See back cover for an English translation of this cover

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91166M

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

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Tohua tēnei pouaka mēnā KĀORE koe i tuhituhi i roto i tēnei pukapuka

Te Mātauranga Matū, Kaupae 2, 2021

91166M Te whakaatu māramatanga ki te tauhohehohe matū

Ngā 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 Puka Rauemi L2–CHEMMR.

Ki te hiahia koe ki ētahi atu wāhi hei tuhituhi whakautu, whakamahia te wāhi wātea kei muri i te pukapuka nei.

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.

Kaua e tuhi ki roto i tētahi wāhi kauruku whakahāngai ( ). Ka tapahia pea tēnei wāhi ina mākahia te pukapuka.

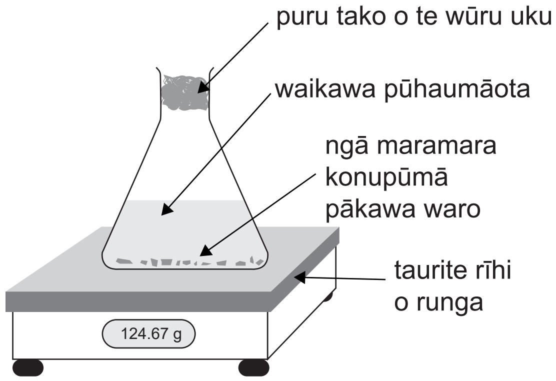
ME HOATU RAWA KOE I TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

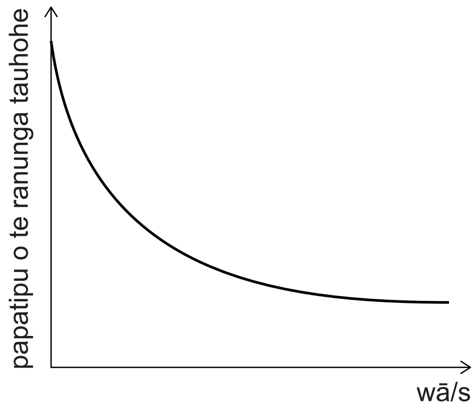
TŪMAHI TUATAHI

(a) Ka tauhohe ngā maramara konupūmā pākawa waro, $CaCO_3(s)$, ki tētahi mehanga waikawa pūhaumāota, $HCl(aq)$. E whakaaturia ana tēnei tauhohenga e te whārite:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(\ell)$$

E aroturukihia ana te tauhohenga mā te ine i te heke o te papatipu o te ranunga tauhohe i roto i te wā. E whakaatu ana tēnei i raro.





(i) He aha e heke ai te papatipu o te ranunga tauhohe i te kauneke o te tauhohenga?

(ii) Whakamāramahia ngā rerekētanga i te pāpātanga tauhohe i waenga maramara konupūmā pākawa waro, $CaCO_3(s)$, me te waikawa pūhaumāota, $HCl(aq)$, i te kauneke o te tauhohenga.

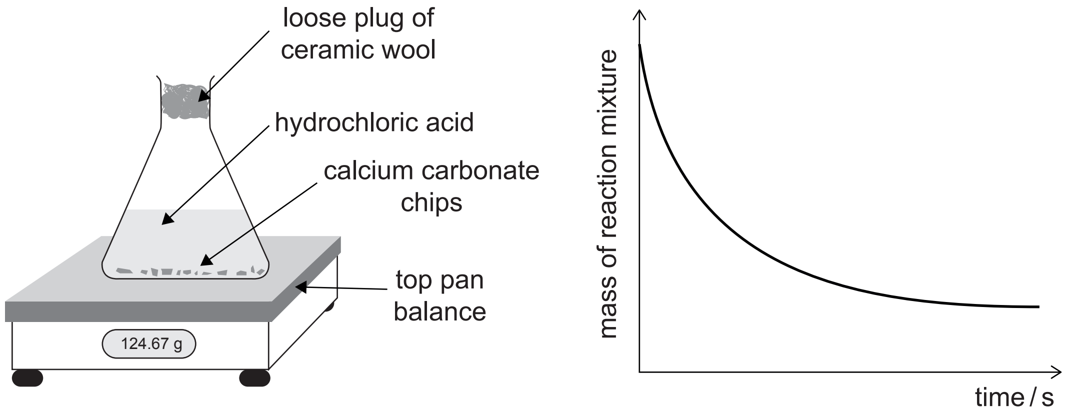
I tō tuhinga me kōrero mō te āhua o te kauwhata.

QUESTION ONE

(a) Calcium carbonate chips, $CaCO_3(s)$, react with a solution of hydrochloric acid, $HCl(aq)$. The reaction is represented by the equation:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(\ell)$$

The reaction is monitored by measuring the decrease in mass of the reaction mixture over time. This is shown below.



(i) Why does the reaction mixture decrease in mass as the reaction proceeds?

(ii) Explain the changes in the rate of reaction between calcium carbonate chips, $CaCO_3(s)$, and hydrochloric acid, $HCl(aq)$, as the reaction proceeds.

Refer to the shape of the graph in your answer.

(b) E rua ngā tauhohe atu anō i whakatūria i waenga i te 5.00 g o te konupūmā pākawa waro, $CaCO_3(s)$, me te 100 mL o te waikawa pūhaumāota, $HCl(aq)$, e ai ki ēnei e whai ake.

	Konupūmā pākawa waro, $CaCO_3(s)$	**Waikawa pūhaumāota, $HCl(aq)$**
Tauhohenga Tuatahi	Ngā maramara	0.500 mol L^{-1}
Tauhohenga Tuarua	Paura	0.500 mol L^{-1}

Whakatauritea ēnei tauhohenga e rua.

I tō tuhinga me kōrero mō te ariā tūtuki me ngā pāpātanga tauhohe.

Me whakaaroaro ki te tapeke o te ngaronga papatipu o ia tauhohenga.

(b) Two further reactions were set up between 5.00 g of calcium carbonate, $CaCO_3(s)$, and 100 mL of hydrochloric acid, $HCl(aq)$, as follows.

	Calcium carbonate, $CaCO_3(s)$	**Hydrochloric acid, $HCl(aq)$**
Reaction One	Chips	0.500 mol L^{-1}
Reaction Two	Powder	0.500 mol L^{-1}

Compare and contrast these two reactions.

Refer to collision theory and rates of reaction in your answer.

You should consider the total mass loss of each reaction.

(c) He pōturi te tauhohenga wāwāhitanga o te mehanga hauwai ōkai-rua, $H_2O_2(aq)$. E whakaaturia ana tēnei tauhohenga e te whārite:

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

E whakaatu ana te whakamātau 'pēniho arewhana' me pēhea te huri i te pāpātanga o te tauhohenga wāwāhitanga mā te tāpiri i tētahi rahinga iti o te konurehu kahautawa, KI(*s*). Ina tāpiria te konurehu kahautawa, he tino nui ngā pāhuka ka puta nā te tere o te hanga o te haurehu hāora.

(i) Tuhia te mahi a te konurehu kahautawa, KI(*s*), i te tauhohenga.

(ii) Me whakawhānui he pēhea te huri a te konurehu kahautawa, KI(*s*), i te pāpātanga o te tauhohe.

I tō tuhinga, me whakapuaki kōrero mō te pūngao hohe me te ariā tūtuki.

Ka whakaaetia te whakamahi hoahoa hei tautoko i tō tuhinga.

(c) The decomposition reaction of hydrogen peroxide solution, $H_2O_2(aq)$, is a slow reaction. This reaction is represented by the equation:

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

The 'elephant's toothpaste' experiment shows how the rate of the decomposition reaction can be changed by adding a small amount of potassium iodide, $KI(s)$. When potassium iodide is added, large amounts of foam are produced as a result of the rapid production of oxygen gas.

(i) State the role of potassium iodide, $KI(s)$, in this reaction.

(ii) Elaborate on how potassium iodide, $KI(s)$, changes the rate of the reaction.

In your answer you should refer to activation energy and collision theory.

You may also include diagrams in your answer.

TŪMAHI TUARUA

(a) Ko te kīanga aumou taurite mō tētahi tauhohenga ko:

$$K_c = \frac{\left[NO_2(g)\right]^2}{\left[NO(g)\right]^2\left[O_2(g)\right]}$$

Tuhia te whārite matū mō tēnei tauhohenga: Me kī ko ngā momo katoa kei roto i te tauhohe e whakaaturia ana i roto i te kīanga K_c.

(b) Mō te tauhohenga i runga ake, ko te uara mō K_c i te 230 °C he 6.44×10^5 (644 000).

I ngā kukūtanga i raro, kāore te tauhohenga i te taurite.

Haurehu	NO	O_2	NO_2
Kukūtanga (mol L^{-1})	0.0102	0.0128	0.989

(i) Mā te whakamahi i te kīanga K_c kei te wāhanga (a) i runga ake me ngā kukūtanga e whakaaturia ana i roto i te tūtohi, whakamāramahia te take kāore te tauhohenga i te taurite.

(ii) Kia eke ai ki te tauritenga, me rata ki te tauhohenga whakamua, whakamuri rānei?

Parahautia tō whakautu.

He wāhi anō mō tō tuhinga mō tēnei tūmahi kei te whārangi 10.

QUESTION TWO

(a) The equilibrium constant expression for a reaction is:

$$K_c = \frac{[NO_2(g)]^2}{[NO(g)]^2[O_2(g)]}$$

Write the chemical equation for this reaction. You can assume all species present in the reaction are represented in the K_c expression.

(b) For the above reaction, the value for K_c at 230 °C is 6.44×10^5 (644 000).

At the concentrations below, the reaction is not at equilibrium.

Gas	NO	O_2	NO_2
Concentration (mol L^{-1})	0.0102	0.0128	0.989

(i) By using the K_c expression in part (a) above and the concentrations shown in the table, explain why the reaction is not at equilibrium.

(ii) To reach equilibrium, would the forward or backward reaction need to be favoured?

Justify your answer.

There is more space for your answer to this question on page11.

(c) E whakaatu ana te whārite e whai ake i tētahi pūnaha kei te taurite.

$$CH_3COOH(aq) + H_2O(\ell) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq) \quad K_c = 1.74 \times 10^{-5}$$

Whakamāramahia, mā te whakamahi i ngā mātāpono taurite, te pānga ki te taunga o te taurite ina:

(i) ka tāpirihia he paku waikawa ewaro kukū, $CH_3COOH(\ell)$

(ii) ka tāpirihia he mehanga konutai waihā waimeha, $NaOH(aq)$.

(c) The following equation shows a system in equilibrium.

$$CH_3COOH(aq) + H_2O(\ell) \rightleftharpoons CH_3COO^-(aq) + H_3O^+(aq) \quad K_c = 1.74 \times 10^{-5}$$

Explain, using equilibrium principles, the effect on the position of the equilibrium when:

(i) a small amount of concentrated ethanoic acid, $CH_3COOH(\ell)$, is added.

(ii) dilute sodium hydroxide solution, $NaOH(aq)$, is added.

(iii) Ina ka whakapikitia te pāmahana o te pūnaha taurite, ka piki hoki te uara K_c.

Parahautia, mā te whakamahi i ngā mātāpono taurite, mēnā ko te tauhohe whakamua he tauhohe putawera, he tauhohe pauwera rānei.

(iii) When the temperature of the equilibrium system is increased, the K_c value also increases.

Justify, using equilibrium principles, whether the forward reaction is exothermic or endothermic.

TŪMAHI TUATORU

(a) He momo amphiprotic te katote hauwai pākawa waro, $HCO_3^-(aq)$, i te mea ka taea te tango, te tuku rānei tētahi iraoho, arā, ka mahi hei waikawa, hei pāpāhua rānei.

Whakaotihia ngā whārite mō ngā tauhohe o te katote hauwai pākawa waro, $HCO_3^-(aq)$, ki te wai kei te tapawhā i raro nei.

HCO_3^- e mahi ana hei:	**Whārite**
waikawa	$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons$
pāpāhua	$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons$

(b) (i) Ko te kukūtanga o tētahi mehanga waikawa hauota, $HNO_3(aq)$, he 0.0625 mol L^{-1}.

Tātaihia te pH.

(ii) Tātaihia te kukūtanga o te katote waihā, $OH^-(aq)$, o tētahi mehanga konurehu waihā, $KOH(aq)$, mēnā ko te pH = 9.5.

QUESTION THREE

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

Complete the equations for the reactions of the hydrogen carbonate ion, $HCO_3^-(aq)$, with water in the box below.

HCO_3^- acting as:	**Equation**
an acid	$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons$
a base	$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons$

(b) (i) A solution of nitric acid, $HNO_3(aq)$, has a concentration of 0.0625 mol L^{-1}.

Calculate the pH.

(ii) Calculate the hydroxide ion, $OH^-(aq)$, concentration of a solution of potassium hydroxide, $KOH(aq)$, that has a pH of 9.5.

(c) E whakaatu ana te tūtohi i te kukūtanga me te pH o ngā mehanga e toru, arā, te konurehu waihā, $KOH(aq)$, te amine mewaro, $CH_3NH_2(aq)$, me te waikawa mewaro, $HCOOH(aq)$.

	KOH(*aq*)	**CH_3NH_2(*aq*)**	**HCOOH(*aq*)**
Kukūtanga (mol L^{-1})	0.100	0.100	0.100
pH	13.0	11.8	2.37

Parahautia he aha e ōrite ai te kukūtanga o ia mehanga i te tūtohi i runga nei, engari he rerekē te pH. Whakamahia he ture tātai hei tautoko i tō tuhinga.

Ka haere tonu te Tūmahi Tuatoru i te whārangi 18.

(c) The table shows the concentration and pH of three solutions: potassium hydroxide, $KOH(aq)$, methanamine, $CH_3NH_2(aq)$, and methanoic acid, $HCOOH(aq)$.

	$KOH(aq)$	$CH_3NH_2(aq)$	$HCOOH(aq)$
Concentration (mol L^{-1})	0.100	0.100	0.100
pH	13.0	11.8	2.37

Justify why each of the solutions in the table above have the same concentration, but a different pH.

Use equations to support your answer.

Question Three continues on page 19.

(d) Me whakawhānui mō te kawe hiko o ngā mehanga o te waikawa pūhaumāota, $HCl(aq)$, te haukini, $NH_3(aq)$ me te haukini pūhaumāota, $NH_4Cl(aq)$.

Whakamahia he ture tātai hei tautoko i tō tuhinga.

	$HCl(aq)$	**$NH_3(aq)$**	**$NH_4Cl(aq)$**
Kukūtanga (mol L^{-1})	0.100	0.100	0.100
Te kawenga hiko	pai	koretake	pai

(d) Elaborate on the electrical conductivity of solutions of hydrochloric acid, $HCl(aq)$, ammonia, $NH_3(aq)$, and ammonium chloride, $NH_4Cl(aq)$.

Use equations to support your answer.

	$HCl(aq)$	**$NH_3(aq)$**	**$NH_4Cl(aq)$**
Concentration (mol L^{-1})	0.100	0.100	0.100
Electrical conductivity	good	poor	good

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

TAU TŪMAHI

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

QUESTION NUMBER

English translation of the wording on the front cover

Level 2 Chemistry 2021

91166M Demonstrate understanding of chemical reactivity

91166M

Credits: Four

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 in the Resource Booklet L2–CHEMMR.

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

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

Do not write in any cross-hatched area (). This area may be cut off when the booklet is marked.

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