education

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NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: CHEMISTRY P2

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MARKS: 150

TIME: 3 hours

This question paper consists of 17 pages, 4 data sheets and a graph paper.

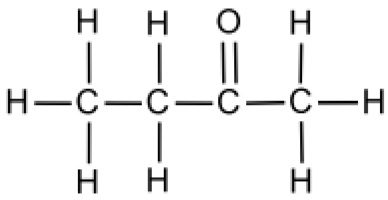
INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on your ANSWER BOOK.
2. This question paper consists of TEN 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 the two subquestions, e.g. between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your FINAL numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions, etc. where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 The structural formula of an organic compound given below represents …



A an alcohol

B an aldehyde

C a ketone

D an ester (2)

1.2 Consider the following organic compounds below;

propanal propane propanol

Arrange the above compounds in order, starting with the one with the lowest boiling point:

A propanol, propane, propanal

B propanol, propanal, propane

C propane, propanal, propanol

D propane, propanol, propanal (2)

1.3 Which ONE of the following alkanes is likely to produce 1 mole carbon dioxide and 2 moles of water when 1 mole of the alkane is burned in excess oxygen?

A Methane

B Ethane

C Propane

D Butane (2)

1.4 Which ONE of the following statements is CORRECT about an exothermic reaction?

A The products have higher enthalpy than the reactants.

B The reactants release heat and therefore have higher enthalpy.

C The heat of reaction is positive as the products have higher energy.

D The reactants absorb heat and therefore the reaction container would feel cold. (2)

1.5 A lump of magnesium is placed into a beaker containing 50 cm^3 of 0,4 $mol{\cdot}dm^{-3}$ sulphuric acid at a temperature of 25 °C.

Which ONE of the following factors will DECREASE the initial rate of reaction?

A Using 100 cm^3 of 0,4 $mol{\cdot}dm^{-3}$ sulphuric acid

B Decreasing temperature of the mixture

C Addition of a positive catalyst

D Using 50 cm^3 of 0,6 $mol{\cdot}dm^{-3}$ of sulphuric acid (2)

1.6 When powdered lime is added into an acidic solution, the pH of the solution changes from 4 to 6.

What is the corresponding change in the hydrogen ion concentration?

A Increases by a factor of 2

B Decreases by a factor of 2

C Increases by a factor of 100

D Decreases by a factor of 100 (2)

1.7 Which ONE of the following statements is TRUE for a reversible chemical reaction which has attained a dynamic equilibrium?

A The rate of forward reaction is equal to the rate of reverse reaction.

B The rate of forward reaction and the rate of reverse reaction remain constant.

C The concentration of the products is equal to the concentration of the reactants.

D Le Chatelier's principle may no longer be applied when the dynamic equilibrium has been attained. (2)

1.8 Consider the following acid-base reaction below.

$$H_2O(\ell) + SO_3^{2-}(aq) \rightleftharpoons HSO_3^-(aq) + OH^-(aq)$$

Which ONE is a pair of bases according to the Lowry-Brønsted theory of acids and bases?

A OH^- and HSO_3^-

B H_2O and HSO_3^-

C SO_3^{2-} and OH^-

D SO_3^{2-} and HSO_3^- (2)

1.9 The standard zinc half-cell is given below.

$$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$$

Which ONE of the following is TRUE about this half-cell?

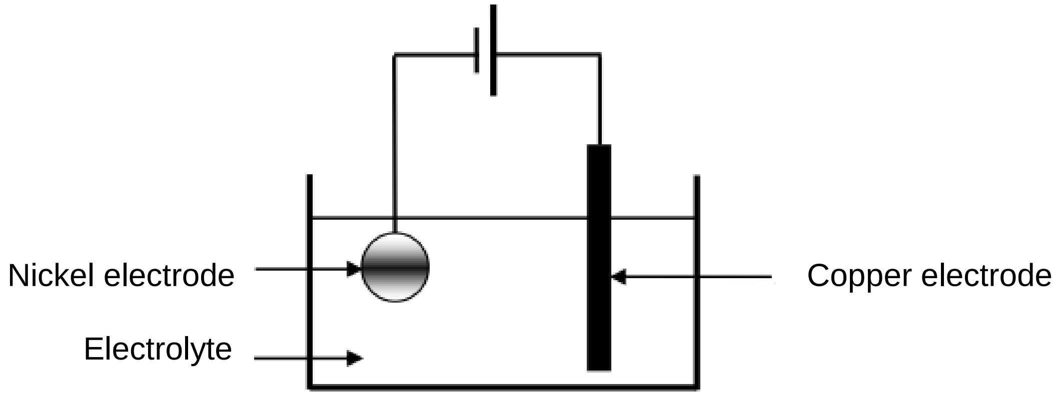
A Zn is always a cathode.

B Zn will not be oxidised spontaneously.

C Zn is the anode when the half-cell is connected to the hydrogen half-cell.

D Zn does not lose electrons as easily as hydrogen does. (2)

1.10. The simplified diagram below represents an electrolytic cell used to electroplate a nickel (Ni) coin with copper (Cu).



Which ONE of the following reactions takes place at the anode?

A $Ni^{2+} + 2e^{-} \rightarrow Ni$

B $Ni \rightarrow Ni^{2+} + 2e^{-}$

C $Cu^{2+} + 2e^{-} \rightarrow Cu$

D $Cu \rightarrow Cu^{2+} + 2e^{-}$ (2)

[20]

QUESTION 2: (Start on a new page.)

The letters **A** to **G** in the table below represent seven organic compounds.

A	O ‖ $CH_3 - C - CH_2 - CH_2 - CH_3$	**B**	Propan -2-ol
C	2-Methylpropan-1-ol	**D**	O ‖ $CH_3 - CH_2 - C - O - H$
E	$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ | $CH_2 - CH$	**F**	2-Methylbutanal
G	$CH_2 = CH_2$		

2.1 Write down the IUPAC name of compound **E**. (3)

2.2 Compounds **A** and **F** are isomers:

2.2.1 Define the term *isomer*. (2)

2.2.2 What type of isomers is compound **A** and **F**? (1)

2.2.3 Write down the homologous series to which compound **F** belongs? (1)

2.3 Compound **B** is an alcohol.

2.3.1 Is compound **B** a primary, secondary or tertiary alcohol? (1)

2.3.2 Explain the answer in QUESTION 2.3.1. (2)

2.4. Write down the STRUCTURAL FORMULA of compound **C**. (2)

2.5 For compound **D,** write down:

2.5.1 The NAME of the functional group. (1)

2.5.2 The IUPAC name. (2)

2.6. Compound **G** undergoes hydrogenation reaction.

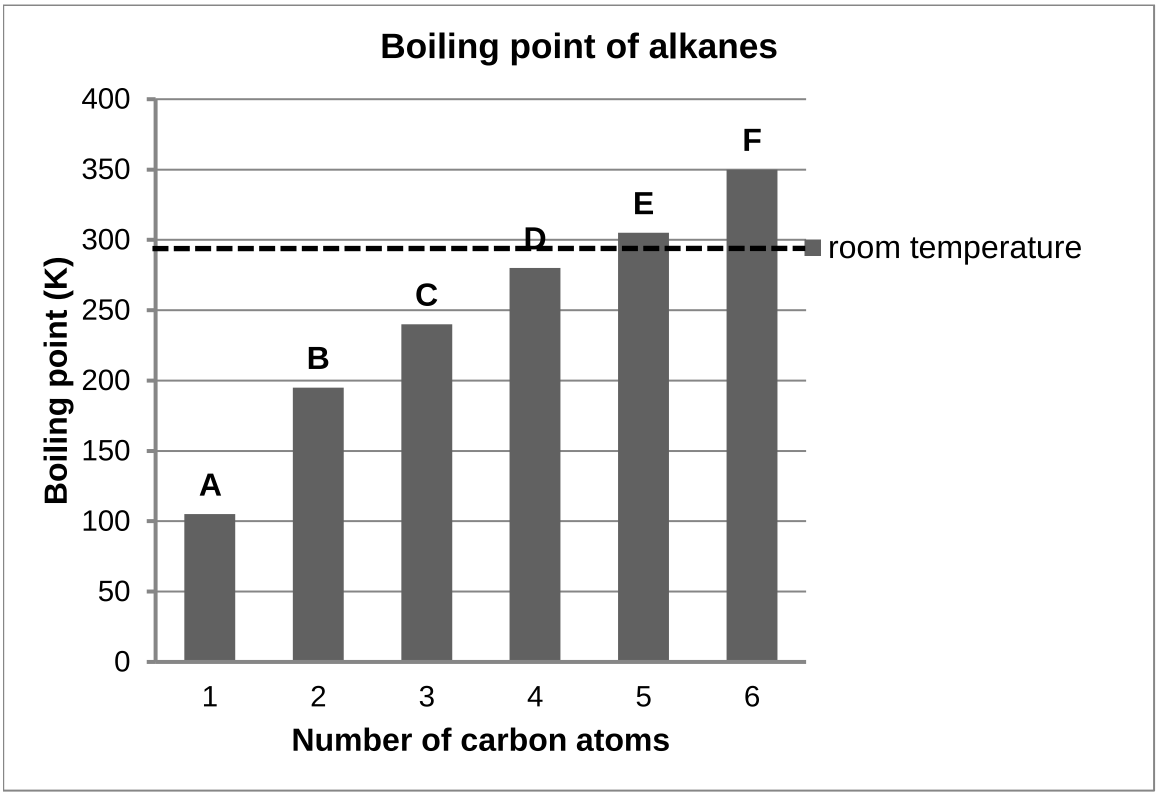
Write down the:

2.6.1 General formula of the homologous series of which compound **G** belongs. (1)

2.6.2 CONDENSED STRUCTURAL FORMULA of the product formed in this reaction. (1)
[17]

QUESTION 3: (Start on a new page.)

During a practical investigation the boiling points of the first six straight chain ALKANES were determined, and the following graph was obtained from the tabulated results.



3.1 Are alkanes SATURATED or UNSATURATED compounds? Explain the answer. (2)

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

3.3 Write down the:

3.3.1 Controlled variable for the investigation. (1)

3.3.2 IUPAC name of the alkane that is liquid at room temperature. (1)

3.3.3 Type of intermolecular force that exists in the compound mentioned in QUESTION 3.3.2. (2)

3.3.4 Structural formula of the CHAIN ISOMER of the alkane with 4 carbon atoms. (1)

3.4 What is the trend of boiling point from compound **A** to **F**?
Fully explain the trend. (4)

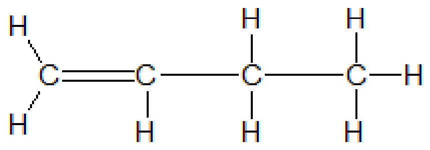
3.5 Will the vapour pressure of the chain isomers of compound **D** be HIGHER THAN, LOWER THAN or EQUAL TO that of compound **D**. (2)

[15]

QUESTION 4: (Start on a new page.)

4.1 Alkenes undergo addition reactions. Reaction **I** and **II** given below represent the equations of incomplete addition reactions. Compound **P** and **Q** are organic products.

Reaction I



+ H_2O → Compound **P** **(Major product)**

Reaction II

2-methylpent-1-ene + HCℓ → Compound **Q** **(Major product)**

4.1.1 Write down the TYPE of addition reaction represented in:

(a) Reaction I (1)

(b) Reaction II (1)

4.1.2 Structural formula of compound **P**. (2)

4.1.3 IUPAC name of compound **Q**. (2)

4.2 Halo-alkanes can either undergo ELIMINATION or SUBSTITUTION in the presence of a strong base. Study the flow diagram below which represents two different reactions

2-bromo-2-methylbutane —Dilute strong base→ Compound **Y**

2-bromo-2-methylbutane —Concentrated strong base→ Compound **X (Major product)**

Write down the

4.2.1 TYPE of reaction will take place when 2-bromo-2-methylbutane is heated in the presence of diluted strong base?

Choose either ELIMINATION or SUBSTITUTION (1)

4.2.2 NAME or FORMULA of the strong base. (1)

4.2.3 Balanced chemical equation for the reaction using STRUCTURAL FORMULAE that takes place when 2-bromo-2-methyl butane reacts with concentrated strong base. (4)

4.2.4 IUPAC name of the compound **Y** (2)

4.3 An ester is formed when ethanoic acid and methanol is heated in the presence of a catalyst.

Write down the:

4.3.1 NAME or FORMULA of the catalyst used. (1)

4.3.2 Balanced chemical equation for the reaction using STRUCTURAL FORMULAE. (5)
[20]

QUESTION 5: (Start on a new page.)

A group of students investigate the rate of reaction using a reaction between magnesium and hydrochloric acid at constant temperature.

The balanced chemical equation for the reaction is:

$$Mg(s) + 2HC\ell(aq) \rightarrow MgC\ell_2(aq) + H_2(g)$$

In one of the experiments they added 0,24 g of pure magnesium ribbon to an EXCESS of dilute hydrochloric acid and the following results were recorded.

Time (seconds)	**Volume of H_2 gas evolved (cm^3)**
0	0
20	90
40	140
60	172
80	195
100	210
120	224
140	224

5.1 Define the term *rate of reaction*. (2)

5.2 Use the GRAPH PAPER provided to draw a graph of volume of H_2 gas produced versus time. (4)

5.3 Use the graph to calculate the average rate of reaction in ($cm^3 \cdot s^{-1}$) during the time interval 50 s to 90 s. (3)

5.4 Give a reason why the gradient of the graph decreases as the reaction proceeds. (1)

5.5 The experiment was repeated using 0,24 g of pure magnesium powder instead of magnesium ribbon.

5.5.1 Calculate the mass of hydrogen gas produced at the end of the reaction. (4)

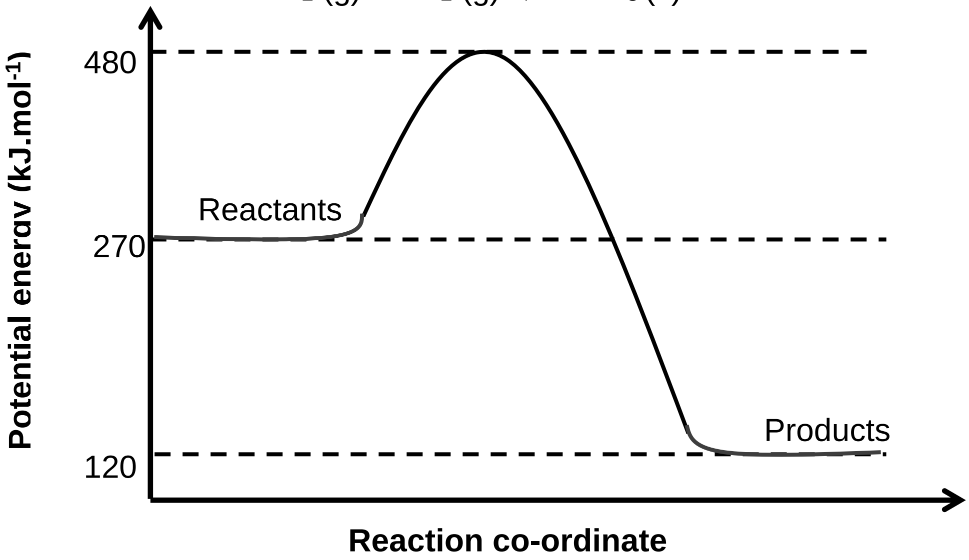
5.5.2 How will the rate of reaction be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME? (1)

[15]

QUESTION 6: (Start on a new page.)

6.1 The energy diagram below shows changes in the potential energy for the reaction between sulphur dioxide and oxygen.

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



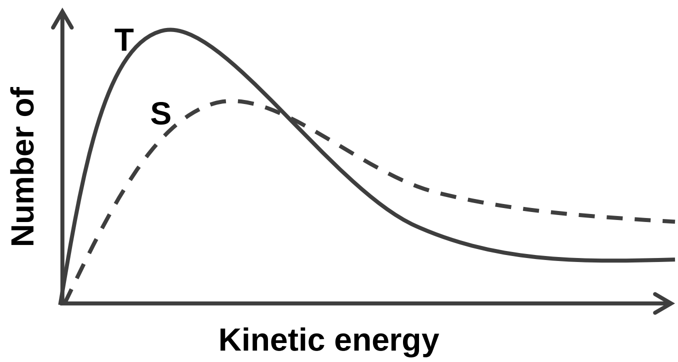
6.1.1 Define the term *activation energy*. (2)

6.1.2 Calculate the activation energy for the reverse reaction. (1)

6.1.3 After a while, a catalyst is introduced in the container.

Copy the above diagram in your ANSWER BOOK and use a dotted line to indicate how a positive catalyst affects the activation energy for the forward reaction. (2)

6.2 The two energy distribution curves below, **T** and **S** represent a gas at different temperatures.



6.2.1 Which ONE of the curves (**T** or **S**) represents the gas at a higher temperature? (1)

6.2.2 Use the COLLISION THEORY and the information on the graph to explain how temperature affects the rate of a reaction. (3)

[9]

QUESTION 7: (Start on a new page.)

When heated hydrogen sulphide gas decomposes according to the following reversible reaction.

$$2H_2S(g) \rightleftharpoons 2H_2(g) + S_2(g)$$

7.1 A 3,4 g sample of H_2S (g) is introduced into an empty rigid container of volume 1,25 dm^3. The sealed container is heated to 483 K, and 0,037 mol of S_2 (g) is present at equilibrium.

7.1.1 Define *Le Chatelier's principle*. (2)

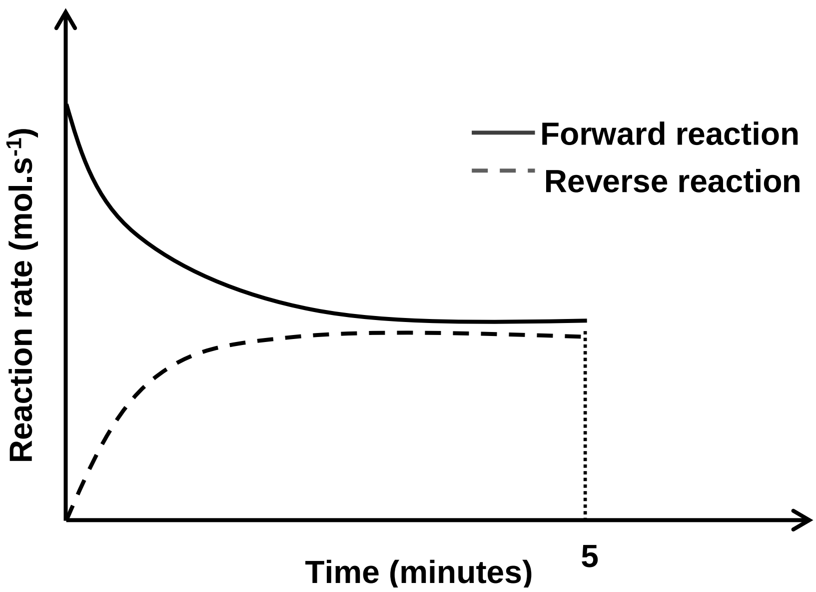
7.1.2 Calculate the equilibrium constant K_c, for the decomposition reaction at 483 K. (8)

7.2 The equilibrium constant, K_c for this reaction is increased by increasing the temperature.

7.2.1 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? (1)

7.2.2 Use Le Chatelier's principle to fully explain the answer in QUESTION 7.2.1. (2)

The sketch graph below was obtained for the equilibrium mixture for the first 5 minutes.



7.2.3 Redraw the graph above in your ANSWER BOOK. On the same set of axes complete the graph showing the effect of the temperature on the reaction rate at the 5th minute. (2)

[15]

QUESTION 8: (Start on a new page.)

Carbonic acid (H_2CO_3) ionises according to the following equation:

$$H_2CO_3(aq) + H_2O(\ell) \rightarrow H_3O^+(aq) + HCO_3^-(aq)$$

8.1 *Is carbonic acid, $H_2CO_3(aq)$, a strong acid* or *a weak acid?*

Give a reason for the answer (2)

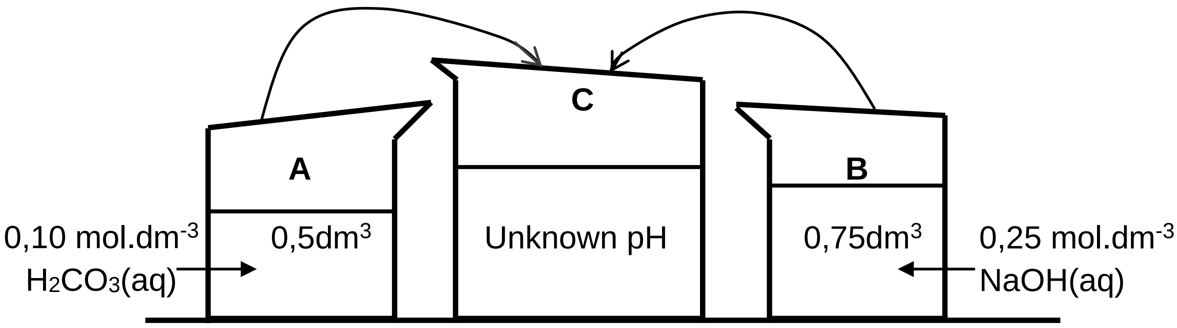
Two beakers **A** and **B** contain the acid and a strong base respectively.

Beaker **A**: 0,5 dm^3 of carbonic acid, $H_2CO_3(aq)$ of concentration 0,10 $mol.dm^{-3}$
Beaker **B**: 0,75 dm^3 of sodium hydroxide, NaOH(aq) of concentration 0,25 $mol.dm^{-3}$

When a 0,10 $mol·dm^{-3}$ solution of H_2CO_3 is prepared, it is found that the concentration of $HCO_3^-(aq)$ ions is 0,012 $mol.dm^{-3}$ at 25 °C.

8.2 Calculate the number of moles of $H_3O^+(aq)$ ions present in H_2CO_3 solution in beaker **A.** (3)

The contents of beakers **A** and **B** are added together in beaker **C**. The solution in beaker **C** has an unknown pH.



The balanced equation for the reaction is:

$$H_2CO_3(aq) + NaOH(aq) \rightarrow NaHCO_3(aq) + H_2O(\ell)$$

8.3 Calculate the:

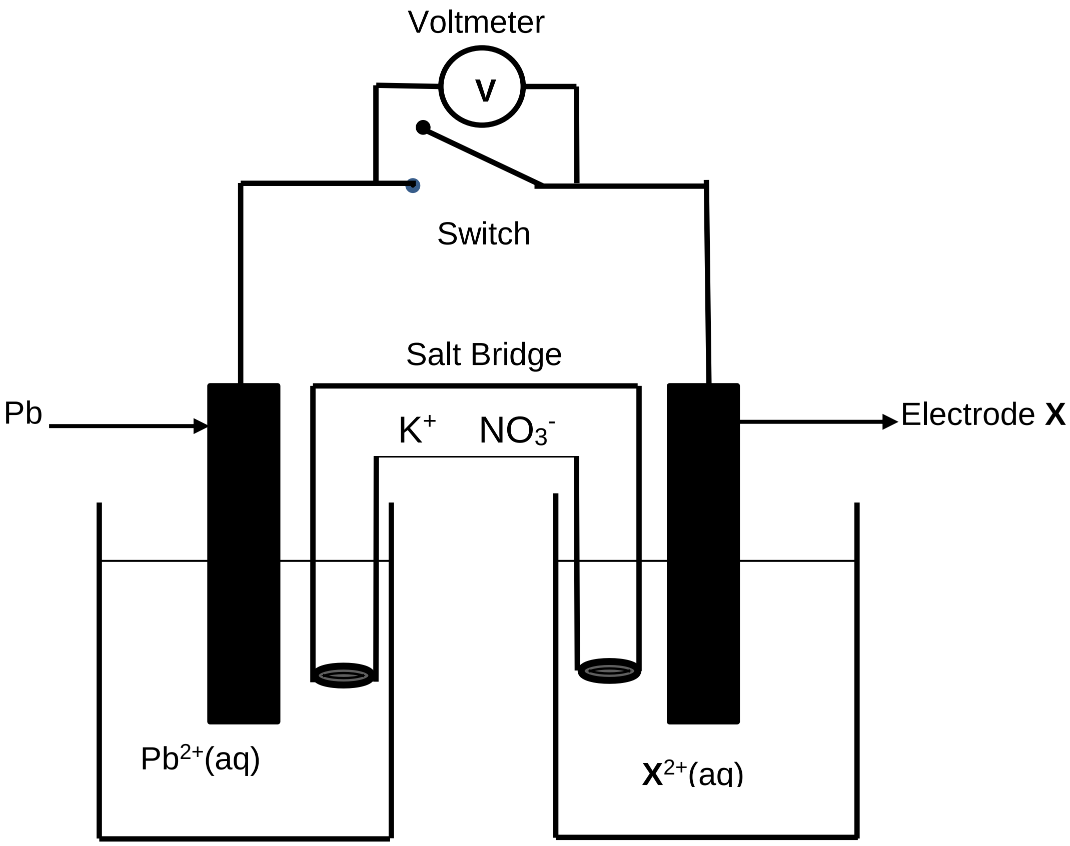
8.3.1 Number of moles of hydroxide (OH^-) ions in beaker **B**. (3)

8.3.2 pH of the solution at the completion of the reaction in beaker **C**. (7)
[15]

QUESTION 9: (Start on a new page.)

A standard electrochemical cell is set up using a standard lead half-cell and X|X^{2+} half -cell as shown in the diagram below. A voltmeter connected across the cell, initially registers 0,47 V.

9.1 Define the term *oxidising agent* in terms of ELECTRON TRANSFER. (2)



When the cell is in operation, electrons flow through the Pb electrode towards the **X** electrode in the external circuit.

9.2 Write down the equation for the half reaction that occurs at the cathode. (2)

9.3 Use the STANDARD ELECTRODE POTENTIAL TABLE to identify metal **X**. (5)

9.4 Write down the cell notation of the above cell. (3)

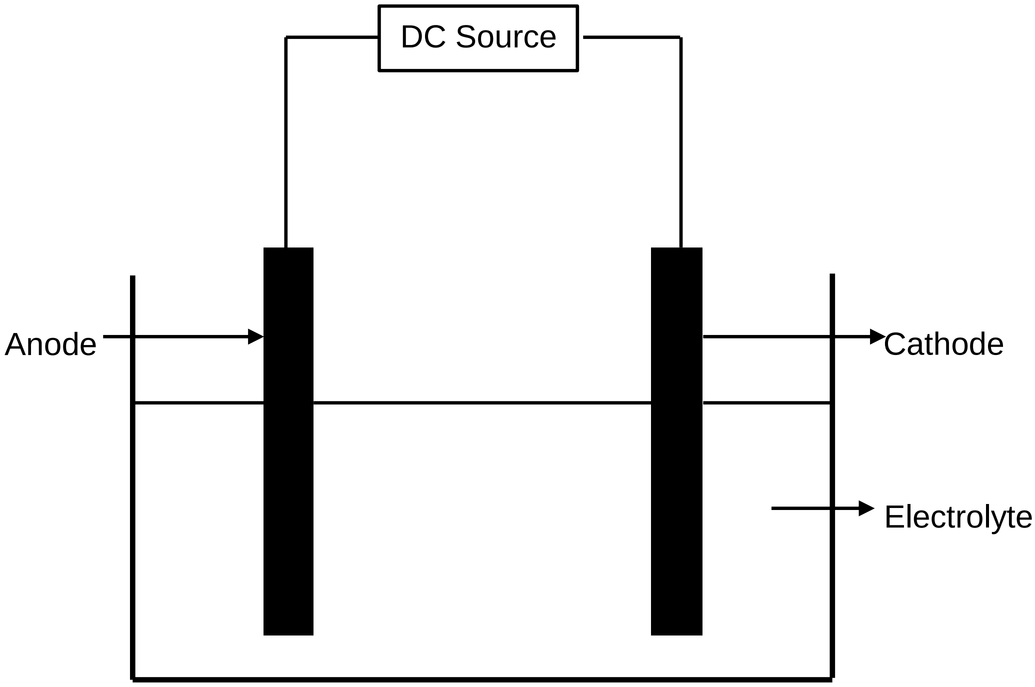
During an experiment, a student set up the electrochemical cell as shown above. After the experiment is over, a student left the switch closed. On the next day, the student opens the switch and takes the voltmeter reading.

9.5 What will be the possible voltmeter reading? Choose from LESS THAN 0,47 V, EQUAL TO 0,47 V or MORE THAN 0,47 V.

Explain your answer by referring to the concentrations of the electrolytes (3)
[15]

QUESTION 10(Start on a new page.)

Copper metal can be purified by electrolysis, using the electrochemical shown below.



10.1 Define the term *electrolysis.* (2)

10.2 Write down the CHEMICAL NAME or FORMULA of the electrolyte. (1)

10.3 On which electrode will copper be formed? Write down only ANODE or CATHODE. Support your answer by writing down the relevant half reaction. (3)

10.4 The solid impurities which form during the electrolysis contain silver.

Refer to the relative strength of reducing agents to explain why silver metal does not react with the electrolyte mentioned in QUESTION 10.2. (3)

[9]

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* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a v_a}{c_b v_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ 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 ELEMENTE1

KEY/*SLEUTEL*

29 1,9 Cu 63,5

- **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 oxidising ability/*Toenemende oksiderende vermoë* (↑)

Increasing reducing ability/*Toenemende reduserende vermoë* (↓)

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

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

Increasing oxidising ability/*Toenemende oksiderende vermoë* (↓)

Increasing reducing ability/*Toenemende reduserende vermoë* (↑)

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

NAME OF THE LEARNER:	

ANSWER SHEET (N.B. Staple the graph paper inside the answer book)

QUESTION 5.2