



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES: CHEMISTRY (P2)

NOVEMBER 2016

MARKS: 150

TIME: 3 hours

This question paper consists of 12 pages, 4 data sheets
and 1 answer sheet.



* L 8 P 2 *



INSTRUCTIONS AND INFORMATION

1. Write your name and class (for example 11A) in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK except QUESTIONS 4.1.2, 4.1.3 and 4.1.6, which have to be answered on the attached ANSWER SHEET. The ANSWER SHEET has to be handed in together with 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.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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

- 1.1 The type of bond formed between a H^+ ion and H_2O is called a/an ...
A hydrogen bond.
B dative covalent bond.
C ionic bond.
D covalent bond. (2)
- 1.2 The shape of the molecule in which the central atom is surrounded by two lone pairs and two bonding pairs is ...
A linear.
B trigonal planar.
C tetrahedral.
D bent. (2)
- 1.3 The intermolecular forces in dry ice (CO_2) are ...
A ion-induced dipole forces.
B hydrogen bonding.
C ion-dipole forces.
D London forces. (2)
- 1.4 The bond energy of a $\text{C}-\text{Cl}$ bond is $338 \text{ kJ}\cdot\text{mol}^{-1}$ whereas the bond energy of a $\text{C}-\text{I}$ bond is $238 \text{ kJ}\cdot\text{mol}^{-1}$. The difference in bond energy exists because ...
A the bond length of the $\text{C}-\text{Cl}$ bond is greater than that of the $\text{C}-\text{I}$ bond.
B chlorine is more electronegative than iodine.
C the bond length of the $\text{C}-\text{I}$ bond is greater than that of the $\text{C}-\text{Cl}$ bond.
D the chlorine atom is bigger than the iodine atom. (2)

- 1.5 A gas of volume V is at a temperature T_1 and pressure P_1 in a gas syringe. If the pressure on the gas is doubled and the temperature halved, then the volume that the gas will occupy is ...

A $\frac{1}{4} V$

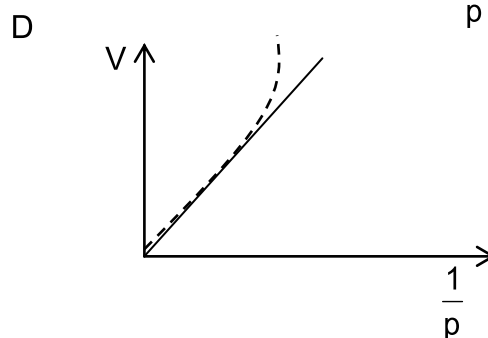
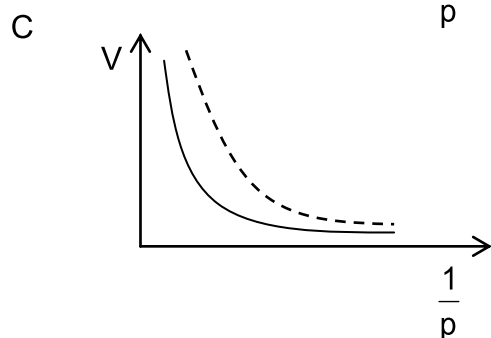
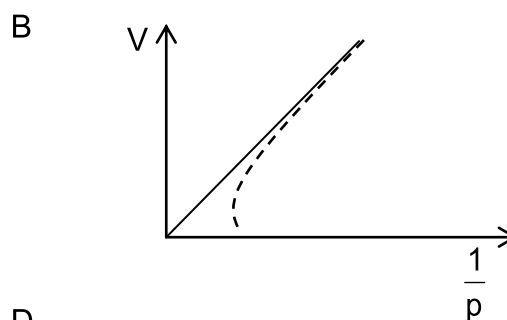
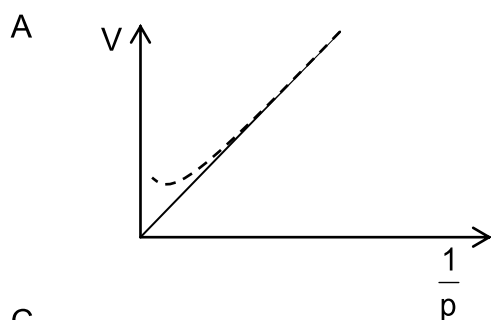
B $\frac{1}{2} V$

C V

D $2 V$

(2)

- 1.6 Which ONE of the graphs below CORRECTLY represents the deviation of a real gas from ideal gas behaviour at very high pressures? The dotted line represents the graph of the real gas.



(2)

- 1.7 The flowers of hydrangeas are natural indicators of soil pH. A natural indicator is made in a laboratory by using hydrangea flowers. NaOH and HCl are added to the indicator and the colour change is recorded in the table below.

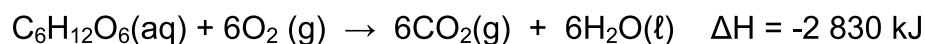
INDICATOR	NATURAL COLOUR	NaOH	HCl
Hydrangea flowers	Blue	Purple	Pink

If orange juice is added to the indicator above, the observed colour may be ...

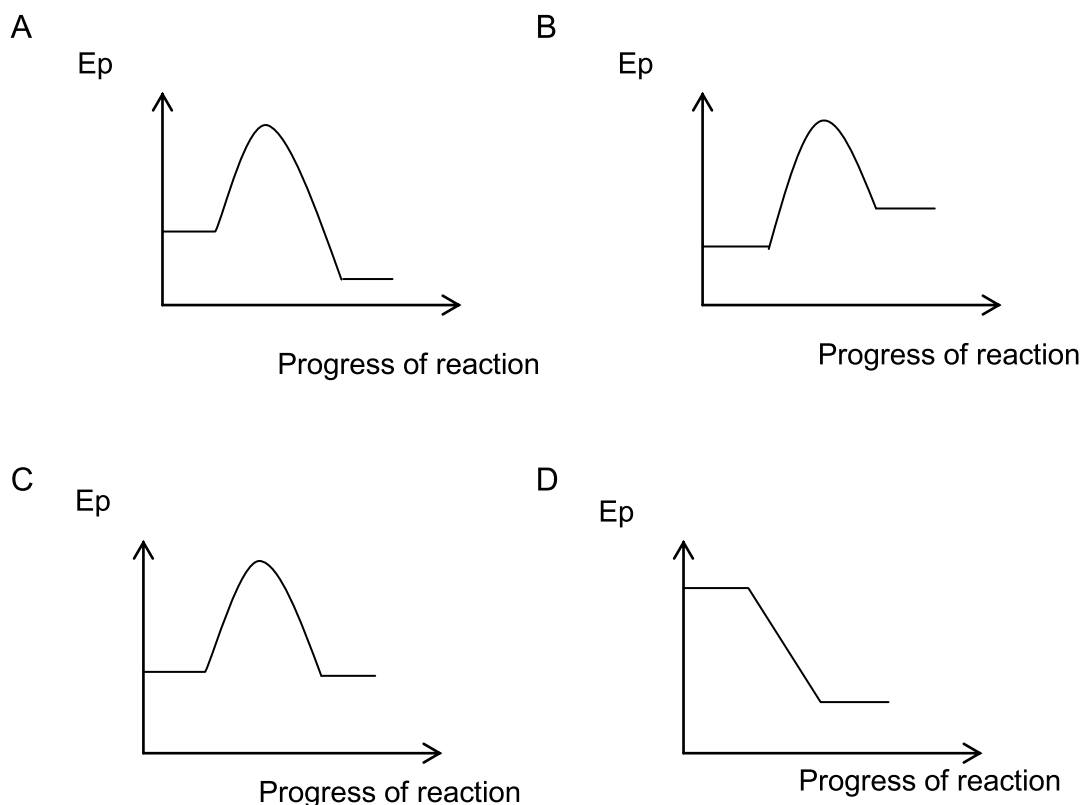
- A brown.
B pink.
C purple.
D blue.

(2)

- 1.8 Cellular respiration occurs inside the cells of all living organisms. Oxygen reacts with glucose in cellular respiration to produce the following compounds according to the balanced equation below:



The potential energy versus progress of reaction diagram for this reaction is ...



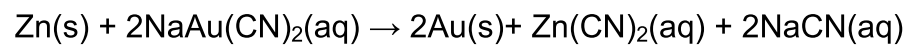
(2)

1.9 The oxidation number of phosphorus in H_3PO_4 is ...

- A +3
- B -2
- C +2
- D +5

(2)

1.10 During the processing of gold ore, zinc is added to the gold cyanide solution to produce gold according to the balanced equation below:



The reducing agent in this reaction is ...

- A Na^+
- B Au^+
- C Zn
- D CN^-

(2)
[20]

QUESTION 2 (Start on a new page.)

Electronegativity of atoms may be used to explain the polarity of bonds.

2.1 Define the term *electronegativity*. (2)

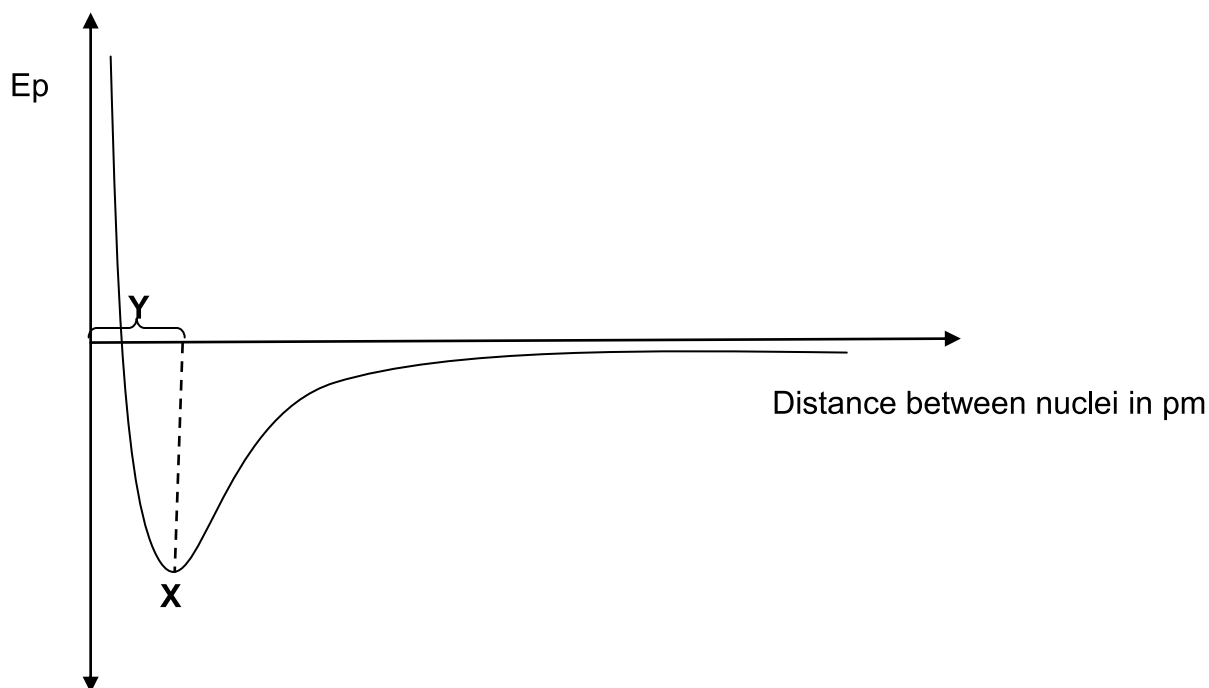
2.2 Draw the Lewis diagram of an oxygen difluoride molecule. (2)

2.3 Calculate the electronegativity difference between O and F in oxygen difluoride and predict the polarity of the bond. (2)

2.4 A polar bond does not always lead to a polar molecule.

Explain the statement by referring to OF_2 and CO_2 molecules. In your explanation, include the polarity of the bonds and the shape of the molecules. (4)

2.5 The diagram below shows the energy change that takes place when two atoms move towards each other.



2.5.1 What does **X** and **Y** represent? (2)

2.5.2 Define the concept represented by **X**. (2)

2.5.3 Explain the relationship between bond order, bond length and bond energy. (3)
[17]

QUESTION 3 (Start on a new page.)

Learners conduct an experiment to investigate the effects of intermolecular forces on boiling points. They use 20 ml of each of the following compounds in their investigation: water, sunflower oil, nail polish remover, glycerine and methylated spirits. The results are shown in the table below:

NAME OF COMPOUND	BOILING POINT (°C)
water	93
sunflower oil	230
nail polish remover	56
glycerine	290
methylated spirits	62

- 3.1 Define the term *boiling point*. (2)
- 3.2 Formulate an investigative question for this experiment. (2)
- 3.3 In which compound in the table above will the strongest intermolecular forces occur? Give a reason for the answer. (2)
- 3.4 The learners now use 40 ml of each of the compounds above in the experiment. Will it affect the boiling points? Choose YES or NO. Give a reason for the answer. (2)
- 3.5 Methylated spirits is highly flammable. State TWO safety precautions that should be taken when using methylated spirits in the laboratory. (2)
- 3.6 Which compound in the table above will have the highest rate of evaporation? Give a reason for the answer. (2)
- 3.7 Sunflower oil is a non-polar compound with induced dipole forces between the molecules, while water is a polar molecule with hydrogen bonds between its molecules. Explain why the boiling point of sunflower oil is higher than the boiling point of water. (2)
- [14]**

QUESTION 4 (Start on a new page.)

- 4.1 Charles' Law describes the relationship between the volume and temperature of an enclosed mass of gas at constant pressure. The volumes of a gas at different temperatures at constant pressure are given in the table below.

VOLUME (cm ³)	TEMPERATURE (°C)
114	0
124	25
134	50
145	75
155	100

- 4.1.1 Explain Charles' Law in terms of the kinetic molecular theory of gases. (2)
- 4.1.2 Draw a graph of volume versus temperature at constant pressure on the attached graph paper. (4)
- 4.1.3 Extrapolate the graph (extend the graph) and state at what temperature the graph intersects the x -axis. (1)
- 4.1.4 What is significant about this temperature? (2)
- 4.1.5 Calculate the volume that this gas will occupy at 120 °C at constant pressure. (3)
- 4.1.6 The experiment is now conducted at a lower constant pressure. On the graph drawn for QUESTION 4.1.2, sketch the graph that will be obtained at a lower pressure. Label this graph P. (2)
- 4.2 An unknown gas with a mass of 0,77 g occupies a volume of 0,32 dm³ at a temperature of 27 °C and a pressure of 96 kPa. Assume that the gas behaves as an ideal gas.
- 4.2.1 Calculate the molar mass of the gas. (5)
- 4.2.2 Write down the MOLECULAR FORMULA or NAME of the gas named in QUESTION 4.2.1. (2)

[21]

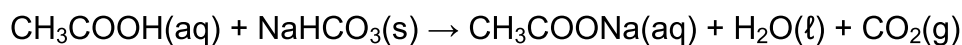
QUESTION 5 (Start on a new page.)

- 5.1 Define the term *concentration*. (2)
- 5.2 Eight (8) grams of $\text{Na}_2\text{S}_2\text{O}_3$ is dissolved in water to prepare 500 cm^3 of solution. Calculate the concentration of the $\text{Na}_2\text{S}_2\text{O}_3$ solution. (3)
- 5.3 A 10 g sample of a compound contains 2,66 g of potassium, 3,54 g of chromium and 3,81 g of oxygen.
- 5.3.1 Define the term *empirical formula*. (2)
- 5.3.2 Determine the empirical formula of this compound. (7)
- [14]**

QUESTION 6 (Start on a new page.)

Learners made a mini volcano in a science laboratory by adding sodium bicarbonate to ethanoic acid. They added 100 mL of a $0,2\text{ mol}\cdot\text{dm}^{-3}$ ethanoic acid solution to 10 g of NaHCO_3 to start the reaction of the volcano.

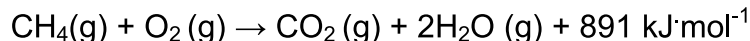
The balanced equation for this reaction is:



- 6.1 Define the term *limiting reagent*. (2)
- 6.2 Determine the limiting reagent in this reaction. (6)
- 6.3 Calculate the mass of the other substance in excess. (3)
- 6.4 Calculate the volume of CO_2 produced at STP. (4)
- [15]**

QUESTION 7 (Start on a new page.)

Methane is used as an alternative fuel. The combustion of methane releases carbon dioxide and water. The balanced equation for this reaction is:

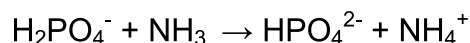


The activation energy for this reaction is $172 \text{ kJ}\cdot\text{mol}^{-1}$.

- 7.1 Is this reaction ENDOTHERMIC or EXOTHERMIC? Give a reason for the answer. (2)
- 7.2 Explain why all chemical reactions need activation energy. (2)
- 7.3 Why is this reaction not considered to be environmentally friendly? (2)
- [6]**

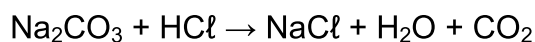
QUESTION 8 (Start on a new page.)

- 8.1 Define an *acid* in terms of the Lowry-Brønsted theory. (2)
- 8.2 Consider the following acid-base reaction:



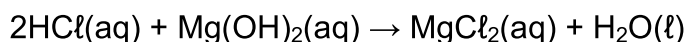
- 8.2.1 Identify the conjugate acid-base pairs in the above reaction. (4)
- 8.2.2 Define the term *ampholyte*. (1)
- 8.2.3 Choose an ampholyte in the above reaction. (2)
- 8.3 Ten grams (10 g) of an impure sample of sodium carbonate is added to 100 cm^3 of a $0,2 \text{ mol}\cdot\text{dm}^{-3}$ solution of hydrochloric acid. The acid is in excess.

The equation for the reaction is:



- 8.3.1 Balance the equation above. (1)
- 8.3.2 Calculate the number of moles of hydrochloric acid. (3)

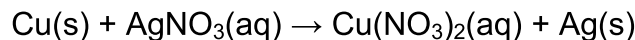
The excess acid neutralises 20 cm^3 of a solution of $0,1 \text{ mol}\cdot\text{dm}^{-3}$ of magnesium hydroxide.



- 8.3.3 Calculate the percentage purity of the sodium carbonate solution. (8)
- [21]**

QUESTION 9 (Start on a new page.)

A silver Christmas tree can be made by placing copper wire, shaped in the form of a tree, into a silver nitrate solution. The unbalanced equation for the reaction is:



- 9.1 Define the term *oxidation* in terms of oxidation number. (2)
- 9.2 Write down the following for the reaction above:
- 9.2.1 Formula of the reducing agent (2)
- 9.2.2 Name of the oxidising agent (2)
- 9.2.3 Oxidation half-reaction (2)
- 9.2.4 Balanced net ionic equation using the ion-electron method (4)
- 9.3 Use oxidation numbers to explain your choice of oxidising agent in QUESTION 9.2.2. (2)
- [14]**

QUESTION 10 (Start on a new page.)

The discovery of gold played a significant role in the economic development of South Africa. In 1970 gold mining in South Africa contributed 68 per cent to global production.

- 10.1 Which TWO mining methods are used in South Africa? (2)
- 10.2 Give TWO reasons why mining is important for the South African economy. (2)
- 10.3 State TWO negative effects of mining, with respect to the environment. (2)
- 10.4 Most alloys of gold are used in jewellery and dentistry. The gold content in jewellery is expressed in carat. The term indicates the number of parts of gold present in each 24 parts of alloy.
- 10.4.1 Pure gold, which is 24 carat, is not used to make jewellery. Give ONE reason why, referring to the properties of gold. (1)
- 10.4.2 Apart from gold being used in jewellery and dentistry, name ONE other use of gold. (1)
- [8]**

TOTAL: 150



**DATA FOR PHYSICAL SCIENCES GRADE 11
PAPER 2 (CHEMISTRY)**

**GEGEWENS VIR FISIIESE WETENSKAPPE GRAAD 11
VRAESTEL 2 (CHEMIE)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIIESE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Avogadro's constant <i>Avogadro-konstante</i>	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$
Molar gas constant <i>Molêre gaskonstante</i>	R	$8,31 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
Standard pressure <i>Standaarddruk</i>	p^θ	$1,013 \times 10^5 \text{ Pa}$
Molar gas volume at STP <i>Molêre gasvolume by STD</i>	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature <i>Standaardtemperatuur</i>	T^θ	273 K

TABLE 2: FORMULAE/TABEL 2: FORMULES

$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$	$pV = nRT$
$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$n = \frac{V}{V_m}$	$c = \frac{n}{V}$ OR/OF $c = \frac{m}{MV}$

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

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 1 H																	2 4 He
3 3 Li	4 4 Be																10 20 Ne
11 11 Na	12 12 Mg																18 40 Ar
19 19 K	20 20 Ca	21 21 Sc	22 22 Ti	23 23 V	24 24 Cr	25 25 Mn	26 26 Fe	27 27 Co	28 28 Ni	29 29 Cu	30 30 Zn	31 31 Ga	32 32 Ge	33 33 As	34 34 Se	35 35 Br	36 84 Kr
37 37 Rb	38 38 Sr	39 39 Y	40 40 Zr	41 41 Nb	42 42 Mo	43 43 Tc	44 44 Ru	45 45 Rh	46 46 Pd	47 47 Ag	48 48 Cd	49 49 In	50 50 Sn	51 51 Sb	52 52 Te	53 53 I	54 131 Xe
55 55 Cs	56 56 Ba	57 57 La	72 72 Hf	73 73 Ta	74 74 W	75 75 Re	76 76 Os	77 77 Ir	78 78 Pt	79 79 Au	80 80 Hg	81 81 Tl	82 82 Pb	83 83 Bi	84 84 Po	85 85 At	86 222 Rn
87 87 Fr	88 88 Ra	89 89 Ac															

58 140 Ce	59 141 Pr	60 144 Nd	61 150 Pm	62 150 Sm	63 152 Eu	64 157 Gd	65 159 Tb	66 163 Dy	67 165 Ho	68 167 Er	69 169 Tm	70 173 Yb	71 175 Lu
90 232 Th	91 238 Pa	92 238 U	93 238 Np	94 238 Pu	95 238 Am	96 238 Cm	97 238 Bk	98 238 Cf	99 238 Es	100 238 Fm	101 238 Md	102 238 No	103 238 Lr

1 1 H	2 2 He
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3 3 Li	4 4 Be
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11 11 Na	12 12 Mg
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19 19 K	20 20 Ca
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27 27 Al	28 28 Si	29 29 P	30 30 S	31 31 Cl	32 32 Ar
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39 39 K	40 40 Ca	41 41 Sc	42 42 Ti	43 43 V	44 44 Cr	45 45 Mn	46 46 Fe	47 47 Co	48 48 Ni	49 49 Cu	50 50 Zn	51 51 Ga	52 52 Ge	53 53 As	54 54 Se	55 55 Br	56 56 Kr
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63 63 Al	64 64 Si	65 65 P	66 66 S	67 67 Cl	68 68 Ar
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71 71 Al	72 72 Si	73 73 P	74 74 S	75 75 Cl	76 76 Ar
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87 87 Fr	88 88 Ra	89 89 Ac	90 90 Th	91 91 Pa	92 92 U	93 93 Np	94 94 Pu	95 95 Am	96 96 Cm	97 97 Bk	98 98 Cf	99 99 Es	100 100 Fm	101 101 Md	102 102 No	103 103 Lr
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107 107 Fr	108 108 Ra	109 109 Ac	110 110 Th	111 111 Pa	112 112 U	113 113 Np	114 114 Pu	115 115 Am	116 116 Cm	117 117 Bk	118 118 Cf	119 119 Es	120 120 Fm	121 121 Md	122 122 No	123 123 Lr
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127 127 Fr	128 128 Ra	129 129 Ac	130 130 Th	131 131 Pa	132 132 U	133 133 Np	134 134 Pu	135 135 Am	136 136 Cm	137 137 Bk	138 138 Cf	139 139 Es	140 140 Fm	141 141 Md	142 142 No	143 143 Lr
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151 151 Fr	152 152 Ra	153 153 Ac	154 154 Th	155 155 Pa	156 156 U	157 157 Np	158 158 Pu	159 159 Am	160 160 Cm	161 161 Bk	162 162 Cf	163 163 Es	164 164 Fm	165 165 Md	166 166 No	167 167 Lr
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171 171 Fr	172 172 Ra	173 173 Ac	174 174 Th	175 175 Pa	176 176 U	177 177 Np	178 178 Pu	179 179 Am	180 180 Cm	181 181 Bk	182 182 Cf	183 183 Es	184 184 Fm	185 185 Md	186 186 No	187 187 Lr
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181 181 Fr	182 182 Ra	183 183 Ac	184 184 Th	185 185 Pa	186 186 U	187 187 Np	188 188 Pu	189 189 Am	190 190 Cm	191 191 Bk	192 192 Cf	193 193 Es	194 194 Fm	195 195 Md	196 196 No	197 197 Lr
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191 191 Fr	192 192 Ra	193 193 Ac	194 194 Th	195 195 Pa	196 196 U	197 197 Np	198 198 Pu	199 199 Am	200 200 Cm	201 201 Bk	202 202 Cf	203 203 Es	204 204 Fm	205 205 Md	206 206 No	207 207 Lr
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201 201 Fr	202 202 Ra	203 203 Ac	204 204 Th	205 205 Pa	206 206 U	207 207 Np	208 208 Pu	209 209 Am	210 210 Cm	211 211 Bk	212 212 Cf	213 213 Es	214 214 Fm	215 215 Md	216 216 No	217 217 Lr
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211 211 Fr	212 212 Ra	213 213 Ac	214 214 Th	215 215 Pa	216 216 U	217 217 Np	218 218 Pu	219 219 Am	220 220 Cm	221 221 Bk	222 222 Cf	223 223 Es	224 224 Fm	225 225 Md	226 226 No	227 227 Lr
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221 221 Fr	222 222 Ra	223 223 Ac	224 224 Th	225 225 Pa	226 226 U	227 227 Np	228 228 Pu	229 229 Am	230 230 Cm	231 231 Bk	232 232 Cf	233 233 Es	234 234 Fm	235 235 Md	236 236 No	237 237 Lr
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231 231 Fr	232 232 Ra	233 233 Ac	234 234 Th	235 235 Pa	236 236 U	237 237 Np	238 238 Pu	239 239 Am	240 240 Cm	241 241 Bk	242 242 Cf	243 243 Es	244 244 Fm	245 245 Md	246 246 No	247 247 Lr
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241 241 Fr	242 242 Ra	243 243 Ac	244 244 Th	245 245 Pa	246 246 U	247 247 Np	248 248 Pu	249 249 Am	250 250 Cm	251 251 Bk	252 252 Cf	253 253 Es	254 254 Fm	255 255 Md	256 256 No	257 257 Lr
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251 251 Fr	252 252 Ra	253 253 Ac	254 254 Th	255 255 Pa	256 256 U	257 257 Np	258 258 Pu	259 259 Am	260 260 Cm	261 261 Bk	262 262 Cf	263 263 Es	264 264 Fm	265 265 Md	266 266 No	267 267 Lr
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261 261 Fr	262 262 Ra	263 263 Ac	264 264 Th	265 265 Pa	266 266 U	267 267 Np	268 268 Pu	269 269 Am	270 270 Cm	271 271 Bk	272 272 Cf	273 273 Es	274 274 Fm	275 275 Md	276 276 No	277 277 Lr
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271 271 Fr	272 272 Ra	273 273 Ac	274 274 Th	275 275 Pa	276 276 U	277 277 Np	278 278 Pu	279 279 Am	280 280 Cm	281 281 Bk	282 282 Cf	283 283 Es	284 284 Fm	285 285 Md	286 286 No	287 287 Lr
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281 281 Fr	282 282 Ra	283 283 Ac	284 284 Th	285 285 Pa	286 286 U	287 287 Np	288 288 Pu	289 289 Am	290 290 Cm	291 291 Bk	292 292 Cf	293 293 Es	294 294 Fm	295 295 Md	296 296 No	297 297 Lr
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291 291 Fr	292 292 Ra	293 293 Ac	294 294 Th	295 295 Pa	296 296 U	297 297 Np	298 298 Pu	299 299 Am	300 300 Cm	301 301 Bk	302 302 Cf	303 303 Es	304 304 Fm	305 305 Md	306 306 No	307 307 Lr
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301 301 Fr	302 302 Ra	303 303 Ac	304 304 Th	305 305 Pa	306 306 U	307 307 Np	308 308 Pu	309 309 Am	310 310 Cm	311 311 Bk	312 312 Cf	313 313 Es	314 314 Fm	315 315 Md	316 316 No	317 317 Lr
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311 311 Fr	312 312 Ra	313 313 Ac	314 314 Th	315 315 Pa	316 316 U	317 317 Np	318 318 Pu	319 319 Am	320 320 Cm	321 321 Bk	322 322 Cf	323 323 Es	324 324 Fm	325 325 Md	326 326 No	327 327 Lr
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321 321 Fr	322 322 Ra	323 323 Ac	324 324 Th	325 325 Pa	326 326 U	327 327 Np	328 328 Pu	329 329 Am	330 330 Cm	331 331 Bk	332 332 Cf	333 333 Es	334 334 Fm	335 335 Md	336 336 No	337 337 Lr
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331 331 Fr	332 332 Ra	333 333 Ac	334 334 Th	335 335 Pa	336 336 U	337 337 Np	338 338 Pu	339 339 Am	340 340 Cm	341 341 Bk	342 342 Cf	343 343 Es	344 344 Fm	345 345 Md	346 346 No	347 347 Lr
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341 341 Fr	342 342 Ra	343 343 Ac	344 344 Th	345 345 Pa	346 346 U	347 347 Np	348 348 Pu	349 349 Am	350 350 Cm	351 351 Bk	352 352 Cf	353 353 Es	354 354 Fm	355 355 Md	356 356 No	357 357 Lr
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351 351 Fr	352 352 Ra	353 353 Ac	354 354 Th	355 355 Pa	356 356 U	357 357 Np	358 358 Pu	359 359 Am	360 360 Cm	361 361 Bk	362 362 Cf	363 363 Es	364 364 Fm	365 365 Md	366 366 No	367 367 Lr
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361 361 Fr	362 362 Ra	363 363 Ac	364 364 Th	365 365 Pa	366 366 U	367 367 Np	368 368 Pu	369 369 Am	370 370 Cm	371 371 Bk	372 372 Cf	373 373 Es	374 374 Fm	375 375 Md	376 376 No	377 377 Lr
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371 371 Fr	372 372 Ra	373 373 Ac	374 374 Th	375 375 Pa	376 376 U	377 377 Np	378 378 Pu	379 379 Am	380 380 Cm	381 381 Bk	382 382 Cf	383 383 Es	384 384 Fm	385 385 Md	386 386 No	387 387 Lr
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381 381 Fr	382 382 Ra	383 383 Ac	384 384 Th	385 385 Pa	386 386 U	387 387 Np	388 388 Pu	389 389 Am	390 390 Cm	391 391 Bk	392 392 Cf	393 393 Es	39
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TABLE 4A: STANDARD REDUCTION POTENTIALS
TABEL 4A: STANDAARD-REDUKSIEPOTENSIALE

Half-reactions/Halfreaksies	E^{θ} (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^- \rightleftharpoons Hg(l)$	+ 0,85
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	0,00
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	- 0,06
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	- 0,13
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	- 0,14
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	- 0,27
$Co^{2+} + 2e^- \rightleftharpoons Co$	- 0,28
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	- 0,40
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	- 0,41
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	- 0,44
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	- 0,74
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	- 0,76
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	- 0,83
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	- 0,91
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	- 1,18
$Al^{3+} + 3e^- \rightleftharpoons Al$	- 1,66
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	- 2,36
$Na^+ + e^- \rightleftharpoons Na$	- 2,71
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	- 2,87
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	- 2,89
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	- 2,90
$Cs^+ + e^- \rightleftharpoons Cs$	- 2,92
$K^+ + e^- \rightleftharpoons K$	- 2,93
$Li^+ + e^- \rightleftharpoons Li$	- 3,05

Increasing oxidising ability/Toenemende oksiderende vermoë

Increasing reducing ability/Toenemende reduserende vermoë



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

Half-reactions/ <i>Halfreaksies</i>	E^{θ} (V)
$\text{Li}^{+} + \text{e}^{-} \rightleftharpoons \text{Li}$	-3,05
$\text{K}^{+} + \text{e}^{-} \rightleftharpoons \text{K}$	-2,93
$\text{Cs}^{+} + \text{e}^{-} \rightleftharpoons \text{Cs}$	-2,92
$\text{Ba}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Ba}$	-2,90
$\text{Sr}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Sr}$	-2,89
$\text{Ca}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Ca}$	-2,87
$\text{Na}^{+} + \text{e}^{-} \rightleftharpoons \text{Na}$	-2,71
$\text{Mg}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Mg}$	-2,36
$\text{Al}^{3+} + 3\text{e}^{-} \rightleftharpoons \text{Al}$	-1,66
$\text{Mn}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Mn}$	-1,18
$\text{Cr}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Cr}$	-0,91
$2\text{H}_2\text{O} + 2\text{e}^{-} \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^{-}$	-0,83
$\text{Zn}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Zn}$	-0,76
$\text{Cr}^{3+} + 3\text{e}^{-} \rightleftharpoons \text{Cr}$	-0,74
$\text{Fe}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Fe}$	-0,44
$\text{Cr}^{3+} + \text{e}^{-} \rightleftharpoons \text{Cr}^{2+}$	-0,41
$\text{Cd}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Cd}$	-0,40
$\text{Co}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Co}$	-0,28
$\text{Ni}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Ni}$	-0,27
$\text{Sn}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Sn}$	-0,14
$\text{Pb}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Pb}$	-0,13
$\text{Fe}^{3+} + 3\text{e}^{-} \rightleftharpoons \text{Fe}$	-0,06
$2\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{H}_2(\text{g})$	0,00
$\text{S} + 2\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0,14
$\text{Sn}^{4+} + 2\text{e}^{-} \rightleftharpoons \text{Sn}^{2+}$	+0,15
$\text{Cu}^{2+} + \text{e}^{-} \rightleftharpoons \text{Cu}^{+}$	+0,16
$\text{SO}_4^{2-} + 4\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}$	+0,17
$\text{Cu}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Cu}$	+0,34
$2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^{-} \rightleftharpoons 4\text{OH}^{-}$	+0,40
$\text{SO}_2 + 4\text{H}^{+} + 4\text{e}^{-} \rightleftharpoons \text{S} + 2\text{H}_2\text{O}$	+0,45
$\text{Cu}^{+} + \text{e}^{-} \rightleftharpoons \text{Cu}$	+0,52
$\text{I}_2 + 2\text{e}^{-} \rightleftharpoons 2\text{I}^{-}$	+0,54
$\text{O}_2(\text{g}) + 2\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{H}_2\text{O}_2$	+0,68
$\text{Fe}^{3+} + \text{e}^{-} \rightleftharpoons \text{Fe}^{2+}$	+0,77
$\text{NO}_3^{-} + 2\text{H}^{+} + \text{e}^{-} \rightleftharpoons \text{NO}_2(\text{g}) + \text{H}_2\text{O}$	+0,80
$\text{Ag}^{+} + \text{e}^{-} \rightleftharpoons \text{Ag}$	+0,80
$\text{Hg}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Hg}(\ell)$	+0,85
$\text{NO}_3^{-} + 4\text{H}^{+} + 3\text{e}^{-} \rightleftharpoons \text{NO}(\text{g}) + 2\text{H}_2\text{O}$	+0,96
$\text{Br}_2(\ell) + 2\text{e}^{-} \rightleftharpoons 2\text{Br}^{-}$	+1,07
$\text{Pt}^{2+} + 2\text{e}^{-} \rightleftharpoons \text{Pt}$	+1,20
$\text{MnO}_2 + 4\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons \text{Mn}^{2+} + 2\text{H}_2\text{O}$	+1,23
$\text{O}_2(\text{g}) + 4\text{H}^{+} + 4\text{e}^{-} \rightleftharpoons 2\text{H}_2\text{O}$	+1,23
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^{+} + 6\text{e}^{-} \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1,33
$\text{Cl}_2(\text{g}) + 2\text{e}^{-} \rightleftharpoons 2\text{Cl}^{-}$	+1,36
$\text{MnO}_4^{-} + 8\text{H}^{+} + 5\text{e}^{-} \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1,51
$\text{H}_2\text{O}_2 + 2\text{H}^{+} + 2\text{e}^{-} \rightleftharpoons 2\text{H}_2\text{O}$	+1,77
$\text{Co}^{3+} + \text{e}^{-} \rightleftharpoons \text{Co}^{2+}$	+1,81
$\text{F}_2(\text{g}) + 2\text{e}^{-} \rightleftharpoons 2\text{F}^{-}$	+2,87

Increasing oxidising ability/*Toenemende oksiderende vermoë*

Increasing reducing ability/*Toenemende reduserende vermoë*



NAME:**CLASS:****QUESTIONS 4.1.2, 4.1.3 and 4.1.6****Hand in this ANSWER SHEET together with the ANSWER BOOK.**