HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 2- Chemistry

SEPTEMBER 2014
TIME: 3 HRS

Total 150

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
   SECTION B (130)

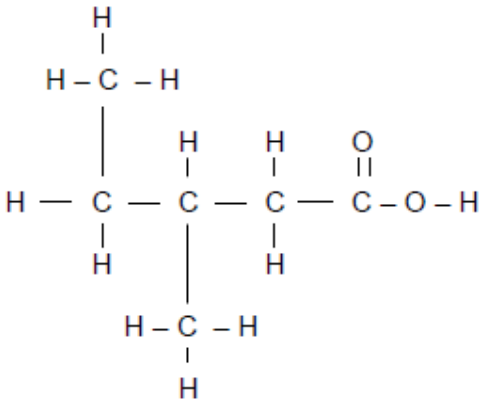
   Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets and a periodic table are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places

SECTION A

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK.

1.1 Look carefully at the following structure:



The IUPAC name of the structure given above is …

A. 1,2-dimethyl butanoic acid.
B. 3-methyl pentanoic acid.
C. hexanoic acid.
D. 1-ethyl-1-methyl propanoic acid.

1.2 Which organic compound is able to undergo an addition reaction?

A CH_4
B CH_3CH_3
C C_2H_2
D $CHC\ell_3$

1.3 The boiling point of CH_4 is much lower than that of HF. Which ONE of the following **best** explains this difference in boiling points?

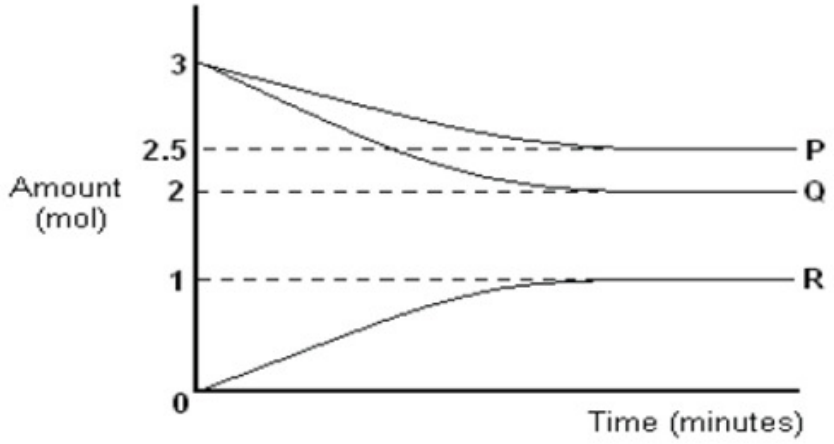
A HF molecules are more polar than CH_4 molecules.

B CH_4 molecules are more polar than HF molecules.

C There are hydrogen bonds between HF molecules.

D There are dipole-dipole forces between CH_4 molecules.

1.4 The accompanying graph shows the change in the mole amounts of P, Q and R with time during a reaction.

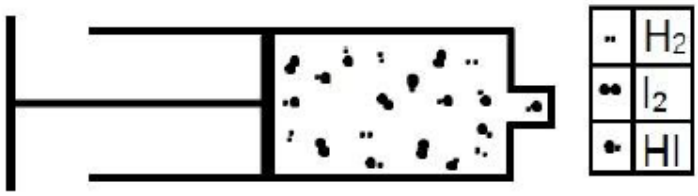


The equation for the reaction can be represented as …

A $P + 2Q \rightarrow 2R$
B $2P + Q \rightarrow R$
C $3P + 2Q \rightarrow R$
D $5P + 2Q \rightarrow 2R$

1.5 A mixture of $H_2(g)$ and $I_2(g)$ is sealed in a gas syringe. The mixture is then allowed to reach equilibrium at a constant temperature according to the equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$



What will happen to the **concentration** and **yield** of HI if the piston is moved inwards while the temperature remains constant?

	[HI]	Yield of HI
A	Increases	Decreases
B	Decreases	Stays the same
C	Decreases	Increases
D	Increases	Stays the same

1.6 The value of the equilibrium constant (*Kc*) for the equilibrium reaction during the preparation of sulphur trioxide according to the reaction,

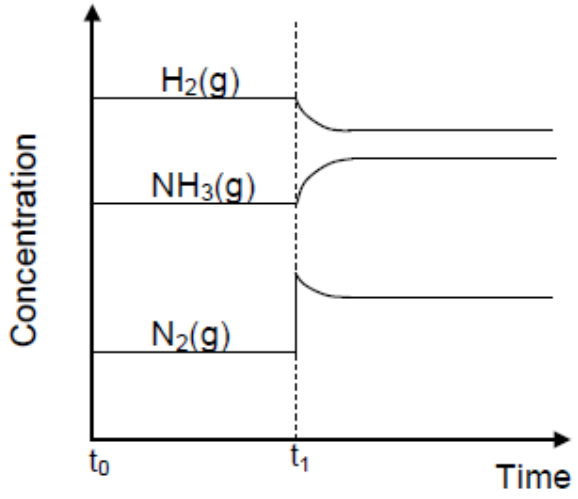
$$2\,SO_2\,(g) + O_2\,(g) \rightleftharpoons 2\,SO_3\,(g) \qquad \Delta H < 0$$

may be INCREASED by ...

A. decreasing the temperature at constant pressure.
B. increasing the temperature at constant pressure.
C. the addition of a catalyst at constant temperature.
D. an increase in pressure at constant temperature.

1.7 The graph below shows a change made to a chemical equilibrium in a closed container at time t_1. The equation for the reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H < 0$$



Which ONE of the following is the change made at time t_1?

A Addition of a catalyst

B Increase in temperature

C Increase in the concentration of $N_2(g)$

D Increase in pressure by decreasing the volume

1.8 Consider the following chemical reaction:

$$NH_3\,(g) + H_2O\,(\ell) \rightarrow NH_4^+\,(aq) + OH^-\,(aq)$$

In this equation, H_2O is the Bronsted-Lowry ...

A acid because it donates a proton.
B base because it donates a proton.
C acid because it accepts a proton.
D base because it accepts a proton.

1.9 The table below represents the Ka value of HCl, HNO_3, H_2SO_4 and CH_3COOH. Which option below is most likely to represent CH_3COOH

	Ka value
A	5×10^{-4}
B	6×10^{-4}
C	5×10^{-2}
D	$1{,}8 \times 10^{-5}$

1.10 Which ONE of the following half reactions occurs at the anode during the electrolysis of an aqueous AgCℓ solution?

A. $C\ell_2 + 2e^- \rightarrow 2C\ell^-$
B. $Ag^+ + e^- \rightarrow Ag$
C. $2C\ell^- \rightarrow C\ell_2 + 2e^-$
D. $Ag \rightarrow Ag^+ + e^-$

[2 x 10 = 20]

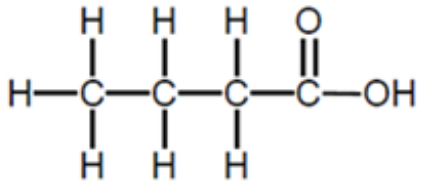
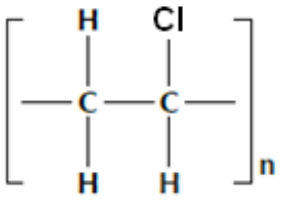
SECTION B

INSTRUCTIONS AND INFORMATION

1. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
2. Show the formulae and substitutions in ALL calculations.
3. Round off your numerical answers to **TWO decimal** places

Question 2

The letters **A** to **H** in the table below represent six organic compounds.

A		**B**	butan-2-ol
C	pent-2-ene	**D**	pentanal
E	C_2H_5OH	**F**	methyl propanoate
G		**H**	3-methylpentane

2.1 Write down the letter that represents a compound that:

2.1.1 Is unsaturated (1)

2.1.2 Is a structural isomer of compound **A** (1)

2.1.3 Is an aldehyde (1)

2.1.4 Belongs to the same homologous series as compound **B** (1)

2.2 Write down the:

2.2.1 IUPAC name of compound A (2)

2.2.2 Structural formula of compound **B** (2)

2.2.3 Name of the homologous series to which compound **F** belongs (1)

2.3 Compound **A** reacts with compound **E** in an acid catalysed condensation reaction.

Write down the:

2.3.1 General name given to this reaction (1)

2.3.2 Structural formula of the organic product formed (2)

2.3.3 IUPAC name of the product formed in 2.3.2 (1)

2.4

2.4.1 Draw the structural formula of compound H (2)

2.4.2 Draw the structural isomer of compound D (2)

2.5

2.5.1 Define polymerisation (2)

2.5.2 Draw the structural formula of a the monomer of compound G (2)

[21]

Question 3

Refer to Table A and B to answer the following questions:

Table A

Alkane	Molecular formula	Boiling point (°C)
Methane	CH_4	-162
Ethane	C_2H_6	-89
Propane	C_3H_8	-42
Butane	C_4H_{10}	0

Table B

Alcohol	Molecular formula	Boiling point
Methanol	CH_3OH	65
Ethanol	C_2H_5OH	78
Propan-1-ol	C_3H_7OH	97
Butan-1-ol	C_4H_9OH	117

3.1 Describe the general trend that is observed from table A. (2)

3.2 Explain this trend, referring to strength of intermolecular forces and energy. (3)

3.3 How would the boiling point of butane compare to an isomer of the compound? (2)

3.4 Explain why the boiling point of propane is lower than that of propan-1-ol (in table B) despite having the same number of carbons. (2)

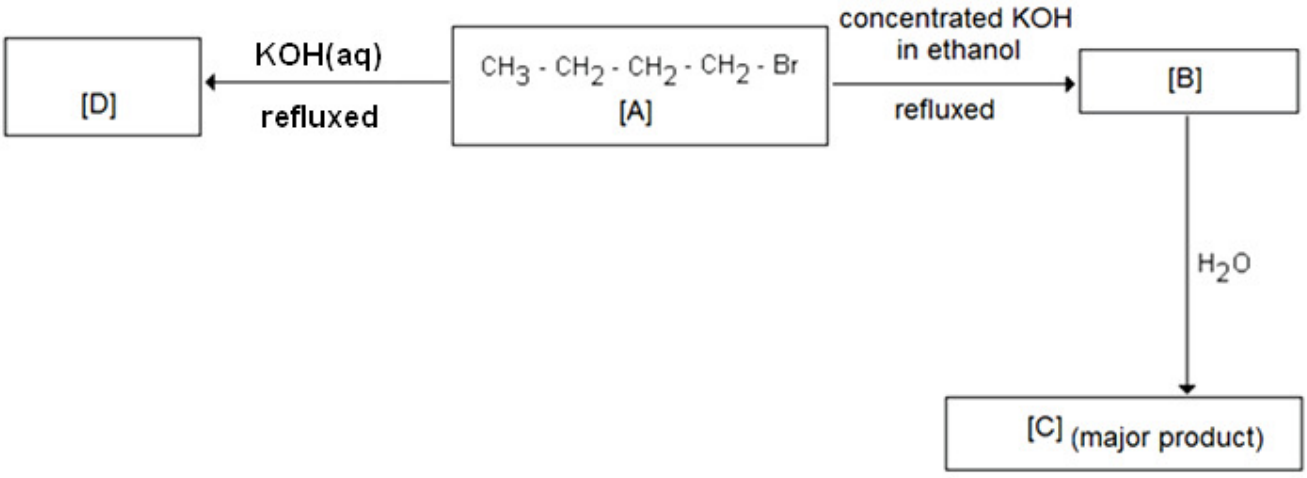
3.5 Define the term volatility (1)

3.6 Which compound from all those listed in Table A and B, would have the highest volatility, explain your answer (also refer to values in the table in your explanation.) (3)

[13]

Question 4

Using the different reactions mentioned in the chart given below answer the following questions.



4.1 Write down the homologous series to which compound **A** belongs. (1)

4.2 Using **semi-structural** formula draw the equation for the conversion of compound **A** to compound **B.** (2)

4.3 Is the compound **B** saturated or unsaturated? Give a reason for your answer. (2)

4.4 Name the type of elimination reaction that is taking place during the conversion of compound **A** to compound **B**. (2)

4.5 Compound **B** is allowed to react with water in the presence of H_2SO_4 to form compound **C**.

Draw the structural formula and give the IUPAC name of compound **C**. (4)

4.6 Compound **A** when refluxed with dilute aqueous KOH forms compound **D**

Draw the structural formula of compound **D**. (2)

[13]

Question 5

A group of grade 12 learners perform a titration practical in the lab in order to determine the concentration of the ethanoic acid solution.

In order to perform the practical they first need to dilute the acid with water.

$CH_3COOH(l) + H_2O(l) \Leftrightarrow CH_3COO^-(aq) + H_3O^+(aq)$

5.1 Give a reason why ethanoic acid is classified as a weak acid. (2)

5.2 The concentration of the hydronium ions in the solution is 1×10^{-3} mol.dm^{-3}.

5.2.1 Determine the pH of the solution. (3)

5.2.2 Calculate the concentration of the OH^- ions in the above solution. (3)

5.3 10 g of NaOH is added to 500cm^3 of water to create an alkaline solution.

Prove with a calculate that the concentration of the NaOH solution is 0,5mol.dm^{-3}. (4)

5.4 100 cm^3 of this alkaline solution is then added to the ethanoic acid solution during the titration.

Write the balanced equation for the reaction above. (3)

5.5 4 g of washing soda crystals ($Na_2CO_3 \cdot 10H_2O$) are dissolved in water and made up to a volume of 500 cm^3. 40 cm^3 of this sample is neutralised by 30 cm^3 of HCl of concentration 0,0027 mol.dm^{-3}. Calculate the percentage of Na_2CO_3 in commercial washing soda. (9)

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$

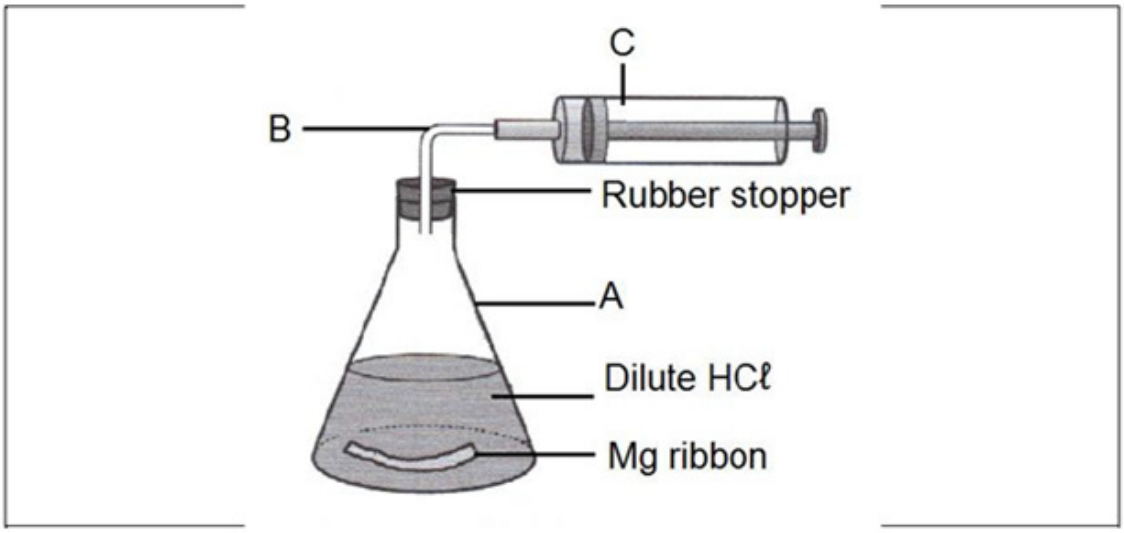
[24]

Question 6

6.1 The reaction between magnesium ribbon and hydrochloric acid is used in an experiment by some learners to investigate the factors that influence the rate of a chemical reaction. The reaction that takes place is:

$$Mg\,(s) + 2\,HC\ell\,(aq) \rightarrow MgC\ell_2\,(aq) + H_2\,(g) \quad (\Delta H < 0)$$

The diagram below shows the basic setup for this investigation.



6.1.1 Give the label for any ONE of the apparatus **labelled** A, B **or** C. (1)

6.1.2 Name ONE apparatus not shown in the diagram which is important for this investigation. (1)

6.1.3 Describe the procedure the learners should follow to measure the rate of the reaction. (2)

6.1.4 In what way will the rate at which the H_2 gas formed be affected if heat was added to apparatus A? Write only INCREASES, DECREASES or STAYS THE SAME as your answer. (1)

6.1.5 Use the collision theory to explain the conclusion you came to in QUESTION 6.1.4. (3)

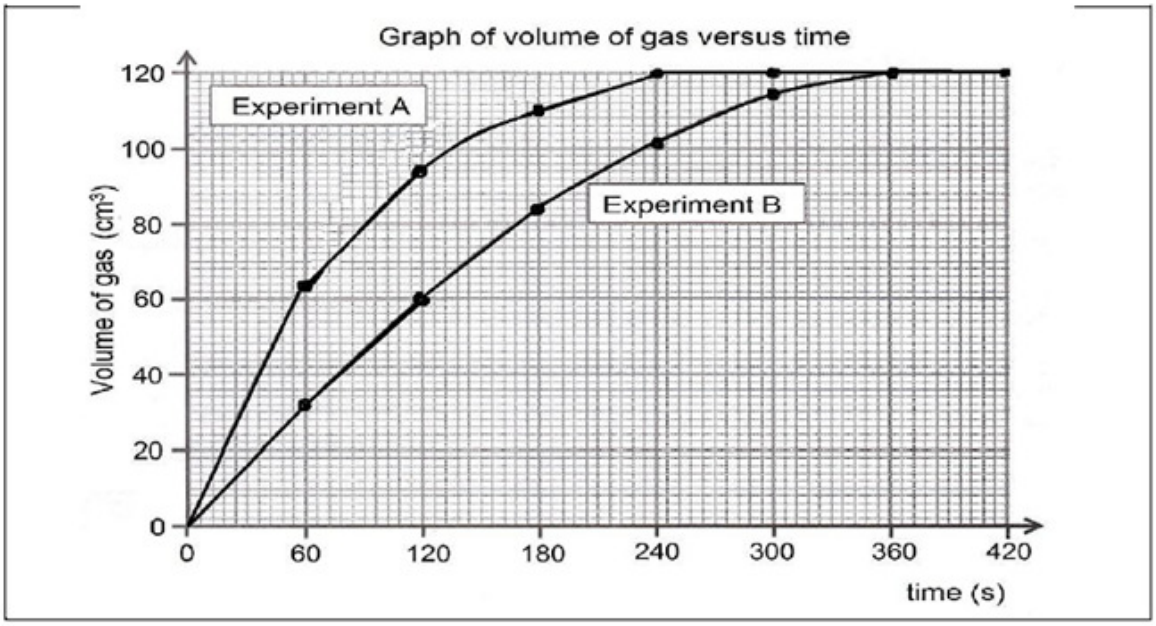
6.1.6 State what type of reaction this is, endothermic or exothermic. Explain your answer (2)

6.1.7 Draw a sketch graph of the energy profile, to illustrate the energy changes referred to in QUESTION 6.1.6. (2)

6.1.8 Assume the learners use magnesium powder (with the same mass as the magnesium ribbon) in place of the magnesium ribbon. Will the rate of the reaction INCREASE, DECREASE or STAY THE SAME? (1)

6.1.9 Explain your answer to QUESTION 6.1.8 by referring to the collision theory. (2)

6.2 In one experiment (A), the learners use 50 cm^3 of HCℓ of known concentration and in another, experiment (B), they use 25 cm^3 of the same HCℓ diluted to 50 cm^3 with distilled water. The graph which follows represents the results obtained.



6.2.1 State an investigative question for this **experiment.** (2)

6.2.2 What volume of gas was formed during the first two minutes in Experiment B? (1)

6.2.3 How much time **(in minutes)** elapsed before Experiment A reached completion? (1)

6.2.4 Which experiment (Experiment A or Experiment B) took place at the faster rate? Refer to the graph and give a reason for your answer. (2)

6.2.5 What conclusion can be drawn from the results obtained? (2)

[23]

Question 7

The following reaction:

$$C_2H_4\,(g) + H_2\,(g) \rightleftharpoons C_2H_6\,(g) \qquad \Delta H < 0$$

is in equilibrium in a closed system at a temperature T.

7.1 During which industrial process is this reaction significant? (1)

7.2 What does it mean when we say that a system is "in dynamic equilibrium", also refer to the concentration of the reactants and products. (2)

7.3 State ***Le Chatelier's principle*** in words. (2)

7.4 Would increasing or decreasing the temperature *T* result in higher yield of C_2H_6 (g)? Give a reason for your answer. (2)

7.5 An unknown number of moles of C_2H_4 (g) and 0,5 moles of H_2 (g) react in a 500 cm^3 closed container. When equilibrium is established at temperature T, it is found that 0,4 moles of C_2H_6 (g) are present in the container. If the equilibrium constant for this reaction equals to 10, calculate the initial number of moles of C_2H_4 put into the container. (8)

7.6 Pressure in the container is increased by decreasing the volume.
What would be the effect on …

7.6.1 the amount of ethane at equilibrium? (1)

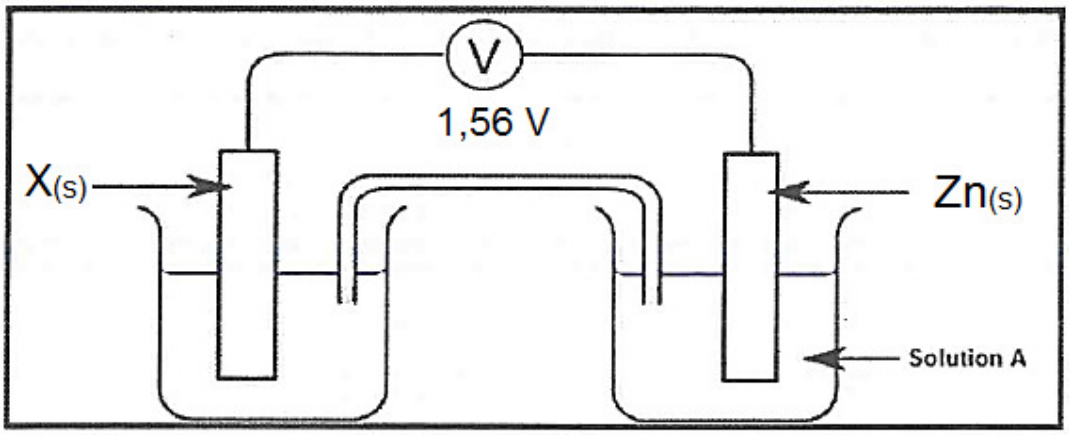
7.6.2 the magnitude of the equilibrium constant? (1)

Write INCREASES, DECREASES or REMAINS UNCHANGED

[17]

Question 8

A standard galvanic (voltaic) cell has a zinc anode. An unknown substance X is the cathode.



8.1 State the two standard conditions that are applicable to the Zn/Zn^{+2} half cell. (2)

8.2 If the initial emf of this galvanic cell is 1,56 V, identify the unknown substance X. (4)

8.3 Identify the reducing agent in this galvanic cell. (1)

8.4 Write down the cell notation for this cell. (3)

8.5 If the concentration of the electrolyte in the Zn/Zn^{+2} half-cell is increased, how will the initial emf of the cell change? Write only INCREASE, DECREASE or REMAIN THE SAME. (1)

8.6 Give an explanation for your answer in 8.5. (2)

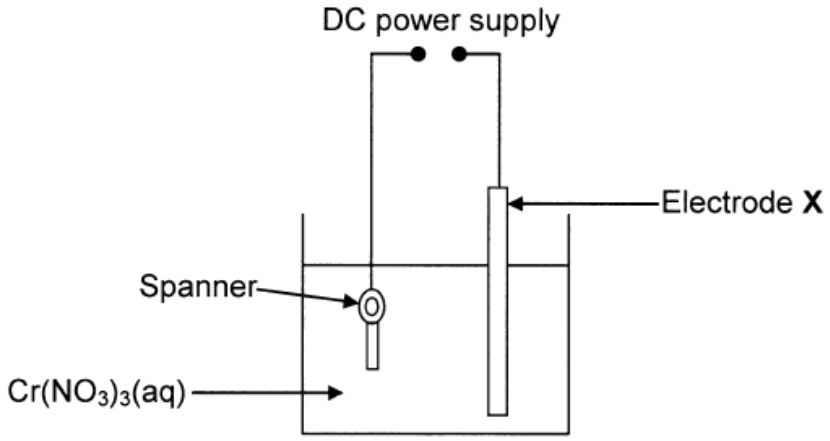
8.7 When the reaction in this galvanic cell reaches equilibrium a voltmeter is connected across its electrodes.

Write down the value of the reading on the voltmeter. (1)

[14]

Question 9

The diagram below represents a simplified electrolytic cell used to electroplate a spanner with chromium. The spanner is continuously rotated during the process of electroplating.



A constant current passes through the solution and the concentration of $Cr(NO_3)_3(aq)$ remains constant during the process. In the process, a total of 0,03 moles of electrons is transferred in the electrolytic cell.

9.1 Define the term *electrolysis*. (2)

9.2 Write down the:

9.2.1 Half-reaction that occurs at the spanner (2)

9.2.2 NAME or FORMULA of the metal of which electrode **X** is made (1)

[5]

Total 150

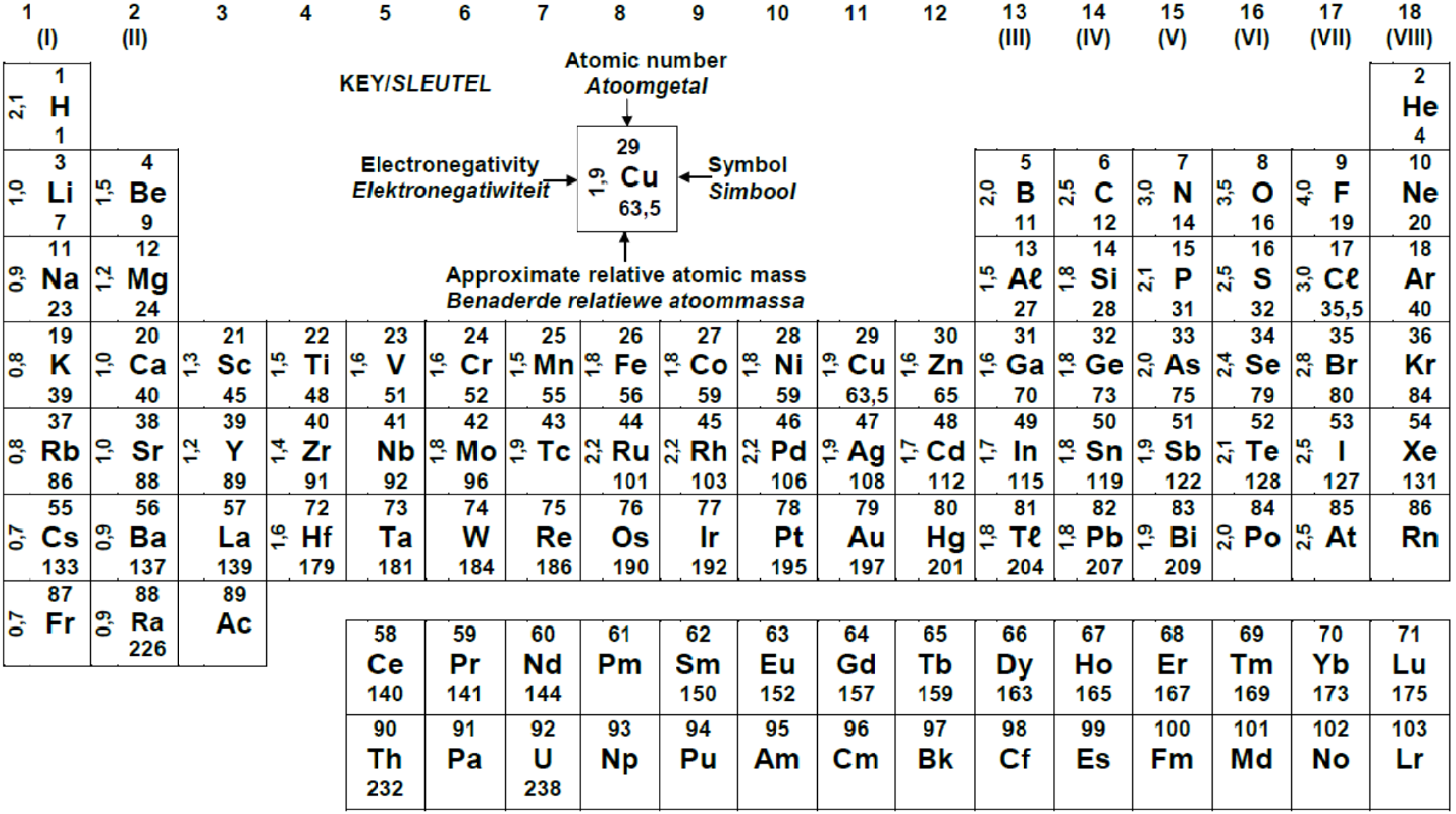
TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^{5}$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	$22{,}4\ dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}\ mol^{-1}$

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE



***attach half reaction tables**