basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NASIONALE
SENIOR SERTIFIKAAT

GRAAD 12

PHSC.2

FISIESE WETENSKAPPE: CHEMIE (V2)

NOVEMBER 2016

PUNTE: 150

TYD: 3 uur

Hierdie vraestel bestaan uit 18 bladsye en 4 gegewensblaaie.

OGGENDSESSIE

INSTRUKSIES EN INLIGTING

1. Skryf jou sentrumnommer en eksamennommer in die toepaslike ruimtes op die ANTWOORDEBOEK neer.

2. Hierdie vraestel bestaan uit TIEN vrae. Beantwoord AL die vrae in die ANTWOORDEBOEK.

3. Begin ELKE vraag op 'n NUWE bladsy in die ANTWOORDEBOEK.

4. Nommer die antwoorde korrek volgens die nommeringstelsel wat in hierdie vraestel gebruik is.

5. Laat EEN reël oop tussen twee subvrae, byvoorbeeld tussen VRAAG 2.1 en VRAAG 2.2.

6. Jy mag 'n nieprogrammeerbare sakrekenaar gebruik.

7. Jy mag toepaslike wiskundige instrumente gebruik.

8. Jy word aangeraai om die aangehegte GEGEWENSBLAAIE te gebruik.

9. Toon ALLE formules en substitusies in ALLE berekeninge.

10. Rond jou finale numeriese antwoorde tot 'n minimum van TWEE desimale plekke af.

11. Gee kort (bondige) motiverings, besprekings ensovoorts waar nodig.

12. Skryf netjies en leesbaar.

VRAAG 1: MEERVOUDIGEKEUSE-VRAE

Verskeie opsies word as moontlike antwoorde op die volgende vrae gegee. Skryf die vraagnommer (1.1–1.10) neer, kies die antwoord en maak 'n kruisie (X) oor die letter (A–D) van jou keuse in die ANTWOORDEBOEK.

VOORBEELD:

1.11 | A | B | C | D |

1.1 In 'n chemiese reaksie sal 'n oksideermiddel …

A protone verloor.

B protone opneem.

C elektrone verloor.

D elektrone opneem. (2)

1.2 'n Katalisator word by 'n reaksiemengsel in ewewig gevoeg.

Watter EEN van die volgende stellings oor die effek van die katalisator is ONWAAR?

A Die tempo van die voorwaartse reaksie verhoog.

B Die tempo van die terugwaartse reaksie verhoog.

C Die ewewigsposisie skuif na regs.

D Die ewewigsposisie bly onveranderd. (2)

1.3 Watter produk sal gevorm word wanneer 'n alkeen in die teenwoordigheid van 'n suurkatalisator met waterdamp (H_2O) reageer?

A Ester

B Alkaan

C Alkohol

D Aldehied (2)

1.4 Watter EEN van die volgende stel 'n SUBSTITUSIEREAKSIE voor?

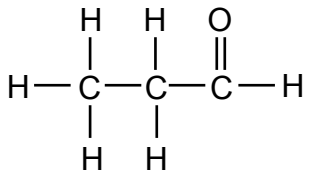
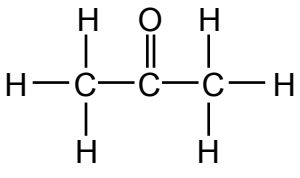
A $CH_2 = CH_2 + HBr \rightarrow CH_3CH_2Br$

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)

1.5 Beskou die twee organiese molekule **I** en **II** hieronder.

I	**II**
	

Watter EEN van die volgende verteenwoordig die homoloë reekse waaraan verbinding **I** en verbinding **II** behoort?

	I	**II**
A	Ketone	Alkohole
B	Aldehiede	Ketone
C	Aldehiede	Alkohole
D	Ketone	Aldehiede

(2)

1.6 Beskou die gebalanseerde vergelykings vir drie reaksies wat hieronder voorgestel word:

I: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

II: $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

III: $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

Watter van die reaksies hierbo is 'n deel van die Ostwaldproses?

A Slegs **I**

B Slegs **II**

C Slegs **III**

D Slegs **II** en **III**

(2)

1.7 Watter EEN van die volgende pare is NIE 'n gekonjugeerde suur-basispaar NIE?

A H_3O^+ en OH^-

B NH_4^+ en NH_3

C $H_2PO_4^-$ en HPO_4^{2-}

D H_2CO_3 en HCO_3^-

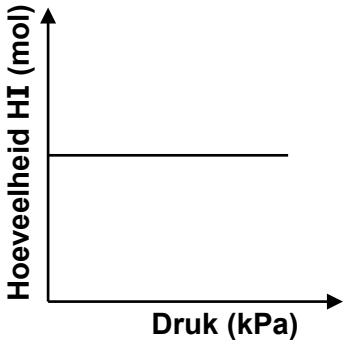
(2)

1.8 Die reaksie tussen waterstofgas en jodiumgas bereik ewewig in 'n geslote houer volgens die volgende gebalanseerde vergelyking:

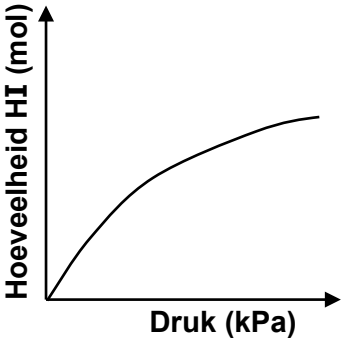
$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

Watter EEN van die grafieke hieronder toon die verwantskap tussen die hoeveelheid HI(g) by ewewig en die druk in die houer by konstante temperatuur?

A



B



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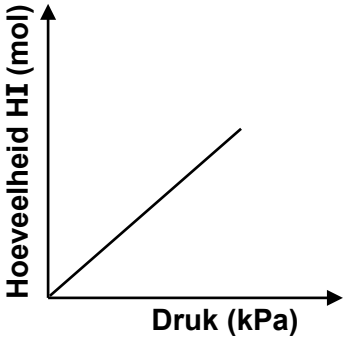
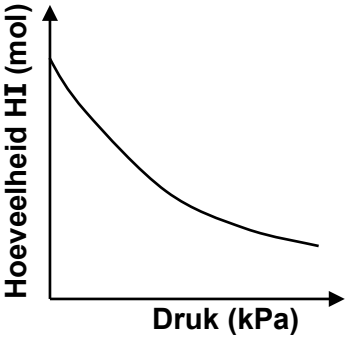


D



(2)

1.9 Watter EEN van die vergelykings hieronder verteenwoordig die halfreaksie wat plaasvind by die KATODE van 'n elektrochemiese sel wat gebruik word om 'n voorwerp te elektroplateer?

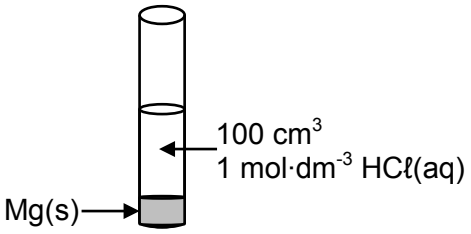
A $Ag \rightarrow Ag^+ + e^-$

B $Cr^{3+} + 3e^- \rightarrow Cr$

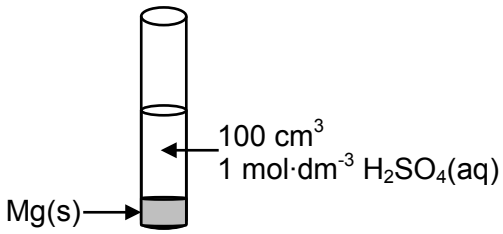
C $Cr^{3+} + e^- \rightarrow Cr^{2+}$

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

1.10 Gelyke hoeveelhede magnesiumpoeier (Mg) reageer onderskeidelik met gelyke volumes en gelyke konsentrasies HCℓ(aq) en H_2SO_4(aq), soos hieronder getoon.



Proefbuis X



Proefbuis Y

Magnesium is in OORMAAT.

Beskou die volgende stellings oor hierdie twee reaksies:

I: Die aanvanklike tempo van die reaksie in proefbuis **X** is gelyk aan die aanvanklike tempo van die reaksie in proefbuis **Y**.

II: Na voltooiing van die reaksies sal die massa magnesium wat in proefbuis **X** oorbly groter wees as dié in proefbuis **Y**.

III: Die hoeveelheid waterstofgas wat in **X** gevorm word, is gelyk aan die hoeveelheid waterstofgas wat in **Y** gevorm word.

Watter van die stellings hierbo is WAAR?

A Slegs **I**

B Slegs **II**

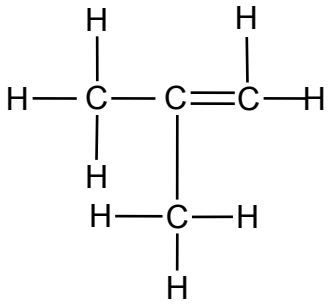
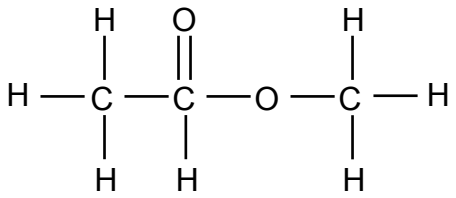
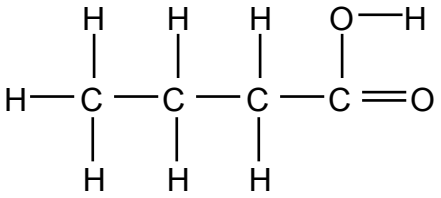
C Slegs **III**

D Slegs **I** en **III** (2)

[20]

VRAAG 2 (Begin op 'n nuwe bladsy.)

Die letters **A** tot **F** in die tabel hieronder verteenwoordig ses organiese verbindings.

A		**B**	Etieletanoaat
C	2,3-dibromo-3-metielpentaan	**D**	Poli-eteen
E		**F**	

2.1 Skryf die LETTER neer wat die volgende verteenwoordig:

2.1.1 'n Koolwaterstof (1)

2.1.2 'n Funksionele isomeer van verbinding **F** (1)

2.1.3 'n Verbinding wat aan dieselfde homoloë reeks as verbinding **B** behoort (1)

2.1.4 'n Plastiek (1)

2.2 Skryf die STRUKTUURFORMULE van ELK van die volgende neer:

2.2.1 Verbinding **C** (3)

2.2.2 Die suur wat gebruik word om verbinding **B** te berei (2)

2.2.3 Die monomeer wat gebruik word om verbinding **D** te berei (2)

2.3 Verbinding **A** reageer met 'n onbekende reaktans, **X**, om 2-metielpropaan te vorm.

Skryf neer die:

2.3.1 NAAM van reaktans **X** (1)

2.3.2 Soort reaksie wat plaasvind (1)

[13]

VRAAG 3 (Begin op 'n nuwe bladsy.)

Die kookpunte van drie isomere word in die tabel hieronder gegee.

	ISOMERE	KOOKPUNT (°C)
A	2,2-dimetielpropaan	9
B	2-metielbutaan	28
C	pentaan	36

3.1 Definieer die term *struktuurisomeer*. (2)

3.2 Watter soort isomere (POSISIE, KETTING of FUNKSIONEEL) is hierdie drie verbindings? (1)

3.3 Verduidelik die neiging in die kookpunte van verbinding **A** na verbinding **C**. (3)

3.4 Watter EEN van die drie verbindings (**A**, **B** of **C**) het die hoogste dampdruk? Verwys na die data in die tabel om 'n rede vir die antwoord te gee. (2)

3.5 Gebruik MOLEKULÊRE FORMULES en skryf 'n gebalanseerde vergelyking vir die volledige verbranding van verbinding **B**. (3)
[11]

VRAAG 4 (Begin op 'n nuwe bladsy.)

Butaan (C_4H_{10}) word in die nywerheid deur die TERMIESE kraking van langketting-koolwaterstofmolekule berei, soos in die vergelyking hieronder getoon. **X** verteenwoordig 'n organiese verbinding wat gelewer word.

$$C_{10}H_{22} \rightarrow \mathbf{X} + C_4H_{10}$$

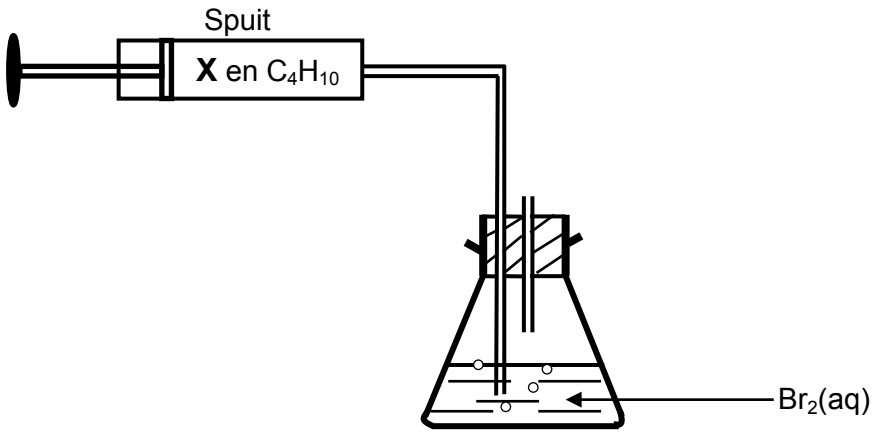
4.1 Skryf neer:

4.1.1 EEN toestand wat nodig is sodat TERMIESE kraking kan plaasvind (1)

4.1.2 Die molekulêre formule van verbinding **X** (1)

4.1.3 Die homoloë reeks waaraan verbinding **X** behoort (1)

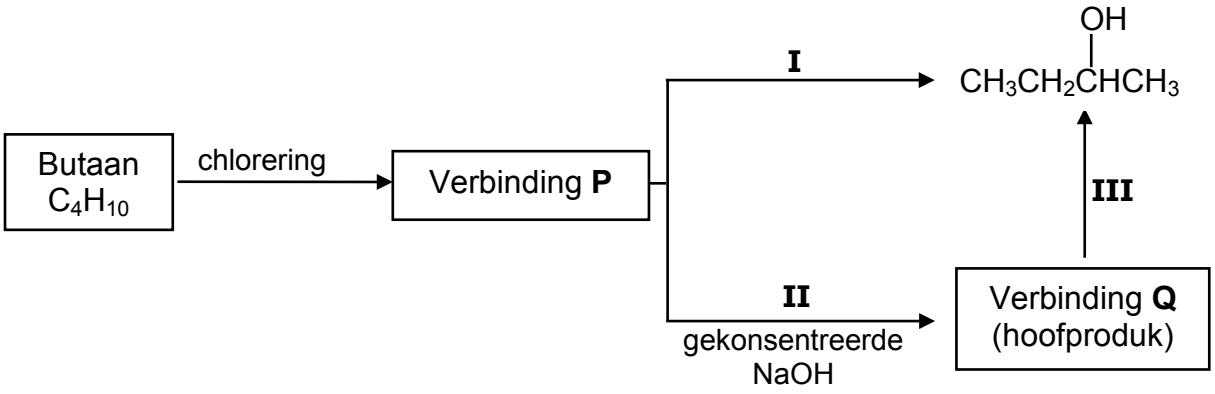
4.2 'n Mengsel van twee gasse, verbinding **X** en butaan, word deur broomwater, $Br_2(aq)$, in 'n koniese fles geborrel soos hieronder geïllustreer. DIE REAKSIE WORD IN 'N DONKER VERTREK UITGEVOER.



Die kleur van die broomwater verander van rooibruin na kleurloos wanneer die mengsel van die twee gasse daardeur geborrel word.

Watter EEN van die gasse (**X** of BUTAAN) ontkleur die broomwater? Verduidelik die antwoord. (4)

4.3 Bestudeer die vloeidiagram hieronder wat verskillende organiese reaksies voorstel, en beantwoord die vrae wat volg.



Skryf neer die:

4.3.1 IUPAC-naam van verbinding **P** (2)

4.3.2 Soort reaksie wat **I** gemerk is (1)

4.3.3 Struktuurformule van verbinding **Q** (2)

4.3.4 Die tipe addisiereaksie wat deur reaksie **III** verteenwoordig word (1)
[13]

VRAAG 5 (Begin op 'n nuwe bladsy.)

Waterstofperoksied, H_2O_2, ontbind om water en suurstof volgens die volgende gebalanseerde vergelyking te lewer:

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

5.1 Die aktiveringsenergie (E_A) vir hierdie reaksie is 75 kJ en die reaksiewarmte (ΔH) is −196 kJ.

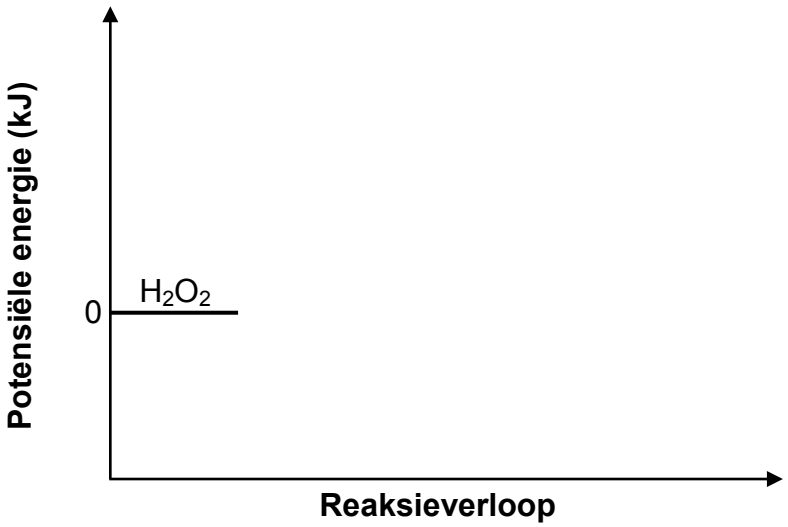
5.1.1 Definieer die term *aktiveringsenergie*. (2)

5.1.2 Teken die assestelsel hieronder in jou ANTWOORDEBOEK oor en voltooi dan die potensiële-energiediagram vir hierdie reaksie.

Dui die waarde van die potensiële energie van die volgende op die y-as aan:

- Geaktiveerde kompleks
- Produkte

(Die grafiek hoef NIE volgens skaal geteken te word NIE.)



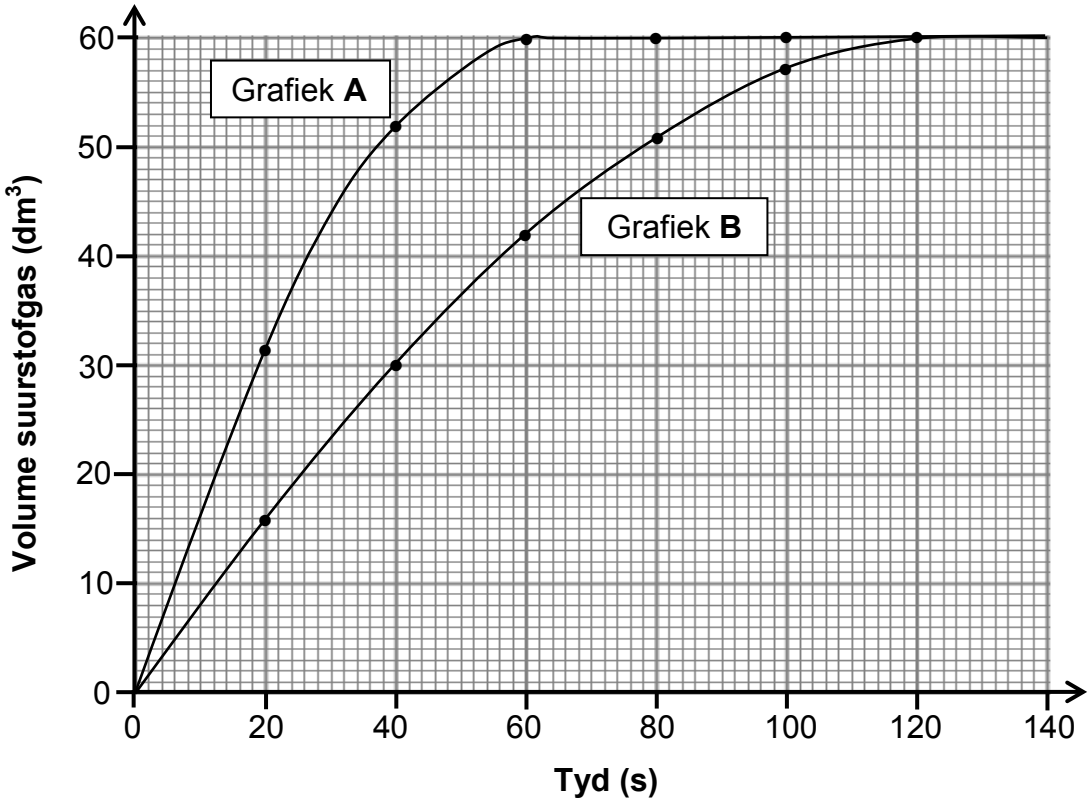
(3)

Wanneer verpoeierde mangaandioksied by die reaksiemengsel gevoeg word, neem die reaksietempo toe.

5.1.3 Op die grafiek wat vir VRAAG 5.1.2 geteken is, gebruik stippellyne om die pad van die reaksie te toon wanneer mangaandioksied bygevoeg word. (2)

5.1.4 Gebruik die botsingsteorie om te verduidelik hoe mangaandioksied die tempo van ontbinding van waterstofperoksied beïnvloed. (3)

5.2 Grafiek **A** en **B** hieronder is verkry vir die volume suurstof wat met tyd onder verskillende toestande gelewer is.



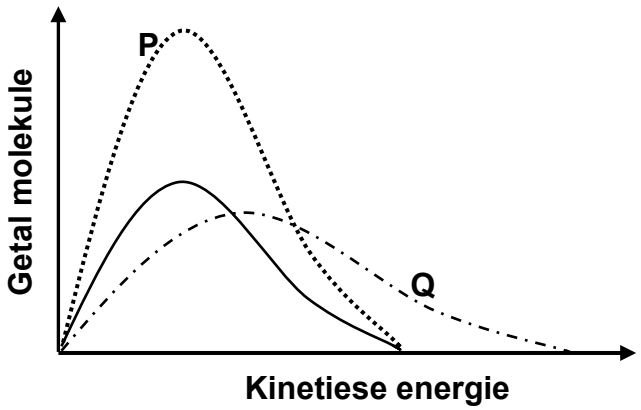
5.2.1 Bereken die gemiddelde reaksietempo (in $dm^3 \cdot s^{-1}$) tussen t = 10 s en t = 40 s vir grafiek **A**. (3)

5.2.2 Gebruik die inligting in grafiek **A** om die massa waterstofperoksied wat in die reaksie gebruik is, te bereken. Aanvaar dat al die waterstofperoksied ontbind het. Gebruik 24 $dm^3 \cdot mol^{-1}$ as die molêre volume van suurstof. (4)

5.2.3 Hoe vergelyk die massa waterstofperoksied wat gebruik is om grafiek **B** te verkry met dié wat gebruik is om grafiek **A** te verkry? Kies uit GROTER AS, KLEINER AS of GELYK AAN. (1)

5.3 Drie energieverspreidingskurwes vir suurstofgas wat onder verskillende toestande gelewer word, word in die grafiek hieronder getoon.

Die kurwe met die soliede lyn verteenwoordig 1 mol suurstofgas by 90 °C.



Kies die kurwe (**P** of **Q**) wat ELK van die volgende situasies die beste verteenwoordig:

5.3.1 1 mol suurstofgas wat by 120 °C gelewer word (1)

5.3.2 2 mol suurstofgas wat by 90 °C gelewer word (1)
[20]

VRAAG 6 (Begin op 'n nuwe bladsy.)

Waterstofgas, $H_2(g)$, reageer met swawelpoeier, S(s), volgens die volgende gebalanseerde vergelyking:

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

Die sisteem bereik ewewig by 90 °C.

6.1 Definieer die term *chemiese ewewig*. (2)

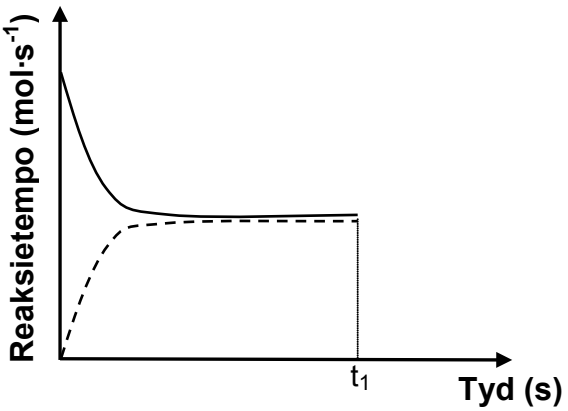
6.2 Hoe sal ELK van die volgende veranderinge die aantal mol $H_2S(g)$ by ewewig beïnvloed?

Kies uit VERHOOG, VERLAAG of BLY DIESELFDE.

6.2.1 Die byvoeging van meer swawel (1)

6.2.2 'n Verhoging in temperatuur
Gebruik Le Chatelier se beginsel om die antwoord te verduidelik. (4)

6.3 Die sketsgrafiek hieronder is vir die ewewigsmengsel verkry.



'n Katalisator word by tyd t_1 by die ewewigsmengsel gevoeg.

Teken die grafiek hierbo in jou ANTWOORDEBOEK oor. Voltooi die grafiek op dieselfde assestelsel om die effek van die katalisator op die reaksietempo's te toon. (2)

Aanvanklik word 0,16 mol $H_2(g)$ en 'n oormaat S(s) by 90 °C in 'n 2 dm^3-houer verseël en die sisteem word toegelaat om ewewig te bereik.

'n Presiese hoeveelheid $Pb(NO_3)_2$-oplossing word nou in die houer bygevoeg sodat AL die $H_2S(g)$ wat in die houer by EWEWIG teenwoordig is, volgens die volgende gebalanseerde vergelyking in PbS(s) omgeskakel word:

$$Pb(NO_3)_2(aq) + H_2S(g) \rightarrow PbS(s) + 2HNO_3(aq)$$

Die massa van die PbS-neerslag is 2,39 g.

6.4 Bereken die ewewigskonstante, K_c, vir die reaksie $H_2(g) + S(s) \rightleftharpoons H_2S(g)$ by 90 °C. (9)

[18]

VRAAG 7 (Begin op 'n nuwe bladsy.)

7.1 'n Leerder los ammoniumchloried($NH_4C\ell$)-kristalle in water op en meet die pH van die oplossing.

7.1.1 Definieer die term *hidrolise* van 'n sout. (2)

7.1.2 Sal die pH van die oplossing GROTER AS, KLEINER AS of GELYK AAN 7 wees? Skryf 'n relevante vergelyking neer om jou antwoord te ondersteun. (3)

7.2 'n Swawelsuuroplossing word berei deur 7,35 g $H_2SO_4(\ell)$ in 500 cm^3 water op te los.

7.2.1 Bereken die aantal mol H_2SO_4 wat in hierdie oplossing teenwoordig is. (2)

Natriumhidroksied(NaOH)-korrels word by die 500 cm^3 H_2SO_4-oplossing gevoeg.

Die gebalanseerde vergelyking vir die reaksie is:

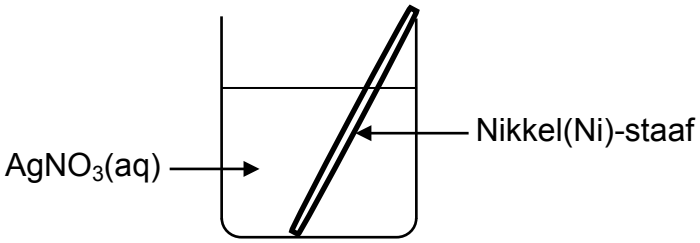
$$H_2SO_4(aq) + 2NaOH(s) \rightarrow Na_2SO_4(aq) + 2H_2O(\ell)$$

Na voltooiing van die reaksie word gevind dat die pH van die oplossing 1,3 is. Aanvaar volledige ionisasie van H_2SO_4.

7.2.2 Bereken die massa NaOH wat by die H_2SO_4-oplossing gevoeg is. Aanvaar dat die volume van die oplossing onveranderd bly. (9)
[16]

VRAAG 8 (Begin op 'n nuwe bladsy.)

8.1 'n Nikkel (Ni)-staaf word in 'n beker geplaas wat 'n silwernitraatoplossing, $AgNO_3(aq)$, bevat en 'n reaksie vind plaas.



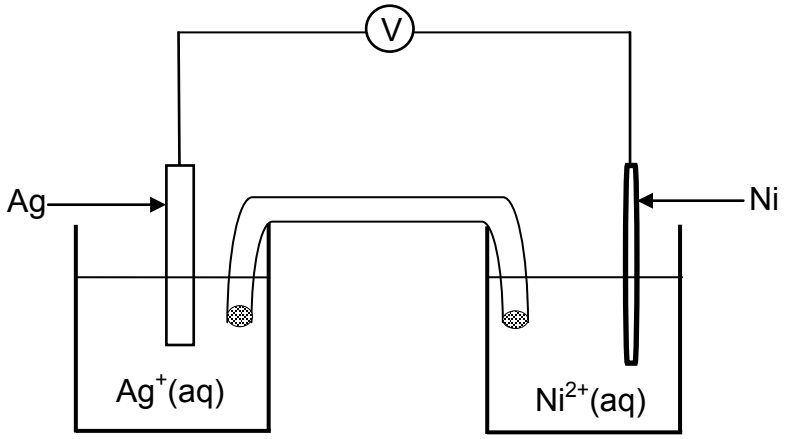
Skryf neer die:

8.1.1 NAAM of FORMULE van die elektroliet (1)

8.1.2 Oksidasie-halfreaksie wat plaasvind (2)

8.1.3 Gebalanseerde vergelyking vir die netto (algehele) redoksreaksie wat plaasvind (3)

8.2 'n Galvaniese sel word nou opgestel deur 'n nikkelhalfsel en 'n silwerhalfsel te gebruik.



8.2.1 Watter elektrode (**Ni** of **Ag**) moet aan die negatiewe terminaal van die voltmeter geskakel word? Gee 'n rede vir die antwoord. (2)

8.2.2 Skryf die selnotasie vir die galvaniese sel hierbo neer. (3)

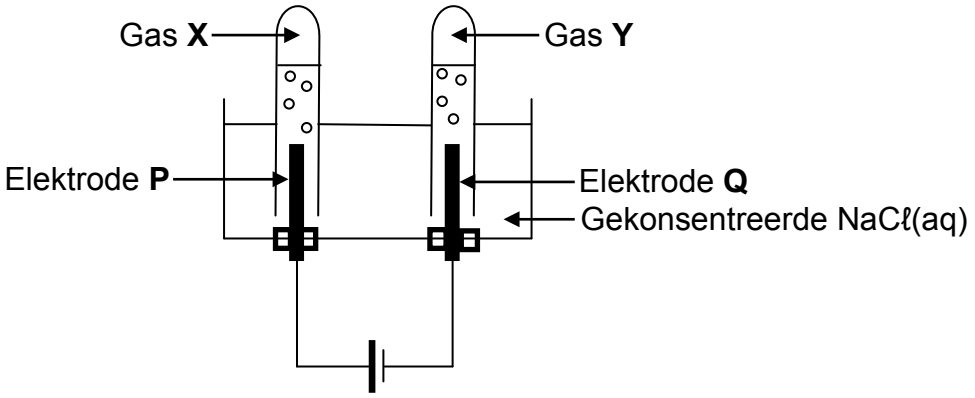
8.2.3 Bereken die aanvanklike lesing op die voltmeter indien die sel onder standaardtoestande funksioneer. (4)

8.2.4 Hoe sal die voltmeterlesing in VRAAG 8.2.3 beïnvloed word indien die konsentrasie van die silwer-ione verhoog word? Kies uit VERHOOG, VERLAAG of BLY DIESELFDE. (1)

[16]

VRAAG 9 (Begin op 'n nuwe bladsy.)

In die elektrochemiese sel hieronder word koolstofelektrodes gebruik tydens die elektrolise van 'n gekonsentreerde natriumchloriedoplossing.



Die gebalanseerde vergelyking vir die netto (algehele) selreaksie is:

$$2H_2O(\ell) + 2C\ell^-(aq) \rightarrow C\ell_2(g) + H_2(g) + 2OH^-(aq)$$

9.1 Is die reaksie EKSOTERMIES of ENDOTERMIES? (1)

9.2 Is elektrode **P** die ANODE of die KATODE? Gee 'n rede vir die antwoord. (2)

9.3 Skryf neer die:

9.3.1 NAAM of FORMULE van gas **X** (1)

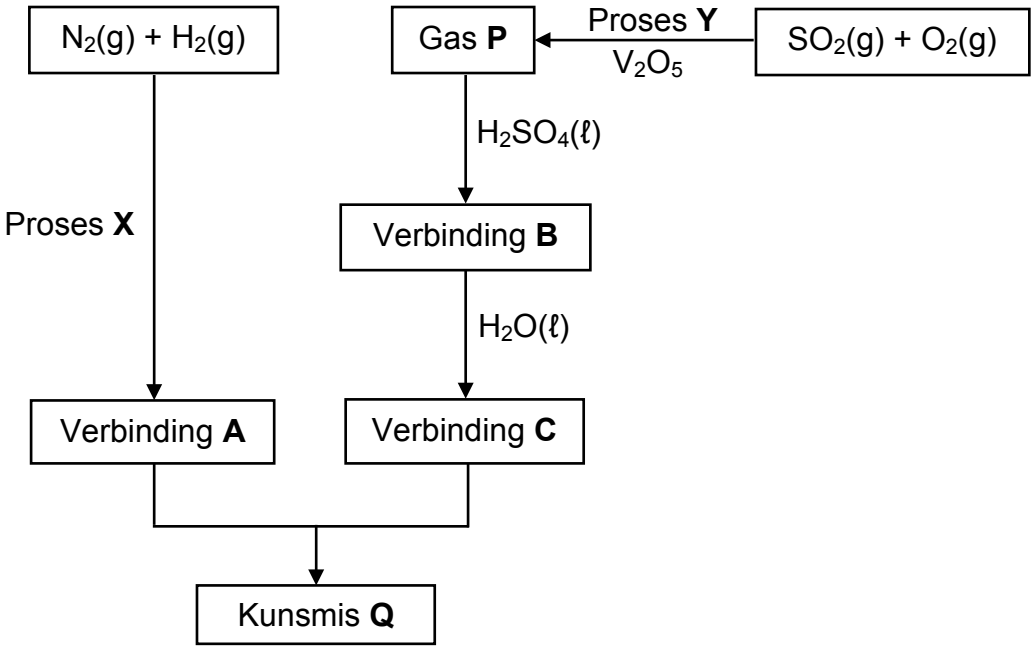
9.3.2 NAAM of FORMULE van gas **Y** (1)

9.3.3 Reduksie-halfreaksie (2)

9.4 Is die oplossing in die sel SUUR of ALKALIES (BASIES) na voltooiing van die reaksie? Gee 'n rede vir die antwoord. (2)
[9]

VRAAG 10 (Begin op 'n nuwe bladsy.)

10.1 Die vloeidiagram hieronder toon die prosesse wat by die industriële bereiding van kunsmis **Q** betrokke is.



Skryf neer die:

10.1.1 Naam van proses **X** (1)

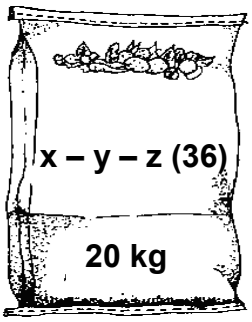
10.1.2 Naam van proses **Y** (1)

10.1.3 NAAM of FORMULE van gas **P** (1)

10.1.4 Gebalanseerde vergelyking vir die vorming van verbinding **B** (3)

10.1.5 Gebalanseerde vergelyking vir die vorming van kunsmis **Q** (4)

10.2 Die diagram hieronder toon 'n sak NPK-kunsmis waarvan die NPK-verhouding onbekend is. Daar is gevind dat die massa stikstof in die sak 4,11 kg en die massa fosfor 0,51 kg is.



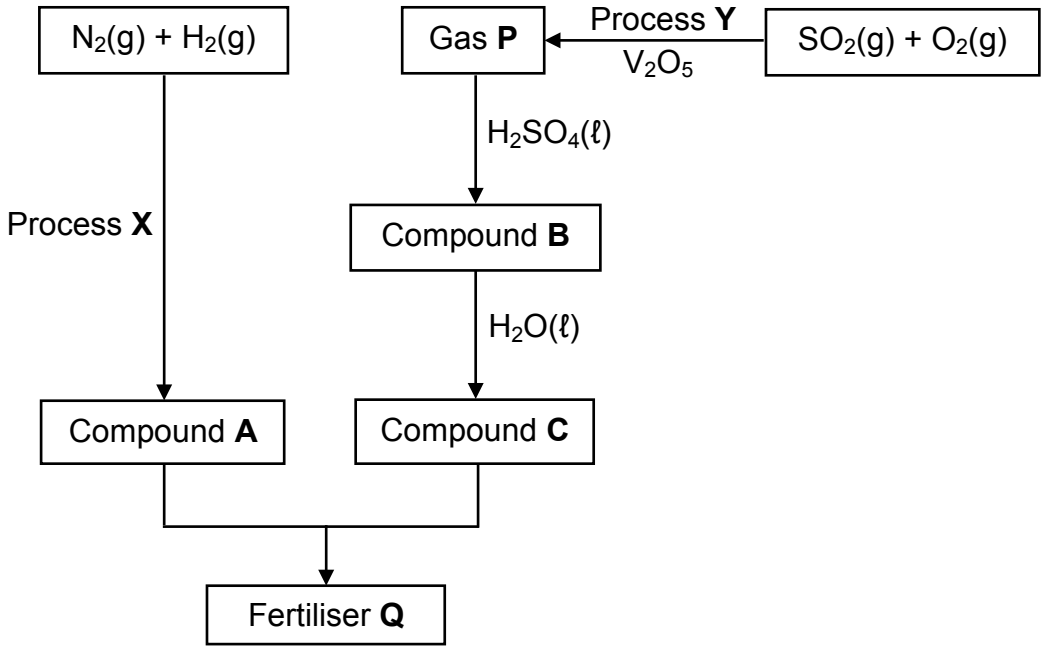
Bereken die NPK-verhouding van die kunsmis. (4)

[14]

TOTAAL: 150

QUESTION 10 (Start on a new page.)

10.1 The flow diagram below shows the processes involved in the industrial preparation of fertiliser **Q**.



Write down the:

10.1.1 Name of process **X** (1)

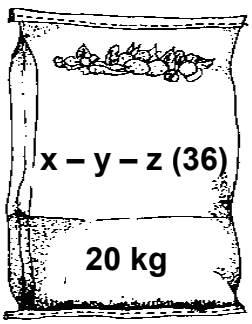
10.1.2 Name of process **Y** (1)

10.1.3 NAME or FORMULA of gas **P** (1)

10.1.4 Balanced equation for the formation of compound **B** (3)

10.1.5 Balanced equation for the formation of fertiliser **Q** (4)

10.2 The diagram below shows a bag of NPK fertiliser of which the NPK ratio is unknown. It is found that the mass of nitrogen in the bag is 4,11 kg and the mass of phosphorus is 0,51 kg.

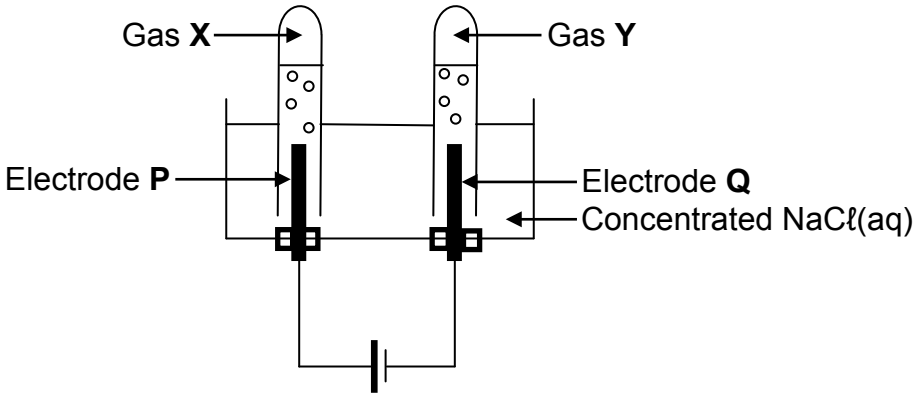


Calculate the NPK ratio of the fertiliser. (4)
[14]

TOTAL: 150

QUESTION 9 (Start on a new page.)

In the electrochemical cell below, carbon electrodes are used during the electrolysis of a concentrated sodium chloride solution.



The balanced equation for the net (overall) cell reaction is:

$$2H_2O(\ell) + 2C\ell^-(aq) \rightarrow C\ell_2(g) + H_2(g) + 2OH^-(aq)$$

9.1 Is the reaction EXOTHERMIC or ENDOTHERMIC? (1)

9.2 Is electrode **P** the ANODE or the CATHODE? Give a reason for the answer. (2)

9.3 Write down the:

9.3.1 NAME or FORMULA of gas **X** (1)

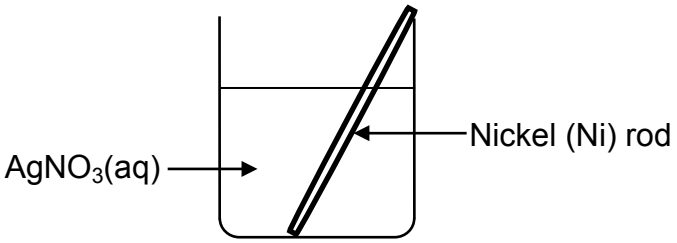
9.3.2 NAME or FORMULA of gas **Y** (1)

9.3.3 Reduction half-reaction (2)

9.4 Is the solution in the cell ACIDIC or ALKALINE (BASIC) after completion of the reaction? Give a reason for the answer. (2)
[9]

QUESTION 8 (Start on a new page.)

8.1 A nickel (Ni) rod is placed in a beaker containing a silver nitrate solution, $AgNO_3(aq)$ and a reaction takes place.



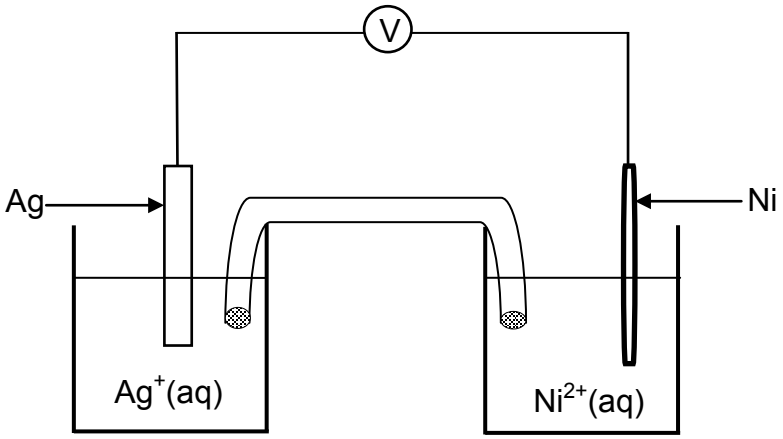
Write down the:

8.1.1 NAME or FORMULA of the electrolyte (1)

8.1.2 Oxidation half-reaction that takes place (2)

8.1.3 Balanced equation for the net (overall) redox reaction that takes place (3)

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



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

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

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

8.2.4 How will the voltmeter reading in QUESTION 8.2.3 be affected if the concentration of the silver ions is increased? Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)

[16]

QUESTION 7 (Start on a new page.)

7.1 A learner dissolves ammonium chloride ($NH_4C\ell$) crystals in water and measures the pH of the solution.

7.1.1 Define the term *hydrolysis* of a salt. (2)

7.1.2 Will the pH of the solution be GREATER THAN, SMALLER THAN or EQUAL TO 7? Write a relevant equation to support your answer. (3)

7.2 A sulphuric acid solution is prepared by dissolving 7,35 g of $H_2SO_4(\ell)$ in 500 cm^3 of water.

7.2.1 Calculate the number of moles of H_2SO_4 present in this solution. (2)

Sodium hydroxide (NaOH) pellets are added to the 500 cm^3 H_2SO_4 solution.

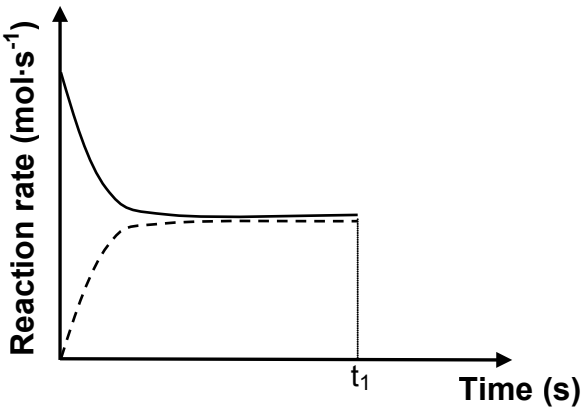
The balanced equation for the reaction is:

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

After completion of the reaction, the pH of the solution was found to be 1,3. Assume complete ionisation of H_2SO_4.

7.2.2 Calculate the mass of NaOH added to the H_2SO_4 solution. Assume that the volume of the solution does not change. (9)
[16]

6.3 The sketch graph below was obtained for the equilibrium mixture.



A catalyst is added to the equilibrium mixture at time t_1.

Redraw the graph above in your ANSWER BOOK. On the same set of axes, complete the graph showing the effect of the catalyst on the reaction rates. (2)

Initially 0,16 mol $H_2(g)$ and excess S(s) are sealed in a 2 dm^3 container and the system is allowed to reach equilibrium at 90 °C.

An exact amount of $Pb(NO_3)_2$ solution is now added to the container so that ALL the $H_2S(g)$ present in the container at EQUILIBRIUM is converted to PbS(s) according to the following balanced equation:

$$Pb(NO_3)_2(aq) + H_2S(g) \rightarrow PbS(s) + 2HNO_3(aq)$$

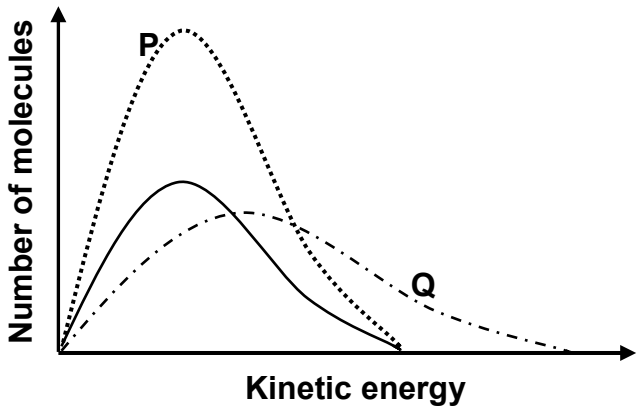
The mass of the PbS precipitate is 2,39 g.

6.4 Calculate the equilibrium constant K_c for the reaction $H_2(g) + S(s) \rightleftharpoons H_2S(g)$ at 90 °C. (9)

[18]

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)
[20]

QUESTION 6 (Start on a new page.)

Hydrogen gas, $H_2(g)$, reacts with sulphur powder, S(s), according to the following balanced equation:

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

The system reaches equilibrium at 90 °C.

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

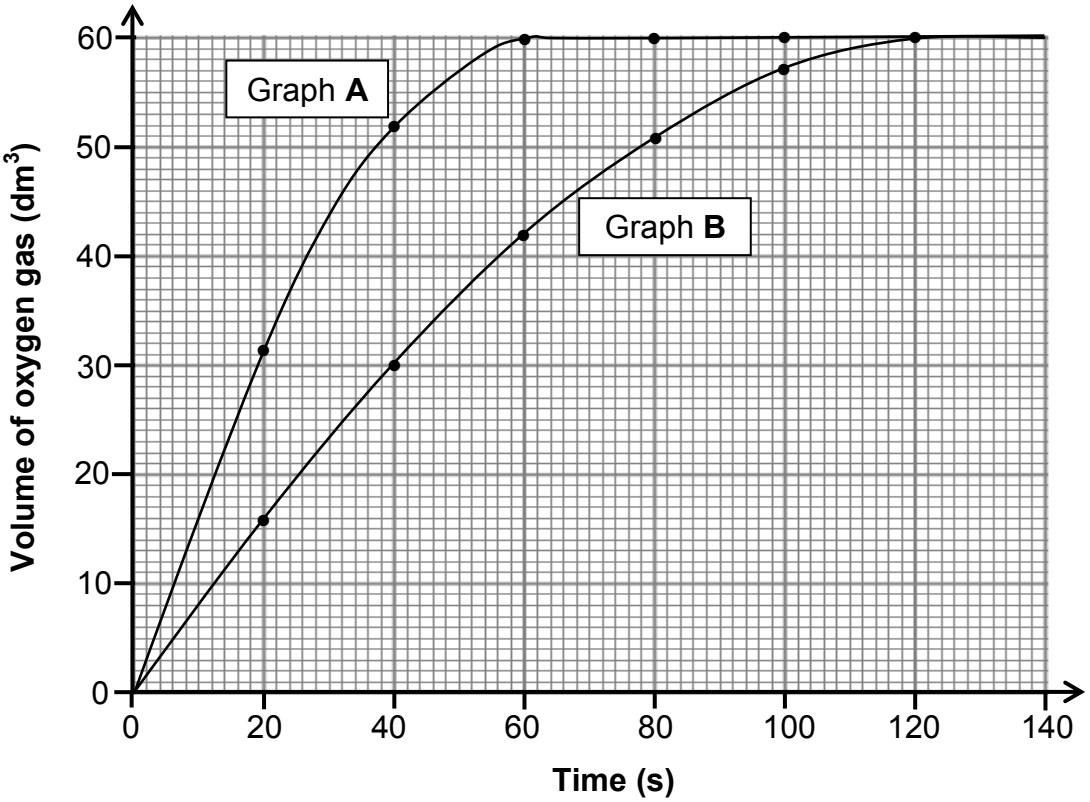
6.2 How will EACH of the following changes affect the number of moles of $H_2S(g)$ at equilibrium?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.2.1 The addition of more sulphur (1)

6.2.2 An increase in temperature
Use Le Chatelier's principle to explain the answer. (4)

5.2 Graphs **A** and **B** below were obtained for the volume of oxygen 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 decomposed. 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)

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.

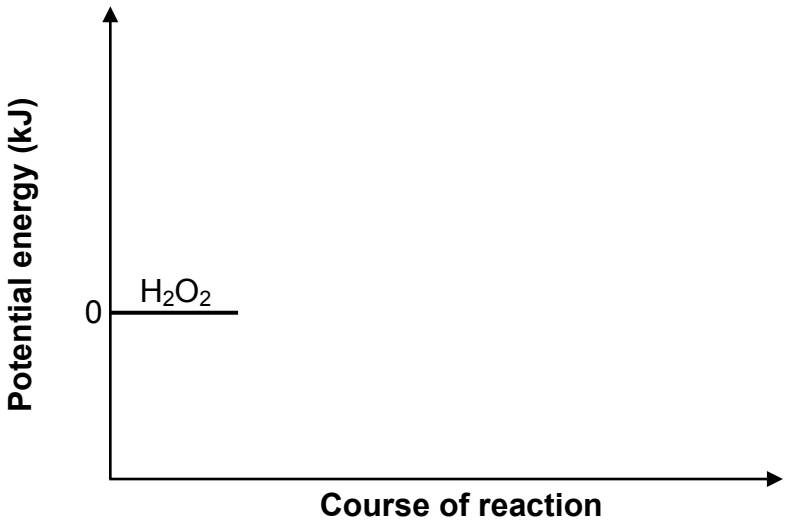
5.1.1 Define the term *activation energy*. (2)

5.1.2 Redraw the set of axes below 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.)



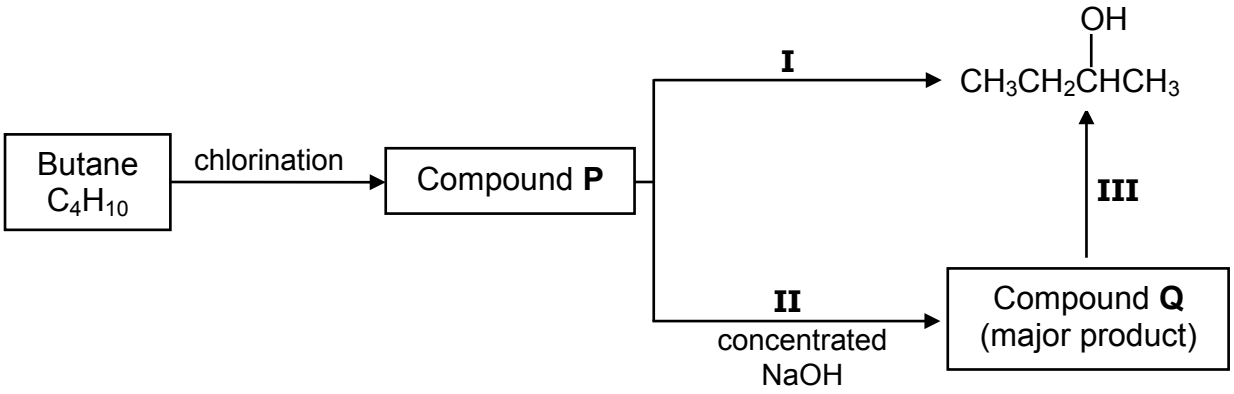
(3)

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)

5.1.4 Use the collision theory to explain how manganese dioxide influences the rate of decomposition of hydrogen peroxide. (3)

4.3 Study the flow diagram below, which represents various organic reactions, and answer the questions that follow.



Write down the:

4.3.1 IUPAC name of compound **P** (2)

4.3.2 Type of reaction labelled **I** (1)

4.3.3 Structural formula of compound **Q** (2)

4.3.4 The type of addition reaction represented by reaction **III** (1)
[13]

QUESTION 4 (Start on a new page.)

Butane (C_4H_{10}) is produced in industry by the THERMAL cracking of long-chain hydrocarbon molecules, as shown in the equation below. **X** represents an organic compound that is produced.

$$C_{10}H_{22} \rightarrow \mathbf{X} + C_4H_{10}$$

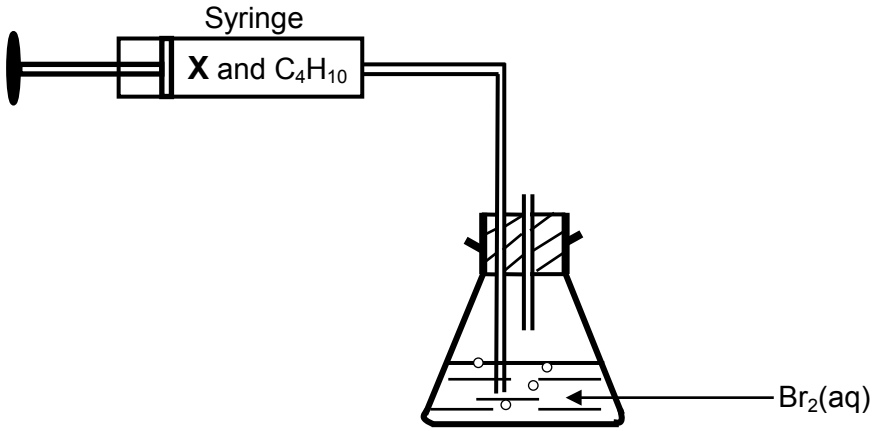
4.1 Write down:

4.1.1 ONE condition required for THERMAL cracking to take place (1)

4.1.2 The molecular formula of compound **X** (1)

4.1.3 The homologous series to which compound **X** belongs (1)

4.2 A mixture of the two gases, compound **X** and butane, is bubbled through bromine water, $Br_2(aq)$, in a conical flask, as illustrated below. THE REACTION IS CARRIED OUT IN A DARKENED ROOM.



The colour of the bromine water changes from reddish brown to colourless when the mixture of the two gases is bubbled through it.

Which ONE of the gases (**X** or BUTANE) decolorises the bromine water? Explain the answer. (4)

QUESTION 3 (Start on a new page.)

The boiling points of three isomers are given in the table below.

	ISOMERS	BOILING POINT (°C)
A	2,2-dimethylpropane	9
B	2-methylbutane	28
C	pentane	36

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

3.2 What type of isomers (POSITIONAL, CHAIN or FUNCTIONAL) are these three compounds? (1)

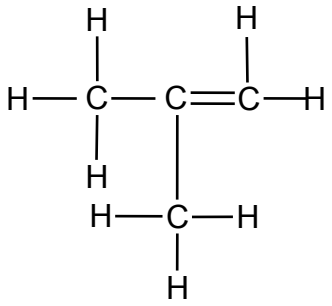
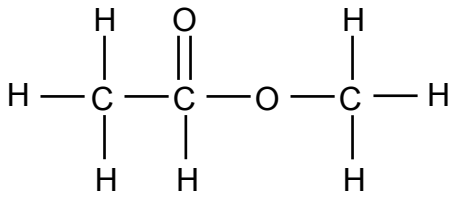
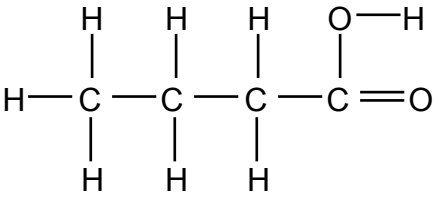
3.3 Explain the trend in the boiling points from compound **A** to compound **C**. (3)

3.4 Which ONE of the three compounds (**A**, **B** or **C**) has the highest vapour pressure? Refer to the data in the table to give a reason for the answer. (2)

3.5 Use MOLECULAR FORMULAE and write down a balanced equation for the complete combustion of compound **B**. (3)
[11]

QUESTION 2 (Start on a new page.)

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

A		**B**	Ethyl ethanoate
C	2,3-dibromo-3-methylpentane	**D**	Polyethene
E		**F**	

2.1 Write down the LETTER that represents the following:

2.1.1 A hydrocarbon (1)

2.1.2 A functional isomer of compound **F** (1)

2.1.3 A compound which belongs to the same homologous series as compound **B** (1)

2.1.4 A plastic (1)

2.2 Write down the STRUCTURAL FORMULA of EACH of the following:

2.2.1 Compound **C** (3)

2.2.2 The acid used to prepare compound **B** (2)

2.2.3 The monomer used to make compound **D** (2)

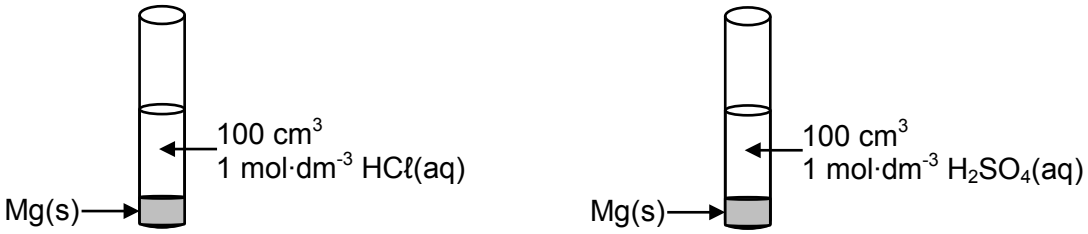
2.3 Compound **A** reacts with an unknown reactant, **X**, to form 2-methylpropane.

Write down the:

2.3.1 NAME of reactant **X** (1)

2.3.2 Type of reaction that takes place (1)
[13]

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)

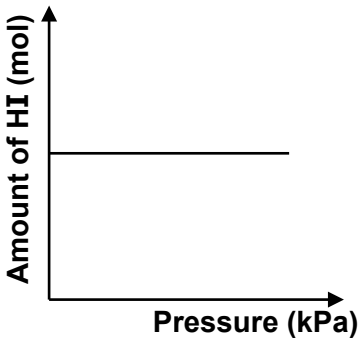
[20]

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

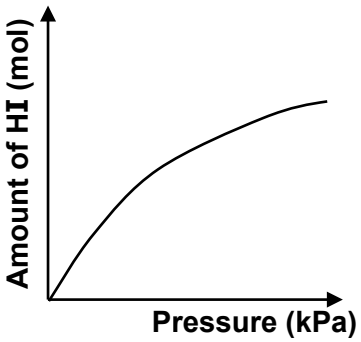
$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

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?

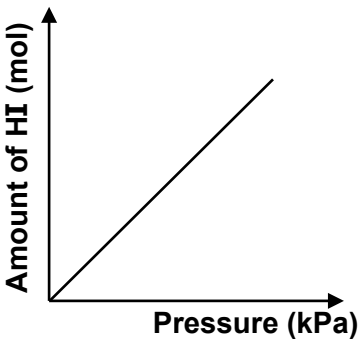
A



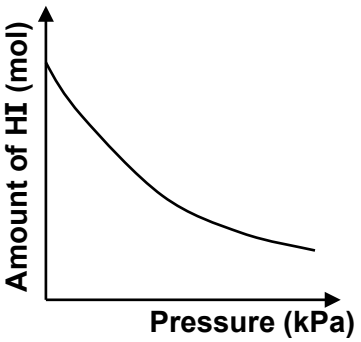
B



C



D



(2)

1.9 Which ONE of the equations below represents the half-reaction occurring at the CATHODE of an electrochemical cell that is used to electroplate an object?

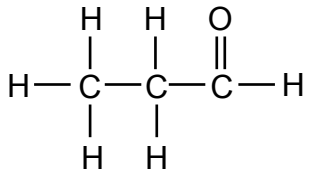
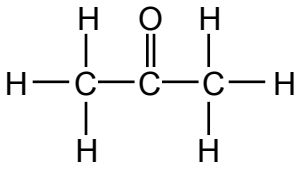
A $Ag \rightarrow Ag^+ + e^-$

B $Cr^{3+} + 3e^- \rightarrow Cr$

C $Cr^{3+} + e^- \rightarrow Cr^{2+}$

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

1.5 Consider the two organic molecules **I** and **II** below.

I	**II**
	

Which ONE of the following represents the homologous series to which compound **I** and compound **II** belong?

	I	**II**
A	Ketones	Alcohols
B	Aldehydes	Ketones
C	Aldehydes	Alcohols
D	Ketones	Aldehydes

(2)

1.6 Consider the balanced equations for three reactions represented below:

I: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

II: $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

III: $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$

Which of the above reactions form(s) part of the Ostwald process?

A **I** only

B **II** only

C **III** only

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

1.7 Which ONE of the following pairs is NOT a conjugate acid-base pair?

A H_3O^+ and OH^-

B NH_4^+ and NH_3

C $H_2PO_4^-$ and HPO_4^{2-}

D H_2CO_3 and HCO_3^- (2)

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Write down the question number (1.1–1.10), choose the answer and make a cross (X) over the letter (A–D) of your choice in the ANSWER BOOK.

EXAMPLE:

1.11 | A | B | C | ~~D~~ |

1.1 In a chemical reaction an oxidising agent will …

A lose protons.

B gain protons.

C lose electrons.

D gain electrons. (2)

1.2 A catalyst is added to a reaction mixture at equilibrium.

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

A The rate of the forward reaction increases.

B The rate of the reverse reaction increases.

C The equilibrium position shifts to the right.

D The equilibrium position remains unchanged. (2)

1.3 What product will be formed when an alkene reacts with water vapour (H_2O) in the presence of an acid catalyst?

A Ester

B Alkane

C Alcohol

D Aldehyde (2)

1.4 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)

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the 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 two subquestions, 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 et cetera where required.

12. Write neatly and legibly.

basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHSC.2

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2016

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages and 4 data sheets.

MORNING SESSION