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Heritage House

GRADE 12 - TRIAL EXAMINATION 2019

PHYSICAL SCIENCES: PAPER 2

Time: 3 Hours

Marks: 200

Examiner: Mr K Mari
Moderator external: Durban – 50 Cluster
Moderator internal: Mr van de Venter

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:

- A question paper of 18 pages
- A yellow answer sheet for questions 3.2
- A green Data and Formula Sheet

Please make sure that your question paper is complete

2. Remove the Data sheets and Answer Booklet from the back of this question paper. **Write your name on the yellow Answer Sheet.**
3. Read the questions carefully.
4. Use the data and formula where necessary.
5. **Start each question on a new page.**
6. It is in your interest to write legibly and to set your work out neatly.
7. Show all working in your calculations.
8. Where appropriate round off your answers to 2 decimal places.
9. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.

Four possible answers are given to each of the questions below. Only ONE is correct. Choose the letter corresponding to the correct answer and place a cross next to the question number on the inside cover of your answer booklet.

A) CH₄
B) Cl₂
C) CO₂
D) HCl

The graph shows the total volume of H_2 gas produced over time for four different conditions. The y-axis represents the total volume of H_2 gas in cm^3 , ranging from 0 to 100. The x-axis represents time in seconds (s), ranging from 0 to 120. The curves are labeled A, B, R (original graph), C, and D. Curve A reaches the highest volume, followed by B, R, C, and D.

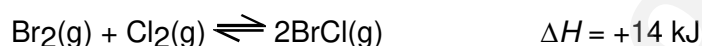
Time (s)	A (cm^3)	B (cm^3)	R (original graph) (cm^3)	C (cm^3)	D (cm^3)
0	0	0	0	0	0
20	45	35	25	15	5
40	70	55	40	25	5
60	78	60	50	32	5
80	80	61	55	33	5
100	80	62	58	34	5
120	80	62	60	35	5

A) Graph A B) Graph B

C) Graph C D) Graph D

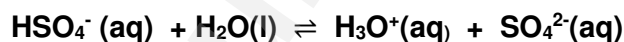
A) $0,27 \text{ mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$ B) $0,09 \text{ mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$
C) $0,81 \text{ mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$ D) The rate of formation of C cannot be determined

- 1.4 Which statement concerning a chemical reaction at equilibrium is not correct?
- A) The concentrations of reactants and products remain constant.
- B) Equilibrium can be approached from both directions.
- C) The rate of the forward reaction equals the rate of the reverse reaction.
- D) All reactions stop.
- 1.5 What will happen to the position of equilibrium and the value of the equilibrium constant when the temperature is increased in the following reaction?

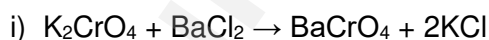


	Position of equilibrium	Value of equilibrium constant
A.	Shifts towards the reactants	Decreases
B.	Shifts towards the reactants	Increases
C.	Shifts towards the products	Decreases
D.	Shifts towards the products	Increases

- 1.6 Identify one conjugate acid-base pair in the following equilibrium equation:

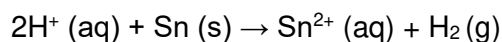


- A) SO_4^{2-} and H_3O^+ B) H_2O and HSO_4^{2-}
- C) H_2O and H_3O^+ D) HSO_4^- and H_3O^+
- 1.7 Which of the following reactions is a redox reaction?



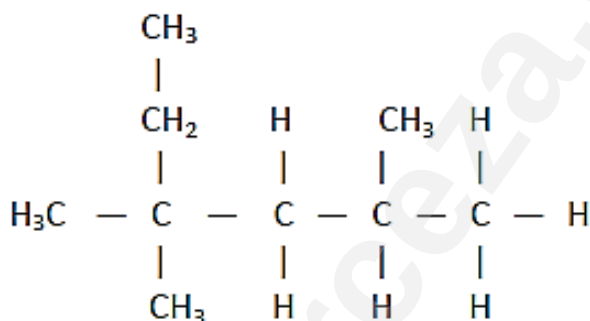
- A) only (i) B) only (ii)
- C) only (iii) D) (i) and (ii)

- 1.8 Consider an electrochemical cell based on the reaction:



Which of the following actions would change the measured cell potential?

- A) increasing the pressure of hydrogen gas in the cathode compartment
 - B) increasing the $[\text{Sn}^{2+}]$ in the anode compartment
 - C) increasing the pH in the cathode compartment
 - D) Any of the above will change the measure cell potential.
- 1.9 The semi-condensed structural formula of an organic compound is shown below:



What is the correct IUPAC name for this organic compound?

- A) 2,4,4-trimethylhexane
 - B) 2-ethyl-2,4-dimethylpentane
 - C) 2,4-dimethyl-4-ethylpentane
 - D) 3,3,5-trimethylhexene
- 1.10 Which one of the following statements is INCORRECT?
- A) Addition of a halogen is called Halogenation.
 - B) Alkenes are more reactive than alkanes.
 - C) Propyl ethanoate can be made from propanoic acid and ethanol.
 - D) Alkenes cannot undergo substitution reactions.

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Question 2

In the table below the melting points and boiling points of different substances at standard pressure are given. Use this information to answer the following questions.

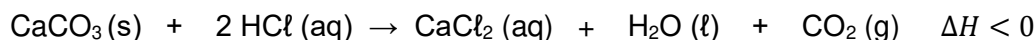
substance	mpt °C	bpt °C
He	-272	-269
HBr	-86,9	-66,8
CCl ₄	-23	77
CO ₂	Sublimes at -78,5	
CH ₄	-184	-162
H ₂ O	0	100

- 2.1 In which one of the substances will the weakest intermolecular forces exist in the solid phase? (2)
- 2.2 Name the specific type of intramolecular bond that exists in the following:
- 2.2.1 the molecules of CO₂ . (1)
- 2.2.2 the molecules of H₂O . (1)
- 2.3 Name the type of intermolecular force that exists between the following:
- 2.3.1 the molecules of CO₂ . (1)
- 2.3.2 the molecules of H₂O . (1)
- 2.4 Define the term polar covalent. (2)
- 2.5 Which one of the substances is a liquid at -10 °C. (2)
- 2.6 Clearly explain why the boiling points of HBr and H₂O are different. (6)
- 2.7 Describe what happens to CO₂ at -78,5 °C. (2)

[18]

Question 3

Learners are investigating how the rate of a reaction changes during a reaction. They are using the reaction of calcium carbonate with hydrochloric acid given below:



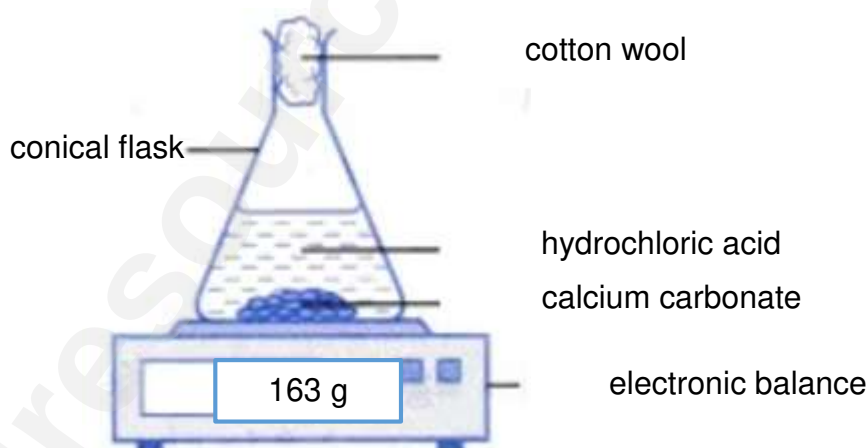
3.1 Define:

3.1.1 *heat of reaction* (2)

3.1.2 *activated complex* (2)

3.2 You are given $\Delta H < 0$ for this reaction. On the set of axes provided on your answer sheet, sketch a potential energy profile graph for this reaction. On your graph, include a label for the x -axis, and indicate on your graph the heat of the reaction and position of the activated complex. (4)

The learners setup their apparatus as shown in the diagram below. A conical flask containing hydrochloric acid solution at room temperature (25°C) is placed on the mass balance and powdered calcium carbonate is carefully added into the flask. The mass of the reaction vessel is measured during the reaction.



3.3 The mass of the reaction vessel is observed to decrease with time. Explain why this happens. (2)

3.4 What is the reason for placing the cotton wool plug in the mouth of the flask? (2)

3.5 When the learners initially set up the experiment, the reaction occurred too fast for them to accurately monitor the change in mass. Suggest two changes that could be made to the experiment to slow the reaction rate so that it could be more accurately measured. (2)

3.6 Describe two alternative methods that could also be used to measure the rate of this reaction. (4)

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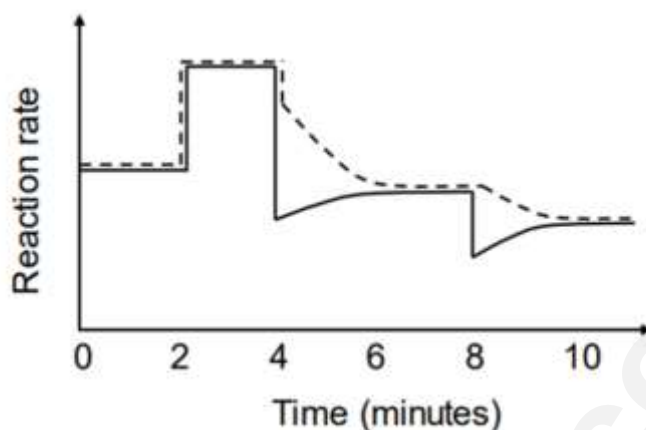
Question 4

A chemical C is made by reacting chemical A with chemical B in a reversible reaction. A, B and C are all gases under the reaction conditions. Research chemists wanted to know what the optimum conditions are in the manufacture of C. They carried out a series of reactions under different conditions of temperature and pressure. The percentage conversion of A at equilibrium is shown in the table below.

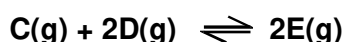
pressure / MPa	temperature / °C	% A converted
10	350	8
	450	12
	550	16
20	350	11
	450	21
	550	29
40	350	18
	450	
	550	49

- 4.1 Predict the approximate percentage of A that is converted at 450 °C and 40 MPa. (2)
- 4.2 Consider the data given in the table.
- 4.2.1 Use the data in the table above to state the effect of increasing pressure on the percentage of A converted.
Choose from INCREASES, DECREASES OR REMAINS THE SAME. (1)
- 4.2.2 What can be deduced, from your answer in question 4.2.1, about the total number of moles of reactants A and B compared with the number of moles of product C in the equation for the reaction when the pressure is increased?
Choose from MORE, LESS OR THE SAME. (1)
- 4.2.3 Use Le Chatelier's Principle to explain how you reached your conclusion in question 4.2.2. (3)
- 4.2.4 Use the data in the table to deduce whether the forward reaction is exothermic or endothermic. (2)
- 4.2.5 Use Le Chatelier's Principle to explain how you reached your conclusion in question 4.2.4. (4)

The reaction rate versus time graph below represents different changes made to the equilibrium mixture.



- 4.3 It was necessary to use a catalyst in the production of C. (2)
- 4.3.1 Define a *catalyst*. (2)
- 4.3.2 At what time was the catalyst added to the system? (1)
- 4.3.3 A change in temperature was made at $t = 4\text{s}$. Was the temperature increased or decreased? (1)
- 4.3.4 Consider the graph and data in the table and state whether the solid line or the broken line represent the forward reaction. (2)
- 4.3.5 Use Le Chatelier's Principle and refer to the graph and the data in the table to explain your answer in question 4.3.4. (4)
- 4.3.6 Use Le Chatelier's Principle to explain what change was made to the equilibrium mixture at $t = 8\text{ minutes}$? (4)
- 4.4 Compound C is now combined with compound D to make compound E. The hypothetical reaction is represented by the balanced equation below.



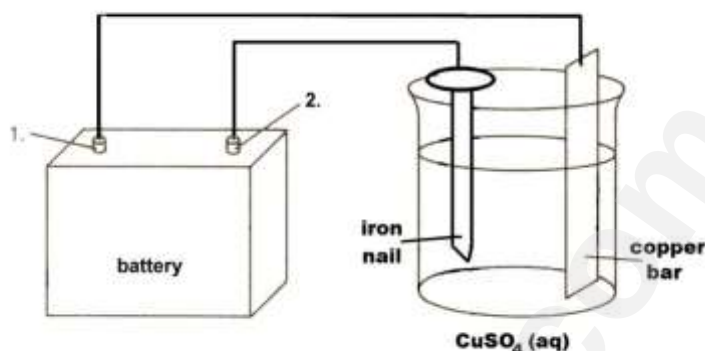
Initially 3 moles of C(g) and 6 moles of D(g) are mixed in a 5 dm^3 sealed container. When the reaction reaches equilibrium at 25°C , it is found that 4 moles of D(g) are present.

- 4.4.1 Define the term chemical equilibrium. (2)
- 4.4.2 Show by calculation that the equilibrium concentration of E(g) is $0,4\text{ mol}\cdot\text{dm}^{-3}$. (3)
- 4.4.3 Another reaction is performed. The initial number of moles of D(g) is now increased while the initial number of moles of C(g) remains the same at 25°C . Calculate how many more moles of D(g) must be ADDED to the original amount (6 mol) so that the concentration of E(g) is $0,8\text{ mol}\cdot\text{dm}^{-3}$ at equilibrium. (9)
- The equilibrium constant (K_c) for this reaction at 25°C is 0,625. (9)

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Question 5

In the electrolytic cell shown here, an iron nail is being plated with copper.

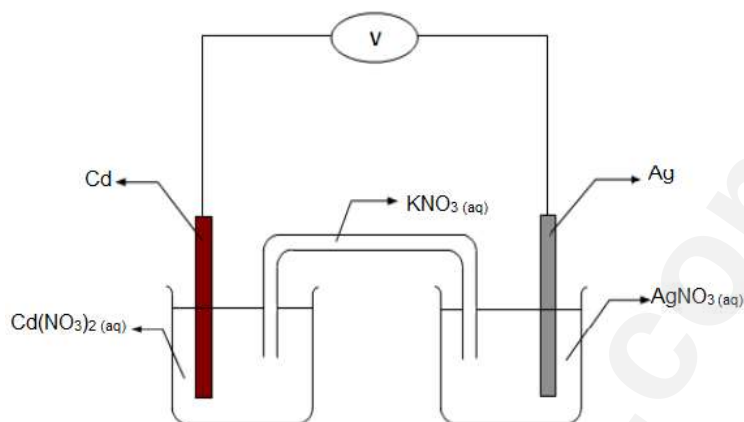


- 5.1 Define *electrolyte*. (2)
- 5.2 Which object, the iron nail or the copper bar, should be connected to the negative pole of the battery? (1)
- 5.3 Write a balanced chemical equation for the half-reaction taking place at the cathode. (2)
- 5.4 Write a balanced chemical equation for the half-reaction taking place at the anode. (2)
- 5.5 Using the numbers indicated on the battery in the diagram indicate the direction of the electrons in the external circuit. (1)
- 5.6 A current flows for a specific amount of time and deposits 0,7 g of pure copper on the nail.
- 5.6.1 Calculate the number of moles of copper deposited. (2)
- 5.6.2 Calculate the number of electrons which flow through the circuit in order to deposit this mass of copper. (4)
- 5.7 Explain what can be done to ensure that a thicker layer of copper is plated on the nail. (1)
- 5.8 Give another industrial use for electrolysis other than electroplating. (1)

[16]

Question 6

A galvanic cell is set up under standard conditions using Cadmium and Silver electrodes as shown in the diagram below.



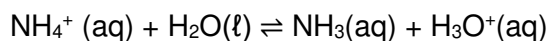
https://scilearn.sydney.edu.au/fychemistry/iChem/galvanic_cells.shtml

- 6.1 State the energy conversion that takes place in this cell. (2)
- 6.2 Write down the cell notation for this cell (include standard conditions). (4)
- 6.3 Define the term *oxidising agent*. (2)
- 6.4 Give the symbol of the oxidising agent in this cell. (1)
- 6.5 Calculate the initial emf of this cell under standard conditions. (2)
- 6.6 State the function of the salt bridge in this cell. (2)
- 6.7 In which direction do anions flow in the salt bridge as the cell operates? Justify your answer. (3)
- 6.8 If 10 ml of $3,0 \text{ mol.dm}^{-3} \text{ AgNO}_3$ solution is added to the half-cell on the right, what will happen to the emf of the cell? Explain. (3)
- 6.9 If 1 gram of solid NaCl is added to the silver half-cell the solution turns milky due to the formation of a precipitate. What will happen to the emf of the cell? Explain. (2)

[21]

Question 7

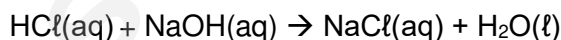
- 7.1 Ammonium chloride crystals, $\text{NH}_4\text{Cl}_{(s)}$, dissolve in water to form ammonium and chloride ions. The ammonium ions react with water according to the balanced equation below:



- 7.1.1 Define the term *salt*. (2)
- 7.1.2 Write down the name of the process described by the underlined sentence. (1)
- 7.1.3 Is ammonium chloride ACIDIC or BASIC in aqueous solution? (2)
- 7.1.4 The salt, ammonium chloride, can be prepared from the reaction of ammonia with hydrochloric acid. Write down a balanced chemical equation for this reaction. (3)
- 7.2 A certain fertiliser consists of 92% ammonium chloride. A sample of mass x of this fertiliser is dissolved in 100 cm^3 of a $0,10 \text{ mol} \cdot \text{dm}^{-3}$ sodium hydroxide solution, $\text{NaOH}_{(\text{aq})}$. The sodium hydroxide solution is in excess. The balanced equation for the reaction is:



- 7.2.1 Calculate the number of moles of sodium hydroxide in which the sample is dissolved. (3)
- During a titration, 25 cm^3 of the excess sodium hydroxide solution is titrated with a $0,11 \text{ mol} \cdot \text{dm}^{-3}$ hydrochloric acid solution, $\text{HCl}_{(\text{aq})}$. At the endpoint it is found that $14,55 \text{ cm}^3$ of the hydrochloric acid was used to neutralise the sodium hydroxide solution according to the following balanced equation:



- 7.2.2 Define *neutralization*. (2)
- 7.2.3 Calculate the mass x (in grams) of the fertiliser sample used. (8)
- 7.3 The ionization constant K_b for each of the following bases in water at 25°C is given in the table below:

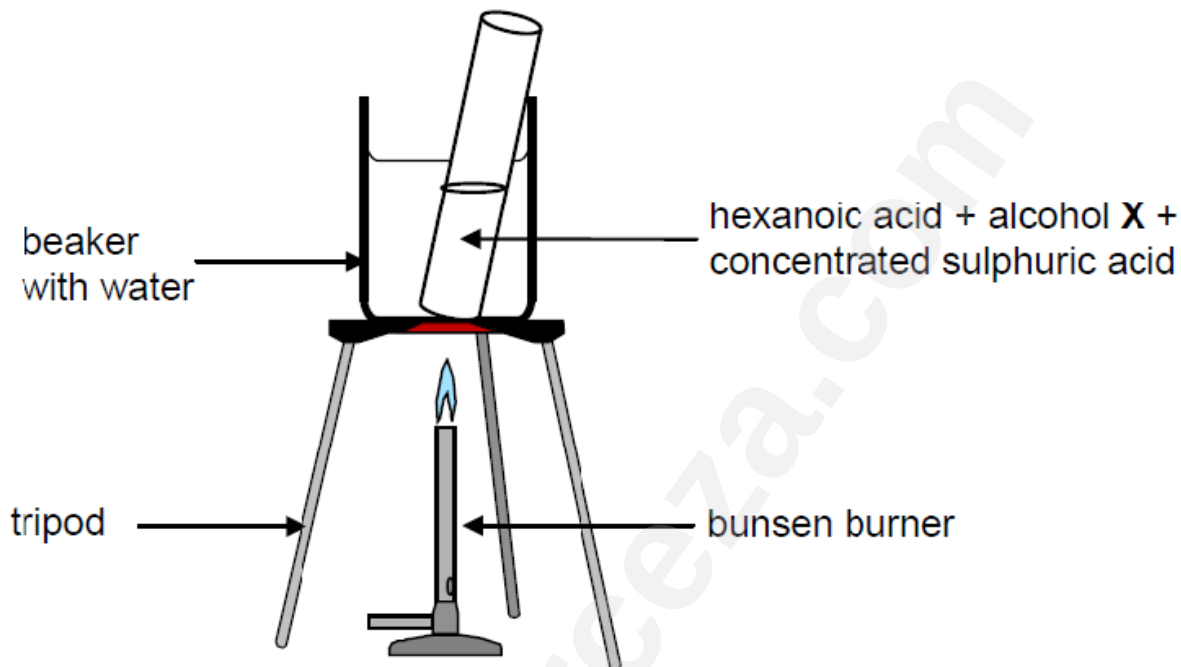
Name	Formula	K_b
Ammonia	NH_3	$1,8 \times 10^{-5}$
Hydrogen carbonate ion	HCO_3^-	$2,4 \times 10^{-8}$

- 7.3.1 Give the Bronsted-Lowry definition for a base. (1)
- 7.3.2 If the concentration for both bases are equal, choose which of these bases would be a better electrical conductor? Justify your answer. (4)
- 7.3.3 Write a balanced chemical equation for the ionization of hydrogen carbonate in water. (3)

[29]

Question 8

Hexanoic acid is responsible for the unique odour associated with goats. When it reacts with alcohol X, ethyl hexanoate, which is used commercially as a fruit flavour, is formed. Students set up the apparatus shown below to prepare ethyl hexanoate in a laboratory.

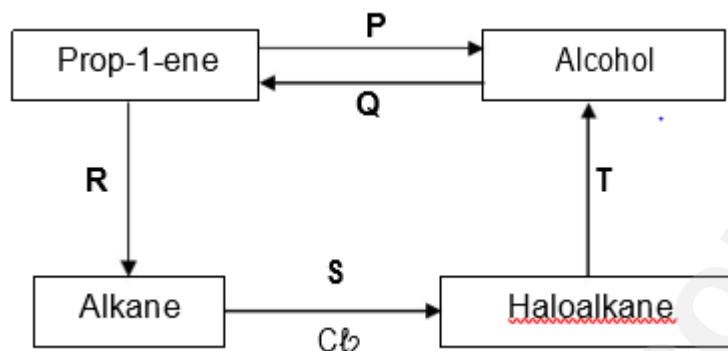


- 8.1 Write down the IUPAC name of alcohol X. (2)
- 8.2 What role does the sulphuric acid play in the above reaction? (1)
- 8.3 Use structural formulae to write down a balanced equation for the preparation of ethyl hexanoate. (6)
- 8.4 Suggest a possible reason for the test tube being heated in a water bath rather than directly over a flame. (1)
- 8.5 Define the term *isomer*. (2)
- 8.6 Write down the IUPAC name of an isomer of the product formed in question 8.3. (2)

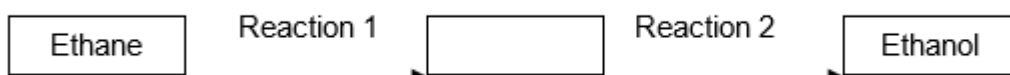
[14]

Question 9

In the flow diagram below prop-1-ene is used as starting reagent in the preparation of other compounds. **P** to **T** represent chemical reactions.



- 9.1 Name the general type of reaction represented by:
- 9.1.1 P (1)
- 9.1.2 S (1)
- 9.1.3 Q (1)
- 9.2 Consider reaction P. Write down the:
- 9.2.1 FORMULA of a suitable catalyst (1)
- 9.2.2 Structural formula of the alcohol (2)
- 9.3 For reaction R, write down:
- 9.3.1 The specific type of addition reaction (1)
- 9.3.2 A balanced equation using structural formulae (3)
- 9.4 During reaction T, the haloalkane reacts with a base to form the alcohol in QUESTION 9.2.2. Write down the:
- 9.4.1 IUPAC name of the haloalkane (2)
- 9.4.2 NAME of a suitable base (1)
- 9.4.3 TWO reaction conditions for this reaction (2)
- 9.5 Ethane can be used as a reactant to produce ethanol through a reaction pathway as represented in the sketch below:

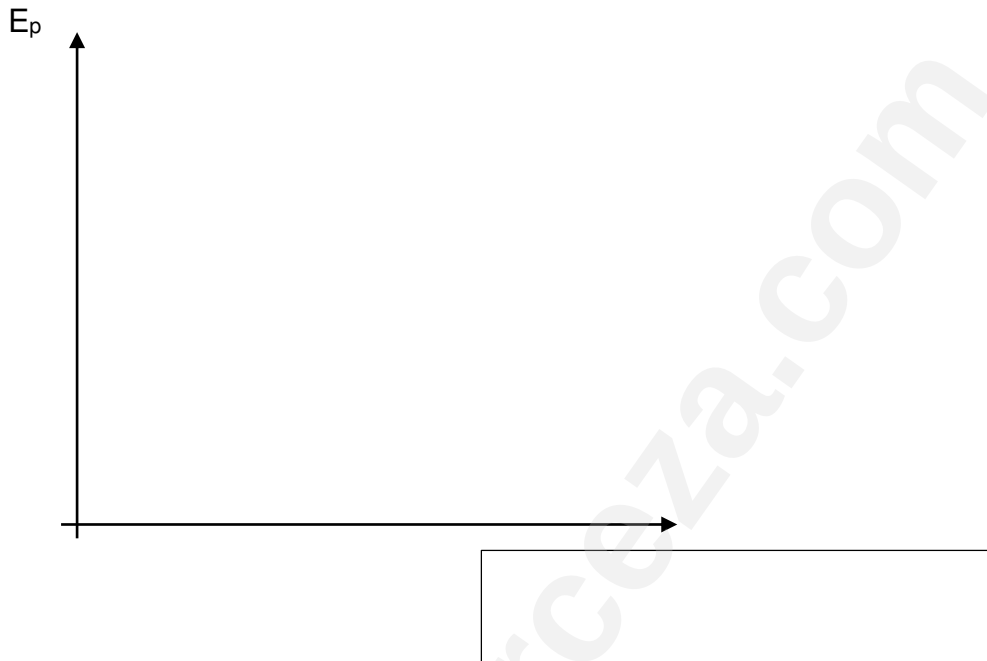


- 9.5.1 Write down the two reaction equations using molecular formula for the conversion of ethane into ethanol. (Note: There is more than one correct answer, but choose only one reaction pathway) (4)
- 9.5.2 Name the type of reaction occurring in reaction 1 (2)
- 9.5.3 Name the type of reaction occurring in reaction 2 (2)

[23]

ANSWER SHEET FOR QUESTION 3.2

NAME: _____



**EXAMINATION DATA SHEET FOR THE PHYSICAL SCIENCES
(CHEMISTRY)**

TABLE 1 PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Magnitude of charge on electron	e	$1,6 \times 10^{-19} \text{ C}$
Mass of an electron	m_e	$9,1 \times 10^{-31} \text{ kg}$
Standard pressure	p^θ	$1,01 \times 10^5 \text{ Pa}$
Molar gas volume at STP	V_m	$22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$
Standard temperature	T^θ	273 K
Avogadro's constant	N_A	$6,02 \times 10^{23} \text{ mol}^{-1}$
Faraday's constant	F	$96\,500 \text{ C} \cdot \text{mol}^{-1}$

TABLE 2 CHEMISTRY FORMULAE

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$	$n = \frac{V}{V_m}$
$c = \frac{n}{V}$ OR $c = \frac{m}{MV}$	$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14} \text{ at } 298 \text{ K}$	
$Q = It$	$E_{\text{cell}}^\theta = E_{\text{cathode}}^\theta - E_{\text{anode}}^\theta$ $E_{\text{cell}}^\theta = E_{\text{oxidising agent}}^\theta - E_{\text{reducing agent}}^\theta$	

TABLE 3 PERIODIC TABLE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Atomic number (Z)																	
	Electronegativity																	
1	1 H 1						1 H 1	2.1										2 He 4
2	3 Li 7	4 Be 9											5 B 10.8	6 C 12	7 N 14	8 O 16	9 F 19	10 Ne 20
3	11 Na 23	12 Mg 24.3											13 Al 27	14 Si 28	15 P 31	16 S 32	17 Cl 35.5	18 Ar 40
4	19 K 39	20 Ca 40	21 Sc 45	22 Ti 48	23 V 51	24 Cr 52	25 Mn 55	26 Fe 56	27 Co 59	28 Ni 59	29 Cu 63.5	30 Zn 65.4	31 Ga 70	32 Ge 72.6	33 As 75	34 Se 79	35 Br 80	36 Kr 84
5	37 Rb 85.5	38 Sr 88	39 Y 89	40 Zr 91	41 Nb 93	42 Mo 96	43 Tc 99	44 Ru 101	45 Rh 103	46 Pd 106	47 Ag 108	48 Cd 112	49 In 115	50 Sn 119	51 Sb 121	52 Te 128	53 I 127	54 Xe 131
6	55 Cs 133	56 Ba 137.3		72 Hf 178.5	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 200.6	81 Tl 204.4	82 Pb 207	83 Bi 209	84 Po -	85 At -	86 Rn -
7	87 Fr	88 Ra																

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lw

TABLE 4 STANDARD ELECTRODE POTENTIALS

Half-reaction			E°/volt
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	-2.37
Al ³⁺ + 3e ⁻	=	Al	-1.66
Mn ²⁺ + 2e ⁻	=	Mn	-1.18
2H ₂ O + 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
Cd ²⁺ + 2e ⁻	=	Cd	-0.40
Co ²⁺ + 2e ⁻	=	Co	-0.28
Ni ²⁺ + 2e ⁻	=	Ni	-0.25
Sn ²⁺ + 2e ⁻	=	Sn	-0.14
Pb ²⁺ + 2e ⁻	=	Pb	-0.13
Fe ³⁺ + 3e ⁻	=	Fe	-0.04
2H ⁺ + 2e ⁻	=	H ₂ (g)	0.00
S + 2H ⁺ + 2e ⁻	=	H ₂ S(g)	+0.14
Sn ⁴⁺ + 2e ⁻	=	Sn ²⁺	+0.15
SO ₄ ²⁻ + 4H ⁺ + 2e ⁻	=	SO ₂ (g) + 2H ₂ O	+0.17
Cu ²⁺ + 2e ⁻	=	Cu	+0.34
2H ₂ O + O ₂ + 4e ⁻	=	4OH ⁻	+0.40
SO ₂ + 4H ⁺ + 4e ⁻	=	S + 2H ₂ O	+0.45
I ₂ + 2e ⁻	=	2I ⁻	+0.54
O ₂ (g) + 2H ⁺ + 2e ⁻	=	H ₂ O ₂	+0.68
Fe ³⁺ + e ⁻	=	Fe ²⁺	+0.77
Hg ²⁺ + 2e ⁻	=	Hg	+0.79
NO ₃ ⁻ + 2H ⁺ + e ⁻	=	NO ₂ (g) + H ₂ O	+0.80
Ag ⁺ + e ⁻	=	Ag	+0.80
NO ₃ ⁻ + 4H ⁺ + 3e ⁻	=	NO(g) + 2H ₂ O	+0.96
Br ₂ + 2e ⁻	=	2Br ⁻	+1.09
Pt ²⁺ + 2e ⁻	=	Pt	+1.20
MnO ₂ + 4H ⁺ + 2e ⁻	=	Mn ²⁺ + 2H ₂ O	+1.21
O ₂ + 4H ⁺ + 4e ⁻	=	2H ₂ O	+1.23
Cr ₂ O ₇ ²⁻ + 14H ⁺ + 6e ⁻	=	2Cr ³⁺ + 7H ₂ O	+1.33
Cl ₂ (g) + 2e ⁻	=	2Cl ⁻	+1.36
Au ³⁺ + 3e ⁻	=	Au	+1.42
MnO ₄ ⁻ + 8H ⁺ + 5e ⁻	=	Mn ²⁺ + 4H ₂ O	+1.51
H ₂ O ₂ + 2H ⁺ + 2e ⁻	=	2H ₂ O	+1.77
F ₂ (g) + 2e ⁻	=	2F ⁻	+2.87

Increasing oxidising ability
↓

↑
Increasing reducing ability