Baulkham llills Iligh School

Trial Examination

IIigher School Certificate

2015

Chemistry

2 Unit

Directions:

- Reading time, 5 minutes
- Working time, 3 hours
- Write your Candidate Number in the space indicated
- Board approved calculators may be used
- Write using black or blue pen only
- Draw diagrams using pencil
- All answers are to be written on the paper provided
- Please check your paper at the start of the exam to ensure all pages are present and correctly collated

Total Marks: 100

This paper contains THREE sections

Section I - **Multiple Choice**
20 marks
Pages 1 - 9

Section II - **Extended Responses**
55 marks
Pages 10 - 22

Section III - **Chemistry of Art**
25 marks
Pages 23 - 26

Section I – 75 marks
20 marks
Part A – 20 marks
Attempt Questions 1 – 20
Allow about 35 minutes for this part

Use the multiple-choice answer sheet for Questions 1 – 20

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1. Ethanol can be converted to ethylene using which reaction and catalyst below?

    a) Addition with a dilute sulphuric acid catalyst
    b) Substitution with a dilute sulphuric acid catalyst
    c) Hydration with a concentrated sulphuric acid catalyst
    d) Dehydration with a concentrated sulphuric acid catalyst

2. Which reagent can be used to differentiate between an alkane and an alkene?

    a) Aqueous bromine
    b) Concentrated sulphuric acid
    c) Zeolites
    d) Ziegler-Natta catalyst

3. The reaction below shows the ionisation of hydrogen fluoride in water.

    $$HF + H_2O \rightleftharpoons H_3O^+ + F^-$$

    Identify the acid / conjugate base pair?

    a) H_2O / H_3O^+
    a) HF / F^-
    b) HF / H_2O
   c) H_3O+ / F^-

4. The element krypton-87 undergoes *beta decay*.

    Which of the following equations correctly represents this reaction?

    a) $\frac{87}{36}Kr \rightarrow \frac{83}{34}Se + \frac{4}{2}\alpha$

    b) $\frac{87}{36}Kr \rightarrow \frac{87}{37}Rb + \frac{\bullet}{-1}e$

    c) $\frac{87}{36}Kr \rightarrow \frac{87}{35}Br + \frac{0}{+1}e$

    d) $\frac{87}{36}Kr \rightarrow \frac{0}{-1}e + \frac{87}{35}Br$

5. Which of the following lists shows the compounds in order of decreasing boiling point?

   a) ethanol > ethane > ethanoic acid
   b) ethane > ethanol > ethanoic acid
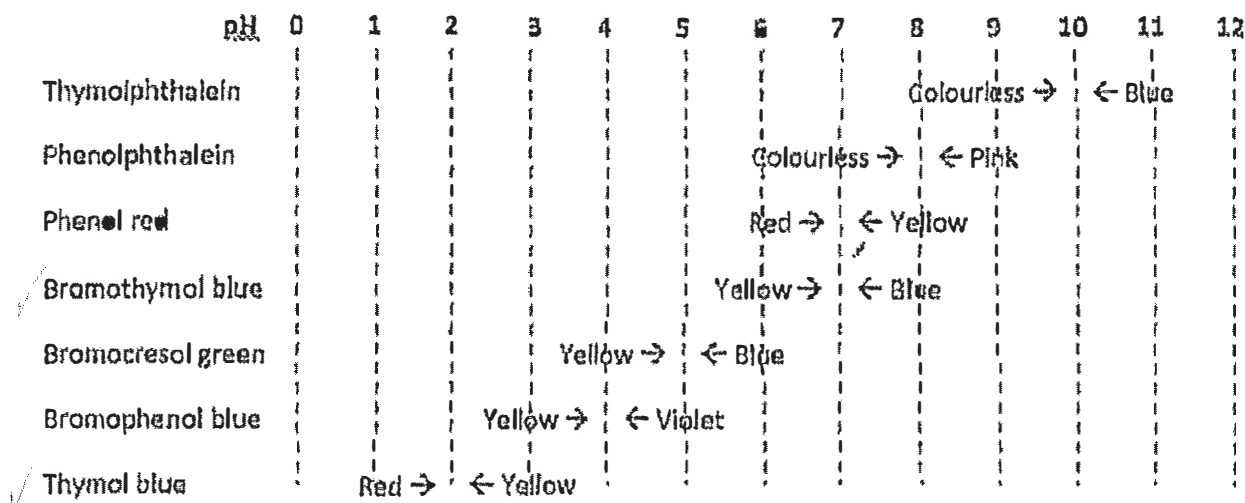   c) ethanoic acid > ethanol > ethane
   d) ethanoic acid > ethane > ethanol

6. The molecular structures of three ethylene-based plastics X, Y and Z are shown below.
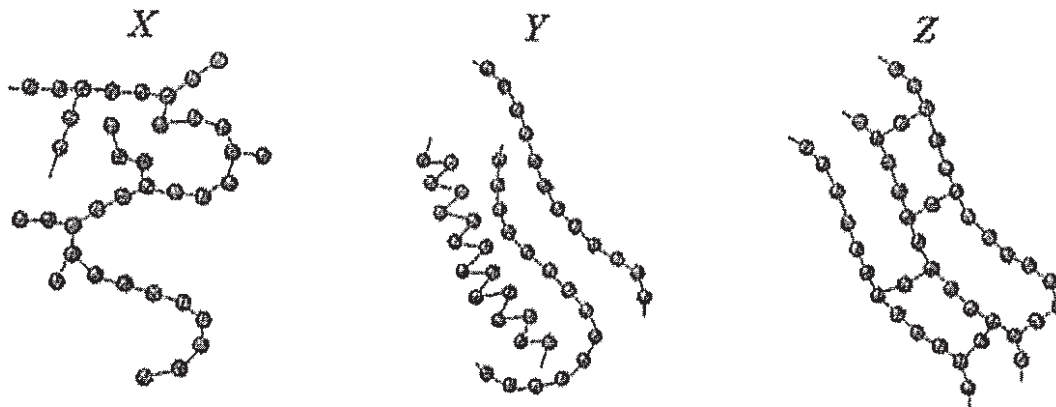
   Which plastic is most likely to be soft and flexible?

   a) X
   b) Y
   c) Z
   d) *Both* Y and Z

7. The chart below shows the colours of some indicators over a range of pH values.

   For the solution of pH 4.5, which set of indicators could be used to give the most accurate determination of pH?

   a) Bromocresol green, phenol red and phenolphthalein
   b) Thymol blue, bromophenol blue and phenolphthalein
   c) Thymol blue, bromothymol blue and thymolphthalein
   d) Thymol blue, bromophenol blue and bromoscrescol green

8. An experiment was performed to determine the volume of carbon dioxide gas released during the fermentation of a glucose solution. The reaction took place over several days in a flask containing yeast that was immersed in a water bath at 28°C and stoppered with cotton wool.
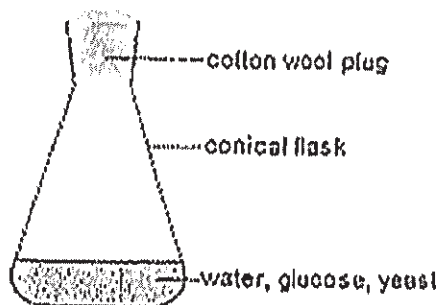
Which of the following factors would most significantly compromise the validity of this experiment?

a) The evaporation of water
b) The temperature of the water bath
c) Measurement error associated with determining the mass lost
d) The lack of oxygen due to the presence of the cotton wool plug

9. The graph below shows how the solubility of carbon dioxide in water varies with temperature at a constant pressure.
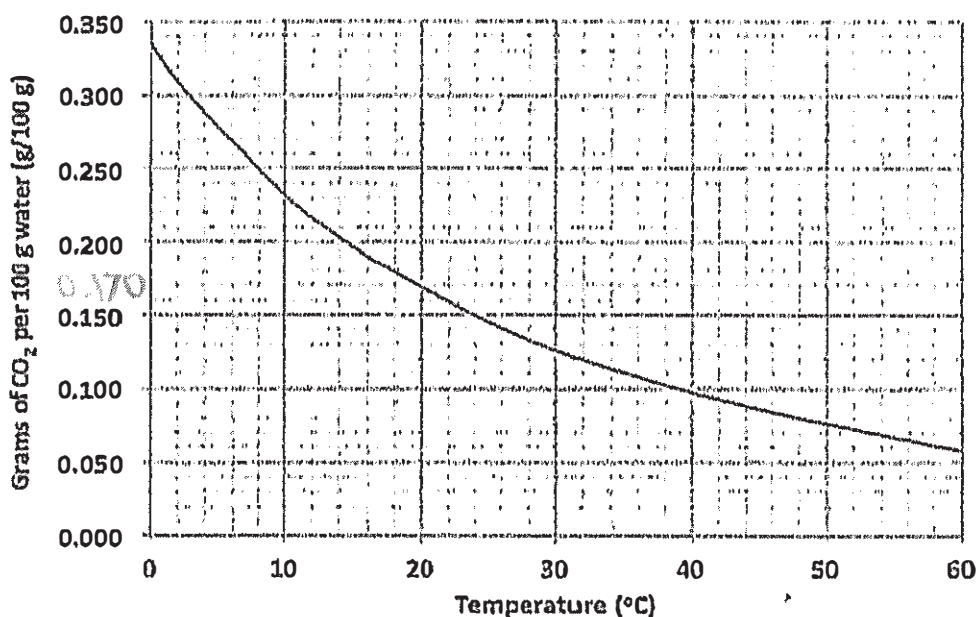

Which of the following statements is correct regarding the solubility of carbon dioxide in 100g of water when the temperature of water is increased from 20°C to 40°C?

a) 36 ml of carbon dioxide will dissolve when measured at 25°C and 100 kPa
b) 36 ml of carbon dioxide will dissolve when measured at 0°C and 100 kPa
c) 39 ml of carbon dioxide will be produced when measured at 25°C and 100 kPa
d) 39 ml of carbon dioxide will be produced when measured at 0°C and 100 kPa
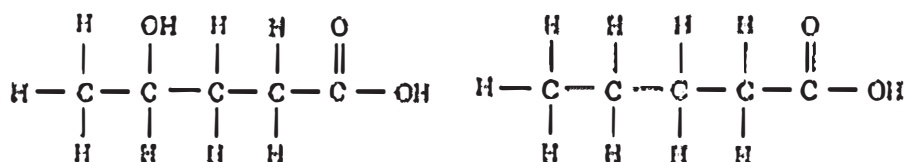
3

10. Polyhydroxyalkanoates (PHAs) are often called bacterial plastics because they are made using genetically modified bacteria. One widely manufactured and used polyhydroxyalkanoate is PHBV.

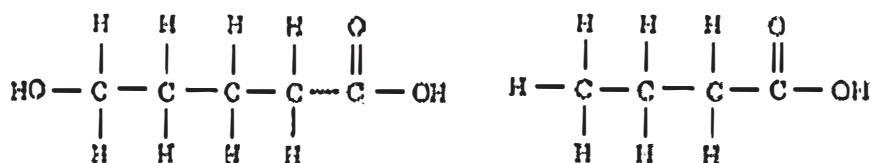PHBV is a condensation polymer with the repeating section of the structure shown below.
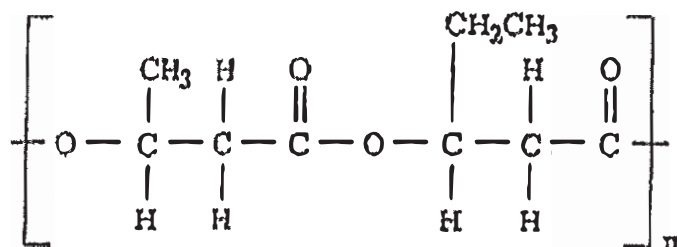
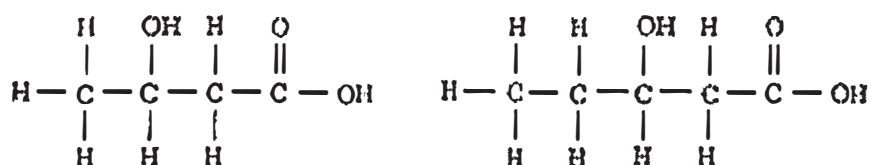Which two monomers are used to make PHBV?

a)

b)

c)

d)

4
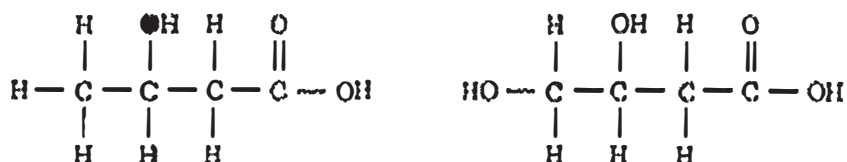
11. Which of the following species is amphiprotic?

    a) NH_4^+
    b) HCO_3^-
    c) H_3O^+
    d) OH^-

12. Copper (I) sulphide can be rapidly roasted in air, enriched with oxygen, to form copper in a flash smelter.

WHB = waste heat boiler (steam generator)
ESP = electrostatic precipitator
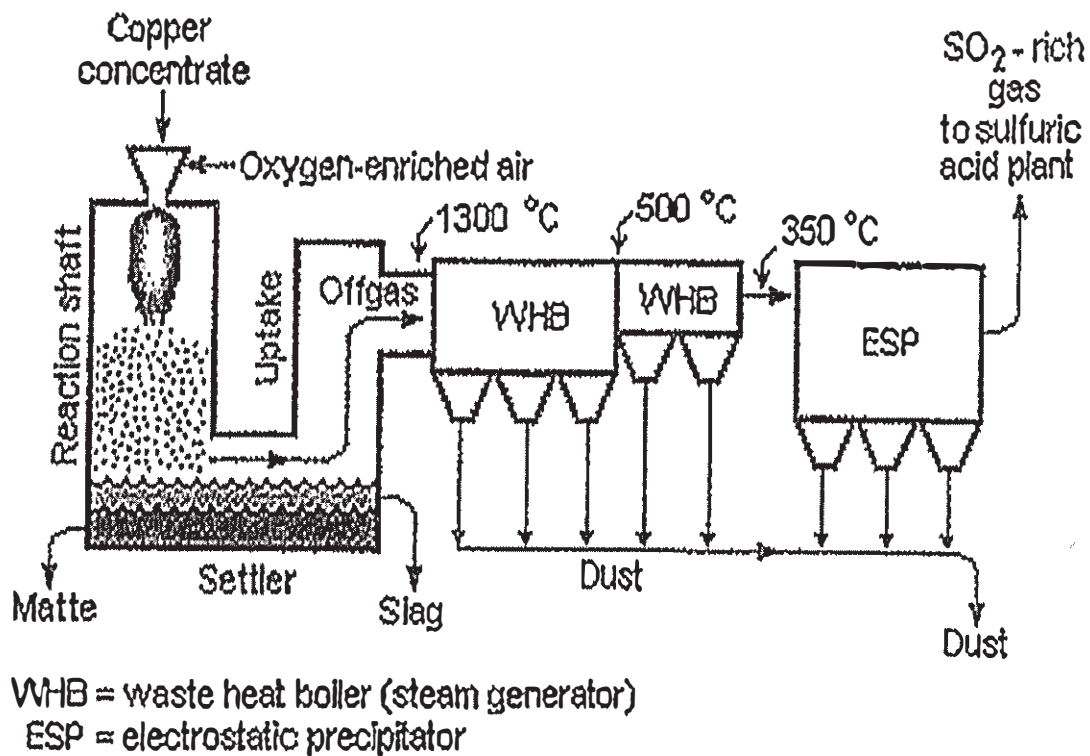
The sulphide ore reacts with oxygen to produce copper and sulphur dioxide gas.

If 5.45 kg of copper is produced, what volume of sulphur dioxide gas (measured at 25°C and 100 kPa) would be generated for use at the sulphuric acid plant?

    a) 531 L
    b) 975 L
    c) 1060 L
    d) 2660 L

5

13. The diagram shows a galvanic cell.
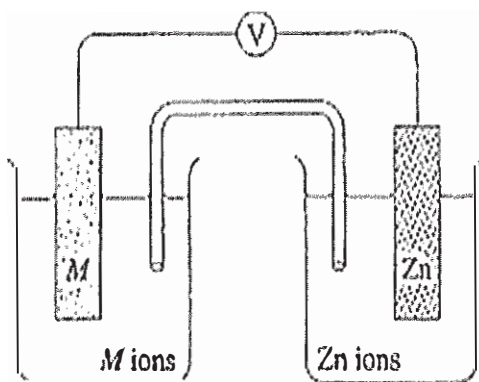
Which of the following metals (M) acting as an anode would produce the lowest theoretical potential for the cell?

a) Calcium
b) Copper
c) Iron
d) Manganese

14. Consider the following graph which relates to the Haber process:
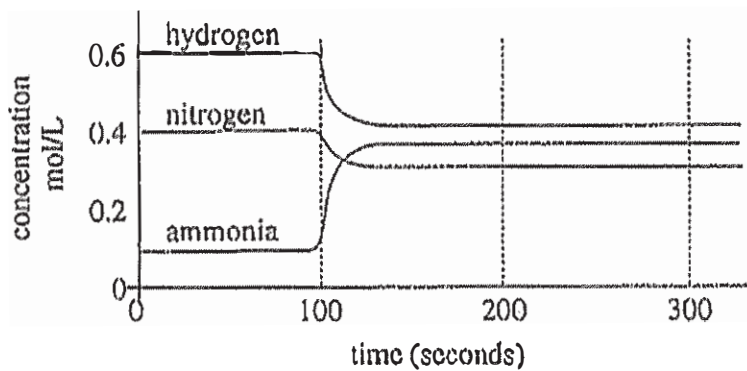
Which of the following caused the changes in concentration observed after 100 seconds had passed?

a) The pressure was decreased
b) The temperature was decreased
c) A catalyst was added to the reaction vessel
d) The volume of the reaction vessel was increased

15. Some reactions of the metals Q, R and S are given below.

Metal	Reaction in air	Reaction with water	Reaction with dilute hydrochloric acid
Q	Burns to form metallic oxide	Reacts with steam to form hydrogen	Hydrogen is formed
R	Reacts slowly to form metallic oxide	Does not react	Does not react
S	Reacts to form metallic oxide	Does not react	Hydrogen is formed

In a galvanic cell, Q+, R+ and S+ would represent cations of these metals.

Which galvanic cell will produce the greatest voltage?

(A)
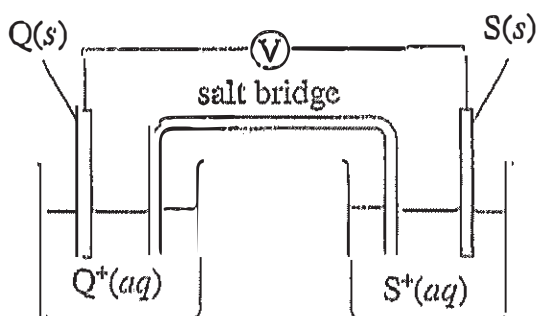
(B)
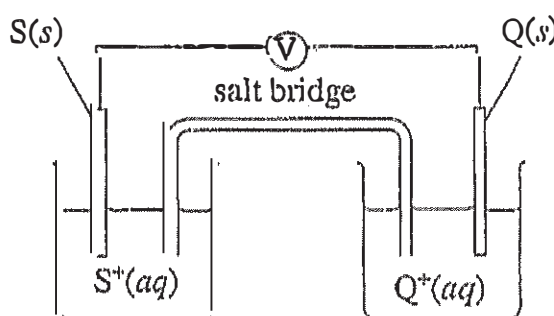
(C)
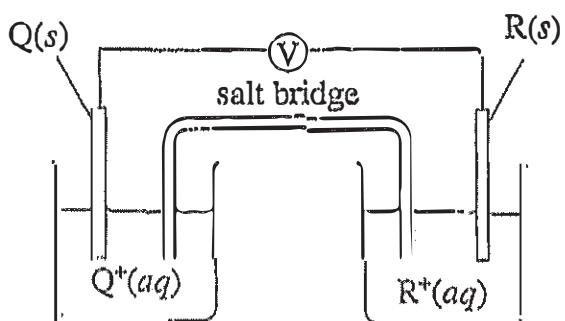
(D)
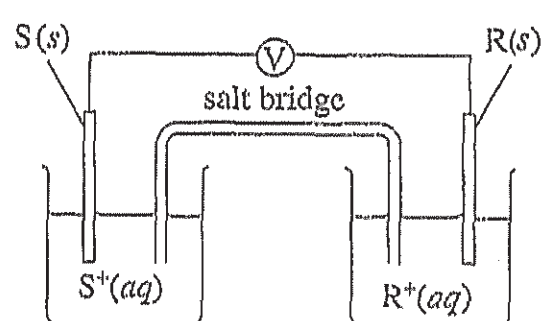
16. A student was given 35 g of glucose to perform an anaerobic fermentation reaction in a flask where the carbon dioxide produced was able to escape. The graph below shows the change in mass of the reaction vessel over seven days.
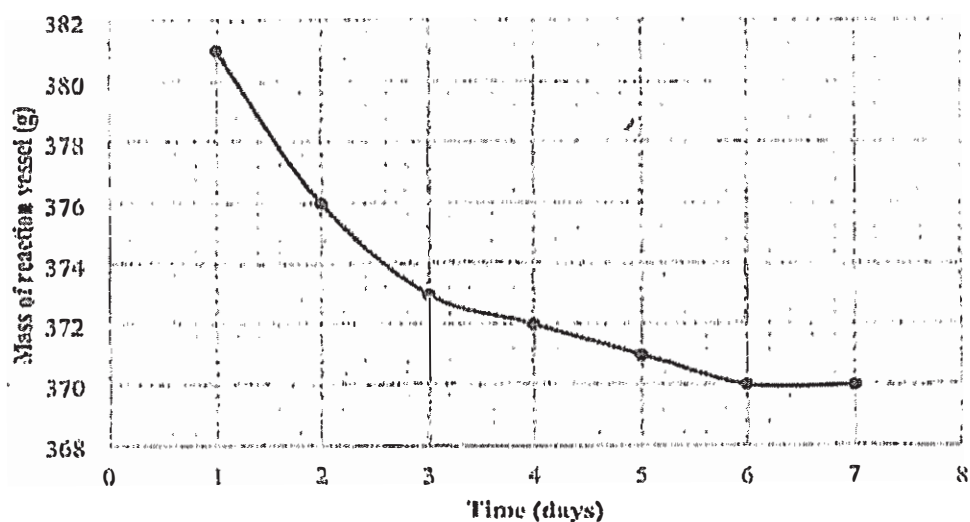
The mass of the reaction vessel becomes constant after Day 6 because –

a) all of the glucose has been used up in the reaction
b) the fermentation reaction has reached equilibrium
c) the ethanol concentration is too high and the yeast have died
d) the carbonic acid produced from the dissolution of carbon dioxide in water lowers the pH and kills the yeast

17. The following graphs show the change in concentration (in mol/L) of three substances, P, Q and R, with time in a reaction mixture, at constant temperature.
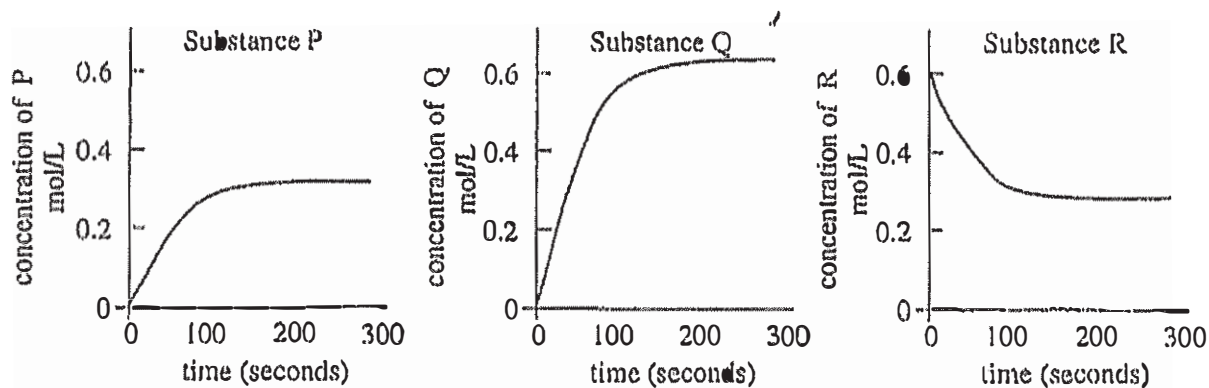
The equation for the reaction is –

a) $P(aq) + Q(aq) \Leftrightarrow R(aq)$
b) $2Q(aq) \Leftrightarrow R(aq) + P(aq)$
c) $R(aq) \Leftrightarrow 2Q(aq) + P(aq)$
d) $P(aq) \Leftrightarrow 2Q(aq) + R(aq)$

18. Consider the following chemical reactions involving acids.

   i) $2HCl(aq) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$
   ii) $CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$
   iii) $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$

   Lavoisier, Davy and Arrhenius each proposed different definitions of acids. The equations matching each chemist's theory would be -

   a) Arrhenius – I, Davy – II and Lavoisier – III
   b) Davy – I, Lavoisier – II and Arrhenius – III
   c) Davy – I, Lavoisier – III and Arrhenius – II
   d) Lavoisier – I, Arrhenius – II and Davy - III

19. The equipment shown was used to heat two reactants with a concentrated sulphuric acid catalyst.
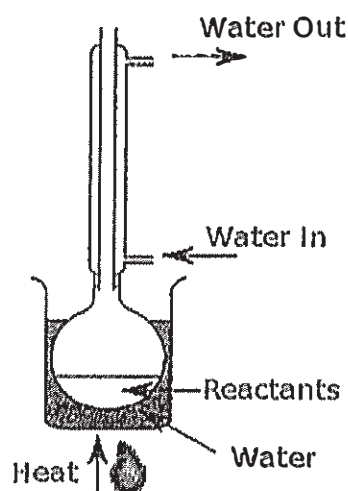
   Which of the following is a possible combination of reactants and product(s)?

	Reactants	Products
a)	Water and sulphuric acid	Hydrogen, oxygen and sulphur
b)	Methanoic acid and ethanoic acid	Methylethanoate
c)	Propanoic acid and butan-1-ol	Butylpropanoate
d)	Butanoic acid and propan-1-ol	Propylbutanoate and water

20. Which of the following describes a correct procedure to test for barium ions in 2mL of a dilute solution?

   a) Add a few drops of dilute sulphuric acid
   b) Add a few drops of dilute sodium hydroxide
   c) Add a few drops of dilute hydrochloric acid, filter and heat the residue
   d) Add a few drops of dilute sodium nitrate, and observe any colour change

End of Section I

Section II – Extended Response
55 marks

Write your answers to Section II in the spaces provided.
Individual marks are indicated for each question

Question 21 (5 marks)

A news article, published in June 12, included the following commentary:

> A 2012 global acidification study found that in the USA, Canada and Western Europe, sulphur dioxide emissions have declined considerably. In China, sulphur dioxide emissions are now reaching levels that haven't been seen in the USA since 1970.

With reference to this report, discuss the decline in emissions of some countries and the reasons for concern about rising emissions in other countries.

5

Question 22 (5 mark)

Examine the galvanic cell in the diagram below.
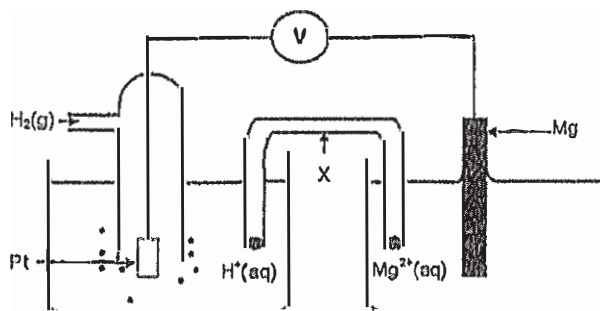
a) Identify the *cathode* in this cell AND write the *half-equation* for the cathode reaction.   **2**

b) Identify TWO conditions for this to be a _standard cell_.   **2**

c) Identify a significant function of the structure labelled 'X' in the diagram.   **1**

Question 23 (4 marks)

There are benefits to be gained by working as part of a team when undertaking an investigation

Justify this statement, with reference to a specific chemical occupation you have studied in your chemistry course.   **4**

Question 24 (5 marks)

The 1.2 volt rechargeable nickel metal hydride (Ni-MH) battery was developed in the 1980's.

This dry cell type battery has the advantages of high energy density, rapid recharge and non-toxic components. One disadvantage is its short 'shelf-life' through self-discharge.

The overall reactions occurring in a Ni-MH battery are represented below.

$$NiO(OH)(s) + MH(s) \rightarrow Ni(OH)_2(s) + M(s)$$

The metal M is actually an intermetallic compound using a blend of metals.

(a) Identify the oxidation state of nickel in $NiO(OH)$ and $Ni(OH)_2$ to determine whether nickel is being oxidised or reduced in this reaction.

2

(b) Compare the structure and chemistry of another type of battery that you have studied, to the Ni-MH battery.

3
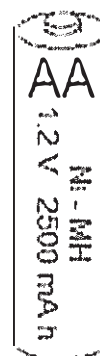
Question 25 (5 marks)

The table below compares some properties of two fuels – octane (found in petrol) and ethanol.

Property	Octane	Ethanol
Molar Mass (g)	114.224	46.068
Boiling point (°C)	126	78
Density (g L^{-1})	700	790
Heat of Combustion (kJ mol^{-1})	5500	1371

a) Suggest a reason why ethanol has a *lower* boiling point **but** is denser than octane.   1

b) Calculate the *heat of combustion* in kJ g of each of these fuels.   2

   (i)   Octane:

   (ii)   Ethanol:

c) Outline ONE advantage and ONE disadvantage in using ethanol as an alternative fuel to octane (petrol). Refer to the calculations in part (b) to support your answer.   2

Question 26 (6 marks)

A chemist titrated 25.0mL of diluted (1:10) household vinegar against a standardised solution of 0.112 mol L^{-1} sodium hydroxide solution.

The chemist used a pH meter, attached to a graphical data recorder. The righ-hand diagram shows the output of the data recorder.
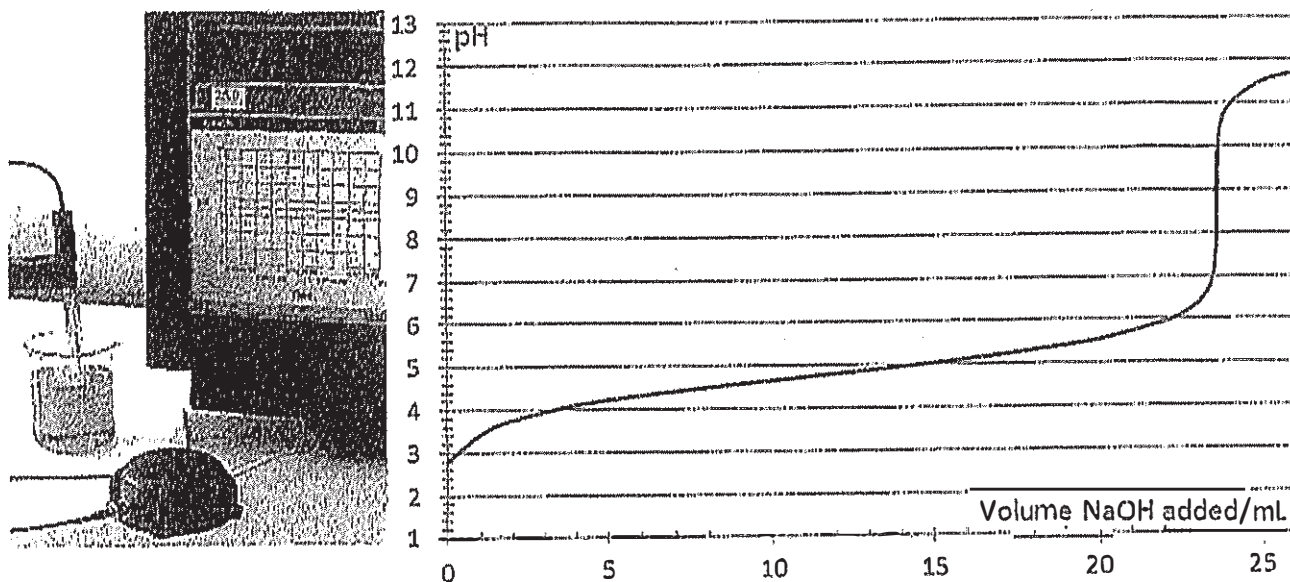
An extract of the chemist's notebook showed:

> Volume diluted vinegar for titration = 25.00 mL (by pipette)
>
> Concentration of standard NaOH solution = 0.112 mol L^{-1}
>
> Equivalence Point = 23.6 mL, pH = 9.1

a) Determine the concentration of acid in the diluted vinegar.   **2**

Question 26 continues on the next page

b)   Explain what the initial pH and equivalence point pH, suggest about the acidic

     properties of vinegar.)   **2**

c)   The chemist needs to use the same pipette to <u>dilute the vinegar AND to</u> measure out
     a <u>25.00mL sample for titration.</u>

     Describe the procedure that should be followed between these TWO steps   **1**

d)   Outline ONE advantage of using a computer-based technology for recording this
     type of measurement.   **1**

Question 27 (4 marks)

Buffers occur in many natural systems, including caves, soils and living organisms. Buffers are found in blood (H_2CO_3 / HCO_3^-) and in internal cell fluids ($H_2PO_4^{-1}$/HPO_4^{2-}).

a)   Describe the function of a buffer.   1

b)   Choose one of the buffer systems above and explain how it is able to act as a buffer
     using chemical equations.   3

Question 28 (3 marks)

a)   Cellulose is a condensation polymer and a biopolymer. It is found in plant cell walls.   **3**

b)   The structures below are representations of two hydroxyl-acids.

Glycolic Acid

Lactic Acid
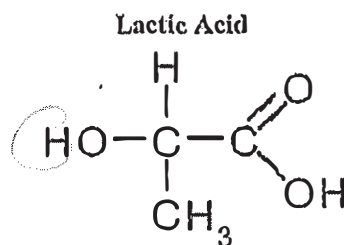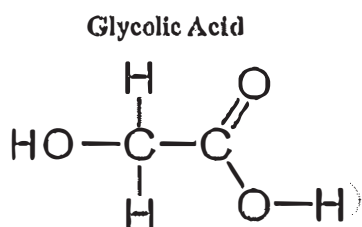
Draw the structural formula of <u>one</u> organic molecule formed when these two acids undergo condensation (note: more than one possible answer).   **1**

Question 29 (4 marks)

Describe the use of *acids* as food additives AND *esters* as flavourings and perfumes.
Include a *named* example of each.

Question 30 (3 marks)

Radioisotopes are used in industry and medicine. Using the table below or otherwise, identify a radioisotope used in one of these fields and relate its use to its properties.

Radioisotope	Radiation emitted	Half life
Americium-241	Alpha, beta	432.6 years
Cobalt-60	Beta, gamma	5.27 years
Caesium-137	Beta, gamma	30 years
Tritium (Hydrogen-3)	Beta	12 years
Technetium-99m	Gamma	6 hours
Iodine-123	Beta, gamma	13.2 hours
Iodine-131	Beta, gamma	8 days

Question 31 (4 marks)

An experiment was conducted to investigate the formation of ammonia in the Haber process.

The graph below shows the system reaching equilibrium after a mixture of the reactants was injected into the reaction vessel at time 0.

At time T_1, the volume of the reaction vessel is doubled.
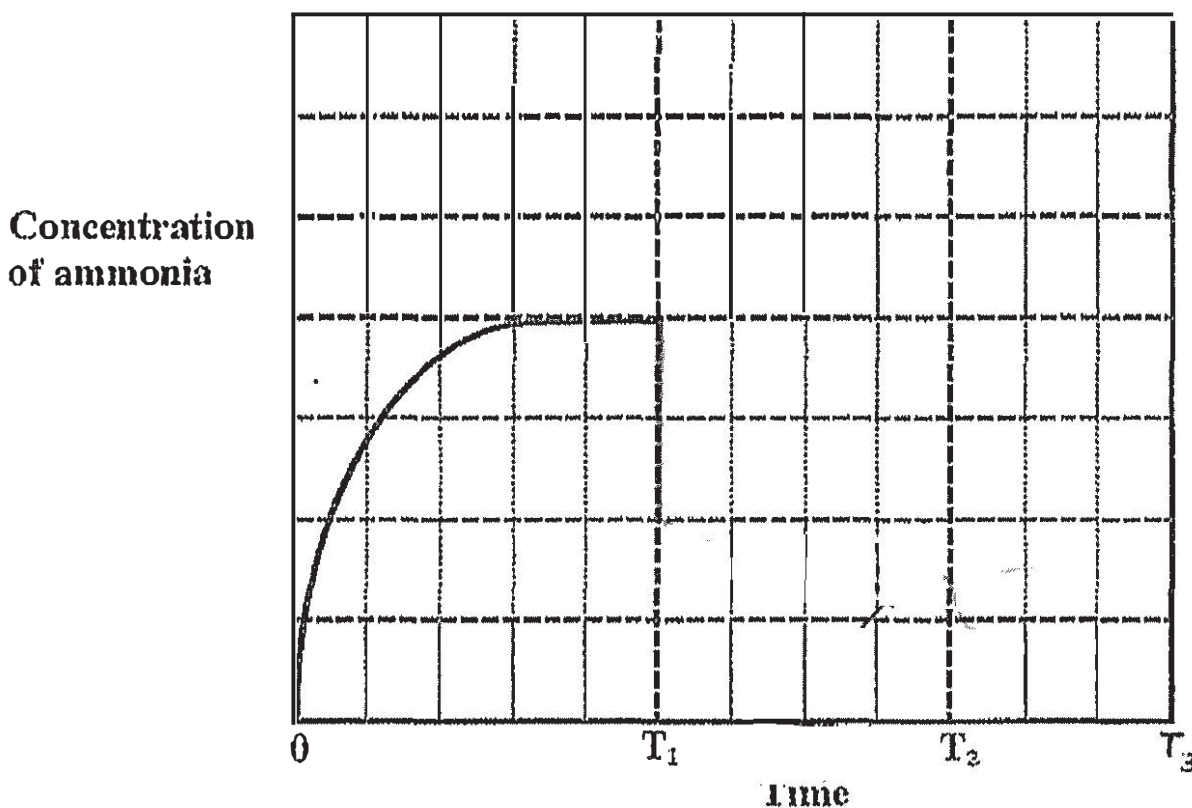
a) Draw a line on this graph to sketch the concentration of ammonia from T_1 to T_2, when equilibrium is re-established, at the same temperature. 1

b) Referring to your graph, justify the use of high pressure in the Haber Process 2

c) At T_2 the temperature was increased. Draw a line on the graph to sketch the concentration of ammonia from T2 to T3 when equilibrium is re-established 1

Question 32 (4 marks)

The oxides of some elements have chemical properties that can be used to identify them as acids, bases or both.

a)   Identify a basic oxide and write a chemical equation to show it acting as a base (other than the example given in b) below).   **2**

b)   The equations below show the behaviour of zinc oxide in two different chemical reactions.   **2**

$$① \quad ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(l)$$
$$② \quad ZnO(s) + H_2O(l) + 2KOH(aq) \rightarrow K_2Zn(OH)_4(aq)$$
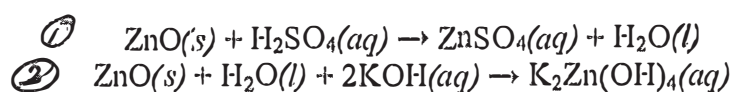
Use these equations to account for zinc oxide's classification as an amphoteric oxide.

Question 33 (3 marks)

In some developing countries, arsenic(III) ions (As^{3+}) in groundwater present a serious health risk for many people. When concentrations exceed 10 ppb, arsenic poisoning can result from drinking contaminated water. The Solar Oxidation and Removal of Arsenic (SORAS) process irradiates drinking water in plastic bottles with sunlight to reduce arsenic(III) levels.

Atomic absorption spectroscopy (AAS) can be used to determine the concentration of arsenic(III) ions in the water. The absorbance values for some standard solutions of arsenic(III) ions are shown in the table below.

Concentration of As(III) ions (ppb)	Absorbance
50	0.12
100	0.23
150	0.35

Samples of groundwater from Bangladesh were tested using AAS and the absorbance values before and after SORAS treatment were measured and recorded.

Sample	Absorbance
Groundwater sample before treatment	0.18
Groundwater sample after treatment	0.13

Evaluate the effectiveness of the SORAS treatment in preventing arsenic poisoning from drinking groundwater. 3

Section III – The Chemistry of Art
25 marks
Write your answers to Section II in the spaces provided.
Individual marks are indicated for each question

Marks

Question 34 – The Chemistry of Art

a)   Explain the trends for electronegativity shown in the diagram below   **3**
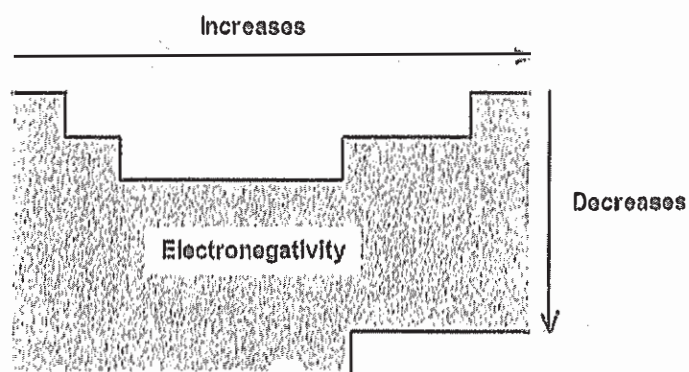
b)   i)   Describe ONE reaction in which $KMnO$ acts as an oxidising agent. Include
half equations and a balanced chemical e uation in your answer   **3**

Question 34 – The Chemistry of Art (continued)

    ii)   Explain why $KMnO_4$ is a strong oxidising agent.   **2**

c)   The structures shown below, marked A and B, represent two complex ions.

              A   **B**
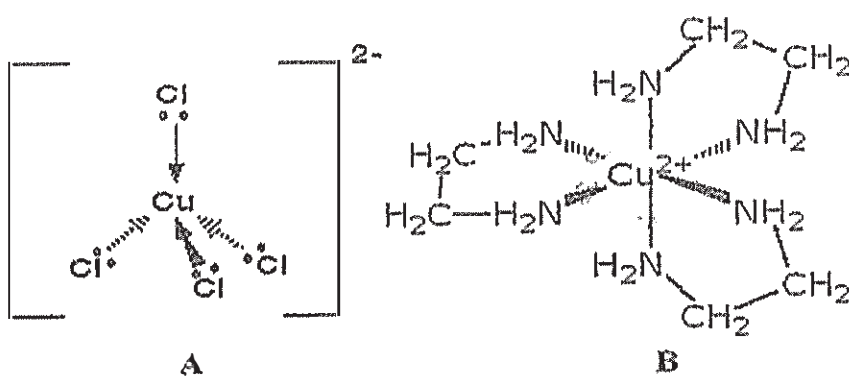
    i)   The oxidation number of copper in structure A is +2. Show how this is derived.   **1**

    ii)   Compare the structure and bonding of ions A and B.   **3**

Question 34 – The Chemistry of Art (continued)

d)   Several methods have been used for analysis and identification of pigments in art.

Name and describe ONE current analytical technology and assess its importance in the identification of elements in substances   .

Include examples of the use of this technology.   7

Question 34 – The Chemistry of Art (continued)

e) Describe the contribution of Pauli to our understanding of electrons in atoms. **2**

f) Bright colours such as green, blue, red and yellow were used extensively by ancient Egyptians in art, body painting and makeup.

    i) Select ONE of the colours above and identify the name or chemical formula of a mineral used to produce the selected colour. **1**

    ii) Outline the procedure that the Egyptians would have followed to make paint from minerals such as the one you identified in (f)(i). **2**

End of Paper

1- D   2-A   3-B   4-B   5- C   6-A   7-D   8- A   9- C   10- C   11-B   12- C   13- D

14- B   15- C   16- C   17-C   18- B   19-D   20-A

Q21

Criteria	Mark
• Clear and significant reference to article • Reason for rising levels in China • Significant reason for decline in emission in USA, Canada and Western Europe • Three reasons for concern about rising emission outlined • A statement relating to rising levels in China being a concern for the rest of the world as atmospheric pollutants are carried around the globe	5
• 4 of the above criteria met	4
• 3 of the above criteria met	3
• 2 of the above criteria met	2
• 1 of the above criteria met	1

SO_2 is an acidic oxide which reacts with water and oxygen resulting in acid rain. SO_2 can form H_2SO_3 which then oxidises to H_2SO_4. Effects of acid rain include change of soil chemistry , plants sensitive to soil pH growth affected, leaf damaged, aquatic life could be killed, limestone, marble and concrete buildings can be damaged and it can affect human health. Strict controls on emission have lowered levels of SO_2 in the USA, Canada and Western Europe. Levels in other countries like China are rising. Atmospheric pollutants are carried around the globe, so this is a problem for all nations.

Q22 (a)

Criteria	Mark
• The platinum electrode is named as the cathode AND a correctly balanced half equation is written	2
• The platinum electrode is named as the cathode OR a correctly balanced half equation is written	1

Cathode is Platinum

Half equation: $H^+_{(aq)} + e^- \longrightarrow {}^x H_{2(g)}$

Q22(b)

Criteria	Mark
• TWO correct conditions identified	2
• ONE correct condition identified	1

Any two conditions:

- Electrode concentration $= 1.0 mol L^{-1}$
- Temperature = 25C
- Standard pressure = 100kPa

Q22 (c)

Criteria	Mark
• A correct and significant function of X is stated	1

- X is a salt bridge with a dissolved salt that allows charges to move so the circuit can be completed.

OR

- The cations and anions in this salt bridge move into the respective electrolytes to maintain their neutrality.

Q23

Criteria	Mark
• THREE or more advantages given, relevant examples given	4
• TWO advantages AND ONE example given	3
• ONE advantages AND ONE example OR TWO advantages given	2
• ONE relevant piece of information	1

ADVANTAGES:

- Roles can be assigned
- Planning can be collaborative
- Risks assessed
- Results discussed
- Validity and reliability assessed
- Goals assessed

Some investigations can be large such as water testing or ion identification. A team can ensure all tests are performed and reliable and valid results are obtained.

Secondary is also necessary to determine the test methodology and expected results. Roles can be swapped between team members allowing skills to be developed.

Q224a)

Criteria	Mark
• Correctly identifies both oxidation states AND the reduction of Nickel	2
• Correctly Identifies both oxidation states OR the reduction of Nickel	1

The oxidation no of nickel in NiO(OH) is +3 and in Ni(OH)$_2$ is +2

Therefore Nickel is being reduced

Q24(b)

Criteria	Mark
• Describes similarities and differences in the structure and chemistry of the chosen battery to that of Ni-MH battery	3
• Describes the structure and chemistry of the chosen battery in detail without comparing it to the Ni-MH battery • Describes both similarity and differences in structure of to that of Ni-MH battery but a mistake was found in the chemistry of the battery chosen	2
• Describes a similarity or difference in the structure and chemistry of the chosen battery to that of a Ni-MH battery	1

Eg A lead acid cell is wet cell battery with a liquid electrolyte, unlike the Ni-MH dry cell. The lead acid cell is made of separate sets of lead and lead(IV) oxide plates immersed in dilute sulphuric acid. The lead plate acts as the anode, oxidising to form Pb^{2+} ions in the form of solid PbSO$_4$

$$Pb_{(s)} + SO_4{}^{2-}{}_{(aq)} \longrightarrow PbSO_{4(s)} + e^-$$

The lead (IV) oxide plate acts as the cathode, reducing Pb^{4+} ions, also in the form of solid PbSO$_4$

The voltage generated by the lead acid cell is approximately 2 volts, considerably higher than the 1.2 volts of the Ni-MH cell. Both cell types are rechargeable and have high energy density.

Being a heavy metal, the lead reduces portability, and poses an environmental problem when the cells are produced or discarded. The Ni-MH cell poses less of an environmental problem as its materials have low toxicity.

Q25(a)

Criteria	Mark
• A correct suggestion is stated and involves a mention of polarity and dispersion forces	1

Eg Although octane is a non-polar molecule and ethanol is a polar molecule, octane has much larger molecules and therefore greater dispersion forces. This makes octane's boiling point higher. However, ethanol's polarity creates hydrogen bonding between molecules and so its molecules are more tightly "pulled together" and more densely packed.

Q25(b)(i)

Criteria	Mark
• The molar heat of combustion of octane is correctly calculated in kJ g^{-1}	1

Heat of combustion of octane is 48.15kJ g^{-1}

Q25(b)(ii)

Criteria	Mark
• The molar heat of combustion of ethanol is correctly calculated in kJ g^{-1}	1

Heat of combustion of ethanol is 29.76kJ g^{-1}

Q25(c)

Criteria	Mark
• Correctly outlines ONE advantage AND ONE disadvantage of the use of ethanol compared to octane	2
• States an advantage OR disadvantage of the use of ethanol compared to octane	1

Eg

Advantages:

1. Ethanol can be obtained from renewable sources including cereal and root crops, sugar cane
2. A blend of 85% petrol and 15% ethanol (E15) may reduce net greenhouse gas emissions.

Disadvatages:

1. Ethanol burns with about 30% less energy than octane.
2. Large areas of land would be needed to be cleared for crop production.

Q26(a)

Criteria	Mark
• Calculate the concentration of acetic acid	2
• Calculates using correct volumes OR correct concentrations	1

The acid is acetic acid concentration is = (23.6 X 0.112) / 25.0 = 0.106 mol L^{-1}

Q26(b)

Criteria	Mark
• Relates the pH values to low ionization of acetic acid and describes it as a weak acid	2
• Relates the pH values to the low ionisation of acetic acid OR describes it as a weak acid	1

Both pH values are higher than those of strong acid. Acetic acid is a weak acid, and is only slightly ionised, so that the H$^+$ ion concentration is much less than that of acetic acid molecules, and the equivalence point pH is greater than 7.

Q26(c)

Criteria	Mark
• Describes procedure for rinsing pipette	1

The pipette should first be rinsed with distilled/demineralised water, then with a small quantity of the diluted vinegar.

Q26(d)

Criteria	Mark
• Outlines ONE advantage	1

Advantages include: greater consistency and repeatability, data logger provides a permanent record, tracks pH changes during the titration.

Q27(a)

Criteria	Mark
• Describes the function of a buffer	1

A buffer is an aqueous solution able to keep the pH at a constant level when small quantities of acids or bases are added.

Q27(b)

Criteria	Mark
• Writes a chemical equation for the buffer system and uses equilibrium principles to explain how the pH is kept constant on the addition of acid and base	3
• Writes a chemical equation for the buffer system and uses equilibrium principles to explain how the pH is kept constant on the addition of acid or base	2
• Writes a chemical equation for the buffer system	1

Q28(a)

Criteria	Mark
• A correct definition is written for condensation polymer AND a biopolymer	2
• A correct definition is written for condensation polymer OR a biopolymer	1

- Condensation polymers are formed by a condensation reaction in which a small molecule such as water is "split out" as a by-product
- Biopolymers are polymers produced by living things

Q28(b)

Criteria	Mark
• A correct structural formula of the dimer is drawn	1

Q29

Criteria	Mark
• TWO or more uses of acids described and TWO or more examples • Use of esters in foods given with TWO or more examples • Use of esters in cosmetics included with one example	4
• TWO or more uses of acids described and ONE examples • Use of esters in foods given with ONE examples • Use of esters in cosmetics included with one example	3
• TWO or more uses of acids described and TWO or more examples OR • Use of esters in foods given with TWO or more examples • Use of esters in cosmetics included with TWO or more examples	2
• TWO or more uses of acids described and ONE examples OR • Use of esters in foods given with ONE example • Use of esters in cosmetics included with ONE example	1

Acids are widely used as food additives due to their sour taste, antioxidant and preservative properties. Used to improve the taste of appearance of a processed food, improves the keeping quality or stability of a food and to preserve food when this is the most practical way of extending its storage life. Examples- citric acid used to impart a sour taste in foods and drinks, lactic acid inhibits spoilage in Spanish olives and used in cheese, yoghurt and other products. Esters tend to have fruity or flowery fragrances and are volatile. Used to flavour food, eg octyle ethanoate (orange) and pentyl ethanoate (banana). Ethyl ethanoate used as nail varnish remover in cosmetics and esters used as fragrances (but not body perfume as they break down quickly), eg Benzyl ethanoate (jasmine)

Q30

Criteria	Mark
• Identifies the radioisotope and field • Relate its use to at least two properties	3
• Identifies the radioisotope and field • Relates its use to at least one property	2
• Identifies the radioisotope and field OR • Relate its use to at least one property	1

Iodine -131 is used in medicine where it is ingested by a patient to treat thyroid disorder or cancers. It has a half life of eight days which is long enough for transportation to where it needs to be used and short enough to minimise a patient's exposure to radiation. Iodine-131 emits beta and gamma radiation. The beta radiation allows any abnormal tissue or cancer cells to be destroyed and the gamma radiation allows for the external imaging so that the target cells or area can be imaged.

Q31(a)

Criteria	Mark
• A line is correctly drawn from T_1 to T_2 from half the T_1 equilibrium value and attains equilibrium at a lower level at T_2	1

31 (b)

Criteria	Mark
• Uses the graph to explain the need to increase pressure to increase the production of ammonia	2
• Does not make any reference to the graph but only uses Le Chatelier's Principle	1

As shown in the graph, the equilibrium portion of ammonia is less at power pressure. High pressure favours the products, which have fewer gaseous molecules than the reactants.

Q31(c)

Criteria	Mark
• A line is correctly drawn from T_2 to T_3 showing the concentration of ammonia decreasing and then attains an equilibrium	1

Q31(b)(ii)

Criteria	Mark
• Refers to the graph to account for the effect of pressure	1

As shown in the graph, the equilibrium proportion of ammonia is less at lower pressure. High pressure favours the products, which have fewer gaseous molecules than the reactants.

Q32(a)

Criteria	Mark
• Correctly identifies a basic oxide and writes a balances chemical equation to show it acting as a base	2
• Correctly identifies a basicoxide OR • Correctly identifies a basic oxide but writes as balances equation to show it acting as a base that is not balanced or has correct formulae for some species	1

Q34- Chemistry of Art Option

a)

criteria	mark
• Definition of electronegativity – affected by nuclear charge, amount of shielding, distance of electrons from the nucleus • Trend across the period is explained – related to the size of the nucleus • Trend down the group is explained – related to increased shielding and greater distance of outer electrons from the nucleus	3
• A definition of electronegativity • A correct explanation for one of the trends	2
• A basic definition of electronegativity OR • A basic explanation of a trend	1

Bi)

criteria	mark
• Colour change • 2 half equations listed • Balanced overall equation listed	3
• 2 of the above	2
• One of the above	1

Some students did not include the colour of the *other* product eg: Br_2, I_2 Fe^{2+} etc...

Bii)

criteria	mark
• Identifies oxidation state of Mn in permanganate as +7 • Explanation of the impact of the high oxidation state and the ions ability to attract electrons	2
• States oxidation state of Mn in permanganate OR • Explanation of the impact of the high oxidation state and the ions ability to attract electrons	1

Possible answer: Mn attached to many O atoms which attract electrons.

Ci)

criteria	mark
• Calculation of oxidation number shown	1

Cii)

criteria	mark
• 3 points of comparison	3
• 2 points of comparison	2
• 1 point of comparison	1

> Bonding of structure A described:
> 4x monodentate ligands (one donor atom)
> coordinately bonded to central Cu^{2+} ion.
> Coordination number = 4
> Bonding in structure B described:
> 3x bidentate ligands (2 donor atoms)
> coordinately bonded to central Cu^{2+} ion
> coordination number = 6

d)

Criteria	mark
• One current analytical technology is named correctly • A thorough description of processes involved • A thorough assessment of importance in identifying elements in substances • Two examples of the use of this technology are explained (eg; Identification of pigments to determine if forgery has occurred, or for conservation work) • A judgement given	7
• As above, but a flaw in a description or assessment or use	6
• an attempt to name one current analytical technology • A sound description • A sound ass't • Two examples of the use of this technology are explained (eg identification of pigments to determine if forgery has occurred) but one explanation flawed • An attempt at a judgement	5
• An attempt to name one current analytical technology • A sound description given • A sound ass't • One example of the use is explained well OR two uses are listed	4
• An attempt to name one current analytical technology • An basic descp OR a basic ass't • One use listed	3
• A basic process is given (2 aspects) OR • 2 uses are listed OR • An assessment of 2 points	2
• An attempt to name one current analytical technology OR • A use of a technology relating to pigment identification is given	1

✓ IR or UV absorption spectroscopy
  Description: must give details of source, detector, absorption spectrum obtained, compare to known database of pigments
  Assessment:
  UV- electron transitions, destructive? Little prep required
  IR – organic only, final groups detected (bond vibrations), destructive?, little prep required
✓ LMA
  Description: laser atomises sample, spark excite → emission, spectroscope (or diffraction grating). Elements id → pigments id.
  Assessment: fast, min prep, multiple layers can be investigated, many elements ID'd at once.

E)

criteria	mark
• Define Pauli Exclusion Principal (An orbital can hold 0, 1, or 2 electrons only, and if there are two electrons in the orbital, they must have opposite (paired) spins) • Explain its significance to understanding of electrons in atoms	2
• Define Pauli Exclusion Principal OR • Explain its significance to understanding of electrons in atoms	1

Fi)

criteria	mark
• Identify one colour • Give the name or chemical formula of that colour	1

Fii)

criteria	mark
• A procedure given, including a pigment and a medium to disperse the pigment	2
• A basic procedure given	1

Fiii)

criteria	mark
• A use of the mineral in face paint or make up identified • An specific risk of this use.	1