SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE

SUID-AFRIKAANSE KOMPREHENSIEWE ASSESSERINGSINSTITUUT

PHYSICAL SCIENCES

2021

GRADE 12 PRELIMINARY EXAMINATION

PAPER 2

MEMORANDUM

TOTAL: 150

TIME: 3 hours

This memorandum consists of 13 pages.

PHYSICAL SCIENCES

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INSTRUCTIONS AND INFORMATION

1. Marks will be awarded for: correct formula, correct substitution, and correct answer with unit.
2. No marks will be awarded if an incorrect or inappropriate formula is used, even though there may be relevant symbols and applicable substitutions.
3. When an error is made during substitution into a correct formula, a mark will be awarded for the correct formula and for the correct substitutions, but no further marks will be given
4. If no formula is given, but all substitutions are correct, the candidate will forfeit one mark.
5. Marks are only awarded for a formula if a calculation has been attempted, i.e. substitutions have been made or a numerical answer given.
6. Final answers to all calculations, when not specified in the question, must be rounded off to a minimum of TWO decimal places.
7. If a final answer to a calculation is correct, full marks will not automatically be awarded. Markers will always ensure that the correct/appropriate formula is used and that workings, including substitutions, are correct.
8. Candidates will only be penalised once for the repeated use of an incorrect unit within a question.
9. Units are only required in the final answer to a calculation.
10. Marks are only awarded for an answer, and not for a unit per se.
11. SI units must be used.
12. If one answer or calculation is required, but two are given by the candidate, only the first one will be marked, irrespective of which one is correct.
13. When a chemical FORMULA is asked, and the NAME is given as answer, the candidate forfeits the marks. The same rule applies when the NAME is asked and the FORMULA is given.
14. When half-reactions are to be written, the correct arrow should be used.
15. In the structural formula of an organic molecule all hydrogen atoms must be shown. Marks will be deducted if hydrogen atoms are omitted.
16. When a structural formula is required, marks will be deducted if the learner writes the condensed formula.
17. When an IUPAC name is asked and the candidate omits the hyphen(s), marks will be forfeited.
18. When a chemical reaction is asked, marks are awarded for correct reactants, correct products and correct balancing If only a reactant(s) or only a product(s) is/are written, without an arrow, no marks are awarded for the reactant(s) or product(s).
19. Positive marking will be indicated where relevant.

QUESTION 1

1.1 C ✓✓ (2)

1.2 D ✓✓ (2)

1.3 A ✓✓ (2)

1.4 C ✓✓ (2)

1.5 B ✓✓ (2)

1.6 B ✓✓ (2)

1.7 C ✓✓ (2)

1.8 A ✓✓ (2)

1.9 B ✓✓ (2)

1.10 B ✓✓ (2)

[20]

QUESTION 2

2.1 2.1.1 E ✓ (1)

2.1.2 A ✓ (1)

2.1.3 B ✓ (1)

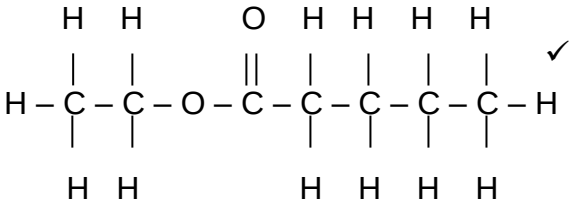
2.2 3-methylbut-1-en ✓ ✓ (2)

2.3 $2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$ ✓ Balancing (3)
✓ Reactants ✓ Products

2.4 2.4.1 Esterification ✓ (1)

2.4.2 H_2SO_4 ✓ (1)

2.4.3 ✓ Functional group ✓ Rest of the molecule (2)



2.4.4 Ethyl pentanoate ✓✓ (2)
[14]

QUESTION 3

3.1 The temperature at which the vapour pressure of a substance equals atmospheric pressure. ✓✓ (2)

3.2 Compound **E** (pentane) is an alkane and has weak Van der Waals forces between its molecules while compound **F** (pentanol) is an alcohol and has strong hydrogen bonds between its molecules. ✓
More energy is required to overcome the stronger intermolecular forces between compound **F** (pentanol) and consequently the boiling point of **F** is higher ✓ than that of compound **E** which requires less energy to overcome its weaker intermolecular forces. ✓ (3)

3.3 A ✓ ✓
Compound A has the lowest boiling point (-42 ˚C) and vapour pressure is inversely proportional to boiling point, which means the compound with the lowest boiling point, has the highest vapour pressure. ✓ (3)

3.4 3.4.1 Higher than ✓ (1)

3.4.2 Compound **D**, Butanol, consists of a carbon chain with 4 carbon molecules, while compound **B**, Propanol, consists of a carbon chain with 3 carbon molecules. Because compound **D** has a longer carbon chain (and consequently a larger molecular mass) ✓ than compound **B**, more energy is required to overcome the intermolecular forces in compound **D** ✓ than what is needed to overcome the intermolecular forces in compound **B**. Because of this, the boiling point of compound **D** will be higher than the boiling point of compound **B**. ✓ (3)

[12]

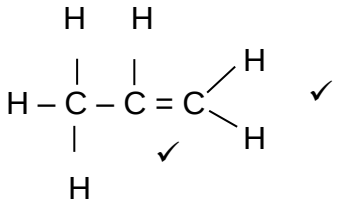
QUESTION 4

4.1 4.1.1 Dehydration ✓ (1)

4.1.2 Sulphuric acid (H_2SO_4) / Phosphoric acid (H_3PO_4) ✓ (1)

4.1.3 Water (H_2O) ✓ (1)

4.1.4

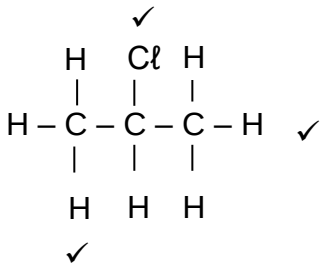


(2)

4.1.5 Propene ✓ (1)

4.2 4.2.1 Hydro halogenation ✓ (1)

4.2.2



(2)

4.2.3 2-chloropropane ✓ (2)

4.3 4.3.1 Substitution / hydrolysis ✓ (1)

4.3.2 Diluted, strong base like NaOH (aq) / KOH (aq) dissolved in ethanol ✓
Mild heat ✓ (2)

[14]

QUESTION 5

5.1 Reaction rate is the change in concentration of reactants or products per unit time. ✓✓ (2)

5.2 5.2.1 How will different reaction conditions (change in the vinegar's temperature) influence the reaction rate of this reaction? ✓✓ (2)

5.2.2 Temperature of the vinegar ✓ (1)

5.2.3 Reaction rate ✓ (1)

5.3 5.3.1 B ✓ (1)

5.3.2 a **Higher temperature** (as seen in experiment II) increases the average kinetic energy of the particles. Particles will move faster and more effective collisions between particles will increase the reaction rate. CO_2 yield will increase in a shorter period of time (as seen in graph A).

A **Lower temperature** (as seen in experiment II) decreases the average kinetic energy of the particles. Particles will move slower and less effective collisions between particles will lower the reaction rate. CO_2 yield will increase over a longer period (as seen in graph B).

Mark allocation	
Average kinetic energy increases / decreases	✓
More / less effective collisions between particles	✓
Reaction rate increase / decrease (seen in CO_2 yield)	✓

(3)

5.4 Higher than ✓ (1)

5.5 For CH_3COOH:
n = cV
n = (2,5)(0.02) ✓
n = 0,05 moles

Ratio CH_3COOH : $NaHCO_3$
1 : 1 ✓
Amount of moles $NaHCO_3$: n = 0,05 moles

For $NaHCO_3$:
$n = \frac{m}{M}$
$0{,}05 = \frac{m}{84}$ ✓
m = 4,2 g

Excess = original mass in flask – mass that reacted with CH_3COOH
= 10 g – 4,2 g ✓
= 5,8 g ✓ (5)

[16]

QUESTION 6

6.1 When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓✓ (2)

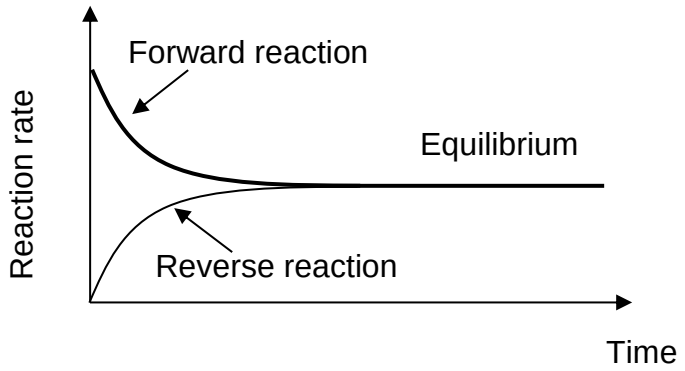
6.2 Endothermic ✓ (1)

6.3 6.3.1 Stay the same ✓ (1)

6.3.2 Decrease ✓ (1)

6.3.3 The forward reaction is an endothermic reaction. A <u>decrease in temperature</u> will be <u>opposed</u> ✓ by <u>favouring the exothermic reaction</u>, ✓ which in this case, is the <u>reverse reaction</u>. Because the reverse reaction is favoured now, the amount of moles CO (g) will decrease.✓ (3)

6.4



Marking of reaction rate graph	
Axis labelled correctly (reaction rate / time)	✓
Correct shape of graph	✓
Correct labels on graph (reaction could be written out as well)	✓

(3)

6.5

	H_2	CO_2	H_2O	CO
Ratio	1	1	1	1 ✓
Initial amount (moles)	0,8	0,8	0	0
Change in amount (moles)	0,55	0,55	0,55	0,55 ✓
Equilibrium amount (moles)	0,25	0,25	0,55	0,55
Equilibrium concentration (mol.dm^{-3}) ✓	0,05	0,05	0,11	0,11 ✓

$K_c = \frac{[H_2O][CO]}{[H_2][CO_2]}$ ✓

$K_c = \frac{(0,11)(0,11)}{(0,05)(0,05)}$ ✓

$K_c = 4,84$ ✓

Marking guidelines	
Ratio	✓
Correct change in amount of moles	✓
Divide by 5 dm^{-3} to calculate equilibrium concentration	✓
Correct equilibrium concentration calculated	✓
K_c equation correct	✓
Correct substitution into K_c equation	✓
Correct answer	✓

(7)

[18]

QUESTION 7

✓ Reactants ✓ Products

7.1 $2HC\ell + Na_2CO_3 \longrightarrow 2NaC\ell + H_2O + CO_2$ ✓ Balancing (3)

7.2 a Strong acid ✓ because $HC\ell$ will ionise completely in water to form a high concentration of H_3O^+ ions. ✓ (2)

7.3 An ampholyte is a substance that can act as either acid or base✓ e.g. H_2O✓ (2)

Note: The example MUST be H_2O (water) because the example must come from the balanced equation in question 7.1.

7.4 The hydrochloric acid solution / $HC\ell$ (aq) ✓ (1)

7.5 Methyl orange ✓ (1)

7.6 $\frac{n_a}{n_b} = \frac{c_a V_a}{c_b V_b}$ ✓

✓ $\frac{2}{1} = \frac{(0,4)(20)}{c_b(16)}$ ✓

$c_b = 0,25\ mol.dm^{-3}$ ✓

$c = \frac{m}{MV}$ ✓

$(0,25) = \frac{m}{(106)(0,016)}$ ✓

$m = 0,424\ g$ ✓

Alternatively

$c = \frac{n}{V}$

$(0,25) = \frac{n}{(0,016)}$

$n = 4 \times 10^{-3}\ mole$ ✓

$n = \frac{m}{M}$

$(4 \times 10^{-3}) = \frac{m}{(106)}$ ✓

$m = 0,424\ g$ ✓ (7)

7.7 pH = -log[H_3O^+] ✓

pH = -log[0,4] ✓

pH = 0,397 ≈ 0,4 ✓ (3)

[19]

QUESTION 8

8.1 Galvanic cell ✓

Because a current is generated through spontaneous chemical reactions, no external source of electric energy is needed. ✓ (2)

8.2 $E^{\theta}cell = E^{\theta}reduction - E^{\theta}oxidation$ ✓

$(+1{,}10) = E^{\theta}reduction - (-0{,}76)$ ✓

$E^{\theta}reduction = +0{,}34\ V$ ✓

X is a Cu electrode. ✓ (4)

8.3 **P** is the salt bridge ✓

The function of the salt bridge is to complete the circuit (to enable current flow) / maintain electrical neutrality of the electrolyte solutions. ✓ (2)

8.4 Reducing agent ✓ (1)

8.5 $Cu^{2+} + 2e^{-} \longrightarrow Cu$ ✓ (2)

8.6 An electrolyte is a solution/liquid/dissolved substance that conducts electricity through the movement of ions. ✓✓ (2)

[13]

QUESTION 9

9.1 Electrolysis is the chemical process in which electrical energy is converted to chemical energy. ✓✓

OR

Electrolysis is the use of electrical energy to produce a chemical change. ✓ (2)

9.2 9.2.1 A ✓ (1)

9.2.2 Chlorine gas ✓ (1)

✓ Reactants ✓ Products

9.3 $2C\ell^- + 2H_2O \longrightarrow C\ell_2 + H_2 + OH^-$ ✓

Also accept if candidate wrote the following net reaction:

$2NaC\ell\ (aq) + H_2O\ (\ell) \longrightarrow C\ell_2\ (g) + 2NaOH\ (aq) + H_2\ (g)$ (3)

9.4 Part C, the membrane, is <u>selectively permeable</u>. ✓ (1)

9.5 Chlorine gas is poisonous for humans and animals when inhaled ✓ because of this, plants are not built close to residential areas. ✓ (2)

[10]

QUESTION 10

10.1 10.1.1 Haber process ✓ (1)

10.1.2 $N_2 + 3H_2 \xrightarrow{\checkmark} 2NH_3$ ✓ (2)

10.2 10.2.1 Ostwald process ✓ (1)

10.2.2 $3NO_2 + H_2O \xrightarrow{\checkmark} 2HNO_3 + NO$ ✓ (2)

10.3 10.3.1 NH_3 ✓ (has to be molecular formula) (1)

10.3.2 HNO_3 ✓ (has to be molecular formula) (1)

10.4 Ammonium nitrate ✓ (has to be the name) (1)

10.5 The farmer should use fertiliser **B** ✓ because fertiliser **B** contains the largest amount of nitrogen (N) ✓ and nitrogen promotes leaf grow which will help the farmer to produce a good yield of spinach. ✓ (3)

10.6 *Eutrophication* is the process by which an ecosystem, e.g. a river or dam, becomes enriched with inorganic plant nutrients, especially phosphorus and nitrogen, resulting in excessive plant growth.✓ As plant growth becomes excessive, the amount of dead and decaying plant material increases rapidly. ✓ (2)

[14]

GRAND TOTAL: [150]