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Book

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of

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books used

External assessment 2021

Question and response book

# Chemistry

## Paper 1

### Time allowed

- Perusal time — 10 minutes
- Working time — 90 minutes

### General instructions

- Answer all questions in this question and response book.
- QCAA-approved calculator permitted.
- QCAA formula and data book provided.
- Planning paper will not be marked.

### Section 1 (20 marks)

- 20 multiple choice questions

### Section 2 (37 marks)

- 8 short response questions





**DO NOT WRITE ON THIS PAGE**  
**THIS PAGE WILL NOT BE MARKED**



# Section 1

## Instructions

- Choose the best answer for Questions 1–20.
- This section has 20 questions and is worth 20 marks.
- Use a 2B pencil to fill in the A, B, C or D answer bubble completely.
- If you change your mind or make a mistake, use an eraser to remove your response and fill in the new answer bubble completely.

	A	B	C	D
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	A	B	C	D
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## Section 2

### Instructions

- Write using black or blue pen.
  - If you need more space for a response, use the additional pages at the back of this book.
    - On the additional pages, write the question number you are responding to.
    - Cancel any incorrect response by ruling a single diagonal line through your work.
    - Write the page number of your alternative/additional response, i.e. See page ...
    - If you do not do this, your original response will be marked.
  - This section has eight questions and is worth 37 marks.
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### QUESTION 21 (3 marks)

Calculate the pH of a 0.1 M aqueous solution of  $\text{Ba}(\text{OH})_2$ , assuming complete dissociation. Show your working.

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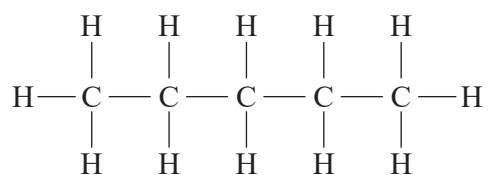
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pH = \_\_\_\_\_ (to one decimal place)

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### QUESTION 22 (4 marks)

The structural formula for pentane ( $C_5H_{12}$ ) is shown.



Draw the structural formulas for two structural isomers of pentane. Name each isomer.

a) Isomer 1

[2 marks]

**Note:** If you make a mistake in the drawing, cancel it by ruling a single diagonal line through your work and use the additional response space on page 16 of this question and response book.

IUPAC name: \_\_\_\_\_

b) Isomer 2

[2 marks]

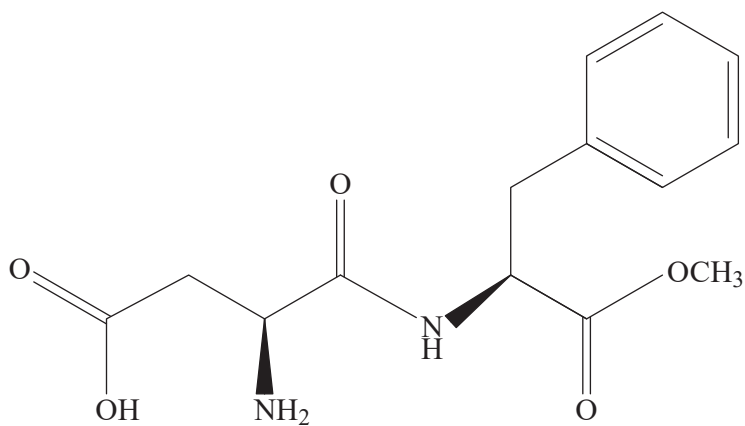
**Note:** If you make a mistake in the drawing, cancel it by ruling a single diagonal line through your work and use the additional response space on page 16 of this question and response book.

IUPAC name: \_\_\_\_\_

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**QUESTION 23 (5 marks)**

Aspartame is a methyl ester of a dipeptide that hydrolyses to form methanol and two amino acids. The structure of aspartame is shown.



a) Identify the two amino acids that form aspartame.

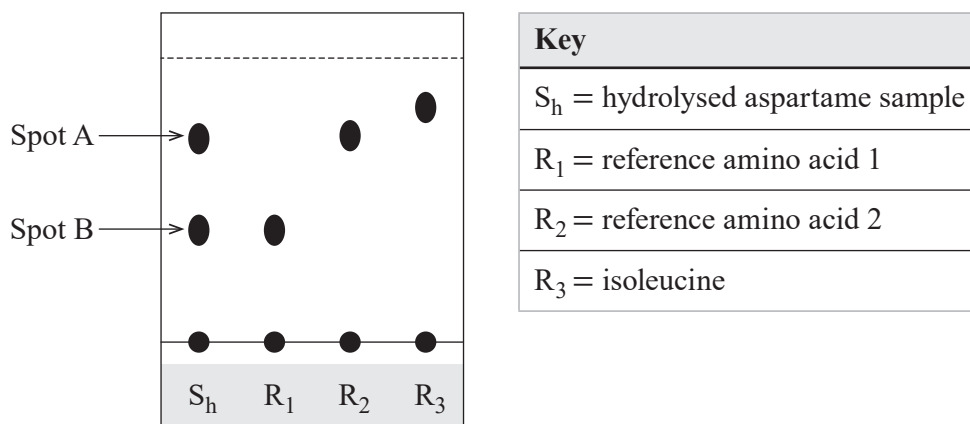
[1 mark]

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A hydrolysed sample of aspartame was analysed with silica thin layer chromatography (TLC), using a mixture of butanol and ethanoic acid as the solvent. The TLC plate was then reacted with ninhydrin to produce spots.



- b) Determine which amino acid in aspartame corresponds to Spot A. Explain your reasoning.

[3 marks]

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- c) Explain why the reference amino acids are included on the TLC plate.

[1 mark]

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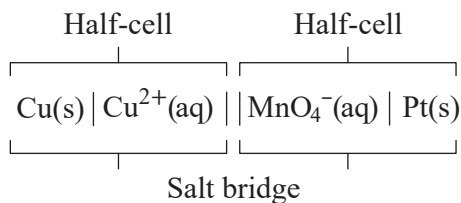


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### QUESTION 24 (6 marks)

The cell diagram represents a voltaic cell at standard conditions. The copper solution is blue because of the presence of  $\text{Cu}^{2+}(\text{aq})$  ions. The acidified permanganate solution is purple because of the presence of  $\text{MnO}_4^{-}(\text{aq})$  ions.



- a) Predict which direction the electrons will flow in the voltaic cell by comparing the relative strength of the oxidising agents. Explain your reasoning.

[3 marks]

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- b) Determine the standard reduction potential,  $E^{\circ}$ , for the cell.

[1 mark]

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- c) Predict two qualitative observations associated with the flow of electrons and the movement of ions in the voltaic cell.

[2 marks]

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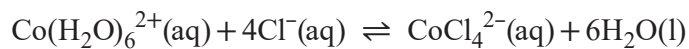
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**QUESTION 25 (5 marks)**

An equilibrium is formed between two differently coloured cobalt species,  $\text{Co}(\text{H}_2\text{O})_6^{2+}(\text{aq})$ , which is pink, and  $\text{CoCl}_4^{2-}(\text{aq})$ , which is blue. The equation for this equilibrium is shown.



- a) Apply Le Châtelier's principle to predict the visible effect of adding  $\text{AgNO}_3$  to an aqueous blue-coloured solution containing  $\text{Co}(\text{H}_2\text{O})_6^{2+}$  and  $\text{CoCl}_4^{2-}$  ions. Explain your reasoning.

[3 marks]

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- b) When a sample of the equilibrium mixture is put into hot water, the mixture turns more blue. Determine whether the forward reaction of the equation is exothermic or endothermic. Explain your reasoning.

[2 marks]

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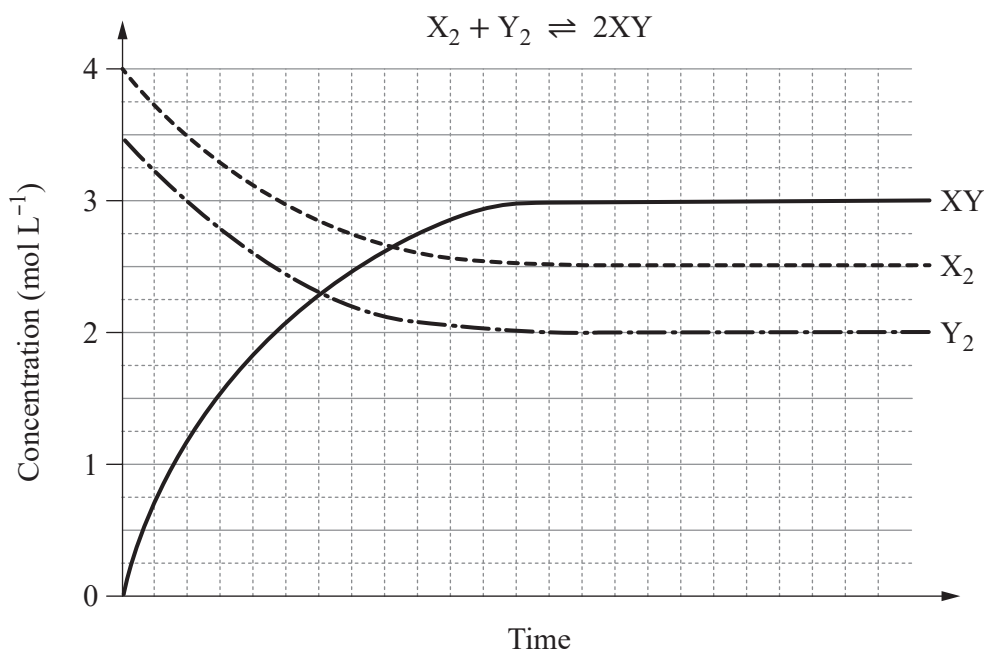
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### QUESTION 26 (5 marks)

The graph represents changes in concentration over time for three gaseous molecules ( $X_2$ ,  $Y_2$  and  $XY$ ) in a closed system at constant temperature and pressure.



a) Identify whether  $XY$  is the reactant or the product.

[1 mark]

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b) Calculate the equilibrium constant ( $K_c$ ) value.

[2 marks]

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$K_c =$  \_\_\_\_\_ (to two significant figures)

c) Determine whether the position of equilibrium favours the reactants or products.  
Explain your reasoning.

[2 marks]

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**QUESTION 27 (6 marks)**

Arsenous acid,  $\text{H}_3\text{AsO}_3$ , reacts with nitrate ions to form arsenic acid,  $\text{H}_3\text{AsO}_4$ , and nitrogen dioxide.

- a) Determine the oxidation number of arsenic in arsenous acid. *[1 mark]*

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- b) Use half-equations to balance the reaction. *[4 marks]*

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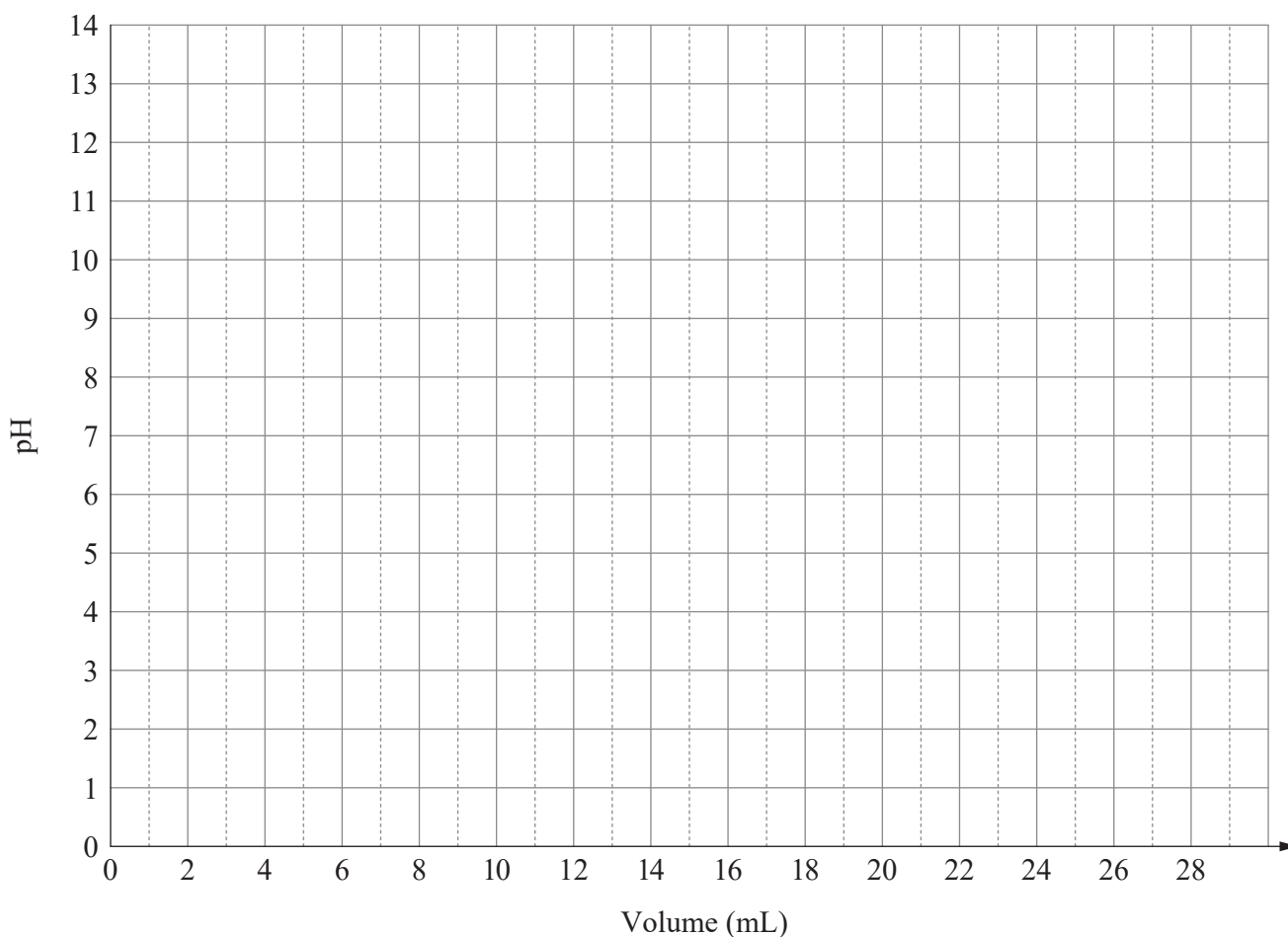
- c) Determine which species is reduced in this reaction. *[1 mark]*

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**QUESTION 28 (3 marks)**

Sketch the titration curve formed when 20 mL of 0.1 M butylamine ( $pK_a = 10.0$ ) is titrated with 0.1 M hydrochloric acid.



**Note:** If you make a mistake in the sketch, cancel it by ruling a single diagonal line through your work and use the additional response space on page 17 of this question and response book.

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**ADDITIONAL PAGE FOR STUDENT RESPONSES**

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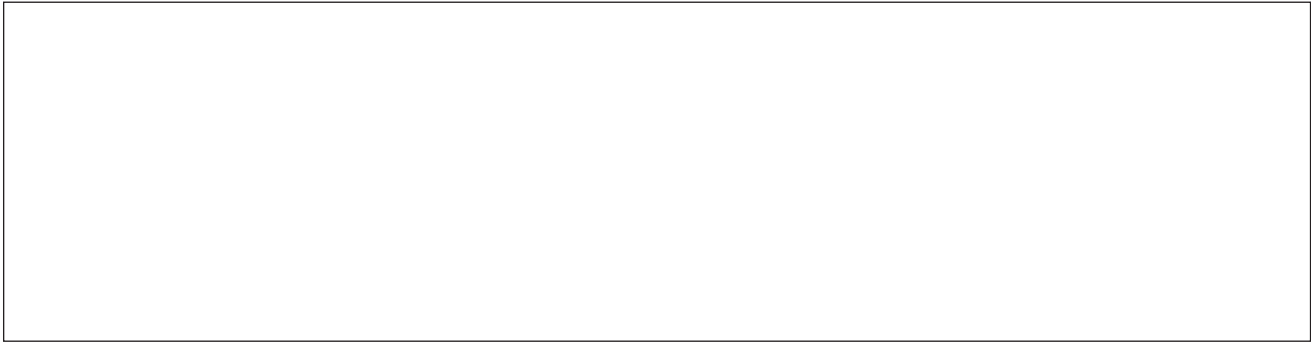
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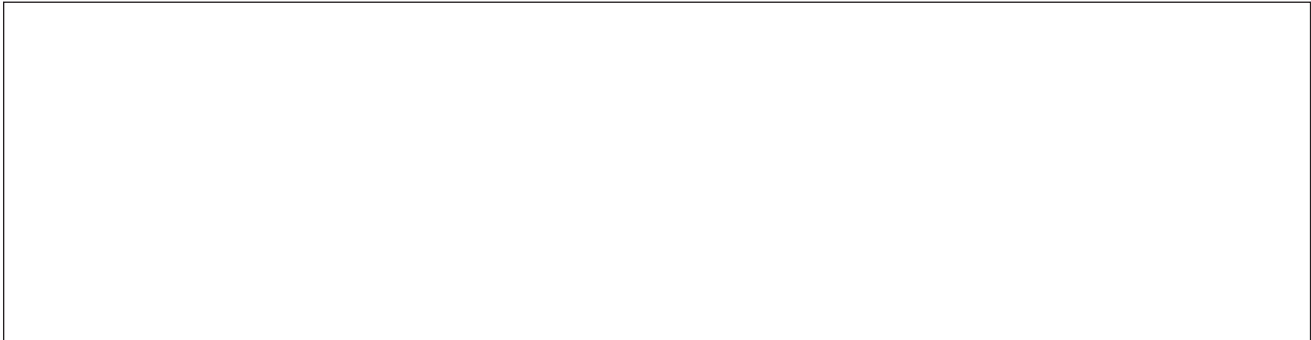
**ADDITIONAL RESPONSE SPACE FOR QUESTION 22a)**

If you want this drawing to be marked, rule a single diagonal line through the drawing on page 3.



**ADDITIONAL RESPONSE SPACE FOR QUESTION 22b)**

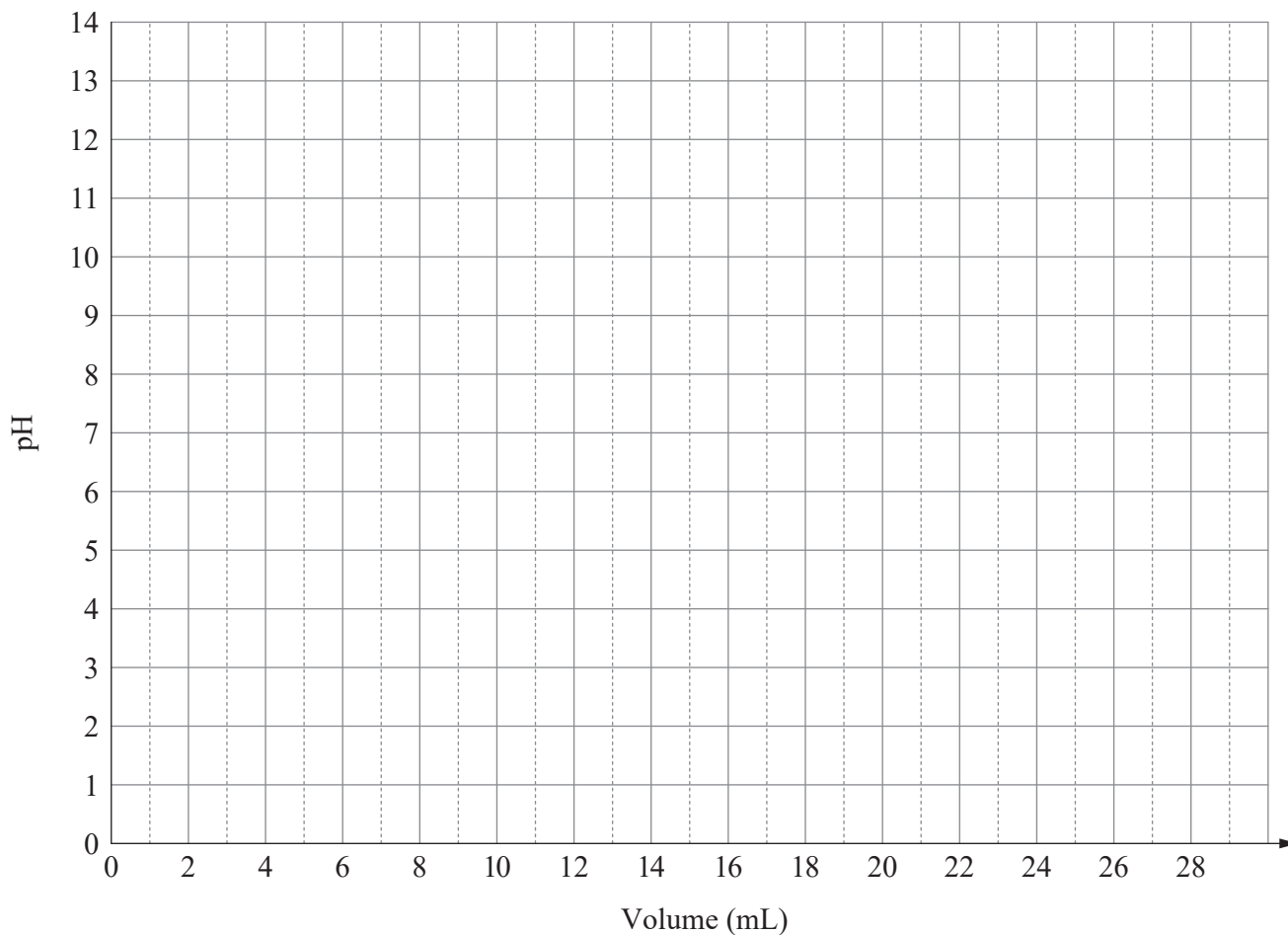
If you want this drawing to be marked, rule a single diagonal line through the drawing on page 3.



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### ADDITIONAL RESPONSE SPACE FOR QUESTION 28

If you want this sketch to be marked, rule a single diagonal line through the sketch on page 10.



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