



CHEMISTRY PRELIM 2026

PHYSICAL SCIENCE

GRADE 12

PAPER 2 : CHEMISTRY

EXAMINER : C. ORCHISON

DATE : 27 JULY 2026

MODERATORS : N. MOSCHIDES

HOURS : 3 HOURS

T. REDDY

MARKS : 200

NAME : _____

INSTRUCTIONS AND INFORMATION

1. This question paper consists of 35 pages with 8 questions.
2. A separate data sheet is provided.
3. Answer all questions on this paper and show all working out.
4. Extra space is provided at the end of the paper should you require it.
5. Use the mark allocation as guide to the maximum time you should spend on a question.
6. Use bullet points for all explanations.
7. Round all answers to 2 decimal places and include the correct SI unit.
8. Answers should be expressed in decimal format and not left as fractions.



QUESTION 1

1.1

A	B	C	D
---	---	---	---

1.2

A	B	C	D
---	---	---	---

1.3

A	B	C	D
---	---	---	---

1.4

A	B	C	D
---	---	---	---

1.5

A	B	C	D
---	---	---	---

1.6

A	B	C	D
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1.7

A	B	C	D
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1.8

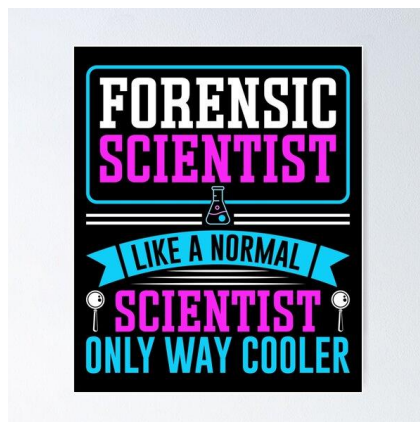
A	B	C	D
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1.9

A	B	C	D
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1.10

A	B	C	D
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- 1.1 Which of the following correctly identifies the polarity of the bonds and molecular shape of phosphorus trihydride ?

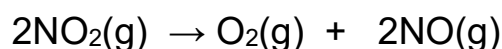
	Polarity of the bonds:	Molecular shape:
A	Non-polar	Trigonal planar
B	Polar	Trigonal planar
C	Non-polar	Trigonal pyramidal
D	Polar	Trigonal pyramidal

- 1.2 50 g of potassium phosphate is added to 400 cm³ of a 1,5 mol.dm⁻³ potassium chloride solution. What is the concentration of potassium ions in the solution?

A 3,3 mol.dm⁻³ B 2,1 mol.dm⁻³ C 5,25 mol.dm⁻³ D 1,32 mol.dm⁻³

- 1.3 The enthalpy for an exothermic reaction is -20 kJ and the activation energy for the reverse reaction is 70 kJ. What is the activation energy for the forward reaction?
- A 70 kJ B 90 kJ C 50 kJ D 20 kJ

- 1.4 Nitrogen dioxide decomposes to form oxygen and nitrogen oxide according to the equation below:



If the concentration of $\text{NO}_2(\text{g})$ decreased from $0,02 \text{ mol.dm}^{-3}$ to $0,01 \text{ mol.dm}^{-3}$ over the course of 50 seconds, what is the rate of formation of $\text{O}_2(\text{g})$ in $\text{mol.dm}^{-3}.\text{s}^{-1}$?

- A 2×10^{-4} B 1×10^{-4} C 4×10^{-4} D $0,5 \times 10^{-4}$

- 1.5 Consider the following hypothetical reaction:



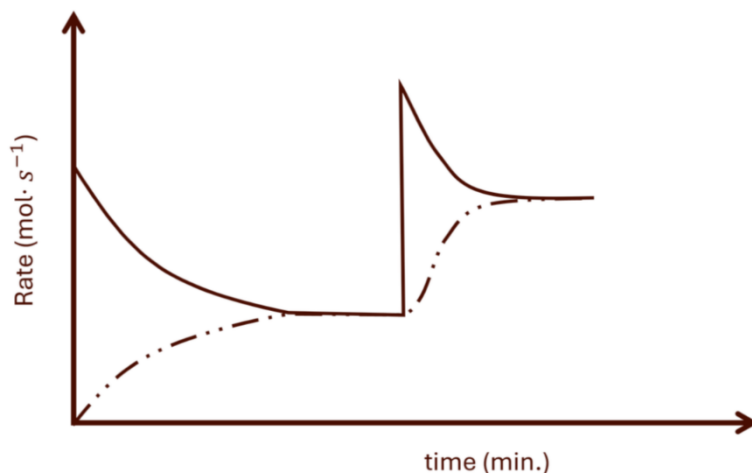
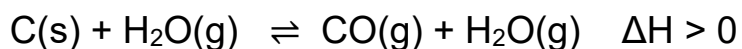
Which option correctly states the effect of increasing the temperature on the initial rate of the forward reaction and the yield of R?

	Rate of the forward reaction:	Yield of R:
A	increase	Increase
B	increase	decrease
C	decrease	Increase
D	decrease	decrease

1.6 The following solutions all have the same concentration and their relevant K_a and K_b values have been shown. Which of them will have the **highest** pH?

- A NaHS - K_b of HS^- is $1,8 \times 10^{-7}$
- B KCN - K_a of HCN is 4×10^{-10}
- C NaClO - K_a of HClO is $3,2 \times 10^{-8}$
- D NH_4NO_3 - K_b of NH_3 is $1,8 \times 10^{-10}$

1.7 You are given the following equilibrium reaction and a rate-time graph as shown.



Which of the following stresses after the initial equilibrium would match the shape of the graph?

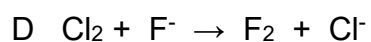
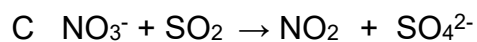
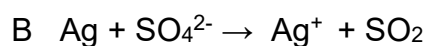
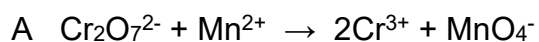
- A an increase in pressure
- B a decrease in temperature
- C an increase in the mass of carbon
- D none of the above

- 1.8 The diagram alongside shows the electrolysis of aqueous potassium iodide after current has been passed through the solution for a few seconds. Phenolphthalein was added to the solution.

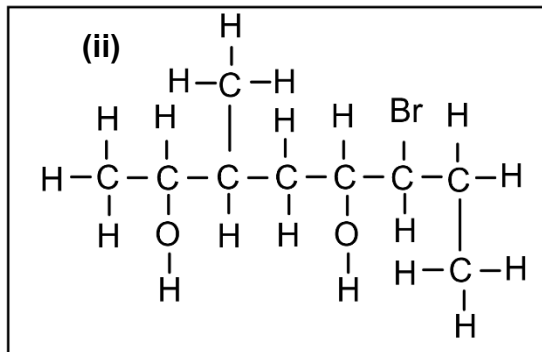
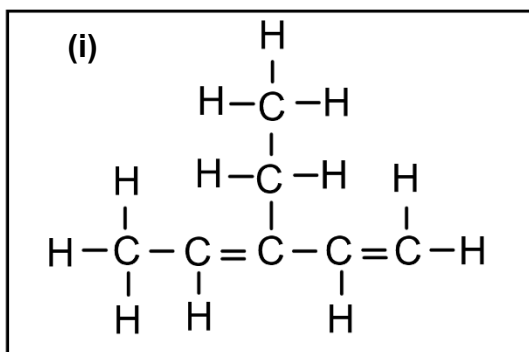


Which of the statements below is correct?

- A the yellow colour at the anode is the result of iodine being oxidized
 - B the pink colour at the cathode is a result of the water being reduced to hydroxide ions
 - C the yellow colour at the cathode is the result of iodide ions being reduced
 - D the pink colour at the anode is a result of the oxidation of potassium metal
- 1.9 An electrochemical cell needs to supply electrical energy to a small lamp. Which of the options below correctly represents a reaction which would meet this requirement?



1.10 Consider the following organic compounds, (i) and (ii). In which option have they both been correctly named?



	Compound (i)	Compound (ii)
A	3-ethylpentane-1,3-diene	3-bromo-1,3-dimethylheptane-2,5-diol
B	3-ethylpenta-1,3-diene	3-bromo-6-methyloctane-5,7-diol
C	3,3-dimethylpentane-1,3-diene	6-bromo-1,3-methylhepta-2,5-diol
D	3-ethylpenta-1,3-diene	6-bromo-3-methyloctane-2,5-diol

20 MARKS

The heinous crime...

While Bela is making coffee, Thato and Yolanda are preparing for M.D. by dancing wildly in the kitchen in their high heels. They less than gracefully collide with each other and wind up on the floor unconscious. In this state they dream that the whole class are forensics scientists being supervised by an unhinged Bela as you test the evidence from a crime she seems to know an awful lot about. For POPIA purposes all names have been changed in the following account...

It was a rainy Thursday morning at 2:13 am when emergency services responded to an anonymous call reporting a fire at LambTech Laboratories. By the time first responders contained

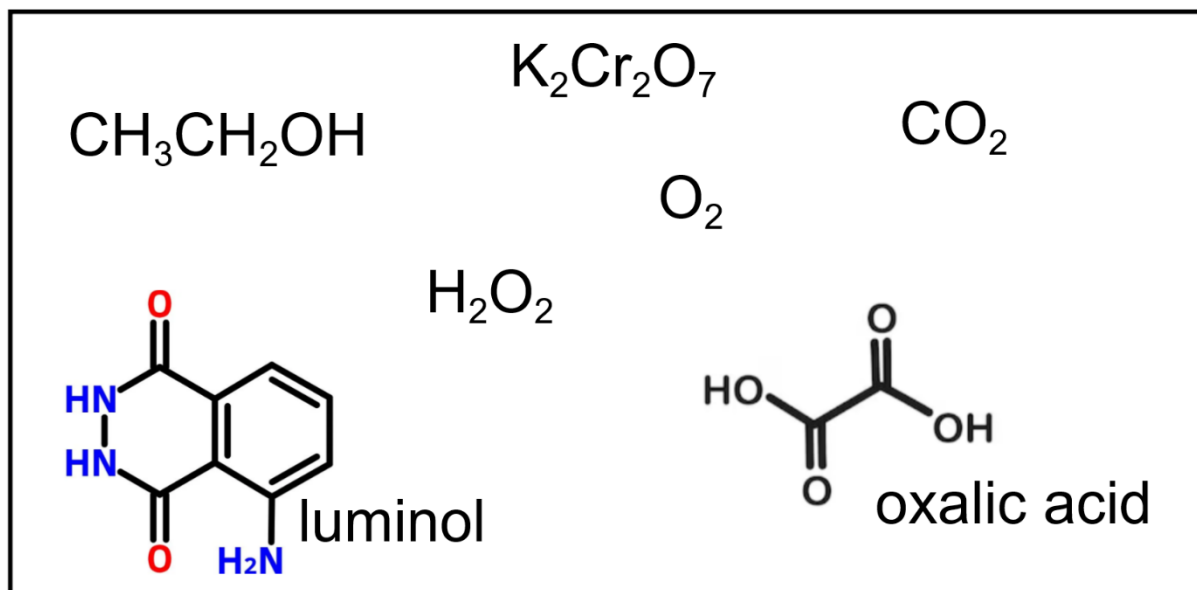


the blaze, Dr. Bo-Peep, lead scientist, was tragically found deceased in her office. Detectives discovered that secret wool-dyeing formulae were missing from the laboratory safe. Ms. Fluff Shearer, who was Dr. Bo-Peep's assistant (and bleats innocence), is currently being detained as a suspect.



QUESTION 2

As a senior forensic analyst, your team has been handed evidence recovered from the scene. You are required to verify that the police have apprehended the correct villain. Before you and your team start analyzing the evidence collected at the crime scene, you need to be familiar with the following chemicals that you will be using and testing:



2.1 Define an *intramolecular bond*.

(1)

2.2 Would it be correct to say that both hydrogen peroxide and oxygen gas contain non-polar covalent bonds ? Explain your answer by referring to specific elements.

(2)

2.3 Identify all of the intermolecular forces present in oxalic acid. (2)

2.4 Which other substances contain the same dominant intermolecular forces as oxalic acid? (2)

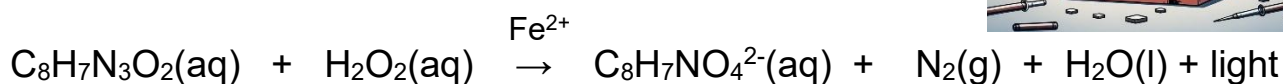
2.5 Fully explain whether or not potassium dichromate would be soluble in $\text{CH}_3\text{CH}_2\text{OH}$. (3)

2.6 Fully explain whether pentan-1-ol would have a higher or lower boiling point than $\text{CH}_3\text{CH}_2\text{OH}$. (3)

13 MARKS

QUESTION 3

One of the very important reactions you will need to understand is that of luminol and hydrogen peroxide according to the unbalanced equation given below. Your team adds 15 g of luminol to 60 cm³ of a 2,5 mol.dm⁻³ solution of hydrogen peroxide and finds that 1,2 dm³ of nitrogen is produced at STP.



3.1 Define *molar concentration*. (1)

3.2 Balance the given equation: (2)



3.3 Determine the limiting reagent in this reaction. (6)

3.4 What is meant by *percentage yield*?

(1)

3.5 Calculate the percentage yield of their experiment.

(6)

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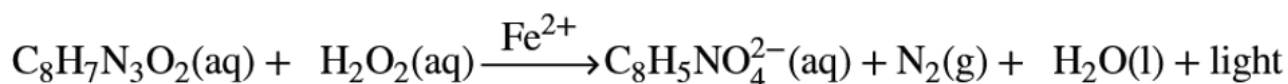
16 MARKS

QUESTION 4

Right.. let's begin.

Once the scene had been cleared, among the ashy remains investigators noted what appeared to be partial shoe imprint in the dried blood of the victim.

The forensics team on the scene sprayed the floor with a chemical cocktail of Luminol and hydrogen peroxide. The reaction emits a characteristic blue glow and produces nitrogen gas.



Ms. Fluff Shearer's shoes were taken into evidence so that they could be tested, and it appeared that she had tried to wash blood off them.

In your lab, your technicians perform an investigation to see how washing away blood affects the rate of the luminol reaction. They mix varying concentrations of luminol with a constant volume of concentrated hydrogen peroxide and a sample of diluted blood. They measured the volume of nitrogen gas produced over time. The data collected for one of the tests is tabulated alongside.

Time (s)	Vol N ₂ (g) produced (cm ³)
0	0
9	17
22	31
30	37
38	41
50	45
60	45

4.1 Define the *rate of a chemical reaction*.

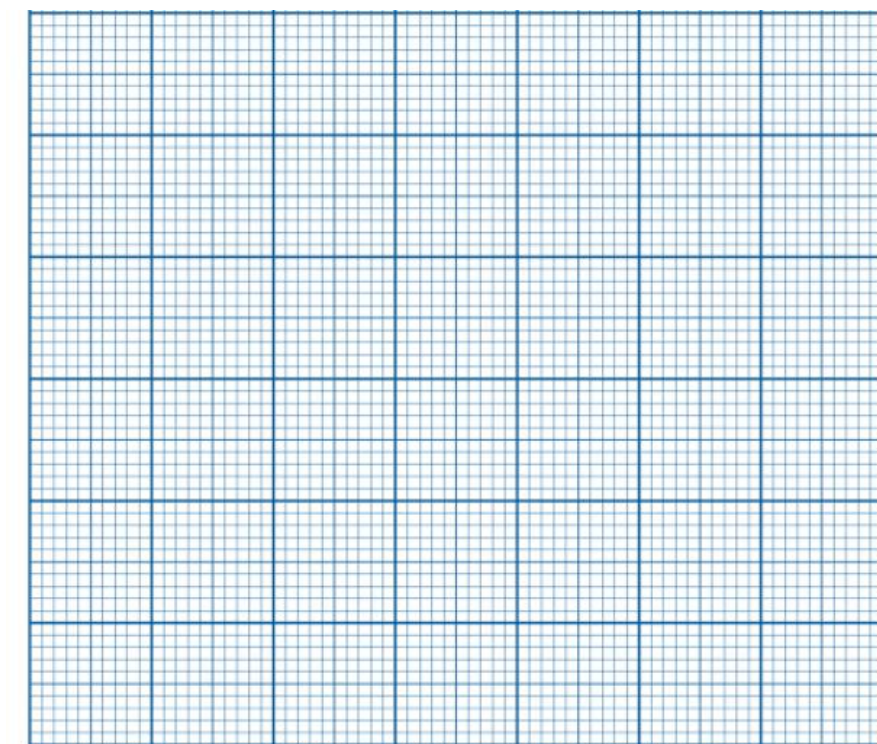
(1)

4.2 Identify the independent variable in the tests that your lab techs were performing.

(1)

This image shows a single page from a notebook or ledger. It features ten horizontal black lines spaced evenly apart, creating nine rows for writing. The lines are thin and extend across the full width of the page. There is no handwriting, printed text, or other markings on the paper.

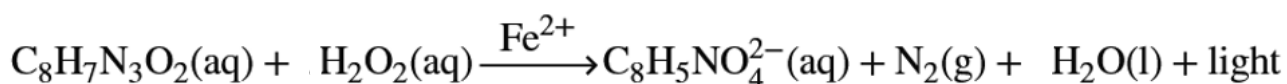
(5)



- 4.5 Calculate the average rate of reaction during the first 35 seconds of the experiment and clearly indicate the points used on your graph. (4)

- 4.6 On the same set of axes, sketch the expected shape of the graph if the experiment was performed using the same concentration of hydrogen peroxide but a lower concentration of luminol. Luminol is the limiting reagent in their experiment. Draw this curve in another colour or highlighter and include a key to distinguish between the graphs. (2)

The luminol reaction is exceptionally slow on its own, however, the ferrous ion (Fe^{2+}) present in the haemoglobin of blood acts as a catalyst, drastically increasing the reaction rate and allowing for the quick confirmation of the presence of blood.



When tested, the luminol reaction confirmed the presence of blood on Ms. Fluff Shearer's shoes.

- 4.7 Define a *catalyst*. (1)

- 4.8 Explain what effect trying to wash her shoes would have had on the reaction. (2)

Forensics use muscle degradation (breaking down of the muscles) of a body to determine time of death. A higher temperature increases the rate of muscle degradation in a body.

- 4.9 On the axes below, sketch a Maxwell-Boltzmann distribution curve for muscle degradation of a body at room temperature, T_1 , as well as for the muscle degradation taking place at a much higher temperature, T_2 . Include all relevant labels. (4)



- 4.10 Explain using collision theory why the estimated time of death for Dr. Bo-Peep was 1:10 am instead of 2:05 am based on her muscle degradation considering where her body was found. (3)



27 MARKS

QUESTION 5

Arson investigators determined that the laboratory fire was intentionally set using an accelerant. Ms. Fluff Shearer cries dramatically and says she knows nothing about any accelerants and claims that Dr. Bo-Peep must have been attacked by the formulae thief before the fire was started because when she ran into the office to alert Dr. Bo-Peep to the blaze, Ms Shearer found Dr. Bo-Peep slumped lifeless in her chair.

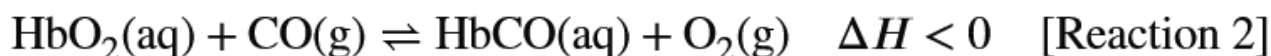


Blood panels run by your team reveal a highly specific competitive equilibrium state.

In the human body, haemoglobin (Hb) establishes a dynamic equilibrium with oxygen to form oxyhaemoglobin (HbO₂), which sustains life:



However, carbon monoxide binds to haemoglobin 200 times more strongly than oxygen, setting up a deadlier, competing dynamic equilibrium system:

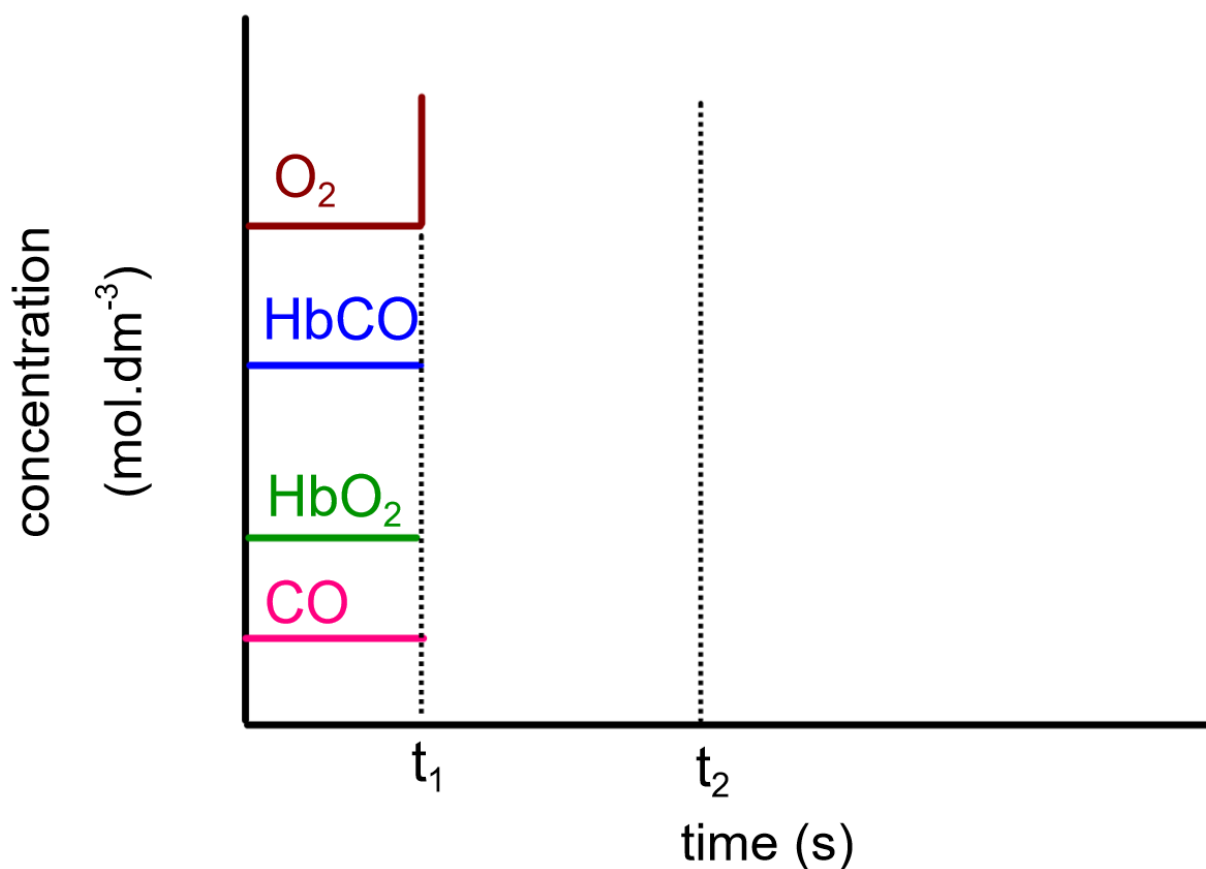


5.1 Explain what is meant by *dynamic chemical equilibrium* (1)

5.2 State *Le Chatelier's principle*. (1)

5.3 Briefly explain, by referring to equilibrium principles, how your toxicology findings of high carboxyhaemoglobin (HbCO) levels would suggest that Dr. Bo-Peep was actually still alive and breathing **during** the fire (which produced CO and CO₂), contrary to what Ms. Fluff Shearer was saying. (3)

Consider the graph given below showing the concentrations of the species involved in equilibrium reaction 2 change as a function of time:



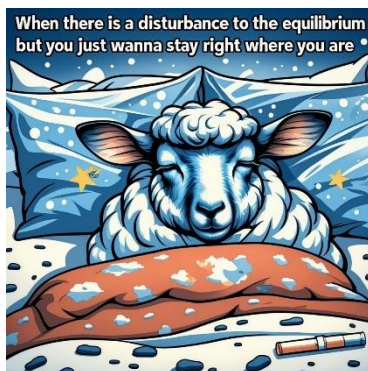
5.4 On the graph above, show the effect on each of the species of the indicated stress that took place at t_1 if equilibrium is re-established at t_2 . (3)

5.5 Fully explain the effect that an increase in the volume of the container would have on all of the species present in reaction 2. (4)

In order to determine the equilibrium constant for Reaction 2 at body temperature (37°C), you set up a closed system in a 2 dm^3 container. Initially you introduce $0,6\text{ mol}$ of HbO_2 and $0,5\text{ mol}$ of CO into the container and allow the system to reach equilibrium. You then find that $0,4\text{ mol}$ of HbCO has been formed. Assume that this volume is applicable to all species involved.

5.6 Write an expression for the equilibrium constant (2)

5.7 Calculate the value of the equilibrium constant at body temperature. (5)



- 5.8 As you know, your forensic lab must store blood control samples in a temperature-controlled refrigerator rather than at room temperature. You overhear one of your lab assistants telling another that the value of the equilibrium constant would be higher at body temperature than in the refrigerator. Are they correct? Explain your answer fully. (4)

23 MARKS

QUESTION 6

Near the origin of the lab fire, investigators found a melted plastic container wrapped in a cloth soaked in an unknown alkaline cleaning agent, which detectives believe Ms. Fluff Shearer used to try to wash away evidence before setting the blaze. The residue contains the strong base, sodium hydroxide. An ash sample recovered from the crime scene is treated with water to dissolve the alkaline residue, creating a 300 cm³ solution of sodium hydroxide of unknown concentration.



To determine its concentration, your team titrates a 25 cm³ sample of this NaOH solution against a standard solution of diprotic oxalic acid, (COOH)₂, with a concentration of 0,07 mol·dm⁻³:

6.1 Define a *Bronsted-Lowry acid*. (1)

6.2 Your lab technician states that this oxalic acid should automatically be considered to be a *weak acid* because it only has a concentration of $0,07 \text{ mol.dm}^{-3}$. Explain fully whether you agree with the technician or not. (3)

6.3 Write the ionization reaction for oxalic acid, assuming full ionization. Include all relevant phases. (3)

6.4 Determine the hydroxide concentration of the standard oxalic acid solution at 25°C . (3)

- 6.5 Write a balanced chemical equation for the reaction of oxalic acid and sodium hydroxide. (3)

In order to determine the equivalence point of the titration, you need to select the most appropriate indicator from the list below:

Indicator	pH Range	Colour below pH range	Colour above pH range
Methyl Orange	3.1 – 4.4	Red	Yellow
Bromothymol Blue	6.0 – 7.6	Yellow	Blue
Phenolphthalein	8.2 – 10	Colourless	Pink

- 6.6 Explain why acids ionize and bases generally dissociate. (2)

- 6.7 A certain weak acid indicator HIn is added to water and ionizes to form In^- . Write the equation for this reaction and clearly indicate all conjugate acids and bases. (3)

- 6.8 Which of the indicators in the table would be most suitable for your titration? Explain your answer by including and referring to a hydrolysis reaction. (3)

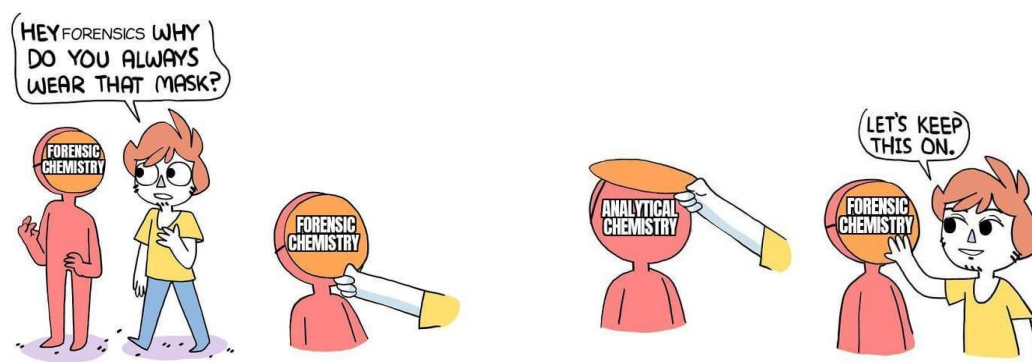
- 6.9 Use your Indicator equilibrium reaction in 6.7 to explain the colour change of your selected indicator in 6.8 above during the course of your titration. State the colours of HIn and In^- in your answer. (4)

- 6.10 Define *neutralization*. (1)

A bottle of 0,1 mol.dm⁻³ sodium hydroxide solution was found in Ms. Fluff Shearer's car which she claims she uses as drain cleaner.

- 6.11 Your team requires an average of $18,6 \text{ cm}^3$ of the oxalic acid to neutralize the sample of sodium hydroxide collected at the scene. Use this information to calculate the concentration of the sodium hydroxide sample found at the scene, and state whether or not this clears Ms. Fluff Shearer.

(6)

[illegible]

Since your lab is responsible for absolutely accurate forensic findings you cannot make any errors when it comes to calculating the concentration of the sample found at the scene.

6.12 Which of the following errors in your titration with oxalic acid would result in your calculated sodium hydroxide concentration being **higher** than it actually was?

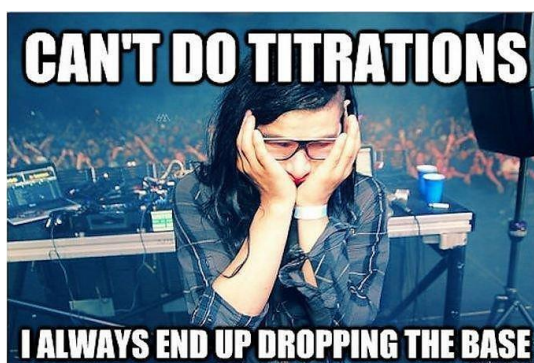
Put a cross over the letter you have selected:

(2)

A	rinsing the pipette with water before pipetting the sodium hydroxide sample from the crime scene
B	rinsing the pipette with a standard solution of $0,1 \text{ mol.dm}^{-3}$ sodium hydroxide before pipetting the sodium hydroxide sample from the crime scene
C	rinsing the pipette with a standard solution of $0,03 \text{ mol.dm}^{-3}$ sodium hydroxide before pipetting the sodium hydroxide sample from the crime scene

6.13 Fully explain your answer to 6.12 above.

(3)



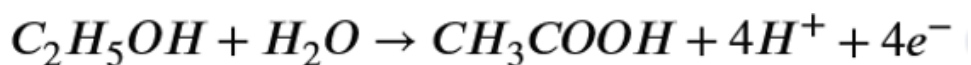
37 MARKS

QUESTION 7

Two hours after the fire, Metro police pulled over a speeding vehicle matching the laboratory surveillance footage. The driver, Sir Horns Rammington, CEO of LambTech's rival company and suspected accomplice of Ms. Fluff Shearer, was highly agitated, smelled of alcohol, and claimed he had been at a bar all night.



A roadside potassium dichromate breathalyser test was administered, tracking the oxidation of volatile ethanol vapours in his breath in order to validate his claims. The half-reaction below shows this reaction:



The chromium ion is green in colour and the dichromate ion is orange. The extent of the colour change in the breathalyser test determines the level of alcohol present.

7.1 Define *oxidation*.

(1)

Sir Horns Rammington's test revealed a distinct colour change **from orange to green**.

7.2 Write the half reaction that correctly represents this process.

(2)

7.3 Does this colour change support that Sir Hons Rammington had indeed been drinking? Explain your answer.

(2)

7.4 Using the information provided, write the net ionic equation for this reaction.

(3)

The safe that the external drive was stolen from was made from a particular metal alloy with copper metal embedded into the safe wall to dissipate the heat from cutting torches, making it difficult for the thief to melt through the barrier. Metal fragments were found on the passenger seat of Sir Horns Rammington's Lamb-bourghini and brought to your lab to be tested.



7.5 Your team first places the metal in a solution of magnesium nitrate and notes that nothing changes, but when placed in a solution of copper (II) nitrate a brownish metal seems to be forming on the metal fragments.

What do these observations tell you about the **reducing ability** of the metal the fragments are made from in relation to two other metals?

(2)

- 7.6 The unknown metal is then connected to copper in a solution of Cu^{2+} ions in a galvanic cell and the emf was measured to be +1,52 V. Determine the identity of the unknown metal. (4)

- 7.7 Define an *electrolyte*. (1)

- 7.8 Name a suitable electrolyte for the salt bridge your team would have used. (1)

- 7.9 Fully explain the movement of the cations in the salt bridge. (3)

- 7.10 Write the cell notation for this cell. Include standard conditions. (3)

- 7.11 If a solution with a lower concentration of Cu^{2+} ions was used instead, explain the effect this would have on the initial emf of the cell. (3)

- 7.12 Using the same galvanic cell, the increase in the mass of the cathode was measured after allowing the cell to run for a time of one hour. If the current was 300 mA, calculate the mass of metal that was deposited on the cathode. (7)

Sterilization of the lab is of utmost importance, and so there is always bleach (which is made from chlorine gas and a base) on hand. Your team is aware of how to manufacture chlorine gas in the lab in an absolute emergency using the electrolysis of **aqueous** sodium chloride.

7.13 Explain the purpose of the polymer membrane in the industrial production of chlorine. (2)

7.14 Give the half-reaction taking place at the cathode. (1)

7.15 Name the products of the electrolysis of **MOLTEN** sodium chloride. (2)

37 MARKS

Compounds P and propane are used as accelerants to start fires, compound Q is used to remove grease from the metal safe, ethyl pentanoate has a fruity aroma of apples and pineapples and was likely used to initially mask the smell of the accelerants being poured across the room.



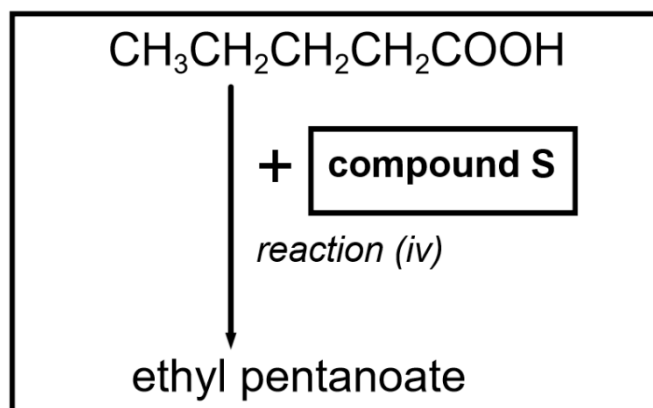
$\text{C}_{15}\text{H}_{32} \xrightarrow{\text{reaction (i)}} 2\text{CH}_2\text{CHCH}_3 + \text{compound P}$

$2\text{CH}_2\text{CHCH}_3 \xrightarrow[\text{reaction (ii)}]{+\text{HBr}} \text{compound Q}$

$\text{compound Q} \xrightarrow[\text{reaction (iii)}]{+\text{Cl}_2} \text{compound R}$

propane

This is a reaction type that is not in your syllabus, so don't panic. Just trust that this conversion is possible. It doesn't affect the rest of the questions at all.



- 8.1 Reaction (i) is used to break compounds into smaller more useful molecules. What is the specific name of this type of reaction? (1)
-
- 8.2 $C_{15}H_{32}$ reacts to form 2 molecules of CH_2CHCH_3 and product P. Give the general formula for the alkanes, and the molecular formula of product P and. (2)
-
- 8.3 Give the IUPAC name of CH_2CHCH_3 . (2)
-
- 8.4 Define a *saturated compound*. (1)
-
-
-
- 8.5 Is compound P saturated or unsaturated? (1)
-
- 8.6 Give the specific name for reaction (ii). (1)
-
- 8.7 Give the condensed structural formula for compound Q and give its IUPAC name. (3)
- 8.8 Write the balanced chemical equation for the complete combustion of propane. (3)
-

8.9 Represent reaction (iii) using full structural formulae and include any relevant reaction conditions. (4)

8.10 Give the general name for reaction (iii). (1)

8.11 Define a *structural isomer*. (1)

8.12 One of the lab techs says that $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$ and ethyl pentanoate are functional isomers of each other. Fully explain why they are incorrect and give the IUPAC name of a correct functional isomer of $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$. (3)

8.13 Name compound S. (1)

8.14 Name the functional group of compound S. (1)

8.15 Draw the structural formula of ethyl pentanoate. (2)

27 MARKS

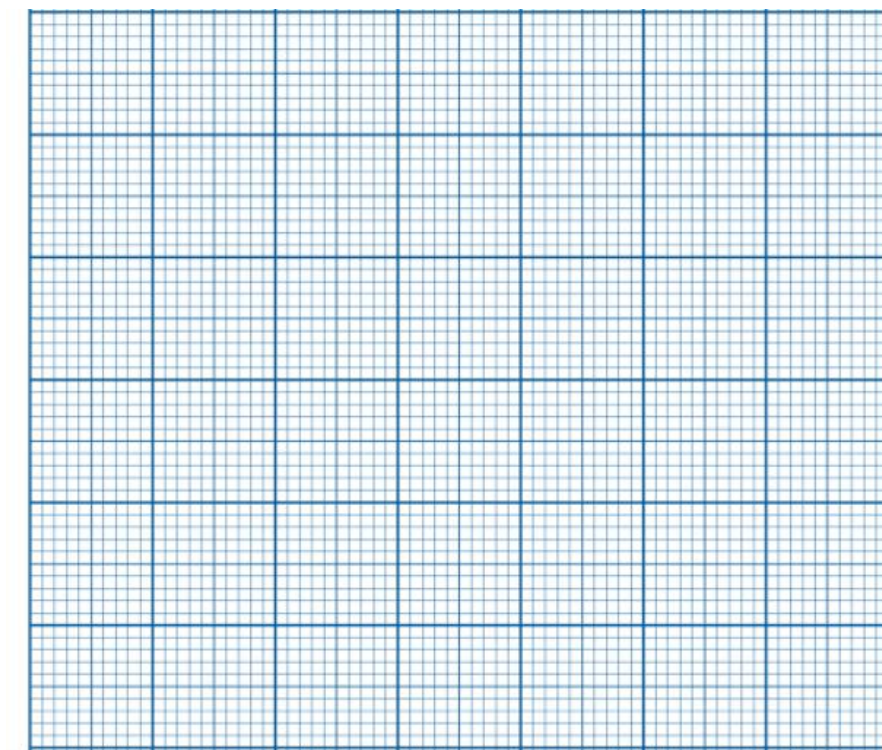
Just as your team are being thanked for helping to put Ms. Fluff Shearer and Sir Horns Rammington behind bars, Thato and Yolanda finally regain consciousness, and the dream ends.

They tell Bela all about their very weird experience and laugh about totally how absurd it was... until Yolanda notices a faint red colour under Bela's high heel shoes.

The end.

... or is it....?

EXTRA GRAPH GRID IF NEEDED



EXTRA SPACE IF NEEDED. PLEASE SHOW VERY CLEARLY WHICH QUESTION YOU ARE ANSWERING IN THIS SPACE.
