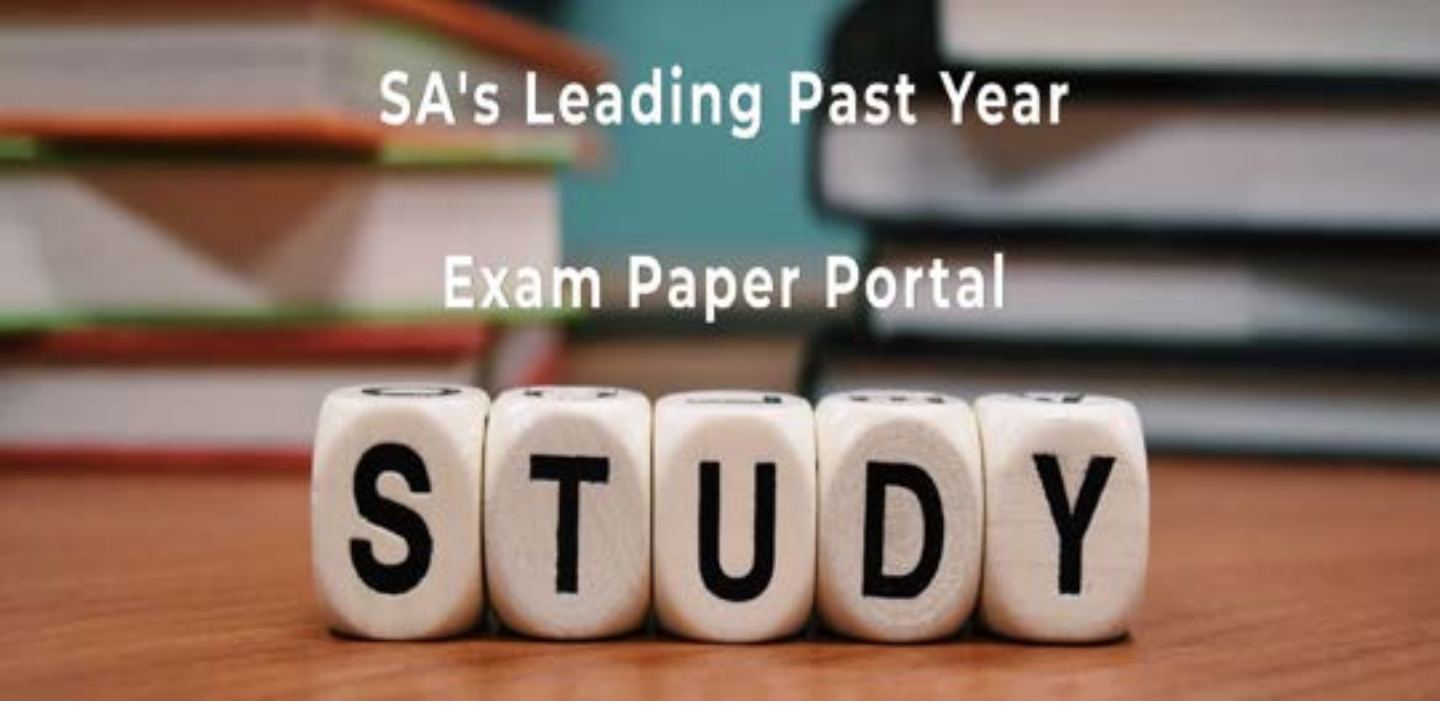

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PREPARATORY EXAMINATION

GRADE 12

PHYSICAL SCIENCES P2 (CHEMISTRY)

SEPTEMBER 2020

MARKS: 150

TIME: 3 HOURS

This question paper consists of 16 pages and 4 data sheets.

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INSTRUCTIONS AND INFORMATION

1. Write your name and other applicable information in the appropriate spaces on the ANSWER BOOK.
2. The question paper consists of EIGHT 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 subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable pocket 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 where necessary.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in your ANSWER BOOK, for example 1.11 E.

1.1 C_2H_4 reacts with H_2 to produce a hydrocarbon as represented below.

$$C_2H_4 + H_2 \rightarrow \text{hydrocarbon}$$

Which ONE of the following is the general formula of the hydrocarbon?

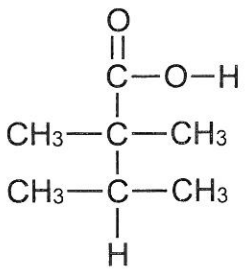
A C_nH_{2n}

B C_nH_{2n+1}

C C_nH_{2n+2}

D C_nH_{2n-2} (2)

1.2 The condensed structural formula of an organic compound is shown below.



Which ONE of the following is the correct IUPAC name of this compound?

A 2,2,3-trimethylbutanoic acid

B 2,3,3-trimethylbutanoic acid

C 2,2,3,3-tetramethylpropanoic acid

D 1,1,2,2-tetramethylpropanoic acid (2)

1.3 Hydrogen bonds ...

A are intramolecular forces.

B are stronger intermolecular forces than chemical bonds.

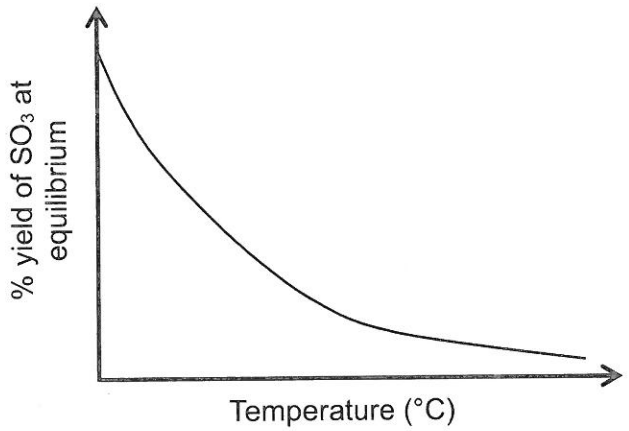
C form between hydrogen atoms in non-polar molecules.

D form between molecules in which hydrogen atoms are bonded to highly electronegative atoms. (2)

1.4 The reaction of sulphur dioxide and oxygen to form sulphur trioxide reaches equilibrium in a closed container according to the following balanced equation:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

The graph below shows how the percentage yield of $SO_3(g)$ at equilibrium changes with temperature.



Which ONE of the following combinations is correct for the REVERSE REACTION?

	TYPE OF REACTION	HEAT OF REACTION (ΔH)
A	Exothermic	$E_{SO_2+O_2} - E_{SO_3}$
B	Endothermic	$E_{SO_3} - E_{SO_2+O_2}$
C	Exothermic	$E_{SO_3} - E_{SO_2+O_2}$
D	Endothermic	$E_{SO_2+O_2} - E_{SO_3}$

(2)

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1.5 Which ONE of the following combinations is correct for an endothermic reaction?

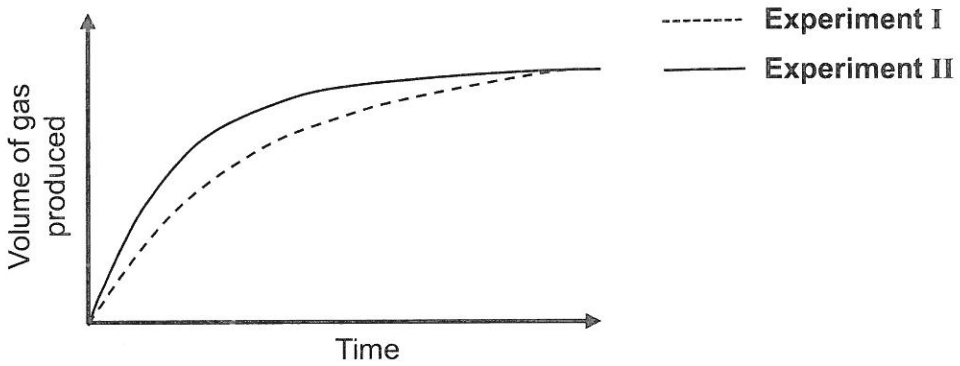
	HEAT OF REACTION (ΔH)	THE POTENTIAL ENERGY OF PRODUCTS IS ...
A	positive	less than that of reactants.
B	positive	more than that of reactants.
C	negative	less than that of reactants.
D	negative	more than that of reactants.

(2)

1.6 The reaction of calcium carbonate with EXCESS dilute hydrochloric acid is used to investigate reaction rate. The balanced equation for the reaction is:

$$CaCO_3(s) + 2HC\ell(aq) \rightarrow CaC\ell_2(aq) + CO_2(g) + H_2O(\ell)$$

Two experiments, I and II, are conducted under different reaction conditions. The results obtained are represented in the graphs below.



Which ONE of the statements below explains the difference in the above graphs the best?

In experiment II:

A A greater volume of acid was used

B More calcium carbonate was used

C Acid of lower concentration was used

D Calcium carbonate of larger surface area was used (2)

1.7 Consider the following balanced equation for a reaction at equilibrium.

$$IC\ell(\ell) + C\ell_2(g) \rightleftharpoons IC\ell_3(s) \qquad \Delta H = -106\ kJ\cdot mol^{-1}$$

Which ONE of the following changes in temperature and pressure will result in the HIGHEST yield of solid?

	TEMPERATURE	PRESSURE
A	Decrease	Decrease
B	Decrease	Increase
C	Increase	Decrease
D	Increase	Increase

(2)

1.8 Which ONE of the following represents the products formed and the pH of the solution when ammonium chloride ($NH_4C\ell$) undergoes hydrolysis?

	PRODUCTS FORMED	pH OF SOLUTION
A	$HC\ell + OH^-$	Above 7
B	$NH_3 + OH^-$	Below 7
C	$NH_4^+ + OH^-$	Above 7
D	$NH_3 + H_3O^+$	Below 7

(2)

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1.9 The pH of the poison released when two different insects, **X** and **Y**, bite their prey, is given below.

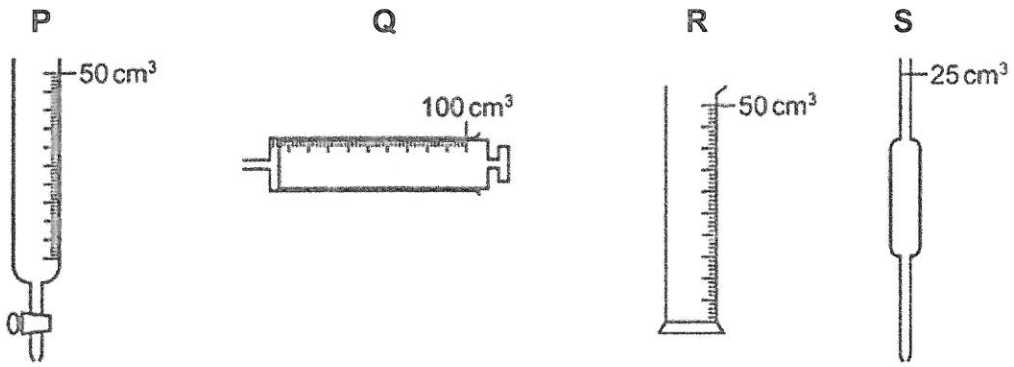
Insect X: pH = 6
Insect Y: pH = 8

Which ONE of the following combinations gives the substances that will most probably bring relief from each of the insect bites?

	INSECT X	INSECT Y
A	Oxalic acid	Sodium hydroxide
B	Sodium hydrogen carbonate	Vinegar
C	Sodium hydroxide	Sodium hydrogen carbonate
D	Vinegar	Lemon juice

(2)

1.10 Consider the apparatus **P**, **Q**, **R** and **S** illustrated below.



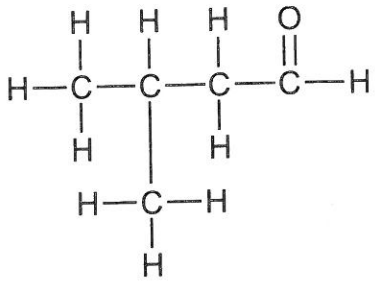
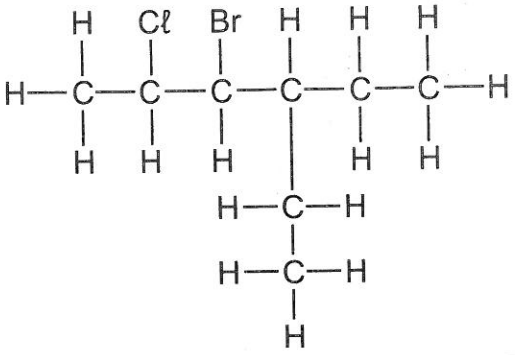
Which ONE of the following correctly links the above apparatus to the purpose for which it can be used?

	APPARATUS	PURPOSE
A	**P**	Measures the volume of acid added to base in a titration
B	**Q**	Measures the amount of calcium carbonate needed in a rate-determining experiment
C	**R**	Measures the volume of gas released in an experiment
D	**S**	Measures 15 cm^3 of base to be used in a titration

(2)
[20]

QUESTION 2 (Start on a new page.)

The letters **A** to **E** in the table below represent four organic compounds.

A	Ethanoic acid	**B**	$C_4H_{10}O$
C		**D**	
E	4-methylhex-2-yne	**F**	C_8H_{18}

2.1 Compounds **A** and **B** are heated in the presence of an acid catalyst.

Write down the:

2.1.1 Type of reaction that takes place (1)

2.1.2 Homologous series to which the organic product formed, belongs (1)

2.1.3 Structural formula of the organic product formed (2)

2.2 For compound **A**, write down the NAME of the:

2.2.1 Strongest intermolecular forces present (1)

2.2.2 Functional group (1)

2.3 Write down the GENERAL FORMULA of the homologous series to which compound **B** belongs. (1)

2.4 For compound **C**, write down the:

2.4.1 IUPAC name (2)

2.4.2 Structural formula of a FUNCTIONAL ISOMER of the SAME chain length (3)

2.5 Write down the IUPAC name of compound **D**. (3)

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2.6 Consider compound **E**.

2.6.1 Is compound **E** a SATURATED or an UNSATURATED hydrocarbon? Give a reason for the answer. (2)

2.6.2 Write down the structural formula of compound **E**. (3)

2.7 During a cracking reaction of compound **F**, ONE inorganic product and TWO organic products are formed. Prop-1-ene is one of the organic products formed.

2.7.1 Define the term *cracking reaction*. (2)

2.7.2 Write down TWO reaction conditions needed for thermal cracking to take place. (2)

2.7.3 Write down the IUPAC name of the other organic product formed. (2)

2.7.4 To which homologous series does the organic product in QUESTION 2.7.3 belong? (1)

2.7.5 Write down the NAME or FORMULA of the inorganic product formed. (1)
[28]

QUESTION 3 (Start on a new page.)

During a practical investigation, the boiling points of three compounds **A**, **B** and **C** were determined and the results recorded in the table below.

COMPOUND	HOMOLOGOUS SERIES	NUMBER OF C ATOMS	BOILING POINT (K)
A	Alkane	1	111,5
B	Alkane	2	184
C	Alcohol	2	351

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

3.2 Write down the structural formula of the functional group of compound **C**. (1)

3.3 Is compound **C** a LIQUID or a GAS at 333 K? (1)

3.4 Which compound (**A**, **B** or **C**) has the highest vapour pressure? Give a reason for the answer. (2)

3.5 During the investigation, the results obtained for the compounds above are compared.

Write down the INDEPENDENT VARIABLE when comparing the results obtained for the following compounds:

3.5.1 Compounds **A** and **B** (1)

3.5.2 Compounds **B** and **C** (1)

3.6 Explain why compound **A** will evaporate faster than compound **B**. Refer to the TYPE and relative STRENGTHS of the intermolecular forces. (3)

3.7 Is it fair to compare compound **A** with compound **B**? Write only YES or NO. (1)

3.8 Give a reason for the answer to QUESTION 3.7 (1)
[13]

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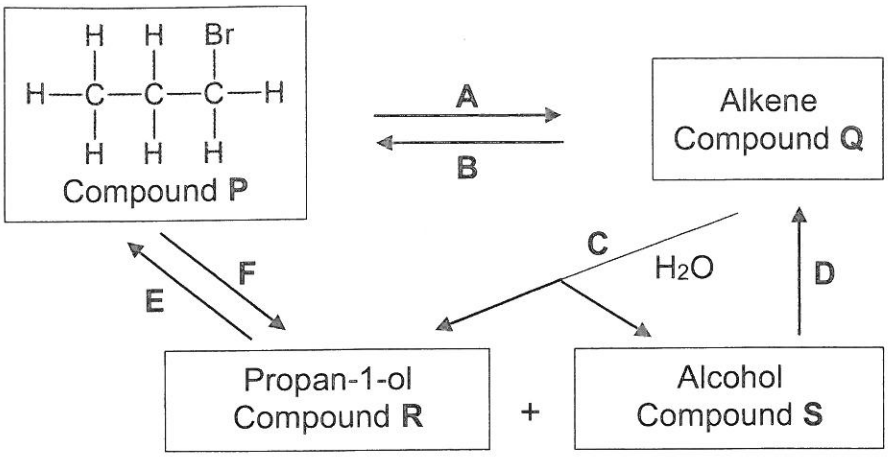
QUESTION 4 (Start on a new page.)

The flow diagram below shows how a haloalkane (compound **P**) can be used to prepare other organic compounds. The letters **A** to **F** represent different organic reactions.



4.1 Is compound **P** a PRIMARY, SECONDARY or TERTIARY haloalkane? Give a reason for the answer. (2)

4.2 Write down the IUPAC name of compound **Q**. (1)

4.3 State TWO reaction conditions for reaction **F**. (2)

4.4 Compounds **R** and **S** are structural isomers.

4.4.1 Define the term *structural isomer*. (2)

4.4.2 Are compounds **R** and **S** POSITIONAL, FUNCTIONAL or CHAIN isomers? (1)

4.4.3 Give a reason for the answer to QUESTION 4.4.2. (1)

4.4.4 Write down the structural formula of compound **S**. (2)

4.5 Write down the name of:

4.5.1 Addition reaction **B** (1)

4.5.2 Elimination reaction **D** (1)

4.5.3 Substitution reaction **F** (1)

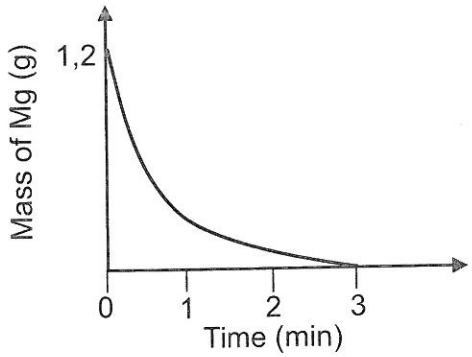
4.6 Using structural formulae, write down a balanced equation for reaction **E**. (4)
[18]

QUESTION 5 (Start on a new page.)

5.1 Learners use the reaction of magnesium powder with dilute hydrochloric acid in an experiment. The balanced equation for the reaction is:

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

Initially, they add 250 cm^3 hydrochloric acid ($HC\ell$) of concentration 0,3 $mol \cdot dm^{-3}$ to 1,2 g of magnesium powder in a test tube. The mass of the magnesium powder is recorded at regular time intervals. The sketch graph of mass against time below was obtained from the results.



5.1.1 Define the term *reaction rate*. (2)

5.1.2 Write down the NAME or FORMULA of the limiting reagent in this reaction. Give a reason for the answer. (2)

5.1.3 Calculate the average rate of the reaction, in $g \cdot min^{-1}$, in the first 2 minutes if the mass of the magnesium decreases by 1,1 g in this time. (3)

5.1.4 Calculate the number of moles of unreacted hydrochloric acid in the test tube after 3 minutes. (6)

5.1.5 Copy the axes and the curve above into your ANSWER BOOK and label it **A**. (No values are needed on the axes.)

On the same set of axes, sketch curve **B** that will be obtained if a catalyst is added to the reaction mixture. (2)

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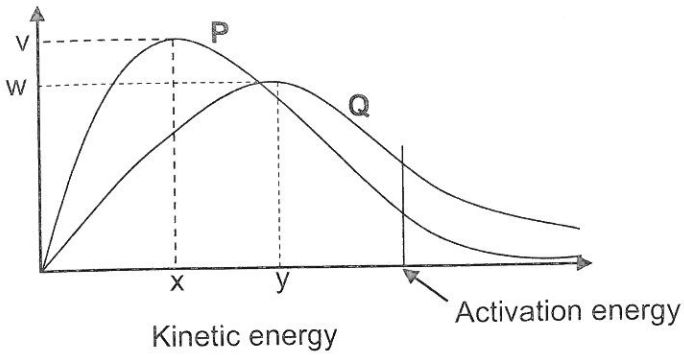
5.2 The Maxwell-Boltzmann distribution curves, **P** and **Q**, for a reaction at two DIFFERENT TEMPERATURES are shown below. The vertical axis is not labelled.



5.2.1 State the TWO criteria, as described by the collision theory, that should be met by any chemical reaction before it can take place. (2)

5.2.2 Write down a suitable label for the vertical axis shown above. (1)

5.2.3 Write down the letter (**v**, **w**, **x** or **y**) that indicates the most probable kinetic energy of molecules in the reaction mixture represented by curve **P**. (1)

5.2.4 Which curve, **P** or **Q**, represents the reaction taking place at the higher rate? Refer to the collision theory to explain the answer. (3)

5.2.5 How will the addition of a catalyst to the reaction mixture affect each of the following?

Write down INCREASE, DECREASE or REMAIN THE SAME.

(a) The peak of curve **P** (1)

(b) The number of molecules with energy equal to or greater than the activation energy (1)

[24]

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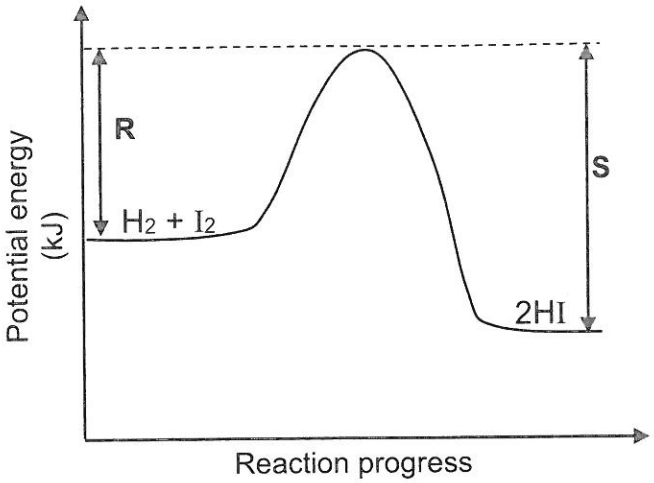
QUESTION 6 (Start on a new page.)

The potential energy graph for the reaction of hydrogen with iodine is shown below. The balanced equation for the reaction is:

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



6.1 Is the forward reaction EXOTHERMIC or ENDOTHERMIC? Give a reason for the answer. (2)

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

6.3 In terms of **R** and **S** shown on the graph, write down an expression for the:

6.3.1 Activation energy for the forward reaction (1)

6.3.2 Heat of reaction (ΔH) for the forward reaction (1)

A catalyst is now added to the reaction mixture.

6.4 Redraw the above graph in your ANSWER BOOK and use a DOTTED LINE to show how the addition of a catalyst will influence the curve. No labels are required. (2)

6.5 How will the catalyst affect the time taken by the reaction to reach equilibrium? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)
[9]

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QUESTION 7 (Start on a new page.)

Excess sulphur and 3 mol oxygen gas are sealed in an empty 3 dm^3 container at a certain temperature. The reaction reaches equilibrium according to the following balanced equation:

$$S(s) + O_2(g) \rightleftharpoons SO_2(g) \qquad \Delta H < 0$$

7.1 Define the term *chemical equilibrium*. (2)

7.2 The equilibrium constant (K_c) for the reaction at this temperature is 2.

7.2.1 Calculate the number of moles of $SO_2(g)$ present at equilibrium. (7)

7.2.2 Calculate the equilibrium concentration of $SO_2(g)$. (2)

7.3 How will each of the following affect the yield of $SO_2(g)$? Write down only INCREASES, DECREASES or REMAINS THE SAME.

7.3.1 More sulphur is added into the container. (1)

7.3.2 The pressure is increased by decreasing the volume of the container at constant temperature. (1)

7.4 The temperature is now changed and it is found that the equilibrium constant (K_c) increases. Did the temperature INCREASE or DECREASE? (1)

7.5 Explain the answer to QUESTION 7.4. (2)

7.6 How will the addition of a catalyst influence the equilibrium constant (K_C) of this reaction? Write down only INCREASES, DECREASES or REMAINS THE SAME. (1)

[17]

QUESTION 8 (Start on a new page.)

8.1 Sulphuric acid, H_2SO_4, ionises in two steps. The first step in this ionisation is represented by the following incomplete equation.

$$H_2SO_4(aq) + H_2O(\ell) \rightleftharpoons \text{Ampholyte } \mathbf{P}(aq) + H_3O^+(aq)$$

8.1.1 Define the term *ampholyte*. (2)

8.1.2 For ampholyte **P**, write down the:

(a) NAME or FORMULA (1)

(b) NAME or FORMULA of its conjugate acid (1)

(c) NAME or FORMULA of its conjugate base (1)

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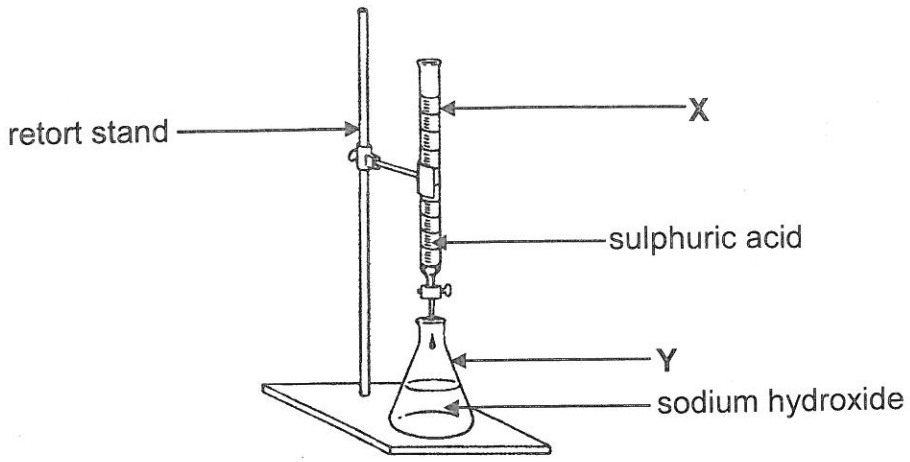
8.2 A 0,1 mol·dm^{-3} sodium hydroxide solution, NaOH(aq), is prepared in a 100 cm^3 volumetric flask. The sodium hydroxide solution is titrated with a 0,12 mol·dm^{-3} sulphuric acid solution, $H_2SO_4(aq)$, using the apparatus illustrated below.



It is found that 15 cm^3 of the $H_2SO_4(aq)$ neutralises an unknown volume of the NaOH(aq). The balanced equation for the reaction is:

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$$

8.2.1 Define the term *strong base*. (2)

8.2.2 Write down the name of the apparatus labelled:

(a) **X** (1)

(b) **Y** (1)

8.2.3 Calculate the volume of sodium hydroxide that remains in **Y** after addition of 15 cm^3 sulphuric acid. (5)

8.3 The excess sodium hydroxide solution in **Y** reacts with 0,4 g impure ammonium chloride, $NH_4C\ell$, according to the following balanced equation:

$$NaOH(aq) + NH_4C\ell(s) \rightarrow NaC\ell(aq) + H_2O(\ell) + NH_3(aq)$$

Calculate the percentage impurities in the ammonium chloride. (7)
[21]

TOTAL: 150

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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 *Avodadro se 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* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

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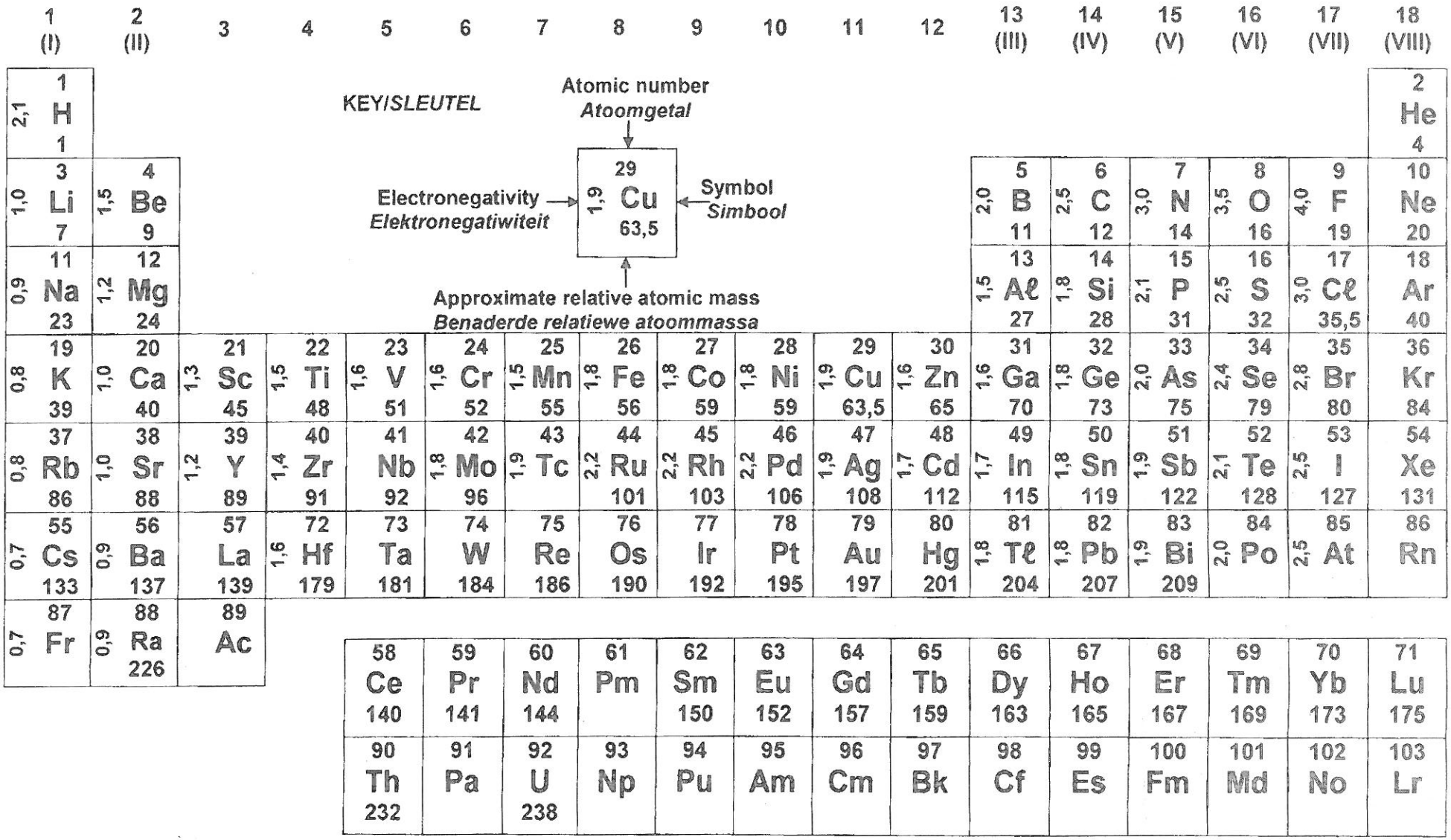
TABLE 3: THE PERIODIC OF ELEMENTS/*TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE*



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