See back cover for an English translation of this cover

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91166M

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MANA TOHU MĀTAURANGA O AOTEAROA

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Tohua tēnei pouaka mēnā KĀORE koe i tuhi kōrero ki tēnei pukapuka

Mātai Matū, Kaupae 2, 2022

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 kua takoto ki te Pukapuka Rauemi L2-CHEMR.

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 2–27 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki tētahi wāhi e kitea ai te kauruku whakahāngai (✂✂). Ka poroa pea taua wāhi ka mākahia ana te pukapuka.

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

TE TŪMAHI TUATAHI

(a) E taea ana te hauwai kahautawa, te HI(g), te whakaputa mā te tauhohenga o te hauwai rehu, $H_2(g)$ ki te hautawa rehu, $I_2(g)$, arā, e whakaaturia ana ki te whārite i raro nei.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta_r H = +\ 53.0\ \text{kJ mol}^{-1}$$

(i) Tuhia te kīanga o te K_c mō tēnei tauhohenga.

$K_c =$

(ii) I te 490 °C, ko te 0.105 mol L^{-1} te kukūtanga o te ranunga taurite mō te $H_2(g)$ me te $I_2(g)$, ā, ko te 0.711 mol L^{-1} kē te kukūtanga o te HI.

Tātaihia te uara o te K_c i te 490 °C.

QUESTION ONE

(a) Hydrogen iodide, HI(g), can be produced through the reaction of hydrogen gas, $H_2(g)$ with iodine gas, $I_2(g)$, as shown in the equation below.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta_r H = +53.0 \text{ kJ mol}^{-1}$$

(i) Write the K_c expression for this reaction.

$K_c =$

(ii) At 490 °C, the equilibrium mixture has a concentration of 0.105 mol L^{-1} for both $H_2(g)$ and $I_2(g)$, while the concentration of HI is 0.711 mol L^{-1}.

Calculate the value of K_c at 490 °C.

(iii) Whakamāramahia mai te hua ka puta ki te uara o te K_c mehemea ka whakapikitia ake te pāmahana o te ranunga taurite.

(iii) Explain what would happen to the value of K_c if the temperature of the equilibrium mixture was increased.

(b) He waikawa marohi te huawai kahautawa, te HI, engari he waikawa ngori te waikawa hauwai pūkōwhai, te HF.

(i) Tuhia ngā whārite hei whakaatu i ō rāua tauhohenga ki te wai, $H_2O(\ell)$.

$HI(g) + H_2O(\ell)$

$HF(g) + H_2O(\ell)$

(ii) Ka waihangahia mai ngā mehanga o te hauwai kahautawa, HI(*aq*), me te hauwai pūkōwhai, HF(*aq*), kia ōrite te kukūtanga.

Whakamāramahia mai te āhua e rerekē ai te pH me te kawenga hiko o ngā mehanga e rua.

(b) Hydrogen iodide, HI, is a strong acid, whereas hydrofluoric acid, HF, is a weak acid.

(i) Write equations to show their reactions with water, $H_2O(\ell)$.

$HI(g) + H_2O(\ell)$

$HF(g) + H_2O(\ell)$

(ii) Solutions of both hydrogen iodide, HI(*aq*), and hydrogen fluoride, HF(*aq*), are made up to the same concentration.

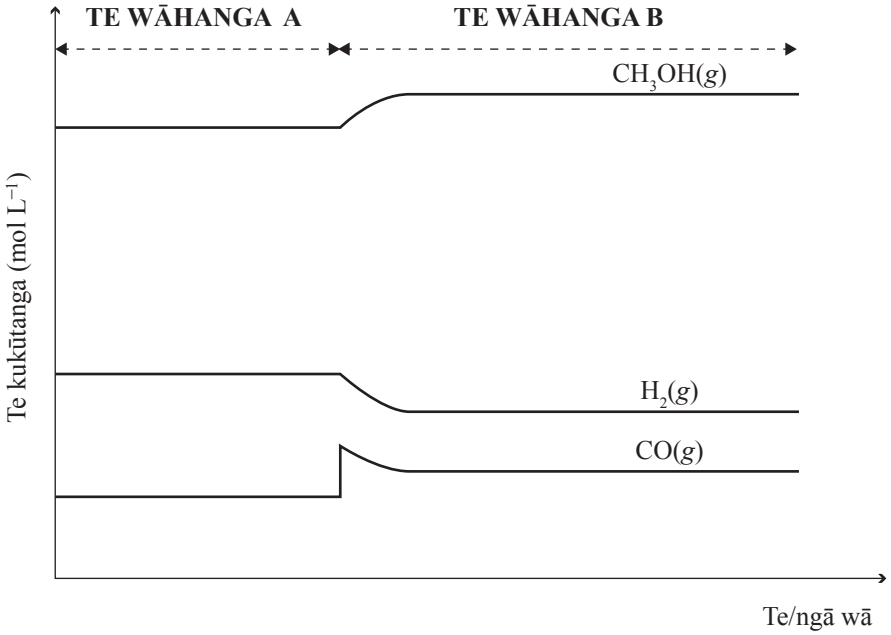
Explain how the pH and electrical conductivity of the two solutions would differ.

TE TŪMAHI TUARUA

(a) Ka whakanaohia te waihā mewaro, $CH_3OH(g)$, mā te tauhohenga o te haukino, $CO(g)$, ki te hauwai rehu, $H_2(g)$. E whakaaturia ana i raro nei te whārite mō te tauritenga kua whakapūmautia.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Kia pūmau rā anō te tauritenga matū, ka tuhia ki te kauwhata i raro nei ngā kukūtanga o ngā momo katoa e kitea ana i roto i te tauhohenga.



(i) Whakamāramahia mai te āhua o tā te kauwhata whakaatu i te tauritenga o te pūnaha mō te roanga o te **Wāhanga A**.

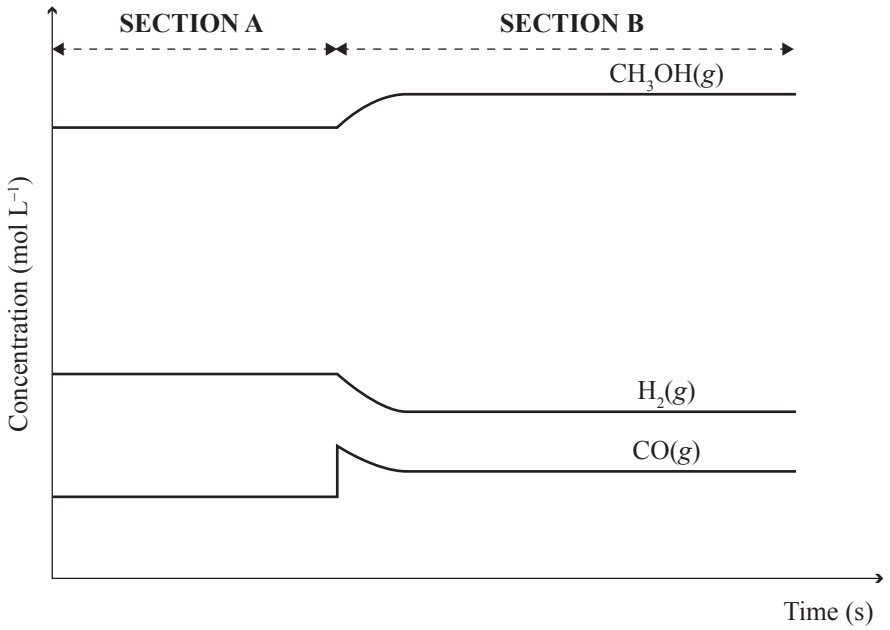
Me kōrero mō ngā pāpātanga o te tauhohenga whakamua, o te tauhohenga whakamuri hoki i tō tuhinga.

QUESTION TWO

(a) Methanol, $CH_3OH(g)$, is manufactured through the reaction of carbon monoxide, $CO(g)$, with hydrogen gas, $H_2(g)$. The equation for the equilibrium that is established is shown below.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

Once chemical equilibrium has been established, the concentrations of all species present in the reaction are recorded and graphed below.



(i) Explain how the graph shows the system is at equilibrium throughout **Section A**.

Refer to the rates of the forward and reverse reactions in your answer.

(ii) I te tīmatanga o te **Wāhanga B**, i te kauwhata o te whārangi o mua, ka āpitihia ētahi haukino, CO(*g*), ki te puoto tauhohe.

Whakamāramahia mai, mā te whakamahi i ngā mātāpono taurite, te āhua o te urupare a te pūnaha e whakahokia atu ai te pūnaha ki tōna tauritenga.

Me kōrero mō te kauwhata i tō tuhinga.

(ii) At the beginning of **Section B**, in the graph on the previous page, some carbon monoxide, CO(*g*), is added to the reaction vessel.

Explain, using equilibrium principles, how the system responds to restore equilibrium.

Refer to the graph in your answer.

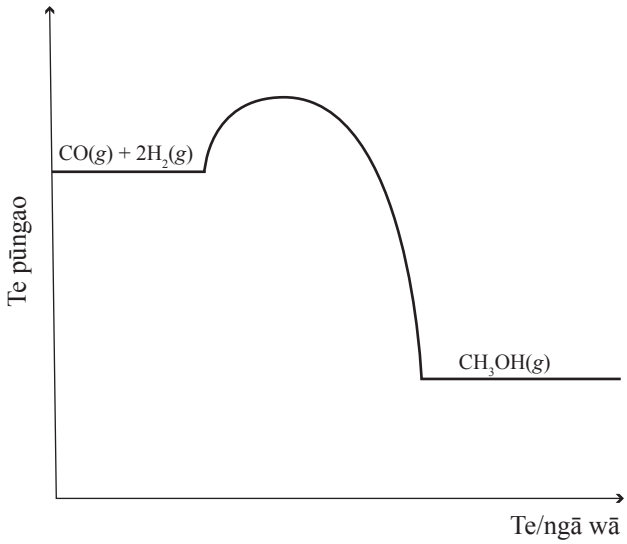
(iii) Mā te whakamahi i ngā mātāpono taurite, whakamāramahia mai te take ka whai hua te whakahaerenga o te tauhohe i tētahi pēhanga teitei ki te whakanaotanga o te waihā mewaro, o te $CH_3OH(g)$.

(b) He tauhohenga pōturi te putanga o te waihā mewaro, o te $CH_3OH(g)$, mai i te haukino, i te $CO(g)$, me te hauwai, me te $H_2(g)$. Hei whakapiki ake i te pāpātanga o te tauhohenga, e taea ana te tāpiri tētahi rahinga iti o te konutea ōkai, o te $ZnO(s)$. Ka taea te konutea ōkai te tango i muri i te otinga o te tauhohenga.

(i) Tuhia mai te mahi a te konutea ōkai, a te $ZnO(s)$, i roto i te tauhohenga.

(ii) E whakaaturia ana i raro nei tētahi hoahoa pūngao mō te tauhohenga kāore i te whakamahi i te konutea ōkai, $ZnO(s)$.

Tāpirihia tētahi rārangi hei whakaatu i te rerekētanga o te hoahoa ina tāpirihia te konutea ōkai.



Ki te hiahia koe ki te tā anō i tō urupare, whakamahia te kauwhata kei te whārangi 24.

(iii) Using equilibrium principles, explain why carrying out the reaction at high pressure is advantageous in the manufacture of methanol, $CH_3OH(g)$.

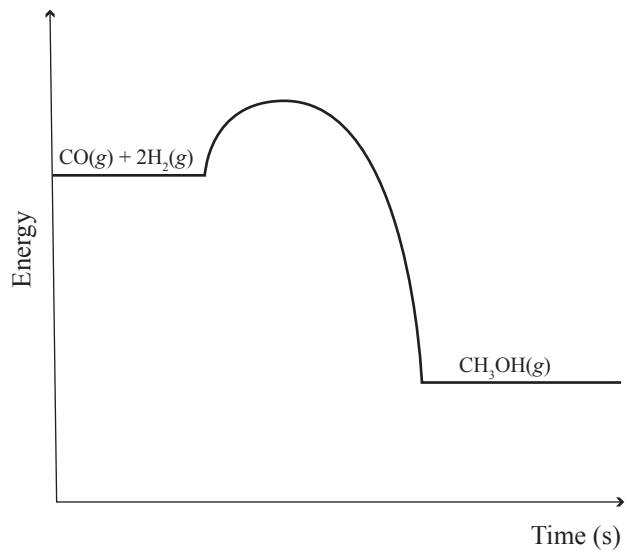
(b) The formation of methanol, $CH_3OH(g)$, from carbon monoxide, $CO(g)$, and hydrogen, $H_2(g)$, is a slow reaction. To increase the rate of reaction, a small amount of zinc oxide, $ZnO(s)$, can be added. This zinc oxide can be recovered after the reaction is complete.

(i) State the role of the zinc oxide, $ZnO(s)$, in the reaction.

(ii) An energy diagram for the reaction without the use of zinc oxide, $ZnO(s)$, is shown below.

Add a line to show how the diagram would differ when zinc oxide is added.

If you need to your response, use the graph on page 25.



(iii) Whakamāramahia mai te āhua o tā te konutea ōkai, o tā te ZnO(*s*), whakapiki ake i te pāpātanga o te tauhohenga.

Me kōrero koe mō te ariā tūtuki me te pūngao hohe i tō tuhinga.

(iii) Explain how zinc oxide, ZnO(*s*), increases the rate of reaction.

Refer to collision theory and activation energy in your answer.

TE TŪMAHI TUATORU

(a) (i) Tātaihia te kukūtanga o te katote hauwai honowai, $H_3O^+(aq)$, i roto i tētahi mehanga waikawa pūhaumāota, HCl(*aq*), e 2.4 nei te pH.

(ii) Ko te 0.450 mol L^{-1} te kukūtanga o tētahi mehanga waihā konukōhatu, LiOH(*aq*).

Tātaihia te pH.

(b) I mōhiotia ngā mehanga e toru, te A, te B, me te C, e ōrite ana te kukūtanga, arā, te konutai waihā, te NaOH(*aq*), te konutai pūhaumāota, te NaCl(*aq*), me te konutai pākawa waro, me te $Na_2CO_3(aq)$. I inea, i tuhia hoki te pH o ia mehanga i raro nei.

	Te Mehanga A	**Te Mehanga B**	**Te Mehanga C**
pH	11.6	13.0	7.0

(i) Tautuhia te A, te B, me te C o ngā mehanga.

A: _____ B: _____ C: _____

(ii) Whakamāramahia katoatia mai te āhua o tō tautuhi i te A, i te B, me te C o ngā mehanga.

Whakamahia ngā whārite e hāngai ana hei tautoko i tō tuhinga.

Ka rere tonu te Tūmahi Tuatoru i te whārangi e whai ake nei.

QUESTION THREE

(a) (i) Calculate the concentration of hydronium ions, $H_3O^+(aq)$, in a solution of hydrochloric acid, HCl(*aq*), that has a pH of 2.4.

(ii) A solution of lithium hydroxide, LiOH(*aq*), has a concentration of 0.450 mol L^{-1}.

Calculate the pH.

(b) Three solutions of equal concentration, A, B, and C were known to be sodium hydroxide, NaOH(*aq*), sodium chloride, NaCl(*aq*), and sodium carbonate, $Na_2CO_3(aq)$. The pH of each solution was measured and recorded below.

	Solution A	**Solution B**	**Solution C**
pH	11.6	13.0	7.0

(i) Identify solutions A, B, and C.

A: _____ B: _____ C: _____

(ii) Fully explain how you identified solutions A, B, and C.

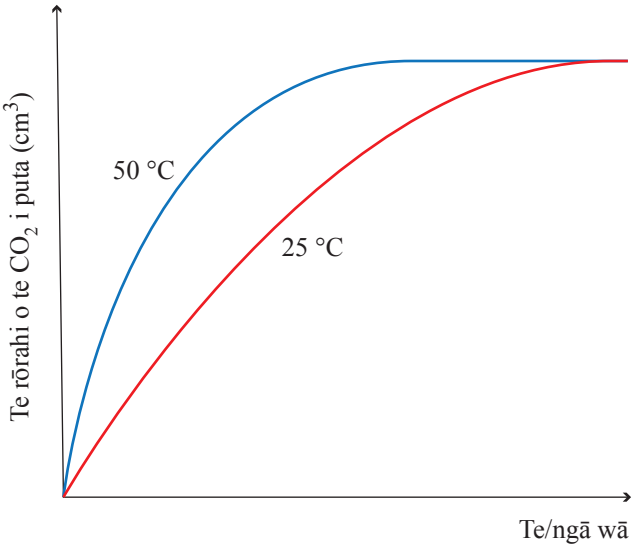
Use relevant equations to support your answer.

Question Three continues on the next page.

(c) I te tautuhinga, ka whakamahia te mehanga konutai pākawa waro, te $Na_2CO_3(aq)$, i roto i tētahi tauhohenga ki te waikawa pūhaumāota, ki te $HCl(aq)$. E whakaaturia ana i raro nei te whārite mō te tauhohenga.

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(\ell) + CO_2(g)$$

I whakahaerehia te tauhohenga i te 25 °C me te 50 °C, ā, i tuhia ki te kauwhata i raro nei te rōrahi o te haurehu CO_2 i puta.



I ngā tauhohenga e rua, he ōrite te kukūtanga me te rōrahi o ia mehanga ka whakamahia.

Whakamāramahia mai te pānga o te pikinga o te pāmahana ki te pāpātanga o te tauhohenga.

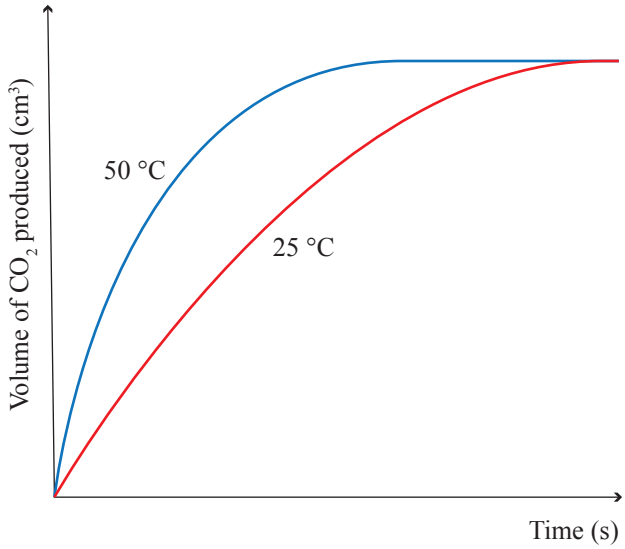
I tō tuhinga, me:

- kōrero mō te ariā tūtuki
- whakaaroaro ki te pāpātanga o te whakaputanga CO_2, me te tapeke o te rōrahi o te CO_2 i whakaputaina rā, mō ia tauhohenga
- kōrero mō ngā rārangi i te kauwhata i runga.

(c) Once identified, the solution of sodium carbonate, $Na_2CO_3(aq)$, was then used in a reaction with hydrochloric acid, $HCl(aq)$. The equation for the reaction is shown below.

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(\ell) + CO_2(g)$$

The reaction was carried out at both 25 °C and 50 °C, and the volume of CO_2 gas produced was recorded on the graph below.



In both reactions, the same concentration and volume of each solution is used.

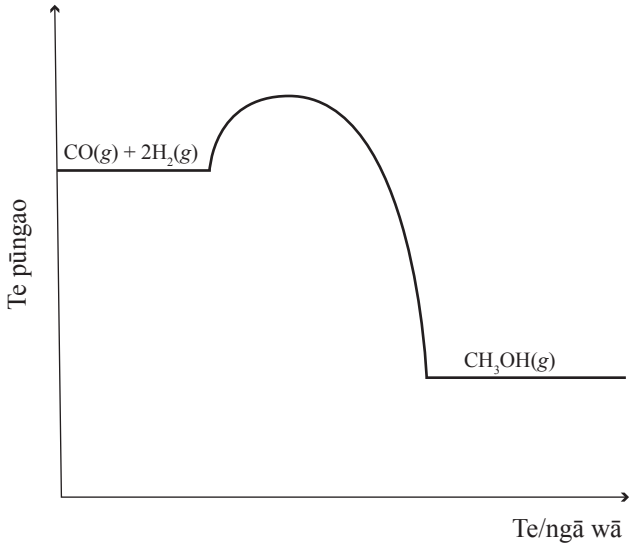
Explain the effect of increased temperature upon the rate of reaction.

In your answer you should:

- refer to collision theory
- consider both the rate of CO_2 production, and the total volume of CO_2 formed, for each reaction
- refer to the lines on the graph above.

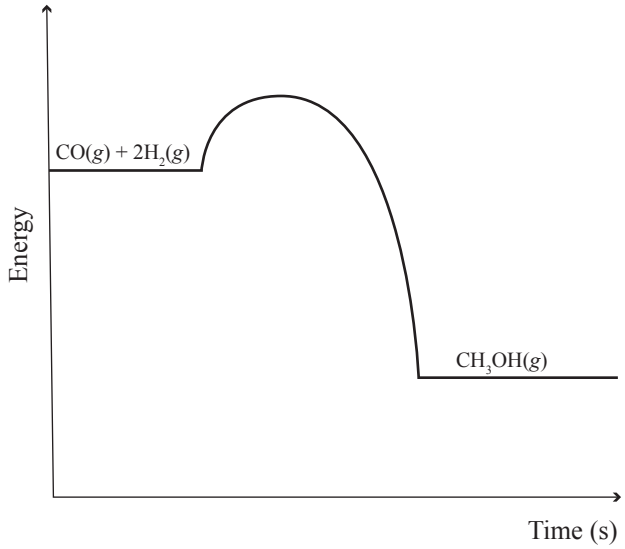
HE HOAHOA WĀTEA

Ki te hiahia koe ki te tā anō i tō urupare ki te Tūmahi Tuarua (b)(ii), whakamahia te kauwhata i raro nei. Kia mārama te tohu ko tēhea te tuhinga ka hiahia koe kia mākahia.



SPARE DIAGRAMS

If you need to your response to Question Two (b)(ii), use the graph 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 2022

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 is provided in the Resource Booklet L2–CHEMR.

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 – 27 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.