

93102



S

SUPERVISOR'S USE ONLY



NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2013 Chemistry

2.00 pm Saturday 16 November 2013
Time allowed: Three hours
Total marks: 40

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 answer ALL the questions in this booklet.

Pull out Resource Sheet S–CHEMR from the centre of this booklet.

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 2–24 in the correct order and that none of these pages is blank.

You are advised to spend approximately 35 minutes on each question.

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

Question	Mark
ONE	
TWO	
THREE	
FOUR	
FIVE	
TOTAL	/40

ASSESSOR'S USE ONLY

(b) Ethanol is a widely discussed and implemented biofuel additive for petrol. Anhydrous ethanol is infinitely miscible (can mix in any ratio) with petrol or water, but petrol and water are immiscible (do not mix).

(i) Explain the observations for miscibility of the three compounds, assuming that petrol is a mixture of mostly C5 to C8 hydrocarbons.

QUESTION FOUR

- (a) A buffer solution contains $0.25 \text{ mol L}^{-1} \text{ NH}_3(aq)$ and $0.20 \text{ mol L}^{-1} \text{ NH}_4\text{Cl}(aq)$.

The activity of an enzyme in 2.50 mL of this buffer solution produces hydrogen ions at the rate of $1.8 \times 10^{-6} \text{ mol s}^{-1}$.

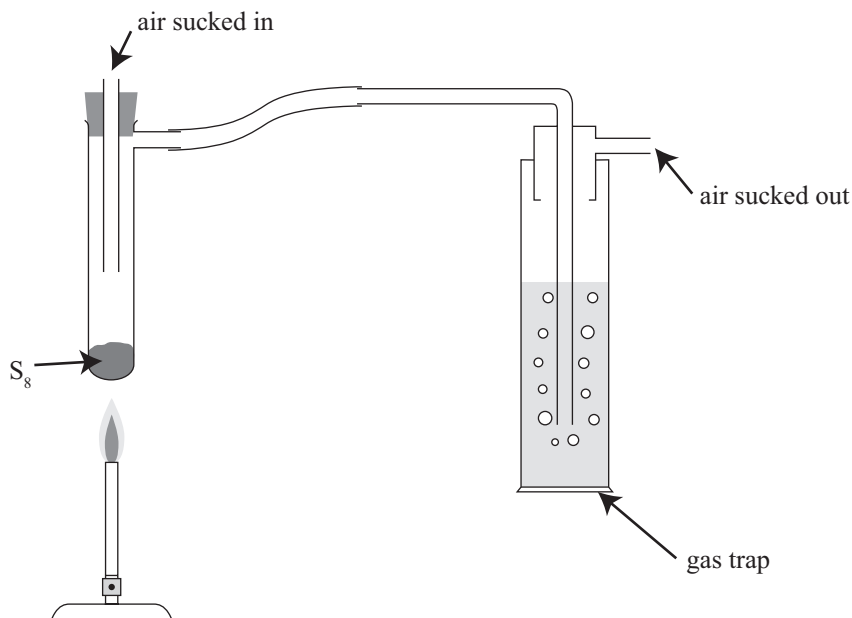
$$\text{p}K_a(\text{NH}_4^+) = 9.24$$

- (i) Calculate the pH of the initial buffer solution.

- (ii) Calculate the pH after the enzyme has been active for 60 seconds (assuming there was no change to the volume).

QUESTION FIVE

A 1.1258 g sample of sulfur, S_8 , was burnt in the apparatus shown below. The gas trap contained a solution of hydrogen peroxide, $H_2O_2(aq)$. (Sulfur spontaneously ignites at $\sim 250^\circ C$, well within the range of a Bunsen burner, and at lower temperatures if finely divided.) Suction was maintained to pull air through the apparatus for some time after combustion was complete.



Subsequently the solution in the gas trap was divided into four equal aliquots (parts). Barium chloride solution, $BaCl_2(aq)$, was added to each aliquot and the resulting white precipitate was collected by filtration under suction, washed with water, and dried to constant weight. The filtrates were also collected and each one titrated with 1.950 mol L^{-1} sodium hydroxide solution, using a methyl orange indicator ($pK_a = 3.7$). The results are presented in the table below.

Analysis results for gas trap solution

Aliquot	Mass of precipitate/g	Titre volume/mL
1	1.9367	8.52
2	1.9386	8.64
3	1.9417	8.54
4	1.9405	8.54

- (a) Explain the chemistry that is occurring during this experiment, and calculate the apparent % purity of the sulfur sample using both sets of data supplied.

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

ASSESSOR'S
USE ONLY

QUESTION
NUMBER

93102