Practical examination

3rd ABU RAYHAN BIRUNI INTERNATIONAL CHEMISTRY OLYMPIAD

G-1

English (Official)

General Instructions

- This exam has 3 problems.
- Before the start of the practical exam, the READ signal is given. You have 15 minutes to read the exam booklet. You may only read during this time. Do not write or use the calculator. Do not work on any problem or interact with any equipment.
- You may begin working when the START signal is given. You have 5 hours to complete the exam. You may complete the tasks in any order, but note that P2 contains waiting periods (two lots of 45 min waiting). During these periods you can work on **P1** or **P3**.
- For questions requiring you to tick the correct box(es), to change your initial answer, shade the check box completely and draw a new box next to it. Tick the box corresponding to your intended answer.
- When necessary, wash your glassware at your workspace with distilled water from a wash bottle into the liquid waste container.
- You must follow the safety rules given below. Any safety rule violation can result in your dismissal from the laboratory and the nullification of your practical examination work.
- All results and answers must be clearly written in pen in their designed areas on the answer sheets. Answers written outside the answer boxes will not be graded. Some figures are reproduced in your question sheets for draft work. They will not be graded. Make sure to copy your final answer onto your answer sheets.
- Write only with the pen provided in the Answer Sheets. Do not use the permanent marker provided for your answers and do not write in pencil. The permanent marker is only for labelling lab equipment. Use only the calculator provided.
- Write relevant calculations where needed. Full marks will be given only for answers showing the correct working.
- The official English version is available upon request for clarification.
- Chemicals and labware, unless otherwise stated, will be refilled or replaced without penalty only once (one item). Each further replacement will result in the deduction of 1 point from your 40 practical exam points.
- You are not allowed to leave your working place without permission. If you need any assistance, raise the corresponding non-verbal communication card.
- Keep all items within the designated area of your bench.
- The lab assistants will announce a 30-minute notice before the STOP signal.
- You must stop your work immediately when the STOP signal is announced. Failure to stop working or writing can lead to nullification of your practical examination work.

Safety Rules

Students must obey the following safety rules. Any student who fails to comply will leave the practical exam and may receive a score of zero for the practical exam.

- Do not eat or drink in the lab. Chewing gum is not allowed.
- Work only in the designated area. Keep your work area and the common work areas tidy.
- No unauthorised experiments are allowed. No modification of the experiments is allowed.
- Vials and screw capped bottles must be kept closed whenever possible.
- Do not pipette with your mouth. Always use a pipette filler bulb.
- Immediately inform your lab assistant about spills, broken glassware, or any accidents.

- All waste must be properly disposed to prevent contamination or injury. Discard the solutions in the containers with the correct labels. Inform your lab assistant when any of the containers are full.
- Contact lenses are prohibited in the laboratory.

In the practical exam hall, students are required to wear:

- full length trousers or other clothing covering their whole legs
- closed-end shoes
- a lab coat
- safety goggles or correcting glasses
- gloves when handling harmful or unknown solutions and substances
- tied back any long hair and/or beards.

Practical examination

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G-3

English (Official)

1																		
1 H 1.008																		2 He 4.003
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.30	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc -	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57-71	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po -	85 At -	86 Rn -
87 Fr -	88 Ra -	89-103	104 Rf -	105 Db -	106 Sg -	107 Bh -	108 Hs -	109 Mt -	110 Ds -	111 Rg -	112 Cn -	113 Nh -	114 Fl -	115 Mc -	116 Lv -	117 Ts -	118 Og -

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm -	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
89 Ac -	90 Th 232.0	91 Pa 231.0	92 U 238.03	93 Np -	94 Pu -	95 Am -	96 Cm -	97 Bk -	98 Cf -	99 Es -	100 Fm -	101 Md -	102 No -	103 Lr -

Equipment list

For problem	Item	Quantity
#1 and #2	Burette, 25 mL	2
	Laboratory stand with burette clamp and ring	1
	Magnetic stirrer with bar and holder	1
	Timer	1
	Erlenmeyer flask, 100 mL	2
	Plastic beaker, 250 mL	20
	Glass beaker, 100 mL	4
	Glass beaker, 200 mL	2
	Funnel, d = 40 mm	2
	Graduated pipette, 10 mL	4
	Volumetric pipette, 50 mL	2
	3-valve pipette bulb	1
	Micropipette, 10-100 µL	1
	Micropipette tips, 10-100 µL	12
	Rack for tips	1
#1 and #3	Pasteur pipette, 2 mL	10
#1, #2 and #3	Spatula	1
	Goggles	1
	Marker	1
	Ruler	1
	Pen	1
	Tissue papers	-
	Yellow papers	4
	Solid waste container	1
	Liquid waste container	1
#1	Calibrated pH meter with electrode immersed in 3 M KCl	1
#2	Funnel, d = 75 mm	1
	Filter paper, d = 110 mm	4
	96-well plate	1
	Cylinder, 10 mL	1
#3	12-well plate	1
	Eppendorf tubes, 0.5 mL	32
	Rack for Eppendorf tubes, 0.5 mL	1

For problem	Item	Quantity
	Rack for Eppendorf tubes, 5 mL	1

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Q1-1

English (Official)

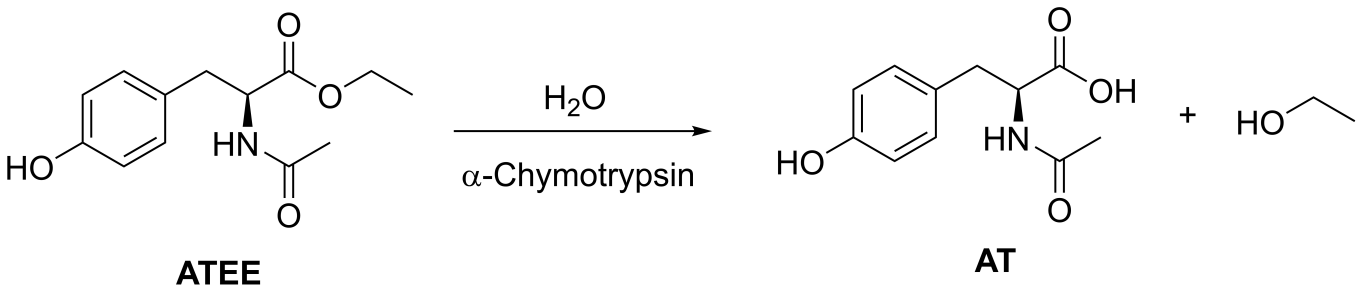
Kinetics of α-Chymotrypsin

16%									
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	∑
10	1	1	20	15	1	2	3	3	56

Chemicals

Name	State	Concentration	Quantity	Placed in	Label
Distilled water	Liquid	–	500 mL	Wash bottle, 500 mL	H_2O
Sodium hydroxide	Aqueous solution	To be determined	100 mL	Glass bottle with a screw cap, 100 mL	NaOH, ??? M
Hydrochloric acid	Aqueous solution	0.0480 M	50 mL	Glass bottle with a screw cap, 100 mL	HCl, 0.0480 M
Phenolphthalein	96% Ethanolic solution	1%	2 mL	Eppendorf tube, 5 mL	PP, 1%
α-Chymotrypsin	Aqueous solution in 0.02 M $CaCl_2$	4.0 mg/L	500 mL	Two plastic bottles with a screw cap, 250 mL	α-Chymotrypsin 4.0 mg/L
N-acetyl-L-tyrosine ethyl ester	10% Ethanolic solution	0.0200 M	250 mL	Plastic bottle with a screw cap, 250 mL	ATEE 0.02 M
Aprotinin	Aqueous solution	0.29 mM	1 mL	Eppendorf tube, 5 mL	I, 0.29 mM
Ethanol	Aqueous solution	10 vol%	200 mL	Plastic bottle with a screw cap, 250 mL	10% EtOH

α-Chymotrypsin (CT) is a proteolytic enzyme (serine protease) found in the digestive systems of many organisms. It facilitates the cleavage of peptide bonds by a hydrolysis reaction. *In vivo* CT is specific towards peptide bonds formed by carboxylic groups of tryptophan, tyrosine, phenylalanine, or leucine. *In vitro* CT also hydrolyses ester and amide bonds. ATEE is one of the synthetic substrates of CT. The hydrolysis reaction is:



The pH dependence of most enzymatic reactions is described by a bell-shape curve. Researchers typically study enzyme kinetics at the optimum pH value where an enzyme exhibits its maximum catalytic activity. In the case of CT, the optimum pH = 8.0.

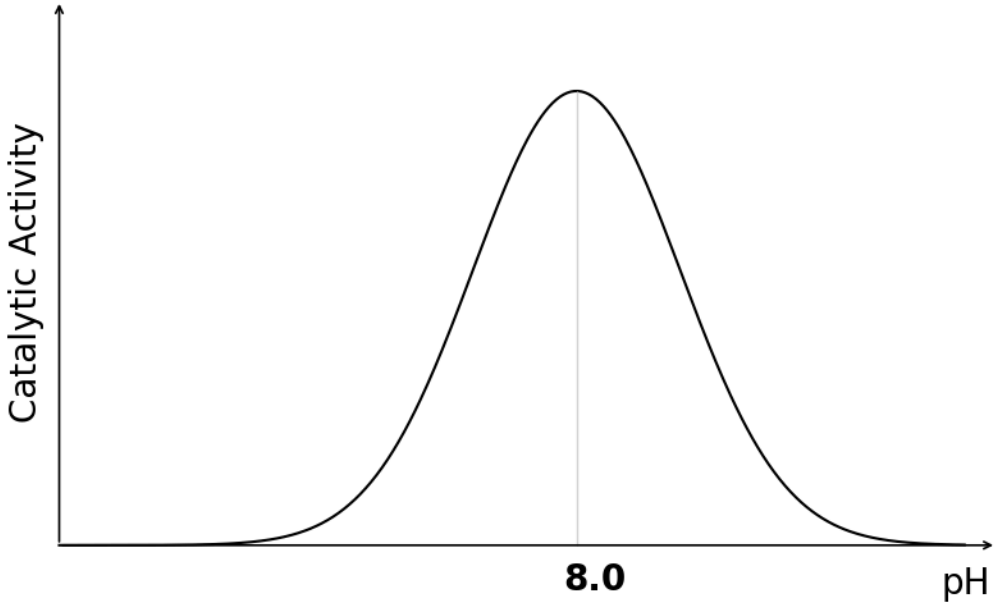


Figure 1. Bell-shape curve of the catalytic activity of the enzyme vs pH of the solution

Kinetics of the above CT-catalysed hydrolysis can be followed by using the 'pH-stat' method. In this method, the pH of the buffer free reaction mixture is maintained constant (~8.0) by adding NaOH to the solution. The rate of NaOH consumption is equal to the rate of ATEE hydrolysis:

$$r_0 = \frac{dn_{\mathrm{NaOH}}}{dt} = -\frac{dn_{\mathrm{ATEE}}}{dt}$$

Aprotinin (I) is a competitive inhibitor of CT.

Part A. Standardisation of NaOH

1. **Transfer** a 10.0 mL aliquot of 0.0480 M HCl solution into a 100.0 mL Erlenmeyer flask.

2. **Add** 2-3 drops of 1% phenolphthalein solution and **titrate** with NaOH solution until a pink colour appears.

3. **Repeat** steps 1-2 as necessary.

Q1.1 (10 points)

Write your accepted volume of NaOH solution, V_{NaOH}.

Q1.2 (1 point)

Write the reaction equation for standardisation of NaOH.

Q1.3 (1 point)

Calculate the exact concentration of NaOH solution.

Part B. Kinetic assay of an enzymatic reaction with the pH-stat method

4. **Prepare** the ATEE solutions (50 mL each) with concentrations (C_0) of 0.0200 M, 0.0100 M, 0.0067 M, and 0.0050 M by diluting the stock ATEE solution with 10 vol% ethanol.

5. **Put** the magnetic stirrer bar into a 250 mL plastic beaker and place it on the stirrer.

6. **Transfer** 50.0 mL of the 4.0 mg/L α-chymotrypsin solution into the beaker using a volumetric pipette and start stirring.

7. **Record** the temperature of the enzyme solution shown on the pH meter.

8. Accurately **add** dropwise the NaOH solution to increase the pH of the enzyme solution up to 8.

Note: If the pH value approaches ~9, just continue your work; if the pH value exceeds 9, accurately bring it back to 8 using the HCl solution.

9. **Transfer** 50.0 mL of the ATEE solution (C_0, M) to the 250 mL plastic beaker placed on the stirrer and immediately **start** the stopwatch.

10. **Maintain** the pH of the reaction mixture within the range 7.9 to 8.1 by adding the NaOH solution.

11. **Record** the volume of the NaOH solution consumed after 5 min.

12. **Repeat** steps **5-11** for the other ATEE solutions you have prepared.

Q1.4 (20 points)

Complete the table with the recorded temperatures of reaction mixtures, T, and the accepted volumes of NaOH consumed, V_{NaOH}, in pH-stating on the Answer Sheet.

Part C. Kinetic study of enzyme inhibition

13. **Prepare** three ATEE solutions (50 mL each) with a concentration (C_0) of 0.0100 M by diluting the stock ATEE solution with 10 vol% ethanol. Using the micropipette, **add** 100 μL, 200 μL, and 300 μL of aprotinin solution (I, 0.29 mM) respectively to the three ATEE solutions you have prepared.

14. **Repeat** steps **5-11** for each of the solutions of ATEE with aprotinin you have prepared.

Q1.5 (15 points)

Complete the table with the recorded temperatures of reaction mixtures, T, and the accepted volumes of NaOH, V_{NaOH}, consumed in pH-stating on the Answer Sheet.

Q1.6 (1 point)

Write the reaction equation(s), which take(s) place during pH-stating.

Q1.7 (2 points)

Complete the table with the calculated r and $\frac{1}{r}$ values on the Answer Sheet.

Q1.8 (3 points)

Plot $\frac{1}{r}$ as a function of $\frac{1}{[\mathrm{ATEE}]}$ for experiments (#1-4) without aprotinin. **Calculate** the $r_{\max}$ and K_M values for enzymatic hydrolysis of ATEE with CT.

Q1.9 (3 points)

Complete the table with the observed K_M values, $K_{M,\text{obs}}$, and **plot** $K_{M,\text{obs}}$ as a function of [I] for experiments (**#5-7**) with aprotinin on the Answer Sheet. **Calculate** the K_I value for Aprotinin.

The Michaelis-Menten equation:

$$r = \frac{r_{\max}[S]}{K_M + [S]}$$

with a competitive inhibitor:

$$r = \frac{r_{\max}[S]}{K_{M,\text{obs}} + [S]}, \quad K_{M,\text{obs}} = K_M\left(1 + \frac{[I]}{K_I}\right)$$

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A1-1

English (Official)

Kinetics of α-Chymotrypsin

16%									
1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	∑
10	1	1	20	15	1	2	3	3	56

1.1 (10pt)

V(NaOH) = _____ mL

1.2 (1pt)

1.3 (1pt)

c(NaOH) = _____ M

1.4 (20pt)

#	C_0, M	[ATEE], M	T, °C	V(NaOH), mL
1	0.0200	0.0100		
2	0.0100	0.0050		
3	0.0067	0.0033		
4	0.0050	0.0025		

1.5 (15pt)

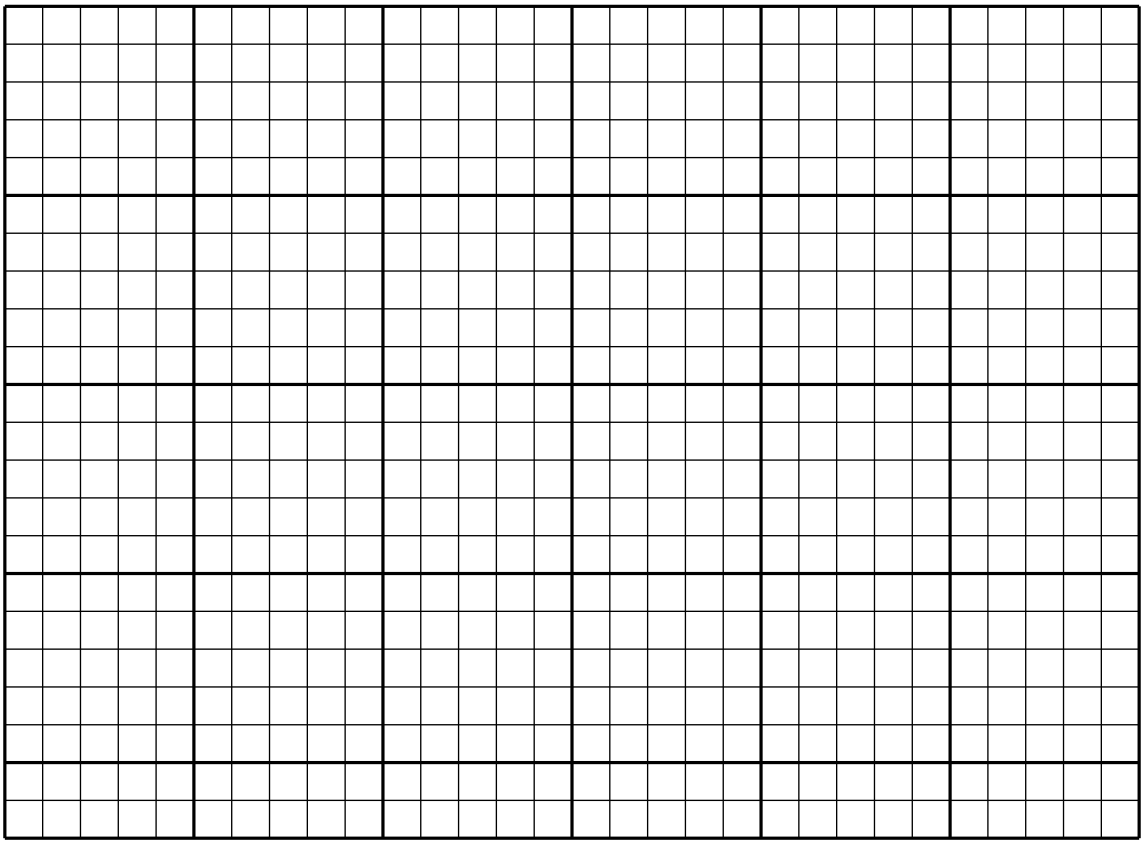
#	C_0, M	[ATEE], M	[I], μM	T, °C	V(NaOH), mL
5	0.0100	0.0050	0.29		
6	0.0100	0.0050	0.58		
7	0.0100	0.0050	0.87		

1.6 (1pt)

1.7 (2pt)

#	[ATEE], M	1/[ATEE], M^{-1}	[I], μM	r, M s^{-1}	1/r, M^{-1} s
1	0.0100	100	0		
2	0.0050	200	0		
3	0.0033	300	0		
4	0.0025	400	0		
5	0.0050	200	0.29		
6	0.0050	200	0.58		
7	0.0050	200	0.87		

1.8 (3pt)

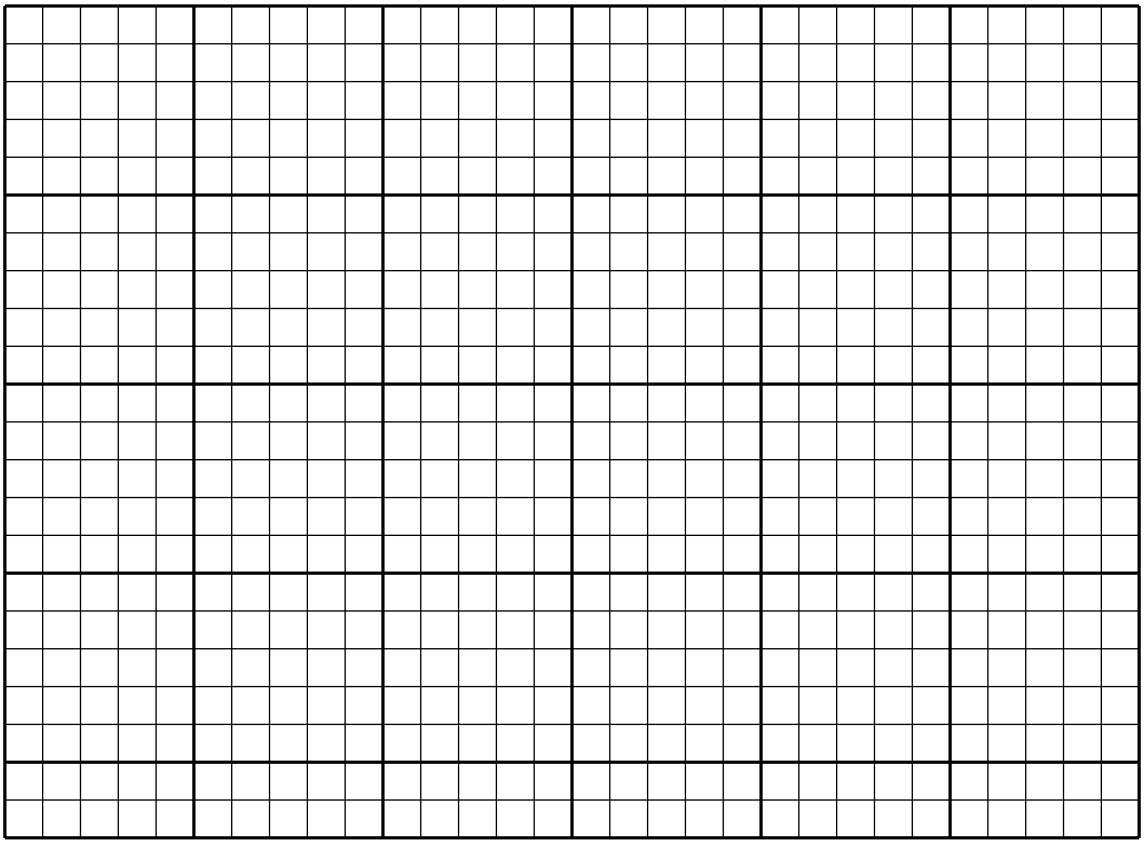


r(max) = _____ M s^{-1}

K_M = _____ M

1.9 (3pt)

#	[I], μM	K(M,obs), M
5	0.29	
6	0.58	
7	0.87	



1.9 (cont.)

$K_I =$ _____ μM

Practical examination

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Q2-1

English (Official)

Zeolites as 'Molecular Sieves'

14%											
2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11	∑
10	1	1	10	1	12	1	1	1	1	1	40

Chemicals

Name	State	Concentration	Quantity	Placed in	Label
Distilled water	Liquid	-	500 mL	Wash bottle, 500 mL	H_2O
Calcium chloride	Aqueous solution	To be determined	150 mL	Plastic bottle with a screw cap, 250 mL	$CaCl_2$, ??? M
Eriochrome black T	Solid	1% w/w in NaCl	100 mg	Stool sample container with spatula	Eriochrome
EDTA	Aqueous solution	0.1000 M	80 mL	Glass bottle with a screw cap, 100 mL	EDTA, 0.1000 M
Zeolite 4 Å for Part A	Solid	-	~0.5 g	Vial, 30 mL	Zeolite 4A Part A X.XXXX g
Zeolite 4 Å for Part B	Solid	-	~0.5 g	Vial, 30 mL	Zeolite 4A Part B X.XXXX g
Ammonia buffer (pH = 10)	Aqueous solution	-	40 mL	Glass bottle with a screw cap, 50 mL	Ammonia Buffer
Copper(II) sulphate	Aqueous solution	0.1000 M	25 mL	Glass bottle with a screw cap, 50 mL	$CuSO_4$, 0.1000 M
Ammonia	Aqueous solution	1 M	4 mL	5 mL Eppendorf tube	NH_3, 1 M

The microporous nature of zeolites allows them to adsorb molecules and ions equal to or smaller than the size of their pore openings, while excluding those that are larger. For this reason, zeolites have earned the name 'molecular sieves'.

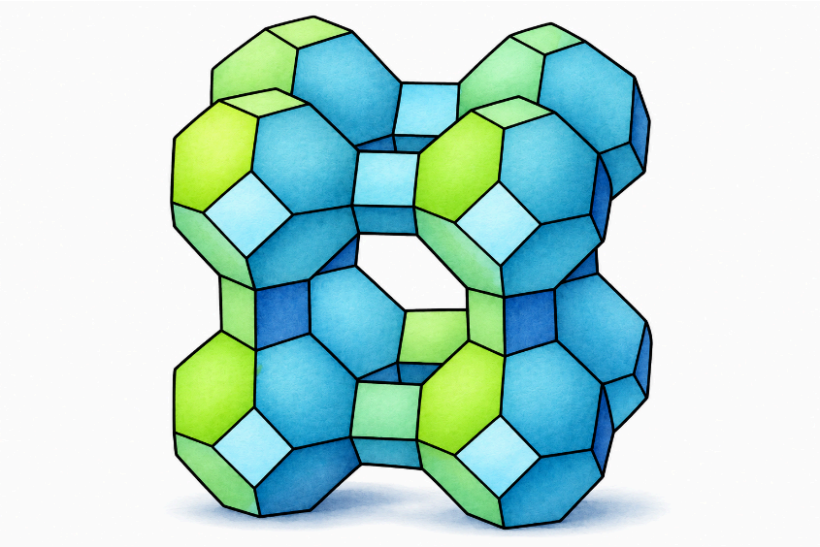


Figure 1. The structure of zeolite 4 Å – $Na_{12}Al_{12}Si_{12}O_{48}{\cdot}27H_2O$. Each corner represents a silicon or aluminum atom; oxygen atoms lie close to the midpoint of each straight line.

Part A. Determination of the ability of zeolite 4 Å to bind Ca^{2+} ions

Determination of the concentration of the $CaCl_2$ solution provided (from the "$CaCl_2$, ???" vial):

1. **Put** a 10.0 mL aliquot of the $CaCl_2$ solution provided into the Erlenmeyer flask.

2. **Add** 4 mL of ammonia buffer solution using a cylinder and add a tip of a spatula of Eriochrome black T indicator.

3. **Titrate** with 0.1000 M EDTA solution until the colour of the solution changes from red to blue.

4. **Repeat** steps 1-3, if required.

Q2.1 (10 points)

Write your accepted volume of EDTA solution, V_1^{EDTA}.

Q2.2 (1 point)

Write the reaction equation occurring during titration.

Q2.3 (1 point)

Calculate the concentration of the $CaCl_2$ solution provided (in M).

Analysis of the ability of Zeolite 4 Å Part A to bind Ca^{2+} ions from the $CaCl_2$ solution provided:

5. Quantitatively **transfer** all the zeolite from the vial labelled Zeolite 4A Part A into a 100 mL beaker. **Do not use any water to do this.** If you need to wash the vial you must use some of the 50.0 mL of calcium chloride solution to be measured out in Part A-6. **Add** the magnetic stirrer bar and **put** the beaker on the stirrer.

6. **Add** 50.0 mL of the calcium chloride solution provided from the "$CaCl_2$, ???" vial using a volumetric pipette to the beaker with zeolite 4A. **Start** stirring, **maintain** the maximum stirring speed whilst avoiding any splashes out of the beaker.

7. **Stir** for 45 min, and then **filter** the suspension to remove the zeolite. **Do not perform any washing with water.**

8. Transfer a 10.0 mL portion of the filtrate into an Erlenmeyer flask, add with swirling 4 mL of ammonia buffer solution using a cylinder, and add a tip of a spatula of Eriochrome black T indicator.

9. **Titrate** with 0.1000 M EDTA solution until the colour of the solution changes from red to blue.

10. **Repeat** steps 8-9 if required.

Q2.4 (10 points)

Write the exact mass of Zeolite 4 Å from the label and your accepted volume of EDTA solution, V_2^{EDTA}.

Q2.5 (1 point)

Calculate the ability (Q_{Ca}, mmol of Ca^{2+}/g of Zeolite 4 Å) of Zeolite 4 Å to bind Ca^{2+} ions.

Part B. Determination of the ability of zeolite 4 Å to bind Cu^{2+} ions

11. Quantitatively **transfer** all the zeolite from the vial labelled Zeolite 4A Part B into a 100 mL beaker. **Do not use any water to do this.** If you need to wash the vial you must use some of the 10.0 mL of $CuSO_4$ solution to be measured out in Part B-12. Add the magnetic stirrer bar and put the beaker on the stirrer.

12. **Add** 10.0 mL of 0.10 M $CuSO_4$ solution using a graduated pipette and **stir** for 45 min.

13. **Filter** the suspension to remove the zeolite. **Do not perform any washing with water.**

14. Using a micropipette, **prepare** solutions (#1-8) of Cu(II) at various concentrations in an 8-well strip of a 96-well plate by mixing of 0.10 M $CuSO_4$, the filtrate from Part B-13, 1.0 M NH_3, and distilled water in the volumes listed in the table below:

#	0.10 M $CuSO_4$, µL	Filtrate B-13, µL	1.0 M NH_3, µL	H_2O, µL	$C_{\mathrm{Cu(II)}}$, mM	Well
1	0	0	150	150	0	A
2	25	0	150	125	8.33	B
3	50	0	150	100	16.7	C
4	75	0	150	75	25.0	D
5	100	0	150	50	33.3	E
6	125	0	150	25	41.7	F
7	150	0	150	0	50.0	G
8	0	150	150	0	?	H

Attention! You must prepare the solutions (#1-8) strictly in numerical order from wells A to H of the strip.

Note! You cannot prepare more than 2 strips of 8 wells.

15. **Raise** your hand and **give** the prepared plate containing the strip of solutions #1-8 to the laboratory assistant. He/she will measure the absorbance in the wells at 630 nm and bring the printed results back to you.

Q2.6 (12 points)

Write the exact mass of Zeolite 4 Å from the label and your accepted absorbance values of the solutions #1-8, A_{630}.

Q2.7 (1 point)

Write the reaction equation taking place during preparation of solutions #1-8.

Q2.8 (1 point)

Determine the concentration of $CuSO_4$ in the filtrate from Part B-13.

Q2.9 (1 point)

Calculate the ability (Q_{Cu}, mmol of Cu^{2+}/g of Zeolite 4 Å) of Zeolite 4 Å to bind Cu^{2+} ions.

Q2.10 (1 point)

Write the net ionic reaction equations for the absorption of Ca^{2+} and Cu^{2+} ions by Zeolite 4 Å.

Q2.11 (1 point)

Calculate the maximum absorbing ability (Q_{max}, mmol of Ca^{2+} or Cu^{2+}/g of Zeolite 4 Å) of Zeolite 4 Å.

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A2-1

English (Official)

Zeolites as 'Molecular Sieves'

14%											
2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	2.11	∑
10	1	1	10	1	12	1	1	1	1	1	40

2.1 (10pt)

V_1(EDTA) = _____ mL

2.2 (1pt)

2.3 (1pt)

c($CaCl_2$) = _____ M

2.4 (10pt)

m(Zeolite 4 Å) = _____ g

V_2(EDTA) = _____ mL

2.5 (1pt)

Q(Ca) = _____ mmol Ca^{2+}/g

2.6 (12pt)

m(Zeolite 4 Å) = _____ g

#	A_{630}
1	
2	
3	
4	
5	
6	
7	
8	

2.7 (1pt)

2.8 (1pt)

$c(CuSO_4)$ = _____ M

2.9 (1pt)

Q(Cu) = _____ mmol Cu^{2+}/g

2.10 (1pt)

2.11 (1pt)

Qmax = _____ mmol/g

Practical examination

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Q3-1

English (Official)

The adventures of Hodja Nasreddin continue

10%			
3.1	3.2	3.3	∑
80	12	0	92

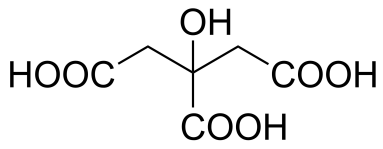
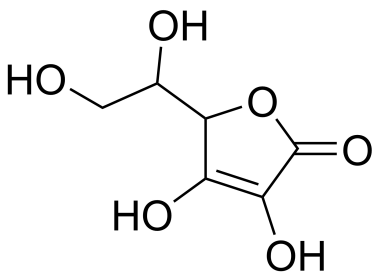
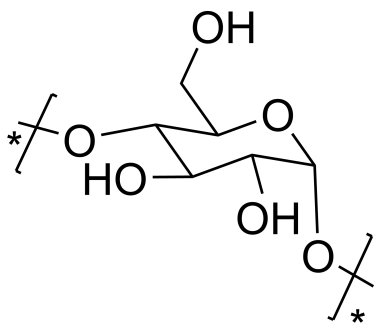
Chemicals

Name	State	Concentration	Quantity	Placed in	Label
Distilled water	Liquid	-	500 mL	Wash bottle, 500 mL	H_2O
A-H	Solid	-	~0.25 g	Eppendorf tubes, 5 mL	A-H



The wife of Hodja Nasreddin was a skilled healer. One day, she asked him to go to the bazaar and bring back the following list of household substances for the treatment of patients:

NaCl, KI, $MgSO_4$, $BaSO_4$, $Na_2S_2O_3$, $NaHCO_3$, $2Na_2CO_3{\cdot}3H_2O_2$, $CaCO_3$, $NaNO_2$, citric acid, ascorbic acid, starch.

		
citric acid	ascorbic acid	starch

Nasreddin, wishing to save some money, turned to his friend, an alchemist. The alchemist had only eight of the necessary substances which he sold to Nasreddin. Unfortunately, Nasreddin lost the labels, and now he is asking for your help.

Q3.1 (80 points)

Identify the contents of tubes A-H. Each tube contains only one substance from the list above.

Q3.2 (12 points)

Match the substances requested by Nasreddin's wife with their applications.

i) contrast for X-ray examination of stomach

ii) laxative

iii) antacid to relieve indigestion

iv) gives the reddish colour to sausages

v) table salt

vi) chalk

vii) holds moisture within dough

viii) prevents the browning of fruit

ix) food preservative

x) dechlorination of water

xi) laundry bleach

xii) treatment of iodine deficiency

Q3.3 (0 points)

Penalties (filled in by the lab assistant during the exam)

Practical examination

3rd ABU RAYHAN BIRUNI INTERNATIONAL CHEMISTRY OLYMPIAD

A3-1

English (Official)

The adventures of Hodja Nasreddin continue

10%			
3.1	3.2	3.3	∑
80	12	0	92

3.1 (80pt)

A	B	C	D	E	F	G	H

3.2 (12pt)

i	
ii	
iii	
iv	
v	
vi	
vii	
viii	
ix	
x	
xi	
xii	

3.3 (0pt)

Extra equipment and chemicals

Item	Penalty	Student signature	Assistant signature
	Free		
	1/40 practical exam points		
	1/40 practical exam points		
	1/40 practical exam points		
	1/40 practical exam points		
	1/40 practical exam points		

Safety violations

Type of violation	Penalty	Student signature	Assistant signature
	Warning		
	Disqualification(40 points)		