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91166M

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Tuhia he (☒) ki te pouaka mēnā kāore koe i tuhi kōrero ki tēnei puka

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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Te Mātai Matū, Kaupae 2, 2023

91166M Te whakaatu māramatanga ki te tauhohehohe matū

Ngā whiwhinga: E whā

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki te tauhohehohe matū.	Te whakaatu māramatanga ki te tauhohehohe matū, kia hōhonu.	Te whakaatu māramatanga ki te tauhohehohe matū, kia tōtōpū.

Tirohia kia kitea ai 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 me ētahi atu rauemi hei toro māu kei te Pukapuka Rauemi L2–CHEMMR.

Ki te hiahia wāhi atu anō koe mō ō tuhinga, whakamahia ngā whārangi wātea kei muri o tēnei pukapuka.

Tirohia kia kitea ai e tika ana te raupapatanga o ngā whārangi 2–23 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki tētahi wāhi e kitea ana te kauruku whakahāngai (AE TUHI I TEW KURUAE TUHI AI). Ka poroa taua wāhi ka mākahia ana te pukapuka.

HOATU TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

TE TŪMAHI TUATAHI

(a) Ko te nuinga o te waikawa kei te puku o te tangata he waikawa pūhaumāota, HCl(*aq*), ā, kei tōna 1.5 te nui o te pH.

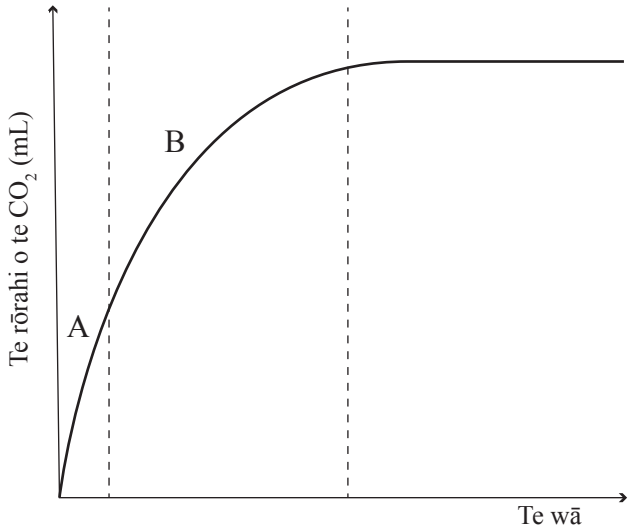
Tātaihia te kukūtanga o ngā katote haungotawai (hydronium), $H_3O^+(aq)$, kei roto i tētahi mehanga waikawa pūhaumāota, 1.5 te nui o te pH.

(b) He konutai hauwai pākawa waro, $NaHCO_3$, kei roto i ngā pire paracetamol pānga wawe ka tauhohea ki te waikawa puku, HCl(*aq*). E whakaaturia ana te whārite i raro nei:

$$NaHCO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(\ell)$$

I hiahia ētahi ākonga ki te tūhura i te roa e tauhohea ai te katoa o te $NaHCO_3$ i tētahi pire paracetamol i te puku o te tangata. I whakahaere rātou i tētahi whakamātau i tauhohea rā tētahi pire, ko te 0.25 karamu o te $NaHCO_3$ kei roto, ki te waikawa pūhaumāota e hemihemi ana, i te paemahana ā-rūma, i tōna 20 °C.

I tuhia, i whakakauwhatatia hoki te rōrahi o te CO_2 i puta rā i te wā o te tauhohe i raro nei.



(i) Mā te whakamahi i te ariā tūtukinga, whakamāramahia te take ka rerekē te poupou o te rārangi i te tauhohe e haere ana.

Me kōrero mō ngā wāhanga A me B i tō tuhinga.

(ii) Kei tōna 37 °C te paemahana i roto i te puku o te tangata.

Whakamāramahia mai te take kāore te whakamātau a ngā ākonga e tautuhi tika i te roa e tauhohea ai te $NaHCO_3$ i te pire, i te puku o te tangata.

Me kōrero mō te ariā tūtukinga i tō tuhinga.

QUESTION ONE

(a) The acid found in human stomachs is primarily hydrochloric acid, HCl(*aq*), and has a pH value of approximately 1.5.

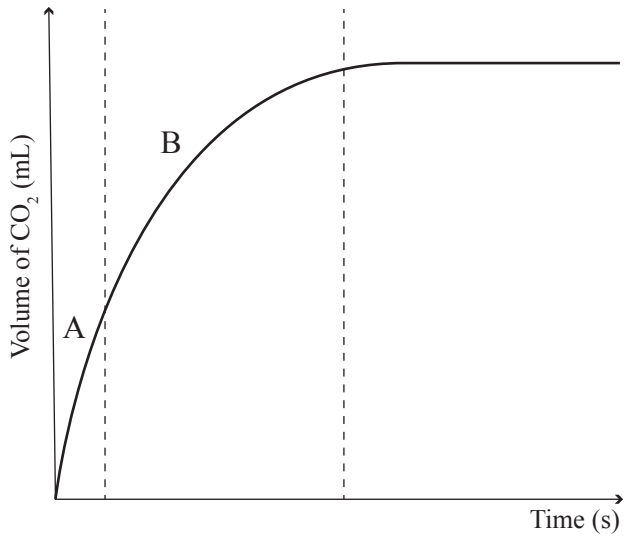
Calculate the concentration of hydronium ions, $H_3O^+(aq)$, present in a hydrochloric acid solution of pH 1.5.

(b) Fast-acting paracetamol tablets contain sodium hydrogen carbonate, $NaHCO_3$, which reacts with stomach acid, HCl(*aq*). The equation is shown below.

$$NaHCO_3(aq) + HCl(aq) \rightarrow NaCl(aq) + CO_2(g) + H_2O(\ell)$$

Some students wanted to investigate how long it takes for all the $NaHCO_3$ in a paracetamol tablet to react in a human stomach. They conducted an experiment where a 0.25 g tablet of $NaHCO_3$ was reacted with an excess of hydrochloric acid at room temperature, approximately 20 °C.

The volume of CO_2 produced during the reaction was recorded and graphed below.



(i) With reference to collision theory, explain why the steepness of the line changes as the reaction proceeds.

Refer to sections A and B in your answer.

(ii) The internal temperature of a human stomach is approximately 37 °C.

Explain why the students' experiment would not give a good indication of how long the $NaHCO_3$ in the tablet takes to react in a human stomach.

Refer to collision theory in your answer.

(c) Ahakoa e kīia ana he waikawa kaha te waikawa kei te puku o te tangata, te waikawa pūhaumāota, te HCl(*aq*), e kīia ana he ngoikore te waikawa pōwaro, arā, te $CH_3CH_2COOH(aq)$.

(i) Whakamāramahia mai te rerekē o te waikawa kaha i te waikawa ngoikore, ā, me hāngai ngā kōrero ki ngā waikawa e rua o runga nei.

Me whai wāhi ngā whārite ki tō tuhinga.

(ii) Whakatauritea te pH me te kawenga ā-hiko o te mehanga waikawa pūhaumāota me te mehanga waikawa pōwaro e ōrite nei te kukūtanga.

(c) While the acid found in human stomachs, hydrochloric acid, HCl(*aq*), is considered a strong acid, propanoic acid, $CH_3CH_2COOH(aq)$, is considered weak.

(i) With reference to these two acids, explain the difference between a strong acid and a weak acid.

Include equations in your answer.

(ii) Compare and contrast the pH and electrical conductivity of hydrochloric acid and propanoic acid solutions which are of equal concentration.

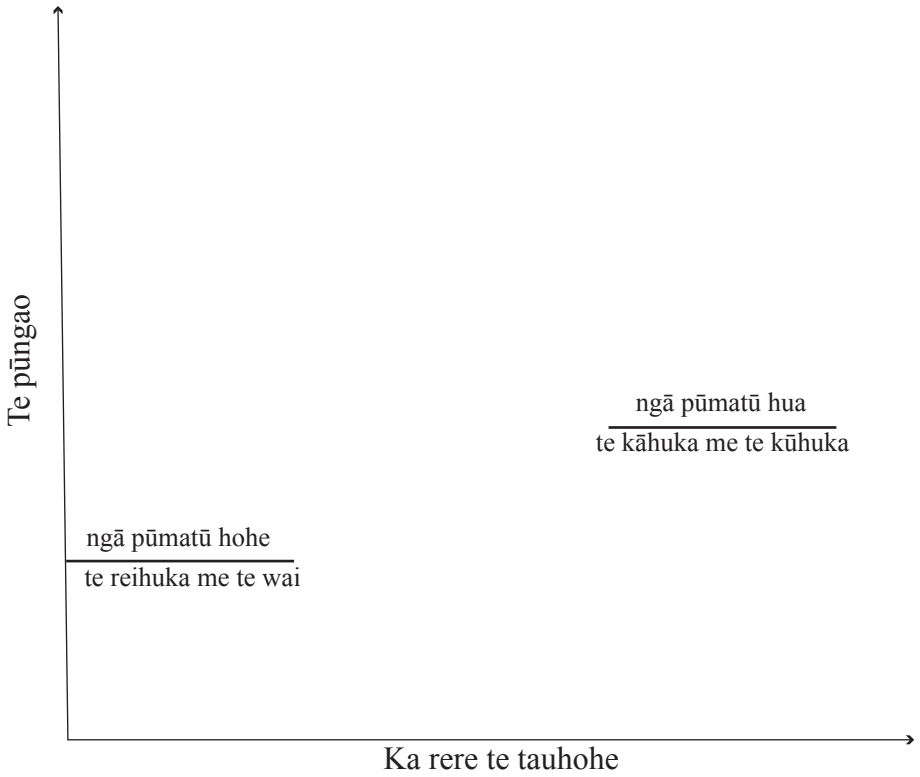
TE TŪMAHI TUARUA

(a) Ka āta nakunaku haere te rāpoi ngota reihuka, ka kitea rā i te miraka, i te puku nā te wai, e hua ai ngā huka kāhuka (galactose) me te kūhuka. Ka tino nui ake te pāpātanga o te tauhohe i tētahi pūmua whākōkī e kīia nei ko te reihake (lactase). Kāore te reihake e pau i tēnei tauhohe.

(i) Tautohua te mahi a te reihake i te tauhohe.

(ii) Whakaotia te hoahoa pūngao kei raro nei mā te **tā i ngā rārangi e rua** hei tohu i te tauhohe ki te āpitihia te reihake, ki te kore hoki e āpitihia te reihake.

Me mātua whai tapanga ō rārangi.



Mēnā me tā anō koe i tō tuhinga, whakamahia te hoahoa kei te whārangi 20.

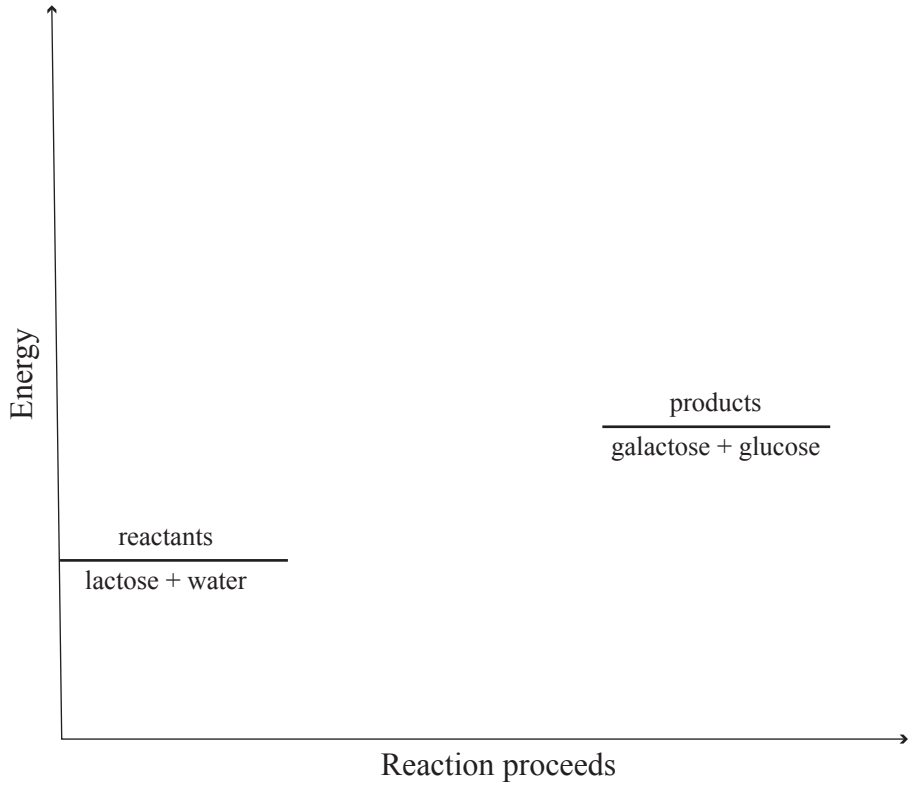
QUESTION TWO

(a) The molecule lactose, which is found in milk, is slowly broken down in the stomach by water into the sugars galactose and glucose. The rate of this reaction is significantly increased by the presence of an enzyme called lactase. The lactase is not used up in the reaction.

(i) Identify the role of lactase in the reaction.

(ii) Complete the energy diagram below by **drawing two lines** to show the reaction with and without the addition of lactase.

Be sure to label your lines.



If you need to redraw your response, use the diagram on page 21.

(iii) Whakamāramahia mai te āhua o te rerekē o te pāpātanga tauhohe ki te whai wāhi mai te pūmua whākōkī reihake.

Me kōrero mō te ariā tūtukinga me te pūngao whakahohe i tō tuhinga.

(b) E whakaaturia ana te tukanga whakahou korohū-mewaro, tētahi o ngā huarahi matua mō te whakaputa i te haurehu hauwai, $H_2(g)$, i raro iho nei.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

(i) Tuhia te kīanga K_c mō te tauhohe.

$K_c =$

(iii) Explain how the rate of reaction is altered by the presence of the lactase enzyme.

Refer to collision theory and activation energy in your answer.

(b) The steam-methane reforming process, which is one of the primary means of producing hydrogen gas, $H_2(g)$, is shown below.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

(i) Write the K_c expression for the reaction.

$K_c =$

(ii) Whakamāramahia mai, mā te whakamahi i ngā mātāpono taurite, te take ka whai hua te tango i te haurehu hauwai, $H_2(g)$, i a ia e hua mai ana, mō te whakaputanga o te haurehu hauwai.

(iii) I ngā wā ka eke te pāmahana ki ngā taumata teitei, ka nui haere te K_c.

Whakamāramahia mai, mā te whakamahi i ngā mātāpono taurite, mēnā rānei he tauhohe pauwera, he tauhohe putawera rānei te tauhohenga whakamua.

(ii) Explain, using equilibrium principles, why removing hydrogen gas, $H_2(g)$, as it forms, is advantageous in the production of hydrogen gas.

(iii) At higher temperatures, the value of K_c increases.

Explain, using equilibrium principles, whether the forwards reaction is endothermic or exothermic.

TE TŪMAHI TUATORU

(a) He wai urutau te wai $H_2O(\ell)$, me te hauwai pākawa waro, $HCO_3^-(aq)$, arā, he wā ōna ka waikawa, ka pāpāhua hoki. E whakaaturia ana te tauhohe o te hauwai pākawa waro ki te wai i raro nei.

$$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons CO_3^{2-}(aq) + H_3O^+(aq)$$

Tautohua ngā pūrua e rua o te waikawa me te pāpāhua, i te tauhohe o te hauwai ki te wai.

Te pūrua 1: _____

Te pūrua 2: _____

(b) E 8.88 te nui o te pH o tētahi mehanga 0.1 mol L^{-1} o te tote konutai winika, $CH_3COONa(aq)$, e waiwai ana, e kahakore ana.

Tuhia ngā whārite i raro nei hei tohu:

(i) i te memeha o te konutai winika i te wai:

(ii) i te tauhohe ka whai, e hua ai he mehanga waiwai:

E tāpua ana te nui ake o te pH o tētahi mehanga konurehu waihā, $KOH(aq)$, i tētahi mehanga konutai winika, $CH_3COONa(aq)$, e taurite ana te kukūtanga.

(iii) Tātaihia te pH o tētahi mehanga 0.1 mol L^{-1} o te konurehu waihā, $KOH(aq)$.

QUESTION THREE

(a) Both water, $H_2O(\ell)$, and hydrogen carbonate, $HCO_3^-(aq)$, are amphiprotic, meaning they can act as either an acid or a base. The reaction of hydrogen carbonate with water is shown below.

$$HCO_3^-(aq) + H_2O(\ell) \rightleftharpoons CO_3^{2-}(aq) + H_3O^+(aq)$$

Identify the two acid/base conjugate pairs in the reaction of hydrogen carbonate with water.

Pair 1: _____

Pair 2: _____

(b) A 0.1 mol L^{-1} solution of the weakly basic salt sodium ethanoate, $CH_3COONa(aq)$, has a pH of 8.88.

Write equations below to show:

(i) The dissolving of sodium ethanoate in water:

(ii) The reaction that follows, which results in a basic solution:

A solution of potassium hydroxide, $KOH(aq)$, of equal concentration has a significantly higher pH than the sodium ethanoate solution, $CH_3COONa(aq)$.

(iii) Calculate the pH of a 0.1 mol L^{-1} solution of potassium hydroxide, $KOH(aq)$.

(iv) Parahautia te rerekētanga o te pH o ngā mehanga e rua.

Me whai wāhi ki tō tuhinga ngā whārite e hāngai ana.

(iv) Justify the difference in the pH of the two solutions.

Include relevant equations in your answer.

(c) E whakaaturia ana te kīanga o te K_c mō tētahi tauhohenga taurite i raro nei.

$$K_c = \frac{[COF_2]^2}{[CF_4][CO_2]} = 2.00 \text{ i te } 1000°C$$

(i) Tuhia te whārite mō tēnei tauhohe mā te whakamahi i te kīanga K_c o runga ake nei.

Me kī, he haurehu ngā momo katoa kei roto i te tauhohe o te kīanga K_c o runga ake nei.

(ii) I whakahaerehia te tauhohenga i te 1000 °C, ā, i waiho kia taurite rā anō. Kātahi ka tuhia te kukūtanga o ngā momo katoa.

Mēnā i ōrite te kukūtanga o te $CF_4(g)$ me te $CO_2(g)$, ā, $[COF_2] = 0.105$ mol L^{-1}, tēnā, tātaihia te kukūtanga o te $CF_4(g)$ e taurite ana.

(c) The K_c expression for a reaction at equilibrium is shown below.

$$K_c = \frac{[COF_2]^2}{[CF_4][CO_2]} = 2.00 \text{ at } 1000 \text{ °C}$$

(i) Using the K_c expression above, write the equation for this reaction.

You can assume all species in the reaction are present in the K_c expression above, and are all gases.

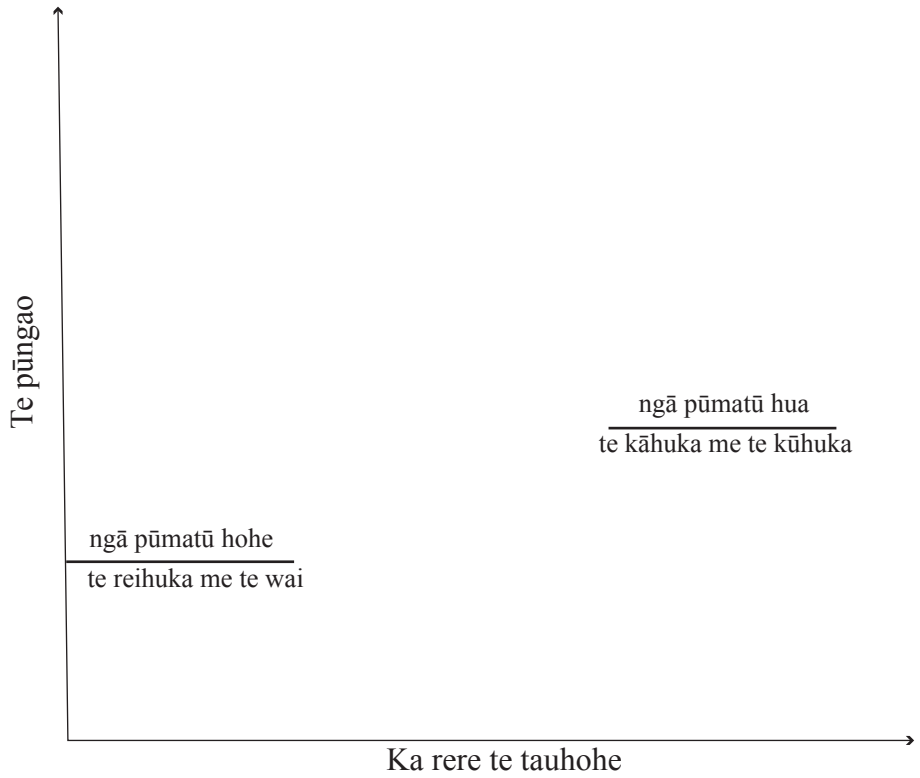
(ii) The reaction was carried out at 1000 °C, and allowed to reach equilibrium. The concentrations of all species were then recorded.

If the concentrations of $CF_4(g)$ and $CO_2(g)$ were found to be equal to one another, and $[COF_2] = 0.105$ mol L^{-1}, calculate the concentration of $CF_4(g)$ at equilibrium.

(iii) Whakamāramahia mai te pānga o te whakanui i te kaha o te pūnaha, mēnā rānei he pānga, ki te āhua o te tauritenga.

HE HOAHOA WĀTEA

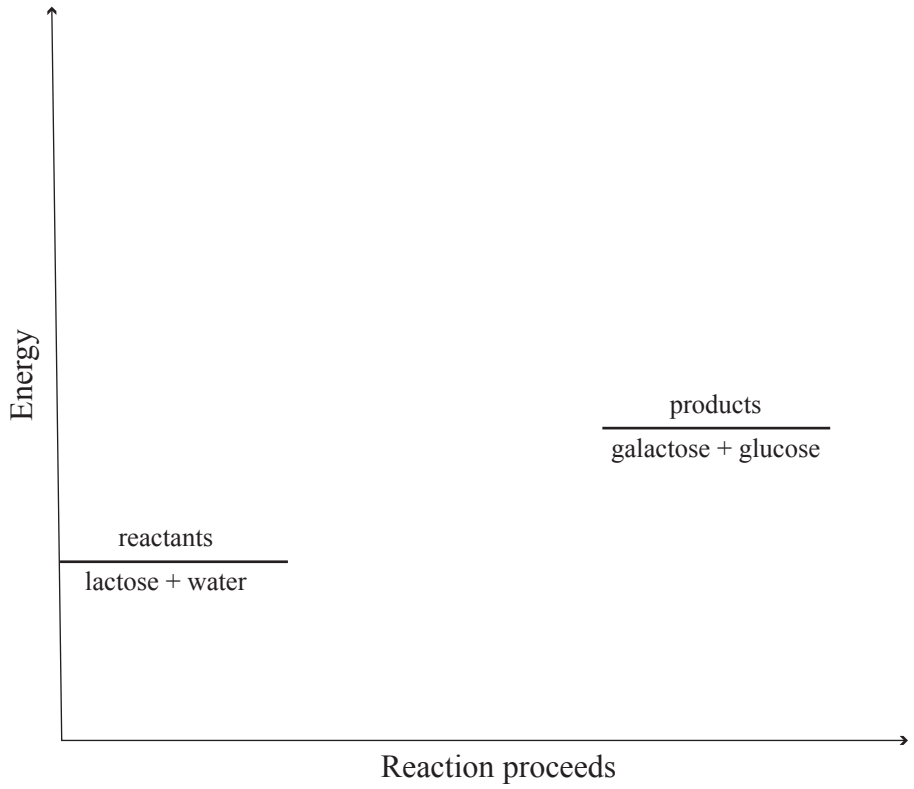
Mēnā me tā anō e koe tō tuhinga mō te Tūmahi Tuarua (a)(ii), whakamahia te hoahoa kei raro nei. Kia mārama tō tohu mai i te tūmahi e hiahia ana koe kia mākahia.



(iii) Explain what effect, if any, increasing the pressure of the system would have on the position of equilibrium.

SPARE DIAGRAMS

If you need to redraw your response to Question Two (a)(ii), use the diagram below. Make sure it is clear which answer you want marked.



He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE 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 2023

91166M Demonstrate understanding of chemical reactivity

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.

91166M

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 and other reference material are 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 2–23 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA DO NOT WRITE). This area will be cut off when the booklet is marked.

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