is an increasingly important energy source, especially for vehicles.



In Australia, E10 petrol (90% petrol; 10% ethanol) is available at most service stations.

Ethanol can be produced industrially from either renewable or non-renewable materials.

1 gallon is a unit used to measure the volume of liquids and is equivalent to 3.8 L.
1 bushel is a unit used to measure the volume of solids and is equivalent to 3.5 cubic metres.

(a) Critically analyse the information portrayed by the cartoon. 3M

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(b) Outline benefits and problems, other than those shown in the cartoon, associated with the use of ethanol as a fuel for vehicles in Australia. 3M

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(c) Compare the processes of ethanol production from renewable materials and non-renewable materials. Include relevant chemical equations in your answer. 3M

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28. Propane, C_3H_8, is a gas used as a fuel when camping. The equation for the combustion of one mole is given.

$$C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(g)} \quad \Delta H = -2220 \text{ kJ/mol}$$

A camper boils 1 litre of water, initially at 20^oC. This uses 350 kJ of heat.

(a) Calculate the mass of propane the camper must carry to enable him to do this. 2M

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(b) What volume would this gas occupy at 100 kPa and 25^oC? 1M

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(c) Sometimes in the combustion of propane, soot (carbon) is formed. Write a balanced equation for the combustion of propane where one of the products is soot. 1M

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29. Describe the physical and chemical methods used to purify and sanitise mass water supplies. 5M

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30. There are benefits and problems associated with the use of radioisotopes in industry and medicine. Analyse the impacts on society of the use of radioisotopes in both industry and medicine. In your answer, give examples of specific radioisotopes. 7M

31. A working electrochemical cell was set up using two half-cells. Its structure is represented below:

$$Fe \ / \ Fe^{2+}_{(aq)}, Fe^{3+}_{(aq)} \ // \ Zn \ / \ Zn^{2+}_{(aq)}$$

(a) Draw a labelled diagram showing how this cell could be set up in the laboratory to measure the potential difference between the electrodes. Include the anode, cathode and direction of electron flow in your labelling. 3M

(b) What is the purpose of the salt bridge in the cell, represented as // above? 2M

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(c) Write a balanced net ionic equation for the reaction that occurs in the electrochemical cell. 1M

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(d) Calculate the theoretical cell voltage if the cell were under standard conditions. 1M

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32. (a) Write a balanced equation for the Haber process, including states of matter. 1M

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(b) Justify the choice of temperature and pressure conditions used to optimise the yield in the Haber process. 4M

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(c) Identify the catalyst used in the Haber process and explain its purpose. 3M

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Section II.

25 marks

Attempt Question 33 - Industrial Chemistry.

Allow about 45 minutes for this part.

Show all relevant working in questions that require calculations.

Question 33. – Industrial Chemistry.

(a) (i) Outline ONE use of sulfuric acid in industry. 1M

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(ii) Describe the Frasch process. 3M

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(b) Methane and steam can react to form carbon monoxide and hydrogen according to the equation:

$$CH_{4(g)} + H_2O_{(g)} \leftrightarrow CO_{(g)} + 3H_{2(g)} \qquad \Delta H = +131 \text{ kJ/mol}$$

4.0 moles of methane and 5.0 moles of steam are placed into a sealed 2.0 litre container which is heated to 450°C and allowed to react until equilibrium is reached.
Measurements show that there is 1.5 moles of methane in the container at equilibrium.

(i) Determine the number of moles of the other gases at equilibrium. 2M

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(ii) Write the expression for the equilibrium constant for this reaction. 1M

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(iii) Determine the numerical value for the equilibrium constant at 450°C. 2M

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(iv) Predict what would happen to the numerical value of the equilibrium constant if volume of the container was increased to 4.0 litres. 1M

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(c) Modelling is used in chemistry to represent chemical reactions and explain concepts. Analyse the model you used in class to demonstrate an equilibrium reaction. 5M

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(d) "Cationic detergents are an ideal replacement for the (earlier) anionic detergents."
Evaluate this statement. 3M

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(e) The production of sodium hydroxide can be carried out industrially using different electrolytic processes.

(i) Describe the diaphragm process and its products. 3M

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(ii) Compare the environmental issues and the technical considerations in the diaphragm process with those associated with the membrane process. 4M

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Multiple-choice Answer Sheet

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

(A) ⬭ (B) ⬬ (C) ⬭ (D) ⬭

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

(A) ⬬ (B) ⬬ (C) ⬭ (D) ⬭

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word correct and drawing an arrow as follows:

correct

(A) ⬬ (B) ⬬ (C) ⬭ (D) ⬭

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) ⬭
11.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
12.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
13.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
14.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
15.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
16.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
17.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
18.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
19.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭
20.	(A) ⬭	(B) ⬭	(C) ⬭	(D) ⬭

Marking Guidelines THSC Exam 2011
Year 12 CHEMISTRY

Multiple choice

Question	Answer		Question	Answer
1	C		11	C
2	D		12	A
3	B		13	A
4	D		14	D
5	B		15	A
6	D		16	B
7	C		17	C
8	B		18	C
9	A		19	D
10	D		20	C

21.

Marking criteria	*Marks*
Calculates the pH of the resultant solution to be 12.052, **with** appropriate working. *(nb. 3 d.p. to match the 3 significant figures in the data provided)*	2
Identifies the pH of the resultant solution to be 12.05, **without** appropriate working. OR Calculates the moles of sodium hydroxide to be 1.02375 X 10^{-2} mol and the moles of hydrochloric acid to be 9.045 X 10^{-3} mol. *(nb. answers should NOT be round off because these are NOT final answers)*	1

22.a.

Marking criteria	*Marks*
Provides the correct equation, including an equilibrium arrow. $HPO_4^{2-} + H_2O \leftrightarrow PO_4^{3-} + H_3O^+$	1

22.b.

Marking criteria	*Marks*
Identifies one conjugates acid/base pair eg. H_3O^+/ H_2O ; HPO_4^{2-}/ PO_4^{3-}	1

22.c.

Marking criteria	*Marks*
Provides a feature of a buffer solution - i.e. → a mixture of a weak acid with its conjugate weak base OR → its function is to resist changes in pH.	1

23.

Marking criteria	*Marks*
Identifies that **HCFCs** can be an alternative because they are **broken down in the troposphere** due to the higher reactivity of the C-H bond OR Identifies that **HFCs** can be an alternative because they **contain no chlorine or bromine** and do not promote ozone destruction even if they are transported to the stratosphere	2
Identifies that either HCFC s or HFCs are used as alternatives to replace CFCs.	1

24.a.

Marking criteria	*Marks*
Provides the correct equation (including an equilibrium arrow), namely → $CH_3CH_2COOH + H_2O \leftrightarrow CH_3CH_2COO^- + H_3O^+$	1

24. b.

Marking criteria	*Marks*
Calculates the % ionisation to be 0.83% with full and appropriate working.	2
Calculates the $[H^+]$ to be 1.6595 X 10^{-3} mol/L	1

25.a.

Marking criteria	*Marks*
Identifies that Method B is qualitative	1

25.b.

Marking criteria	*Marks*
Provides the analysis that since the water hardness calculated via method A of 17mg/L equates to 17 ppm, the water is classified as soft.	1

26.

Marking criteria	*Marks*
For the cell nominated, describes → the oxidation reaction AND the reduction reaction AND the electrolyte(s) required	3
For the cell nominated, describes TWO of the three points identified above	2
For the cell nominated, describes ONE of the three points identified above	1

27.a.

Marking criteria	*Marks*
NOTE: critically means provide extra depth rather than find fault. Draws out the contradictory relationship between the positive statement 'ethanol save oil' and the negative background information '1/2 gallon oil per bushel of corn' & 'more fuel for processing' AND Draws out the contradictory relationship between the positive statement 'ethanol reduces pollution' and the negative background information 'pesticides' & 'chemical fertiliser'	3
Draws out ONE of the relationships as outlined above OR Identifies the TWO positive statements AND identifies TWO negative statements provided by the cartoon	2
Identifies the TWO positive statements provided by the cartoon OR Identifies the TWO negative statements provided by the cartoon OR Identifies ONE positive statement and ONE negative statement provided by the cartoon	1

27.b.

Marking criteria	*Marks*
Outlines TWO advantages of ethanol as a fuel **other than** those identified in 27.a. AND Outlines TWO disadvantages of ethanol as an alternative fuel **other than** those identified in 27.a.	3
Outlines ONE advantage AND ONE disadvantage of using ethanol as a fuel **other than** those provided by the cartoon	2
Outlines ONE advantage OR ONE disadvantage of using ethanol as a fuel **other than** those provided by the cartoon	1

27.c.

Marking criteria	*Marks*
Provides a correct balanced equation for the fermentation of glucose *(nb. no states or catalysts required)* AND Provides a correct balanced equation for the hydration of ethene *(nb. no states or catalysts required)* AND Compares the processes of fermentation of glucose and hydration of ethene by providing THREE similarities and/or differences between the two processes For example:	3

Feature being compared	Fermentation	Hydration	Similarity /difference
Starting material	glucose	ethene	difference
Catalyst used?	yes	yes	similarity
Nature of catalyst	Biological (organic)	inorganic	difference
Identity of catalyst	yeast	dilute H_3PO_4 or dilute H_2SO_4	difference
Another product?	yes (CO_2)	no	difference
Other reactant?	no	yes (H_2O)	difference

Provides a correct balanced equation for the fermentation of glucose AND Provides a correct balanced equation for the hydration of ethene AND Compares the processes of fermentation of glucose and hydration of ethene by providing ONE similarity or difference between the two processes	2
Provides a correct balanced equation for the fermentation of glucose OR Provides a correct balanced equation for the hydration of ethene OR Compares the processes of fermentation of glucose and hydration of ethene by providing ONE similarity or difference between the two processes	1

28.a.

Marking criteria	*Marks*
Calculates the mass of propane required as 6.95 g with full and appropriate working	2
Identifies the mass of propane required as 6.95 g without full and appropriate working OR Calculates the moles of propane used to be 0.1576 mol.	1

28.b.

Marking criteria	*Marks*
Calculates the volume of propane to be 3.9L	1

28.c.

Marking criteria	*Marks*
Provides a correct, balanced equation. eg. $C_3H_{8(g)} + 2O_{2(g)} \rightarrow 3C_{(s)} + 4H_2O_{(l)}$ *nb. there is more than one correct answer*	1

29.

Marking criteria	*Marks*
Demonstrates an extensive knowledge of BOTH chemical and physical processes used to purify AND sanitise a town water supply by describing FIVE different processes including details about chemicals used &/or specialised equipment used (where appropriate)	5
Demonstrates a thorough knowledge of BOTH chemical and physical processes used to purify AND sanitise a town water supply by describing THREE or FOUR different processes including details about chemicals &/or specialised equipment used (where appropriate) OR Demonstrates a sound knowledge of FIVE techniques (which include both chemical and physical)used to purify and sanitise a town water supply by outlining the features of the techniques.	3-4
Demonstrates a basic knowledge of BOTH chemical and physical processes used to purify and sanitise a town water supply by identifying an example of each (ie. TWO processes) OR Demonstrates a sound knowledge of EITHER chemical or physical processes used to purify and sanitise a town water supply by outlining the features of ONE example of a process.	2
Demonstrates a basic knowledge of EITHER chemical or physical processes used to purify and sanitise a town water supply by identifying ONE example.	1

30.

Marking criteria	*Marks*
* Demonstrates a thorough knowledge and understanding of THREE named radioisotope(s) – one must be used in industry; one must be used in medicine; the third can be used in either industry or medicine * Describes the use in industry and in medicine of the named radioisotopes * Describes the benefits and problems of their use on society * Provides a judgement * FOR 7 MARKS – demonstrates coherence and logical progression and includes correct use of scientific principles and ideas	6-7
* Demonstrates a sound knowledge and understanding of a named radioisotope and its use in industry AND a named radioisotope and its use in medicine (ie. TWO radioisotopes) {OR two named isotopes with their uses} * Describes the use in industry and in medicine of the named radioisotopes * Describes the benefits and problems of their use on society	4-5
* Demonstrates an understanding of one named radioisotope. * Identifies the use in industry or medicine of the named radioisotope. * Outlines the benefit(s) and/or problem(s) of their use	2-3
Identifies a radioisotope used in medicine/industry OR Identifies a benefit/problem of the use of a radioisotope	1

31.a.

Marking criteria	*Marks*
* Draws an appropriate diagram that shows all the components of an electrochemical cell that could be set up in a laboratory * The diagram is fully labelled to identify all components of the equipment (voltmeter, beakers, conducting wire, salt bridge) and chemicals used (zinc electrode, iron electrode, Zn^{2+} solution, Fe^{2+} solution, Fe^{3+} solution) * AS WELL, the diagram is labelled to identify the anode (Zn), the cathode (Fe) and direction of electron flow (from anode to cathode)	3
* TWO of the three points as outlined above	2
* Presents a diagram that is partially labelled to identify the direction of electron flow from anode to cathode	1

32.b.

Marking criteria	*Marks*
(1) Identifies that the salt bridge allows for the migration (movement) of ions which …… (2) allows ions to flow acting as charge carriers and completing the circuit AND ALSO (3) allows ions to flow through it from one electrolytic solution to the other to maintain the electro-neutrality of each solution	2
Outlines ONE of the three points above	1

32.c.

Marking criteria	*Marks*
Presents the appropriate equation for the cell that has been drawn for 32.a. The best answer is $Zn_{(s)} + 2Fe^{3+} \rightarrow Zn^{2+} + 2Fe^{2+}$	1

32.d.

Marking criteria	*Marks*
Determines the voltage to be +1.53V (or +0.32V for an incorrect answer to 32.c.) NOTE: a negative voltage is incorrect.	1

33.a.

Marking criteria	*Marks*
Presents a correct equilibrium equation, including states: $N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$	1

33.b.

Marking criteria	*Marks*
(1) Identifies that the chemical reaction for the Haber process is exothermic (E) (2) Identifies that the temperature used is a compromise condition (C) (3) Identifies the typical temperature used in modern-day Haber process plants (400-500°C) (T) AND explains the choice of temperature, relating to both Le Chatelier's Principle and the Collision Theory (TY, TR) (4) Identifies the typical pressure used in modern-day Haber process plants (25 MPa) (P) AND explains the choice of pressure, relating to Le Chatelier's Principle (PY)	4
(1) Identifies that the chemical reaction for the Haber process is exothermic (E) (2) Identifies/implies that the temperature used is a compromise condition (C/CI) (3) Identifies the typical temperature used in modern-day Haber process plants (400-500°C) (T) AND explains the choice of temperature, relating to both Le Chatelier's Principle and the Collision Theory (TY, TR) OR Identifies the typical pressure used in modern-day Haber process plants (25 MPa) (P) AND explains the choice of pressure, relating to Le Chatelier's Principle (PY)	3
(1) Identifies that high temperature increases rate of reaction AND Identifies that low temperature increases yield AND Identifies that high pressure increases yield OR (2) Identifies the specific temperature AND the specific pressure used in modern-day Haber process plants	2
Identifies that high temperature increases rate of reaction OR Identifies that low temperature increases yield OR Identifies that high pressure increases yield OR Identifies the specific temperature used in modern-day Haber process plants OR Identifies the specific pressure used in modern-day Haber process plants	1

33.c.

Marking criteria	*Marks*
(1) Identifies the catalyst as iron (II/III) oxide, magnetite or Fe_3O_4 (with no incorrect contradictory information!) AND explains its purpose by describing a cause & effect relationship, namely :- (2) Cause: a catalyst lowers the activation energy requirement (3) Effect: increases the reaction rate (or lowers the temperature required for reaction)	3
Provides TWO of the three points as above	2
Provides ONE of the three points as above	1

OPTION – Industrial Chemistry

a. (i).

Marking criteria	*Marks*
Identifies ONE use of sulfuric acid in industry and provides one feature of this use	1

a.(ii).

Marking criteria	*Marks*
Identifies (in words or via a **very clear**, well labelled diagram) that the Frasch process involves embedding THREE concentric pipes into the sulfur deposit AND Correctly identifies the pipe through which each of the three mixtures travels:- (superheated water =outermost pipe; air = innermost pipe; sulfur/water dispersion = middle pipe) AND Outlines features of each step of the process AND Provides specific details regarding the superheated water (@ 165°C) AND the air (compressed)	3
Correctly identifies the pipe through which each of the three mixtures travels (as above) AND	2

Outlines features of each step of the process	
Outlines features of each step of the process BUT mixes up the order of the pipes through which each mixture travels	1

b. (i).

Marking criteria	*Marks*
Identifies the number of moles of the three other gases as: moles H_2O = 2.5 mol moles CO = 2.5 mol moles H_2 =. 7.5 mol	2
Determines the number of moles of ONE of the three gases (as above)	1

b.(ii).

Marking criteria	*Marks*
Provides a correct equilibrium constant expression. $K = \frac{[H_2]^3[CO]}{[CH_4][H_2O]}$ *nb. must include 'K ='*	1

b.(iii).

Marking criteria	*Marks*
Determines the value of K to be 70.13 with appropriate working (including a substituted equilibrium constant expression) AFTER determining the concentration of each of the four gases OR Determines a value of K that is correct for an incorrect answer in b.(i)	2
Determines the value of K to be 281.25 with appropriate working (including a substituted equilibrium constant expression) because the values substituted were moles rather than concentrations	1

b.(iv).

Marking criteria	*Marks*
Identifies that the value of K will NOT CHANGE	1

c.

Marking criteria	*Marks*
Outlines an appropriate model of an equilibrium system that was used in class AND Clearly relates THREE or FOUR features of the model to specific characteristics of chemical systems at equilibrium. For example: (1) a closed system (2) dynamic in nature (3) rate of forward reaction is equal to rate of reverse reaction (4) [reactants] and [products] remain constant (5) imposing a change on the system results in a new equilibrium being established	4-5
Outlines an appropriate model of an equilibrium system that was used in class AND Implies ONE or TWO of the key features of a chemical system at equilibrium or reaching equilibrium	2-3
Outlines a feature of the model used in class OR Outlines an advantage of using models OR Outlines a limitation of using models	1

d.(i).

Marking criteria	*Marks*
Makes a judgement AND Provides, in brief, THREE reasons to back up the judgement OR provides, in more detail, TWO reasons to back up the judgement AND The answer DOES NOT contain incorrect or contradictory information For example, "in brief" → they have different uses "in more detail" → anionic detergents are used in shampoos and general cleaning products whereas cationic detergents are used in hair conditioners and fabric softeners	3
Makes a judgement AND Provides, in brief, TWO reasons to back up the judgement OR provides, in more detail, ONE reason to back up the judgement	2
Provides, in brief, ONE piece of information that compares/contrasts anionic and cationic detergents	1

e.(i).

Marking criteria	*Marks*
Describes, in detail, the process of sodium hydroxide production using a diaphragm cell including its structural features (eg. titanium anode) and its chemistry (eg. Cl^- is oxidised at the anode) AND Identifies the three products produced NOTE: the best answers used a well labelled diagram only to answer this question	3
Describes the process of sodium hydroxide production using a diaphragm cell including its structural features and its chemistry BUT with some of the key details missing AND Identifies the three products produced	2
Identifies the three products produced	1

e.(ii).

Marking criteria	*Marks*
Compares the two processes for THREE or FOUR significant/specific issues (a mix of environmental & technical) by providing details relating to each issue for both processes with an appropriate link word (eg. "whereas", "both")	3-4
As above for TWO issues OR Describes TWO issues associated with the diaphragm process and then separately describes the same two issues for the membrane process	2
Describes ONE issue associated with the diaphragm process and then separately describes the same issue for the membrane process	1