Education

KwaZulu-Natal

Department of Education

REPUBLIC OF SOUTH AFRICA

CURRICULUM DIRECTORATE

LEARNER ASSISTANCE REVISION DOCUMENT

SOLUTIONS P2

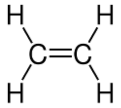
GRADE 12 - 2020

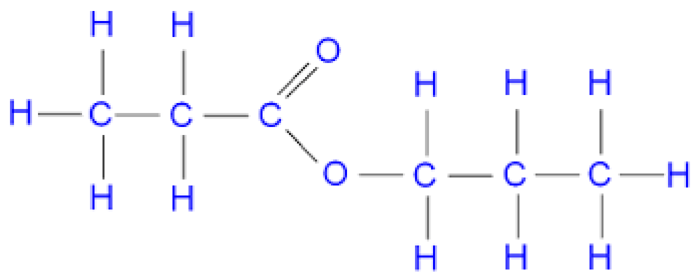
PHYSICAL SCIENCES

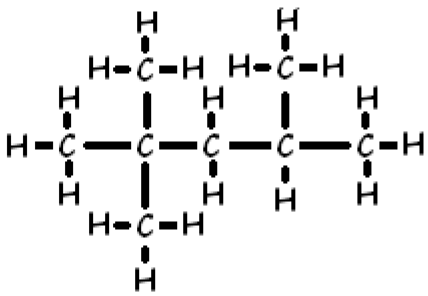
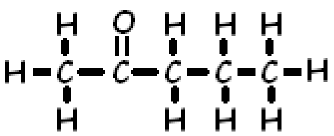
CHEMISTRY- PAPER 2

ORGANIC CHEMISTRY

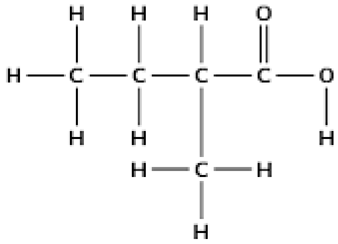
	Question 1	(2)
1.1	A ✓✓	(2)
1.2	B ✓✓	(2)
1.3	B ✓✓	(2)
1.4	B ✓✓	(2)
1.5	A ✓✓	(2)
1.6	B ✓✓	(2)
1.7	A ✓✓	(2)
1.8	D ✓✓	(2)
1.9	B ✓✓	(2)
1.10	D ✓✓	(2)
1.11	A ✓✓	(2)
1.12	C ✓✓	(2)
1.13	B ✓✓	(2)
1.14	D ✓✓	(2)
		[28]

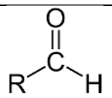
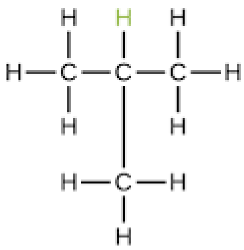
	Question 2	
2.1.1	Alkyne ✓	(1)
2.1.2	Hydroxyl ✓	(1)
2.1.3	C ✓	(1)
2.1.4	2-methylpentan-2-one ✓✓	(2)
2.1.5	 ✓✓	(2)
2.1.6	$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 16H_2O$ ✓ ✓ ✓bal	(3)
2.2.1	Compounds with the same molecular formula but different positions of the side chain, substituent or functional group on the parent chain. ✓✓	(2)
2.2.2	C and D ✓	(1)

2.3	 ✓✓	(2)
2.4	Propanoic acid ✓✓	(2)
		[17]

	Question 3	
3.1.1	B ✓	(1)
3.1.2	E ✓	(1)
3.1.3	F ✓	(1)
3.2.1	2-bromo ✓ -3-chloro ✓ -4-methylpentane ✓	(3)
3.2.2	Ethene ✓	(1)
3.3.1	 ✓✓	(2)
3.3.2	 ✓✓	(2)
3.4.1	Compounds that have the same molecular formula but different functional groups. ✓✓	(2)
3.4.2	B and F ✓	(1)

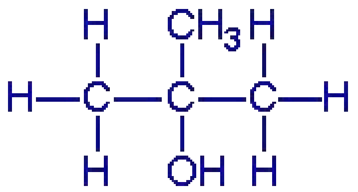
	Question 4	
4.1.1	Carboxyl group ✓	(1)
4.1.2	Ketones ✓	(1)
4.1.3	Addition ✓	(1)

4.2	Ethene ✓	(1)
4.3	CO_2 / Carbon dioxide ✓ H_2O / Water ✓	(2)
4.4.1	 ✓✓	(2)
4.4.2	 ✓✓	(2)
		[10]

	Question 5	(2)
5.1.1	B ✓✓	(2)
5.1.2	 ✓✓	(2)
5.1.3	C_nH_{2n-2} ✓	(1)
5.1.4	✓ ✓ ✓ 4-ethyl-5-methylhept-2-yne	(3)
5.1.5	Butan-2-one ✓ ✓	(2)
5.2.1	Alkanes ✓✓	(2)
5.2.2	 ✓✓ 2-methylpropane ✓✓	(2)
5.3.1	Haloalkanes ✓	(1)
5.3.2	Substitution ✓	(1)

	Question 6	
6.1	Temperature at which the vapour pressure of a substance is equal to the atmospheric pressure. ✓✓	(2)

6.2.1	As the chain length increases, the boiling point increases ✓	(1)
6.2.2	An increase in chain length leads to an increase in the strength of London forces and molecular mass, resulting in higher boiling point and more energy required to overcome the London forces. ✓✓✓	(3)
6.2.3	Alkene – London forces ✓ Alcohols – London forces, dipole-dipole forces and hydrogen bonds. ✓ Since hydrogen bonds are stronger than London forces, the boiling point of alcohols will be higher. ✓	(3)
		[9]

	Question 7	
7.1	Single bonds between carbon atoms ✓	(1)
7.2.1	- O – H ✓	(1)
7.2.2	 ✓✓	(2)
7.3.1	What is the relationship between the boiling point and chain length in alkanes? ✓✓	(2)
7.3.2	Alkanes have London forces. As chain length increases, so does London forces. ✓✓	(2)
7.4	Propane – London forces. ✓✓ Propanol – London forces, dipole-dipole forces and hydrogen bonds. ✓✓ Since hydrogen bonding is stronger than london forces, the boiling point of propanol is greater than the boiling point of propaneas more energy is required to overcome the intermolecular forces.	(2)
		[10]

Question 8

8.1.1	Alkene ✓	(1)
8.2.1	Addition ✓	(1)
8.2.2	Substitution ✓	(1)
8.2.3	Dehydration ✓	(1)
8.2.4	Addition ✓	(1)
8.3	Propan-2-ol ✓	(1)
8.4	Catalyst / Dehydration agent ✓	(1)
8.5	Concentrated strong base / NaOH Warm ethanolic , Mild heat any 2 ✓✓	(2) **[9]**

Question 9

9.1 Haloalkane/alkyl halide ✓ (1)

9.2

9.2.1 Elimination/dehydrohalogenation ✓ (1)

9.2.2 Substitution/hydrolysis ✓ (1)

9.2.3 Esterification/condensation ✓ (1)

9.3

9.3.1
- (Mild) heat/Heating/ ✓
- Dilute (strong base) NaOH/KOH/LiOH) ✓

OR

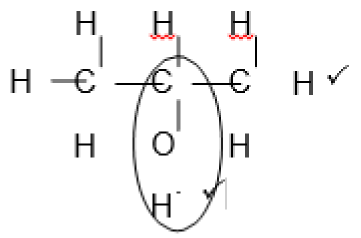
Add water/H_2O*H_2O by* (2)

9.3.2 Propan-1-ol/1-propanol ✓✓

Marking criteria
- Correct stem and functional group i.e. propanol✓
- Whole name correct propan-1-ol ✓

(2)

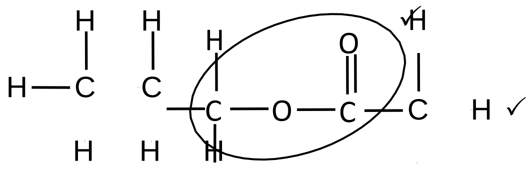
9.4



9.5

POSITIVE MARKING FROM Q4.3.2 ONLY IF THE COMPOUND IN Q4.3.2 IS AN ALCOHOL.

9.5.1



9.5.2 (Concentrated) sulphuric acidH_2SO_4 ✓ (1)

[13]

CHEMICAL CHANGE

Energy changes

Class activity

1.1 A – Energy of reactants ✓ (1)
B – Activation energy for the forward reaction without the catalyst ✓ (1)
C - Activated complex ✓ (1)
D – Activation energy for the forward reaction with the catalyst ✓ (1)
E – Energy of products ✓ (1)
F – Enthalpy / heat of reaction ✓ (1)
(1)
(1)

1.2 $\Delta H = E_{products} - E_{reactants}$ ✓
$= 60 - 40$ ✓
$= 20kJ$ ✓ (3)

1.3 Exothermic ✓ (1)

1.4 Non-spontaneous ✓✓ (2)

1.5 Decreases ✓ (1)
[12]

CHEMICAL EQUILIBRIUM

Question 1

1.1.1 dynamic equilibrium✓ (1)
1.1.2 NH_3 was added to the system✓ (1)
1.1.3 According to Le Chatelier an increase in the [NH_3] will cause the equilibrium system to counteract the stress by favouring the side that decreases NH_3✓.
The reverse reaction is favoured✓ (equilibrium system shifts to the left). The H_2 and N_2 increases. ✓ (3)

1.1.4

	N_2	H_2	NH_3
Ratio	1	3	2
Initial	1,5	2	0
Change	-0,5 ✓	-1,5 ✓	+1 ✓
Equilibrium	1 ✓	0,5 ✓	1
[ ]	2	1	2

$$K_c = \frac{[NH_3]^2}{[H_2]^3[N_2]^1} \quad ✓$$
$$= \frac{2^2}{1^3 2} \quad ✓$$
$$K_c = 8 \quad ✓$$

(8)

1.1.5 (a) Decrease✓ (1)

(b) According to Le Chatelier, an increase in temperature will cause the system to counteract by favouring the side that will decrease the temperature✓. The endothermic reaction will cause a decrease in temperature✓ and thus the reverse reaction is favoured✓. When the reverse reaction is favoured [reactants] increases and [products] decreases✓. Kc is the ratio of [products] and [reactants]✓.

The Kc value will therefore decrease. (5)

1.2.1 decrease✓✓ (2)

1.2.2 remains the same✓✓ (2)

[23]

Question 2

2.1 $2XA_2 + A_2 \rightleftharpoons 2XA_3$✓✓ (2)

2.2.1 When an external stress (change in pressure, temperature or concentration) is applied to a system in chemical equilibrium, the equilibrium point will change in such a way as to counteract the stress.✓✓ (2)

2.2.2 **Stress:** Decrease pressure

Response: Favour reverse reaction✓ Graph shows rates of both reactions decreased but reverse decreased the least (favoured).

Reason: the reverse reaction produces more moles of gas✓ relieving stress of decreased pressure.✓ (3)

2.3 $K_c = \frac{[XA]^2[A_2]}{[XA_3]^2}$ ✓✓ (2)

2.4

	$2XA_3$	$2XA_2$	A_2
Mol ratio (R)	2	2	1
Mol start (I)	**5**	0	0
Mols used/formed (C)	3 ✓	(3	1,5) ✓
Mol eqm (E)	2	(3	**1,5)** ✓
Conc. at eqm (vol = 2 dm^3)	1	1,5	0,75 ✓

$K_c = \frac{(1,5)^2(0,75)}{1^2}$ ✓

$= 1,69$ ✓ (6)

[15]

Question 3

3.1 Forward reaction✓ because the reaction rate increases / there were only products at the start of the reaction✓ (2)

3.2 Kc <1✓ The amount of reactants are greater than the amount of products✓ (2)

3.3 5 minutes✓ (1)

3.4 Equal to✓✓ (2)

3.5
- Both the forward and reverse reaction rates will initially decrease✓
- The rate of the forward reaction will decrease more as the forward reaction is endothermic✓
- Thus, the reverse reaction is initially favoured✓
- Decreasing the yield of NO✓ (4)

3.6

$$Kc = \frac{[NO]^2}{[N_2][O_2]}$$ ✓ ✓ (2)

3.7 Concentrations:

R	N_2	+	O_2	$\rightleftharpoons$	2NO	
I	0		0		8	✓
C	+x		+x		-2x	✓
E	x		x		8-2x	

$$K_c = \frac{[NO]^2}{[N_2][O_2]}$$

$$(4{,}8 \times 10^{-4}) = \frac{(8-2x)^2}{(x)(x)} \quad ✓✓$$

$$x = [N_2] = 3{,}96\,mol.dm^{-3} \quad ✓$$

(5)
[18]

Question 4

4.1.1 Greater than✓ - steeper gradient✓ at time t_i /gradient decreases from t_1 to t_2✓ (3)

4.1.2 Equal to✓ (1)

4.1.3

	HCl	O_2	H_2O	Cl_2
R	4	1	2	2
I	1	0,3	0	0
C	$4 \times 0{,}2 = 0{,}8$✓	0,2✓		
E	0,2	0,1 ✓	0,4	0,4

n(HCℓ) = 10,8 – 0,2 mol✓ (4)

4.1.4 n(H_2O) = 0,4 mol✓
n($Cℓ_2$) = 0,4✓ + ✓ for method. (3)

4.1.5

$$K_c = \frac{[H_2O]^2 ✓ [Cl_2]^2}{[HCl]^4 ✓ [O_2] ✓} \quad ✓$$

(4)

4.1.6

HCl: $c = \frac{n}{V} ✓ = \frac{0,2}{5} = 0,04$ ✓

O_2: $\frac{0,1}{5} = 0,02$ ✓

(H_20) $\frac{0,4}{5} = 0,08$

(Cl_2) $\frac{0,4}{5} = 0,08$ ✓

$$K_c = \frac{(0,08)^2.(0,08)^2}{(0,04)^4.0,02}$$

$K_c = 800$ ✓

(4)

4.2 Decrease✓.An increase in temperature will favour the reverse✓ reaction, as it is endothermic✓, to try to reduce the heat. This will decrease the yield✓ low Kc. (4)

4.3.1 Decrease✓✓ (2)
4.3.2 Remain the same✓✓ (2)
4.3.3 Decreases✓✓ (2)

[29]

Question 5

5.1 Small, thus low concentration of product. Equilibrium lies to the left{little NO✓ (2)
5.2 0,2 mol✓ (1)
5.3 1,8 mol✓ (1)

5.4

$c = \frac{n}{V} ✓ = \frac{0,4}{2} ✓ = 0,2\ mol.dm^{-3}$ ✓

(2)

5.5

$K_c = \frac{[NO]^2}{[N_2][N_2]}$ ✓

$= \frac{(0,2)^2}{(3,4)(0,9)}$ ✓ ✓

$= 0,013$ ✓

(4)

5.6 Kc increased at higher temperature✓

Thus more products✓
Thus equilibrium shifts to right✓
Thus forward reaction is endothermic✓ (4)

[14]

Question 6

6.1 $2SO_2 + O_2 \rightleftharpoons 2SO_2$✓✓ (2)
6.2 concentration of SO_3✓ decreases✓ (2)
6.3 forward reaction rate increases more than the reverse
thus the forward reaction is endothermic✓✓ (2)
6.4 equilibrium✓ (1)
6.5 both rates decrease immediately✓✓ (2)

Question 7

7.1 Reversible reaction✓ (1)
7.2 To favour the forward reaction/production of ammonia./
To increase the yield of ammonia./Prevent the
decomposition of NH_3.✓ (1)
7.3 20%✓ (1)
7.4.1 The (forward) reaction is exothermic ✓

An increase in temperature favours the endothermic
reaction✓

The reverse reaction is favoured (resulting in a lower yield
of ammonia)✓ **OR**
The (forward) reaction is exothermic✓

A decrease in temperature favours the
exothermic reaction✓

The forward reaction is favoured (resulting in a
higher yield of ammonia)✓ (3)

7.4.2 An increase in pressure favours the reaction that produces
the lower number of moles/volume of gas✓

The forward reaction is favoured (resulting in a higher yield
of ammonia)✓ **OR**

A decrease in pressure favours the reaction that produces the
higher number of moles/volume of gas✓
Forward reaction is favoured (resulting in a higher yield of ammonia)✓ (2)
[17]

ACIDS AND BASES

Activity 1

1. B✓✓ (2)

2. B✓✓ (2)
3. A✓✓ (2)
4. C✓✓ (2)
5. B✓✓ (2)

[10]

Structured Activities

Question 1

1.1.1 Each molecule can donate two hydrogen atoms ✓✓ (2)

1.1.2 H_2SO_4 ✓ (1)

1.2.1 Strong acid ✓ (1)

1.2.2 $pH = -\log[H_3O^+]$ ✓
$1 = -\log[H_3O^+]$ ✓
$[H_3O^+] = 10^{-1}$
$[H_3O^+] = 0.1\ mol.dm^{-3}$ ✓ (3)

[7]

Question 2 (NORTH-WEST (SEPTEMBER) 2015)

2.1 An acid as a proton (H^+) donor ✓✓ (2)

2.2.1 HF / F^- and H_3O^+ / H_2O ✓✓ (2)

2.2.2 Water✓ (1)

2.3.1 Sulphuric acid ionises completely in water. ✓ (1)

2.3.2 $H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$

$[H_3O^+] = 2 \times 0{,}025$
$= 0.05\ mol.dm^{-3}$ ✓

$pH = -\log[H_3O^+]$ ✓
$pH = -\log[0.05]$ ✓
$pH = 1.30$ ✓ (4)
[10]

Question 3 (MPUMALANGA (SEPTEMBER) 2015)

3.1.1 A solution of precisely known concentration ✓✓ (2)

3.1.2 $c = \frac{m}{MV}$ ✓
$0{,}2$✓ $= \frac{m}{56 \times 0{,}3}$ ✓ (4)
$m = 3{,}36\ g$ ✓

3.1.3 $pOH = -\log[OH^-]$ ✓

$pOH = -\log[0{,}2]$ ✓

$pOH = 0{,}70$ ✓

$pOH + pH = 14$

$0{,}70 + pH = 14$ ✓

$pH = 13{,}30$ ✓ (5)

3.1.4 Bromothymol blue ✓ (1)

3.1.5 $\frac{C_aV_a}{C_bV_b} = \frac{n_1}{n_2}$ ✓

$\frac{C_a \times 20}{0{,}2 \times 15}$ ✓ $= \frac{1}{2}$✓

$C_a = 0{,}075\ mol.dm^{-3}$ ✓ (4)
[16]

ELECTROCHEMICAL CELLS

MULTIPLE CHOICE QUESTIONS

1.1 C✓✓ (2)

1.2 D✓✓ (2)

1.3 C✓✓ (2)

1.4 A✓✓ (2)

1.5A✓✓ (2)
[10]

Question 2 DBE FEB-MARCH 2017

2.1

2.1.1 Salt bridge ✓ (1)

2.1.2 Voltaic / Galvanic cell ✓ (1)

2.2

2.2.1 Decreases✓ (1)

2.2.2 Increases ✓ (1)

2.3

2.3.1 $Y(s) \rightarrow Y^{2+}(aq) + 2e^-$ ✓✓ Ignore phases

OR

$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$

(2)

2.3.2 $Y(s)\ |Y^{2+}(aq)\ ||A\ell^{3+}(aq)\ |A\ell(s)$ **OR** $Mg(s)\ |Mg^{2+}(aq)\ ||A\ell^{3+}(aq)\ |\ A\ell(s$

OR

$Y(s)\ |\ Y^{2+}$ (1 $mol{\cdot}dm^{-3}$) ✓ || $A\ell^{3+}$(1 $mol{\cdot}dm^{-3}$) | $A\ell(s)$ ✓✓

Accept (3)

$Y\ |\ Y^{2+}\ ||\ A\ell^{3+}\ |\ A\ell$

2.4

OPTION 1	**Notes**
$E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓ $0,7$ ✓ $= -1,66$ ✓ $- E^{\theta}$ $E^{\theta}_{oxidation} = -2,36$ (V) ✓ Y is Mg ✓	• Accept any other correct formula from the data sheet. • Any other formula using unconventional abbreviations, e.g. • $E°_{cell} = E°_{OA} - E°_{RA}$ followed by correct substitutions
OPTION 2 ✓$A\ell^{3+}(aq) + 3e^-$ $A\ell(s)$ $E^{\ominus} = -1,66$ V ✓ $Y(s)$ $Y^{2+}(aq) + 2e^-$ $E^{\ominus} = +2,36$ V ✓ $Y(s) + A\ell^{3+}(aq) \rightarrow Y^{2+}(aq) + A\ell(s)$ $E^{\ominus} = +0,7$ V ✓ Y is Mg	

)

[12]

Question 3 (DBE FEB-MARCH 2017)

3.1 Bauxite ✓ (1)

3.2 Oxidation ✓ (1)

3.3 Reduce melting point ✓

OR
To lower the temperature / energy needed to melt the $A\ell_2O_3$.

ACCEPT
To dissolve the $A\ell_2O_3$ so that it can electrolysed easier

(1)

3.4 $A\ell^{3+}(aq) + 3e^- \rightarrow A\ell(s)$ ✓✓

Ignore phases

(2)

3.5 $C + O_2$✓ $\rightarrow CO_2$✓ ✓bal **OR**
$2A\ell_2O_3 + 3C \rightarrow 4A\ell + 3CO_2$ (3)

[8]

Question 4 DBE FEB-MAR 2018

4.1

4.1.1 A substance that loses/donates electrons. ✓ (1)

4.1.2 Platinum/Pt ✓ (1)

4.1.3 Sn^{2+}(aq)/tin(II) ions/*tin(II)* ✓ (1)

4.1.4 Pt| Sn^{2+}(1 mol·dm^{-3}) ,Sn $^{4+}$ ✓ (1 mol·dm^{-3}) || Ag^+ (1 mol·dm^{-3}) | Ag(s) ✓✓ (3)

ACCEPT
Pt| Sn^{2+} | Sn $^{4+}$ || Ag^+ | Ag

4.1.5 $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ ✓
= +0,80 ✓ - (+0,15) ✓
= 0,65 V ✓

(3)
[9]

Question 5 DBE MAY-JUNE 2017

5.1 Electrolytic (cell) ✓ (1)

5.2 P ✓ (1)

5.3

5.3.1 Au(s) → Au^{3+}(aq) + $3e^-$ ✓✓ (2)

5.3.2 (+)3 ✓ (1)

5.3.3 <u>Electrical energy (is converted) to chemical energy</u>. ✓ (1)

5.3.4 Becomes smaller / thinner / eroded / decrease in mass. ✓ (1)

5.4 **ANY ONE**
- Increase in value. Protection against rust. ✓

(1)

5.5 **ANY ONE**
- Replace Au^{3+}(aq) / electrolyte with Ag^+(aq) / silver(I) solution / use a silver solution
- Replace P / anode / gold with Ag(s) / silver

[8]

CHEMICAL SYSTEMS

Question 1 (DBE FEB-MARCH 2018 Q10)

1.1
1.1.1 $N_2(g) + 3H_2(g)$ ✓ → $2NH_3(g)$ ✓ bal ✓ (1)

1.1.2 $(NH_4)_2SO_4$ ✓ (1)
1.1.3 Ostwald process ✓ (1)
1.1.4 Ammonium nitrate ✓ (1)
1.2
1.2.1 The ratio of nitrogen (N), phosphorous (P) and potassium (K) in a certain fertiliser.✓ (1)
1.2.2 Percentage fertiliser in the bag. ✓ (1)
1.2.3 **OPTION 1:** $\% K = \frac{12}{5}$ ✓ x 22% ✓

= 9,17%

$\therefore m(N) = \frac{9,17}{100} \times 10$ kg✓

= 0,92 kg ✓ (4)

OPTION *2:*

$\frac{100}{22}$ ✓ x 10 = 2,2 kg

$\therefore m(K) = \frac{5}{12}$ ✓ (2,2) ✓

= 0,92 kg ✓

[10]

Question 2

2.1
2.1.1 II – IV – III - I ✓ (1)

2.1.2 $2NH_3 + H_2SO_4$ ✓ → $(NH_4)_2SO_4$ ✓ Bal ✓

2.1.3 Vanadium pentoxide ✓ (1)

2.1.4 $SO_3(g) + H_2SO_4$ ✓→ $H_2S_2O_7$ ✓ Bal ✓ (3)

2.1.5 Sulphuric acid will form (white) mists./The reaction is very exothermic/gives off too much heat./Corrosive reaction. ✓

(1)

2.2

Marking criteria
- Calculate m(fertiliser). ✓
- Use ratio $\frac{2}{X+3}$ /m(P) = ½m(K) ✓
- Use m(K) = 3,33 kg ✓
- Final answer: 3 ✓

OPTION 1	OPTION 3
m(fertiliser) = $\frac{20}{100} \times 50$ ✓ = 10 kg m(K) = $\frac{2}{X+3} \times 10$ ∴3,33 ✓ = $\frac{2}{X+3}$ ✓ ×10 ∴ X = 3 ✓	(fertiliser) = $\frac{20}{100} \times 50$ ✓ = 10 kg m(P) = ½m(K) ✓ = ½(3,33) = 1,665 kg m(X) = 10 – 3,33 ✓– 1,665 = 5,005 N : P : K = 5,005 : 1,665 : 3,33 = 3 : 1 : 2 ∴ X = 3 ✓
OPTION 2 m(K) = $\frac{2}{X+3}$ ✓ × $\frac{20}{100}$ x 50 ✓ = 3,33 ✓ X = 3 ✓	

(4)
[13]

Question 3

3.1

3.1.1 Ammonia √ (1)

3.1.2 NO_2 √ (1)

3.1.3 Catalytic oxidation of ammonia √ (1)

3.1.4 Platinum/Pt √ (1)

3.1.5 Ostwald (process) √ (1)

3.1.6 Haber (process) √ (1)

3.1.7 $NH_3 + HNO_3$ √ → NH_4NO_3 √ Bal. √ (3)

3.2

3.2.1

OPTION 1	OPTION 2
N : P : K 10 : 5 : 15 m(fertiliser) $= \frac{30}{100} \times 15$ = 4,5 kg m(P) = $\frac{5}{30} \times 4,5$ √ = 0,75 kg √	m(fertiliser) $= \frac{5}{100} \times 15$ √ = 0,75 kg √ (2)

3.2.2 %fertiliser = 10 + 5 + 15 = 30%

%filler = 100 – 30 = 70%   m(filler) $= \frac{70}{100}$ ✓ x 15 ✓

= 10,5 kg✓

(3)

[13]

The End