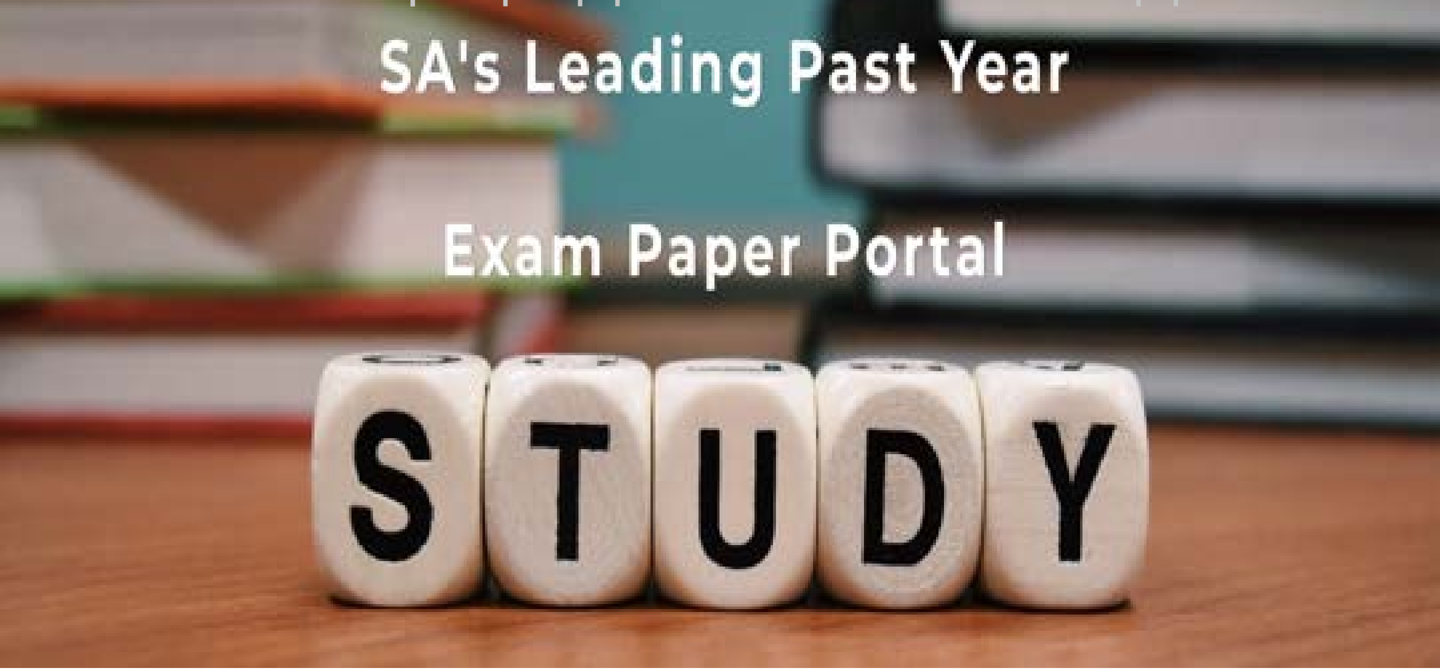
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CAPE WINELANDS EDUCATION DISTRICT

PHYSICAL SCIENCES P2

GRADE 12

COMMON PRELIMINARY EXAMINATION

SEPTEMBER 2024

MARKS: 150

TIME: 3 hours

This exam paper consists of 15 pages and 4 datasheets

INSTRUCTIONS AND INFORMATION

1. Write your name in the space below and submit the Examination Paper with your Answer Book.

   NAME & SURNAME: ________________________________

   GRADE: ______

2. This question paper consists of 9 QUESTIONS. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your FINAL numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions etc. where required.
12. Write neatly and legibly.

QUESTION 1 (MULTIPLE-CHOICE)

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) on your ANSWER BOOK.

1.1 Which ONE of the following represents a SUBSTITUTION REACTION?

A $CH_2 = CH_2 + HBr \rightarrow CH_3CH_2Br$

B $CH_2 = CH_2 + H_2O \rightarrow CH_3CH_2OH$

C $CH_3CH_2OH \rightarrow CH_2 = CH_2 + H_2O$

D $CH_3CH_2OH + HBr \rightarrow CH_3CH_2Br + H_2O$ (2)

1.2 Which ONE of the following compounds will have the lowest melting point?

A propan-1-ol

B propanoic acid

C propane

D propanal (2)

1.3 Which ONE of the following equations represents a cracking process?

A $CH_2 = CH_2 + HBr \rightarrow CH_2BrCH_3$

B $CH_3(CH_2)_5CH = CH_2 + H_2 \rightarrow CH_3(CH_2)_6CH_3$

C $CH_3(CH_2)_6CH_3 \rightarrow CH_3(CH_2)_4CH_3 + CH_2 = CH_2$

D $CH_3(CH_2)_7OH \rightarrow CH_3(CH_2)_5CH = CH_2 + H_2O$ (2)

1.4 Which ONE of the following will RAPIDLY decolourise bromine water?

A $CH_3CH_2CH_3$

B CH_3CHCH_2

C CH_3COOCH_3

D CH_3CH_2COOH (2)

1.5 A catalyst is added to the following reaction mixture at equilibrium.

$$H_2(g) + S(s) \rightleftharpoons H_2S(g) \qquad \Delta H < 0$$

Which ONE of the following statements about the effect of the catalyst is FALSE?

A The equilibrium position remains unchanged.

B The equilibrium position shifts to the right.

C The rate of the forward reaction increases.

D The rate of the reverse reaction increases. (2)

1.6 A hypothetical reaction reaches equilibrium at 10 °C in a closed container according to the following balanced equation:

$$A(g) + B(g) \rightleftharpoons AB(g) \qquad \Delta H < 0$$

The temperature is now increased to 25 °C. Which ONE of the following is correct as the reaction approaches a new equilibrium?

	REACTION RATE OF REVERSE REACTION	YIELD OF PRODUCTS
A	Increases	Remains the same
B	Increases	Increases
C	Increases	Decreases
D	Decreases	Decreases

(2)

1.7 Which of the following is not a conjugate acid-base pair?

A HCl and Cl^-

B HCO_3^- and H_2CO_3

C HSO_4^- and H_2SO_4

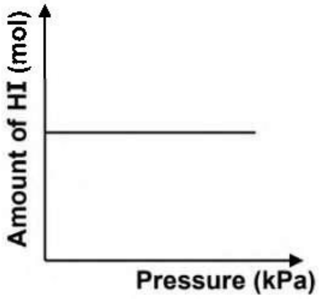
D OH^- and H_3O^+ (2)

1.8 The reaction between hydrogen gas and iodine gas reaches equilibrium in a closed container according to the following balanced equation:

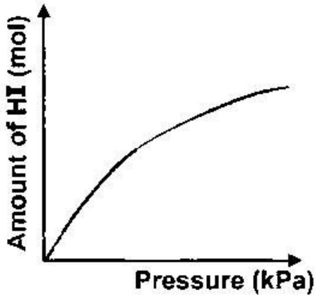
$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Which ONE of the graphs below shows the relationship between the amount of HI(g) at equilibrium and the pressure in the container at constant temperature?

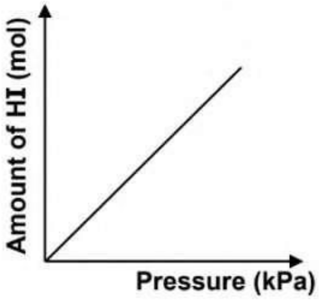
A



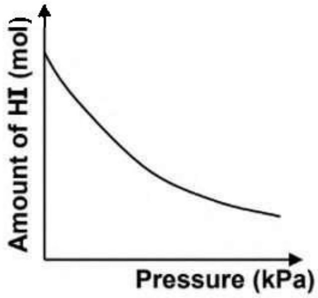
B



C



D



(2)

1.9 The cell notation of a galvanic cell is given as:

$Mg(s)|Mg^{2+}(aq)\ ||Sn^{2+}(aq)\ |Sn(s)$

A bulb connected across the two electrodes initially glows brightly. After some time the brightness of the bulb decreases. This is because the …

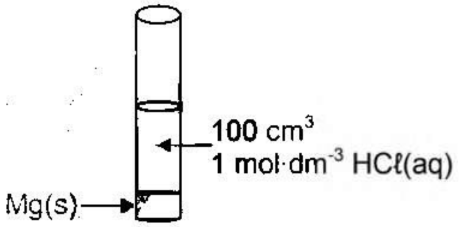
A concentration of Sn^{2+} decreases.

B concentration of Mg^{2+} decreases.

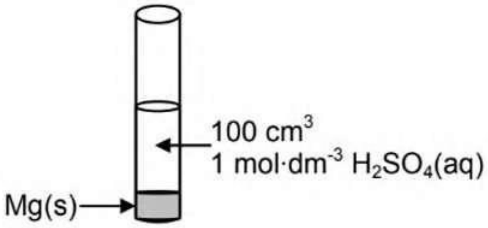
C Sn electrode is used up.

D Mg electrode is used up. (2)

1.10 Equal amounts of magnesium (Mg) powder react respectively with equal volumes and equal concentrations of HCl(aq) and H_2SO_4(aq), as shown below.



Test tube X



Test tube Y

The magnesium is in EXCESS.

Consider the following statements regarding these two reactions:

I: The initial rate of the reaction in test tube **X** equals the initial rate of the reaction in test tube **Y**.

II: After completion of the reactions, the mass of magnesium that remains in test tube **X** will be greater than that in test tube **Y**.

III: The amount of hydrogen gas formed in **X** is equal to the amount of hydrogen gas formed in **Y**.

Which of the above statements is/are TRUE?

A **I** only

B **II** only

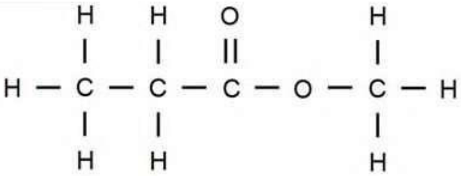
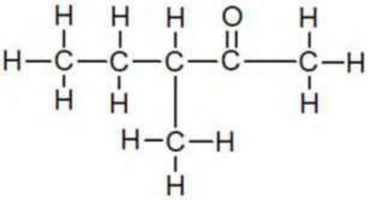
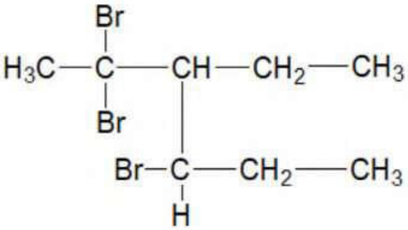
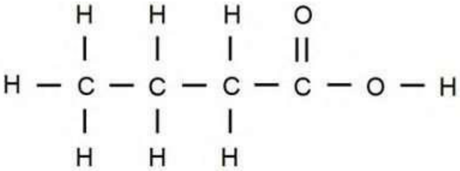
C **III** only

D **I** and **III** only (2)

[20]

QUESTION 2 (Start on a new page)

Letters **A** to **H** in the table below represent eight organic compounds of different *homologous series.*

A	C_9H_{20}	**B**	Pentanal
C	$CH_3CHOHCH_2CH_3$	**D**	$CHCC(CH_3)_2(CH_2)_3CH_3$
E		**F**	
G		**H**	

2.1 Define the term *homologous series.* (2)

2.2 Write down the letter(s) for:

2.2.1 A ketone (1)

2.2.2 TWO compounds that are FUNCTIONAL ISOMERS of each other. (1)

2.2.3 A compound with the general formula C_nH_{2n-2}. (1)

2.2.4 A compound containing the carboxyl group. (1)

2.3 Give the STRUCTURAL formula of a POSITIONAL ISOMER of compound **C**. (2)

2.4 Write down the IUPAC name of:

2.4.1 Compound **F** (2)

2.4.2 Compound **G** (3)

2.5 Give the STRUCTURAL formula of compound **B**. (2)

2.6 Using MOLECULAR formulae, write down the balanced equation for the complete combustion of compound **A**. (3)

[18]

QUESTION 3 (Start on a new page)

The boiling points of four organic compounds at a specific pressure are compared.

	COMPOUND	**BOILING POINT (°C)**
A	Pentane	36
B	2-methylbutane	28
C	2,2-dimethylpropane	10
D	Pentanal	103
E	Butanoic acid	…………

3.1 Define the term *boiling point.* (2)

3.2 Consider compounds **A** to **C**.

3.2.1 Fully explain the trend in boiling points from compound **A** to **C**. (4)

3.2.2 Which compound will have the highest vapour pressure? (1)

3.2.3 Explain your answer to QUESTION 3.2.2. (1)

3.3 Compounds **D** and **E** are compared. Is the boiling point of compound **E** GREATER THAN, SMALLER THAN or EQUAL TO 103°C? Fully explain the answer. (4)

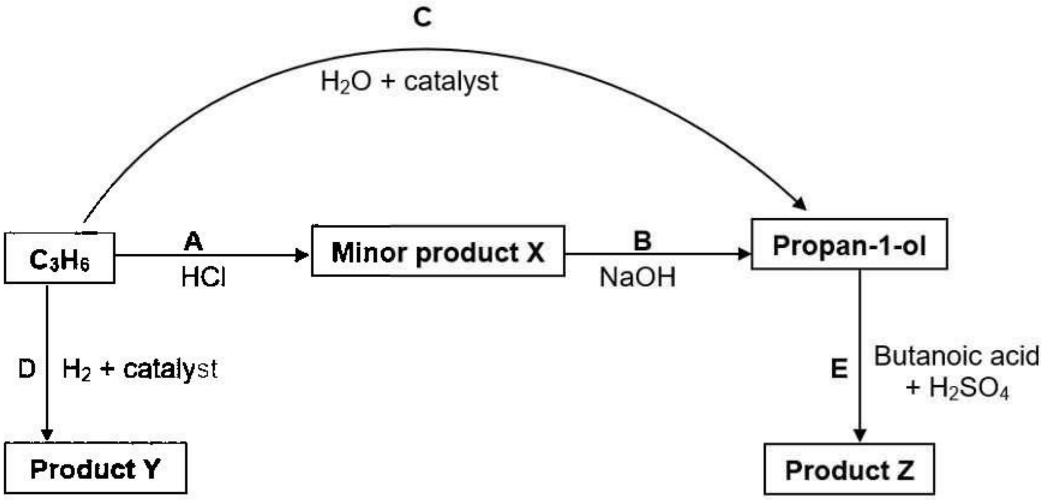
3.4 Is the comparison in QUESTION 3.3 fair? (1)

3.5 Explain the answer to QUESTION 3.4. (1)

[14]

QUESTION 4 (Start on a new page)

Unsaturated organic compounds are often used in the production of other organic compounds. **Propene (C_3H_6)** is used as a starting reactant to produce various other organic compounds as shown in the diagram below. Study the diagram and answer the questions that follow.



4.1 In reaction **A**, the addition of hydrochloric acid produces a minor product **X**.

4.1.1 Identify the type of addition reaction that takes place. (1)

4.1.2 Draw the STRUCTURAL formula of the minor product **X** that forms in the reaction and write down the IUPAC name. (3)

4.1.3 State the reaction condition for reaction **A**. (1)

4.2 In reaction **B**, the minor product **X** is added to water and there is an addition of a dilute strong base at room temperature.

4.2.1 Identify the type of reaction that takes place. (1)

4.2.2 Explain what will happen when a concentrated strong base is added instead of a dilute strong base. (1)

4.2.3 Is the alcohol formed in reaction **B** a PRIMARY, SECONDARY or TERTIARY alcohol? Motivate your answer. (2)

4.2.4 How would an increase in temperature affect the amount of propan-1-ol produced? Only write INCREASE, DECREASE or REMAIN THE SAME. (1)

4.3 Reaction **C**, produces propan-1-ol and a *positional isomer* of propan-1-ol.

4.3.1 Define the term *positional isomer*. (2)

4.3.2 Write down the chemical formula or name of the catalyst used in reaction **C.** (1)

4.4 Write the IUPAC name of product **Y** formed in reaction **D**. (2)

4.5 Reaction **E** is commonly used in the food industry.

4.5.1 Name the type of reaction represented. (1)

4.5.2 Write down the IUPAC name of the organic product **Z**. (2)

4.5.3 State the function of H_2SO_4 in the reaction. (1)

[19]

QUESTION 5 (Start on a new page)

Hydrogen peroxide, H_2O_2, decomposes to produce water and oxygen according to the following balanced equation:

$$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$$

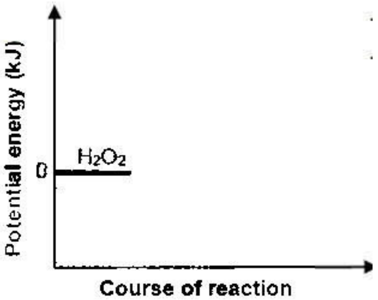
5.1 The activation energy (E_A) for this reaction is 75 kJ and the heat of reaction (ΔH) is –196 kJ.

5.1.1 Define the term *activation energy.* (2)

5.1.2 Redraw the set of axes alongside in your ANSWER BOOK and then complete the potential energy diagram for this reaction. Indicate the value of the potential energy of the following on the y-axis:

- Activated complex
- Products

The graph does NOT have to be drawn to scale.)

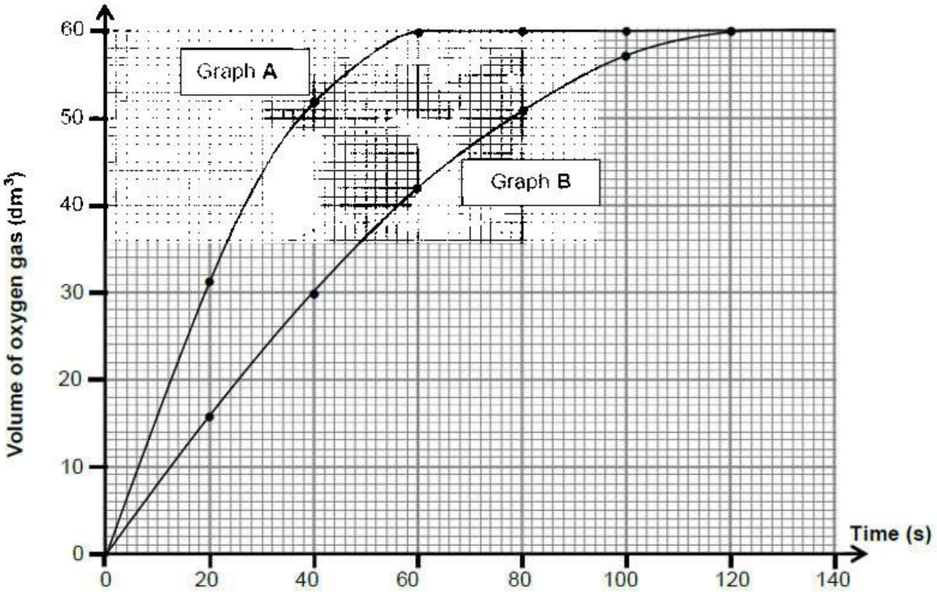


(3)

When powdered manganese dioxide is added to the reaction mixture, the rate of the reaction increases.

5.1.3 On the graph drawn for QUESTION 5.1.2, use broken lines to show the path of the reaction when the manganese dioxide is added. (2)

5.2 Graphs **A** and **B** below were obtained for the volume of oxygen gas produced over time under different conditions.

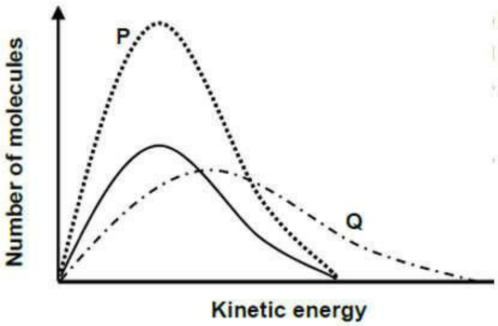


5.2.1 Calculate the average rate of the reaction (in $dm^3 \cdot s^{-1}$) between t = 10 s and t = 40 s for graph **A**. (3)

5.2.2 Use the information in graph **A** to calculate the mass of hydrogen peroxide used in the reaction. Assume that all the hydrogen peroxide decomposes. Use 24 $dm^3 \cdot mol^{-1}$ as the molar volume of oxygen. (4)

5.2.3 How does the mass of hydrogen peroxide used to obtain graph **B** compare to that used to obtain graph **A**? Choose from GREATER THAN, SMALLER THAN or EQUAL TO. (1)

5.3 Three energy distribution curves for the oxygen gas produced under different conditions are shown in the graph below. The curve with the solid line represents 1 mol of oxygen gas at 90 °C.



Choose the curve (**P** or **Q**) that best represents EACH of the following situations:

5.3.1 1 mol of oxygen gas produced at 120 °C (1)

5.3.2 2 moles of oxygen gas produced at 90 °C (1)

[17]

QUESTION 6 (Start on a new page)

6.1 The thermal decomposition of calcium carbonate ($CaCO_3$) that takes place in a closed container can be represented by the following equation:

$$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

Equilibrium is reached at 700 °C.

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

6.1.2 It is found that the value of K_c increases when the container is heated to 900°C. Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Use *Le Chatelier's principle* to explain your answer. (4)

6.2 The following reaction is investigated in a laboratory:

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

Initially 3,45 mol of $SO_2(g)$ and an unknown mass, **X**, of $O_2(g)$ are sealed in a 3 dm^3 flask and allowed to reach equilibrium at a certain temperature.

At equilibrium it is found that the concentration of $SO_3(g)$ present in the flask is 0,65 $mol{\cdot}dm^{-3}$.

6.2.1 Calculate the mass of $O_2(g)$ initially present in the flask if the equilibrium constant (K_c) at this temperature is 1,52. (9)

6.2.2 The volume of the container is now decreased to 1 dm^3 while the temperature is kept constant. How will each of the following be affected? Write down only INCREASES, DECREASES or REMAINS THE SAME.

6.2.2.1 The value of K_c. (1)

6.2.2.2 The number of moles of $O_2(g)$ present in the equilibrium mixture. (1)

[17]

QUESTION 7 (Start on a new page)

150 g of impure barium hydroxide is dissolved in 2 dm^3 of water. 2 dm^3 of a hydrochloric acid solution, with a concentration of 0,75 $mol.dm^{-3}$, is then added to the barium hydroxide solution. A scientist measures the pH of the solution after the addition of the hydrochloric acid solution and finds the combined solution to have a pH of 12. The reaction between barium hydroxide and hydrochloric acid is represented below:

$$Ba(OH)_2(aq) + 2HC\ell(aq) \rightarrow BaC\ell_2(aq) + 2H_2O(\ell)$$

7.1 Define an acid in terms of *Lowry-Brønsted*. (2)

7.2 Calculate the concentration of hydroxide ions present in the solution after the hydrochloric acid solution was added. (5)

7.3 Calculate the *percentage purity* of the sample of barium hydroxide. (7)

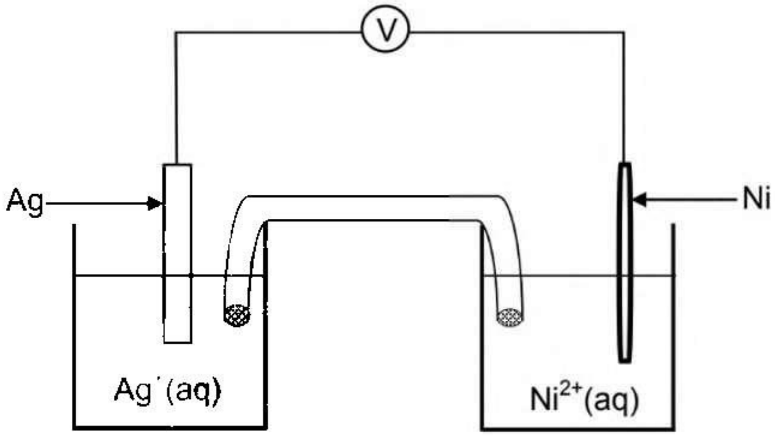
7.4 Suggest an indicator that would be appropriate to use to indicate the endpoint during a titration between barium hydroxide and hydrochloric acid. Choose from *methyl orange*, *bromothymol blue* or *phenolphthalein*. (1)

7.5 Explain your answer to QUESTION 7.4 by referring to the strengths of the acid and base as well as the pH. (3)

[18]

QUESTION 8 (Start on a new page)

A galvanic cell is set up using a nickel half-cell and a silver half-cell.



8.1 Which electrode (**Ni** or **Ag**) must be connected to the negative terminal of the voltmeter? Give a reason for the answer. (2)

8.2 Write down the cell notation for the galvanic cell above. (3)

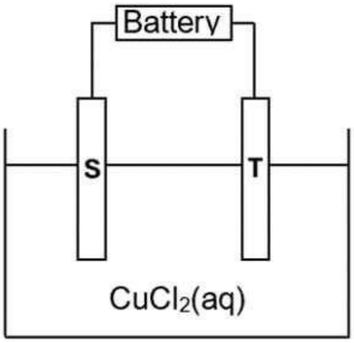
8.3 Calculate the initial reading on the voltmeter if the cell functions under standard conditions. (4)

8.4 How will the voltmeter reading in QUESTION 8.3 be affected if the concentration of the silver ions is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[10]

QUESTION 9 (Start on a new page)

In the electrolytic cell below, two carbon rods are used as electrodes and a concentrated copper(II)chloride solution ($CuC\ell_2$) is used as an *electrolyte*.



When the cell is in operation, a gas is released at electrode **S** while electrode **T** is covered with a brown layer.

9.1 Write down a half reaction to explain the observation made at:

9.1.1 Electrode **S**. (2)

9.1.2 Electrode **T**. (2)

9.2 Which electrode, **S** or **T**, is the anode? Give a reason for the answer. (2)

9.3 A current of 2,5 A passes through the cell for 5 hours.
Calculate the:

9.3.1 Total charge that flows through the cell during this time. (2)

9.3.2 Increase in mass of the cathode. (5)

9.4 The carbon rods in the above cell are now replaced with COPPER RODS and the cell is allowed to operate for some time.

The following observations are made at electrode **S**:

- No gas is released.
- Its surface appears rough and corroded.

9.4.1 Refer to the RELATIVE STRENGTHS OF REDUCING AGENTS and explain these observations. (3)

9.4.2 This cell can be used for the purification of copper. Which electrode (**S** or **T**) will be replaced with the impure copper during this purification process? (1)

[17]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 2 (CHEMISTRY)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 2 (CHEMIE)

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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_aV_a}{c_bV_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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* $E^{\theta}_{cell} = E^{\theta}_{oxidisingagent} - E^{\theta}_{reducingagent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	
$I = \frac{Q}{\Delta t}$	$n = \frac{Q}{q_e}$ where n = number of electrons

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

KEY/*SLEUTEL*

Atomic number / *Atoomgetal*: 29
Electronegativity / *Elektronegatiwiteit*: 1,9
Symbol / *Simbool*: Cu
Approximate relative atomic mass / *Benaderde relatiewe atoommassa*: 63,5

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
1 2,1 H 1																	2 He 4
3 1,0 Li 7	4 1,5 Be 9											5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24											13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															
				58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
				90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Increasing strength of oxidising agents / *Toenemende sterkte van oksideermiddels* ↑

Half-reactions/*Halfreaksies*			E^{θ} (V)
$F_2(g) + 2e^-$	⇌	$2F^-$	+ 2,87
$Co^{3+} + e^-$	⇌	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	⇌	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	⇌	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	⇌	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	⇌	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	⇌	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	⇌	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	⇌	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	⇌	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	⇌	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	⇌	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	⇌	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	⇌	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	⇌	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	⇌	H_2O_2	+ 0,68
$I_2 + 2e^-$	⇌	$2I^-$	+ 0,54
$Cu^+ + e^-$	⇌	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	⇌	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	⇌	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	⇌	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	⇌	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	⇌	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	⇌	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	⇌	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**⇌**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	⇌	Fe	− 0,06
$Pb^{2+} + 2e^-$	⇌	Pb	− 0,13
$Sn^{2+} + 2e^-$	⇌	Sn	0,14
$Ni^{2+} + 2e^-$	⇌	Ni	− 0,27
$Co^{2+} + 2e^-$	⇌	Co	− 0,28
$Cd^{2+} + 2e^-$	⇌	Cd	− 0,40
$Cr^{3+} + e^-$	⇌	Cr^{2+}	− 0,41
$Fe^{2+} + 2e^-$	⇌	Fe	− 0,44
$Cr^{3+} + 3e^-$	⇌	Cr	− 0,74
$Zn^{2+} + 2e^-$	⇌	Zn	− 0,76
$2H_2O + 2e^-$	⇌	$H_2(g) + 2OH$	0,83
$Cr^{2+} + 2e^-$	⇌	Cr	− 0,91
$Mn^{2+} + 2e^-$	⇌	Mn	− 1,18
$A\ell^{3+} + 3e^-$	⇌	$A\ell$	− 1,66
$Mg^{2+} + 2e^-$	⇌	Mg	− 2,36
$Na^+ + e^-$	⇌	Na	− 2,71
$Ca^{2+} + 2e^-$	⇌	Ca	− 2,87
$Sr^{2+} + 2e^-$	⇌	Sr	− 2,89
$Ba^{2+} + 2e^-$	⇌	Ba	− 2,90
$Cs^+ + e^-$	⇌	Cs	− 2,92
$K^+ + e^-$	⇌	K	− 2,93
$Li^+ + e^-$	⇌	Li	− 3,05

Increasing strength of reducing agents / *Toenemende sterkte van reduseermiddels* ↓

TABLE 4B: STANDARD REDUCTION POTENTIALS
TABEL 4B: STANDAARD-REDUKSIEPOTENSIALE

Increasing strength of oxidising agents /*Toenemende sterkte van oksideermiddels* ↓

Half-reactions/*Halfreaksies*			E^θ (V)
$Li^+ + e^-$	$\rightleftharpoons$	Li	− 3,05
$K^+ + e^-$	$\rightleftharpoons$	K	− 2,93
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	− 2,92
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	− 2,90
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	− 2,89
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	− 2,87
$Na^+ + e^-$	$\rightleftharpoons$	Na	− 2,71
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	− 2,36
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	− 1,66
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	− 1,18
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	− 0,91
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	− 0,76
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	− 0,74
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	− 0,44
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	− 0,41
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	− 0,40
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	− 0,28
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	− 0,27
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	− 0,14
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	− 0,13
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	− 0,06
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87

Increasing strength of reducing agents /*Toenemende sterkte van reduseermiddels* ↑