91166M

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SUPERVISOR'S USE ONLY

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Te Mātauranga Matū, Kaupae 2, 2015

91166M Te whakaatu māramatanga ki te tauhohehohe matū

9.30 i te ata Rāhina 23 Whiringa-ā-rangi 2015
Whiwhinga: Whā

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki te tauhohehohe matū.	Te whakaatu māramatanga hōhonu ki te tauhohehohe matū.	Te whakaatu māramatanga matawhānui ki te tauhohehohe matū.

Tirohia mēnā e rite ana te Tau Ākonga ā-Motu (NSN) kei runga i tō puka whakauru ki te tau kei runga i tēnei whārangi.

Me whakamātau koe i ngā tūmahi KATOA kei roto i tēnei pukapuka.

He taka pūmotu kua whakaritea ki te Rau Rauemi L2-CHEMMR.

Mēnā ka hiahia whārangi atu anō koe mō ō tuhinga, whakamahia ngā whārangi wātea kei muri o tēnei pukapuka, ka āta tohu ai i te tau tūmahi.

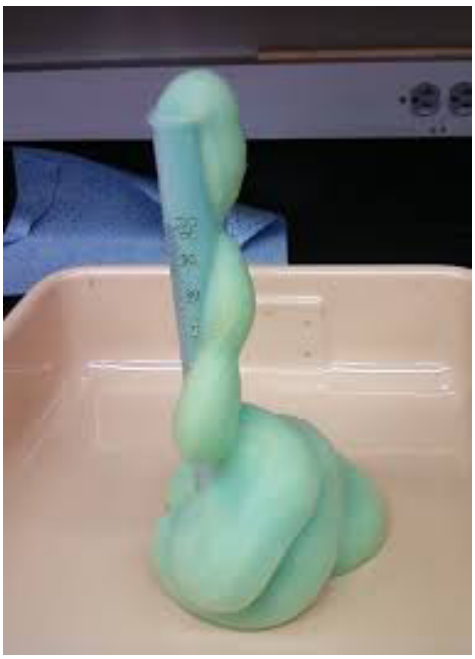
Tirohia mēnā e tika ana te raupapatanga o ngā whārangi 2–21 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

ME HOATU RAWA KOE I TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

TAPEKE

MĀ TE KAIMĀKA ANAKE

TŪMAHI TUATAHI



MĀ TE KAIMĀKA ANAKE

E whakaatu ana te ‘pēniho arewhana’ i te wāwāhinga o te hauwai hāora-rua, H_2O_2, kia huri hei wai me te haurehu hāora.

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$

Ka taea tēnei tauhohenga te mātakitaki mā te tāpiri hopiwē ki te mehanga hauwai hāora-rua. I te putanga o te haurehu hāora, ka hukahuka haere te hopiwē, e ai ki te whakaahua i te taha matau. Ka taea te whakamahi te wā ka tae atu te hukahuka ki runga o te puoto ine hei ine i te pāpātanga o te tauhohenga.

E toru ngā whakamātautau i whakahaerehia hei tūhura i ngā take e huri ai te pāpātanga o te tauhohenga.

Whakamātautau	Kukūtanga o te H_2O_2	Paemahana °C	He MnO_2 iti kei roto
1	20%	20	āe
2	20%	30	āe
3	30%	20	āe

(a) He tino pōturi te tauhohenga wāwāhinga o te hauwai hāora-rua, H_2O_2. Mā te tāpiri i te iti o te paura konupango hāora-rua, MnO_2, ka taea te whakatere ake te pāpātanga o te tauhohenga.

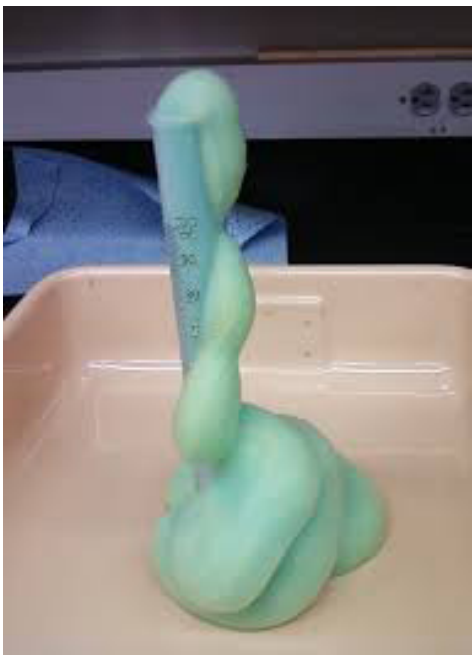
(i) Whakamāramahia te take he iti noa iho te konupango hāora-rua e hiahiatia ana hei whakatere ake i te pāpātanga o te tauhohenga.

QUESTION ONE

The 'elephant toothpaste' demonstration shows the decomposition of hydrogen peroxide, H_2O_2, into water and oxygen gas.

$$2H_2O_2(aq) \rightarrow 2H_2O(\ell) + O_2(g)$$

This reaction can be observed by adding detergent to the hydrogen peroxide solution. As oxygen gas is produced, the detergent foams up, as seen in the photograph on the right. The time taken for the foam to reach the top of the measuring cylinder can be used to measure the rate of the reaction.



Three experiments were carried out to investigate factors that change the rate of the reaction.

Experiment	Concentration of H_2O_2	Temperature °C	Presence of small amount of MnO_2
1	20%	20	yes
2	20%	30	yes
3	30%	20	yes

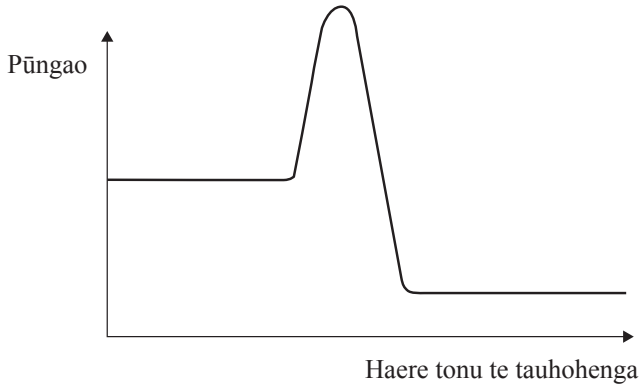
(a) The decomposition reaction of hydrogen peroxide, H_2O_2, is very slow. By adding a small amount of powdered manganese dioxide, MnO_2, the rate of the reaction can be increased.

(i) Explain why only a small amount of manganese dioxide is needed to increase the rate of the reaction.

MĀ TE KAIMĀKA ANAKE

(ii) E whakaatu ana te hoahoa i raro nei i te hoahoa pūngao mō te tauhohenga wāwāhinga me te **kore** konupango hāora-rua.

Tapaina tēnei hoahoa ka whakamahi hei āwhina i a koe ki te whakamārama he pēhea te whakatere ake i te pāpātanga o te tauhohenga mā te tāpiri i te konupango hāora-rua.



(b) Whakatauritehia te Whakamātautau 2 ki te Whakamātautau 1.

I tō tuhinga, me:

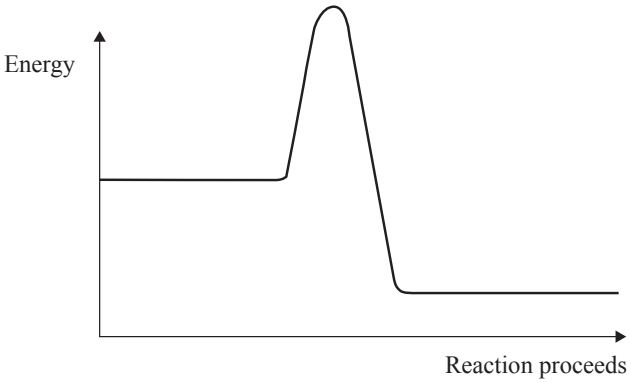
- tautohu te take e huria ana, ā, me te pānga o tēnei ki te pāpātanga o te tauhohenga
- whakamārama mai te pānga ki te pāpātanga o te tauhohenga mā te kōrero mō ngā tukinga korakora me te pūngao hohenga, ina hāngai ana.

He wāhi anō mō tō tuhinga mō te Tūmahi Tuatahi (b) kei te whārangi 6.

ASSESSOR'S USE ONLY

(ii) The diagram below shows the energy diagram for the decomposition reaction **without** manganese dioxide.

Label this diagram and use it to help you explain how the addition of manganese dioxide speeds up the rate of the reaction.



(b) Compare Experiment 2 with Experiment 1.

In your answer, you should:

- identify the factor being changed, and the effect this will have on the rate of reaction
- explain the effect on the rate of reaction by referring to the collision of particles and activation energy, where appropriate.

There is more space for your answer to Question One (b) on page 7.

MĀ TE KAIMĀKA ANAKE

(c) Whakatauritehia te Whakamātautau 3 ki te Whakamātautau 1.

I tō tuhinga, me:

- tautohu te take e huria ana, ā, me te pānga o tēnei ki te pāpātanga o te tauhohenga
- whakamārama mai te pānga ki te pāpātanga o te tauhohenga mā te kōrero mō ngā tukinga korakora me te pūngao hohenga, ina hāngai ana.

ASSESSOR'S USE ONLY

(c) Compare Experiment 3 with Experiment 1.

In your answer, you should:

- identify the factor being changed, and the effect this will have on the rate of reaction
- explain the effect on the rate of reaction by referring to the collision of particles and activation energy, where appropriate.

TŪMAHI TUARUA

MĀ TE KAIMĀKA ANAKE

(a) He matū pūnoa te mehanga haukini, $NH_3(aq)$, i roto i te taiwhanga kura.

(i) Whakamāramahia mai, mā tētahi whārite, mēnā he waikawakawa, kawakore rānei te mehanga haukini.

(ii) I te nuinga o te wā ka tapaina ngā pātara mehanga haukini ko te haukini waihā, $NH_4OH(aq)$.

Whakamāramahia mai he aha i tika ai ngā ingoa e rua, arā te haukini me te haukini waihā.

(b) He momo "amphiprotic" te katote hauwai pākawa waro, HCO_3^-, i te mea ka taea te tuku me te tango i tētahi iraoho, arā, ka mahi hei waikawa, hei kawakore rānei.

Tuhia ngā whārite mō ngā tauhohenga o HCO_3^- me te wai: kia kotahi te whārite ina mahi hei waikawa, kia kotahi ina mahi hei kawakore.

Ko te HCO_3^- e mahi ana hei	**Whārite**
waikawa	$HCO_3^- + H_2O \rightleftharpoons$
kawakore	$HCO_3^- + H_2O \rightleftharpoons$

QUESTION TWO

ASSESSOR'S USE ONLY

(a) Ammonia solution, $NH_3(aq)$, is a common chemical in the school laboratory.

(i) Explain, using an equation, whether ammonia solution is acidic or basic.

(ii) Bottles of ammonia solution are often labelled ammonium hydroxide, $NH_4OH(aq)$.

Explain why both names, ammonia and ammonium hydroxide, are appropriate.

(b) The hydrogen carbonate ion, HCO_3^-, is an amphiprotic species because it can donate or accept a proton, therefore acting as an acid or base.

Write equations for the reactions of HCO_3^- with water: one where it acts as an acid, and one where it acts as a base.

HCO_3^- acting as	**Equation**
an acid	$HCO_3^- + H_2O \rightleftharpoons$
a base	$HCO_3^- + H_2O \rightleftharpoons$

MĀ TE KAIMĀKA ANAKE

(c) (i) I roto i tētahi mehanga waikawa hauota, $HNO_3(aq)$, he katote hauwai honowai, H_3O^+, me te kukūtanga o te 0.0243 mol L^{-1}.

Whakatauria, mā te tātai, he aha te pH me te kukūtanga o ngā katote waihā, OH^-, i roto i tēnei mehanga.

$K_w = 1 \times 10^{-14}$

pH = _____

_____

$[OH^-]$ = _____

_____

(ii) Whakatauria te kukūtanga o te katote waihā, $[OH^-]$, o tētahi mehanga konurehu waihā, $KOH(aq)$, me te pH o te 11.8.

_____

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(d) He waikawakawa ngori te mehanga waikaha ewaro, $CH_3COOH(aq)$, me te mehanga haukini pūhaumāota, $NH_4Cl(aq)$.

Tautohua me te parahau, mā te whakamahi whārite, ko tēhea o ngā mehanga waikawa he kaha ake te kawenga hiko.

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ASSESSOR'S USE ONLY

(c) (i) A solution of nitric acid, $HNO_3(aq)$, has a hydronium ion, H_3O^+, concentration of 0.0243 mol L^{-1}.

Determine, by calculation, the pH and the concentration of hydroxide ions, OH^-, in this solution.

$K_w = 1 \times 10^{-14}$

pH = _____

_____

$[OH^-]$ = _____

_____

(ii) Determine the hydroxide ion concentration, $[OH^-]$, of a solution of potassium hydroxide, $KOH(aq)$, with a pH of 11.8.

_____

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(d) Ethanoic acid solution, $CH_3COOH(aq)$, and ammonium chloride solution, $NH_4Cl(aq)$, are both weakly acidic.

Identify and justify, using equations, which acid solution has greater electrical conductivity.

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(e) E whakaatu ana te tūtohi i te pH o ngā mehanga waikawa e rua, arā, te waikawa mewaro, HCOOH, me te waikawa pūhaumāota, HCl, ā, he kukūtanga o te 0.1 mol L^{-1} tō ngā mehanga e rua.

Mehanga	HCOOH(*aq*)	HCl(*aq*)
pH	2.4	1

Whakatauritehia te pH o ia mehanga, me te pāpātanga o te tauhohenga ka tūmanakohia mā tētahi ripene konupora mā, Mg, e 2 cm te roa.

MĀ TE KAIMĀKA ANAKE

ASSESSOR'S USE ONLY

(e) The table shows the pH of two acidic solutions, methanoic acid, HCOOH, and hydrochloric acid, HCl, which both have a concentration of 0.1 mol L^{-1}.

Solution	HCOOH(*aq*)	HCl(*aq*)
pH	2.4	1

Compare and contrast the pH of each solution, and their expected rate of reaction with a 2 cm strip of cleaned magnesium ribbon, Mg.

TŪMAHI TUATORU

MĀ TE KAIMĀKA ANAKE

(a) Ko te aumou taurite mō tētahi tauhohenga whai pūhui A, B, C, me D ka whakaaturia ko:

$$K_c = \frac{[C]^3[D]}{[A][B]^2}$$

Tuhia te whārite matū mō tēnei tauhohenga:

(b) Ka taea te tauhohenga i waenga i te waikawa ewaro me te waihā ewaro te whakahoki. Ko te ehākawa ewaro me te wai ngā hua ka puta. I roto i tētahi pūnaha kati, ka whakaritea tētahi taurite akiaki.

waikawa ewaro + waihā ewaro $\rightleftharpoons$ ehākawa ewaro + wai

$CH_3COOH(aq) + C_2H_5OH(aq) \rightleftharpoons CH_3COOC_2H_5(aq) + H_2O(\ell)$

(i) Whakamāramahia mai, mā te whakamahi i ngā mātāpono taurite, te pānga o te tāpiri waihā ewaro atu anō ki te ranunga tauhohenga.

(ii) He āhua pōturi te tauhohenga, nō reira ka tāpirihia atu anō he iti waikawa pungatara kukū hei whākōkī.

Whakamāramahia mai, mā te whakamahi i ngā mātāpono taurite, te pānga o te tāpiri i tēnei whākōkī ki te ranunga taurite.

QUESTION THREE

ASSESSOR'S USE ONLY

(a) The equilibrium constant for a reaction involving compounds A, B, C, and D is shown as:

$$K_c = \frac{[C]^3[D]}{[A][B]^2}$$

Write the chemical equation for this reaction.

(b) The reaction between ethanoic acid and ethanol is reversible. Ethyl ethanoate and water are the products formed. In a closed system, a dynamic equilibrium is set up.

ethanoic acid + ethanol $\rightleftharpoons$ ethyl ethanoate + water

$CH_3COOH(aq) + C_2H_5OH(aq) \rightleftharpoons CH_3COOC_2H_5(aq) + H_2O(\ell)$

(i) Explain, using equilibrium principles, the effect of adding more ethanol to the reaction mixture.

(ii) The reaction is quite slow, so a small amount of concentrated sulfuric acid is added as a catalyst.

Explain, using equilibrium principles, the effect of adding this catalyst to the equilibrium mixture.

MĀ TE KAIMĀKA ANAKE

(c) E whakaatu ana te whārite matū e whai ake i te tauhohenga nō te Tukanga Pā e puta ai te waikawa pungatara.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -200 \text{ kJ mol}^{-1}, \; K_c = 4.32 \text{ i te } 600°C$

(i) Whakaotihia te kīanga aumou taurite mō tēnei tauhohe.

$K_c =$

(ii) I roto i te ranunga tauhohenga te kukūtanga i te 600°C o ngā haurehu e whai ake:

$[SO_2(g)] = 0.300 \text{ mol L}^{-1}$

$[O_2(g)] = 0.100 \text{ mol L}^{-1}$

$[SO_3(g)] = 0.250 \text{ mol L}^{-1}$

Parahautia te take kāore tēnei ranunga tauhohenga i te taurite.

Ki tō tuhinga me whakamahi e koe te kīanga tauritenga mai i te wāhanga (c)(i) me ngā raraunga i tukuna i runga ake hei whakaatu kāore te ranunga tauhohenga i te taurite.

Ka haere tonu te Tūmahi Tuatoru i te whārangi 18.

ASSESSOR'S USE ONLY

(c) The following chemical equation represents a reaction that is part of the Contact Process which produces sulfuric acid.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\Delta H = -200$ kJ mol^{-1}, $K_c = 4.32$ at 600°C

(i) Write an equilibrium constant expression for this reaction.

$K_c =$

(ii) A reaction mixture has the following concentration of gases at 600°C:

$[SO_2(g)] = 0.300$ mol L^{-1}

$[O_2(g)] = 0.100$ mol L^{-1}

$[SO_3(g)] = 0.250$ mol L^{-1}

Justify why this reaction mixture is not at equilibrium.

In your answer you should use the equilibrium expression from part (c)(i) and the data provided above to show that the reaction mixture is not at equilibrium.

Question Three continues on page 19.

(iii) I tāruatia te tauhohenga i te whārangi o mua ake ki te 450°C.

MĀ TE KAIMĀKA ANAKE

Whakamāramahia mai, mā te whakamahi i ngā mātāpono taurite, ka pēhea te pānga o te huringa paemahana ki:

- te uara o K_c
- te pūwāhi o te tauritenga.

(iii) The reaction on the previous page was repeated at 450°C.

ASSESSOR'S USE ONLY

Explain, using equilibrium principles, how the change in temperature will affect:

- the value of K_c
- the position of equilibrium.

He whārangi anō ki te hiahiatia.
Tuhia te (ngā) tau tūmahi mēnā e tika ana.

TAU TŪMAHI

MĀ TE KAIMĀKA ANAKE

Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

ASSESSOR'S USE ONLY

English translation of the wording on the front cover

Level 2 Chemistry, 2015

91166M Demonstrate understanding of chemical reactivity

9.30 a.m. Monday 23 November 2015
Credits: Four

91166M

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of chemical reactivity.	Demonstrate in-depth understanding of chemical reactivity.	Demonstrate comprehensive understanding of chemical reactivity.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table is provided on the Resource Sheet L2–CHEMMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–21 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.