

# LABORATORY MANUAL

## CHEMISTRY I

TMS 0424

LATIPAH MOHD NOOR  
SITI RUBAINI MAT



# **LABORATORY MANUAL CHEMISTRY I TMS 0424**

**LATIPAH MOHD NOOR  
SITI RUBAINI MAT**

USIM Publisher  
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Bandar Baru Nilai  
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**2012**



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## DIRECTOR'S KEY NOTE



Assalamualaikum warahmatullah,

I would like to express gratitude to those involved in this publication initiated by a series of workshop which is organized for the Tamhidi Chemistry Unit. Cooperation by the lab assistants and teachers were very much appreciated. I believe that with the full dedication and strong teamwork, the compilation of this laboratory manual will be a success.

This Laboratory Manual is a guideline for students in Semester II to complete their studies of foundation chemistry. Each experiment is carefully chosen and edited for the purpose of maximizing the impact in the learning outcome. Students should be able to incorporate what they have learnt in the lecture hall and tutorials classes with the experiments in this Laboratory Manual. Students should also be curious enough to explore similar experiments which they can find in many websites, some with even related simulations, calculations and discussions.

I believe that this Laboratory Manual will be used to its full potential for the teaching and learning purposes, and these students may still going to refer to this manual when they have moved on to the undergraduate level. It is hoped that Tamhidi Centre will be able to develop students that can integrate the naqli and aqli knowledge along with good character development as a platform to create an excellent generation corresponding with the university's mission.

Berilmu, Beramal, Bertaqwa.

Dr Nurlida Basir  
Director of Tamhidi Centre, USIM  
13 January 2012

## LABORATORY SAFETY RULES AND AGREEMENT

Name : \_\_\_\_\_

Matrics Number : \_\_\_\_\_ Tutorial : \_\_\_\_\_

Instructor's Name: 1 ) \_\_\_\_\_

2) \_\_\_\_\_

### Read these General Laboratory Safety Rules carefully.

1. Attendance is **COMPULSORY**. If a student is unable to attend any practical classes, *a medical certificate (MC) or a letter of exemption* should be produced.
2. **SAFETY IS A PRIORITY**. Remember the location and proper use of all laboratory safety equipment, including eyewash, safety shower, fire alarm, fire extinguisher, and telephone. Notify your lecturer immediately of **ANY** injury, spill, fire, or explosion. **NEVER** leave an ongoing experiment unattended. Always know the hazards and physical and chemical properties of the materials used. Notify your lecturer and follow appropriate procedures if there is a mercury spill due to a broken mercury thermometer. Take every precaution to keep all chemicals from coming into contact with your skin and clothing, and away from flames.
3. When attending practical classes, every student should bring along a small towel, a jotter / log book ready and wear a **LAB COAT**, proper closed toed shoes (no sandals or slippers) and safety goggles (when needed). Pants (or long skirts) and closed toed shoes are required for admittance to the labs. You will not be allowed into the lab if you show up dressed inappropriately. Long hair and loose clothing must be confined or tied back. Head scarves should be tucked under your lab coat. High heels, baggy clothing, dangling jewellery, and shoes made of woven materials are strongly discouraged. Do not wear contact lenses for experiments when handling volatile solutions because they may be trapped under the lenses.
4. Every student must check the condition of all the apparatus to be used before starting the experiments. If there is a shortage of apparatus or breakage, please report it to the lecturer or the lab assistant immediately.
5. Be careful not to contaminate the chemicals. To avoid contamination, **NEVER** put your pipette into the reagent bottle and **NEVER** return unused chemicals to their bottle. When pouring out reagents, hold the stopper in your hand. Do not put it on the table. When replacing the stopper, place it first at the opening to ensure that any droplets present do not split outside the reagent bottle.

6. Take only sufficient amounts of chemicals for your experiments and use them with care. Try to dispense only what will be needed. Share any excess. Do not waste chemicals.
7. Playing, pranks and other acts of mischief are strictly forbidden. You are strictly forbidden to eat or drink in the laboratory at anytime. Do not taste anything. If instructed to smell a chemical, do so by carefully fanning the top of test tube or bottle so that a little of the vapour is directed towards your nose.
8. Never remove chemicals from the labs or stockrooms without proper authorisation. Unauthorized experiments, work, and preparations are not allowed. Know and follow the specified procedures for each experiment.
9. Read labels carefully. Label all containers to avoid errors. Make sure that the label is at the top when pouring out liquids from their bottles.
10. Turn off or lower all Bunsen flames when not in use. When heating liquid in a beaker, always place it on wire gauze on a tripod stand. Ensure that the mouth of the test tube is not pointed towards yourself or your friends when heating liquids in a test tube.
11. Handle compounds that emit irritating vapours in the fume cupboard. Ensure there are no flames in the vicinity before working with inflammable compounds. Immediately douse off any flame with fire extinguisher.
12. Clean up small spills immediately. Do not throw any solid wastes into the sinks. Dispose of organic solvents in the waste container provided. Keep your work area clean and tidy. All glassware must be washed after use. Return the apparatus and reagent bottles after the experiments.
13. Wash your hands and arms with soap and water before you leave the lab, even if you have been wearing gloves.

**I understand that the laboratory situation is potentially dangerous. Therefore, I have read and understood the lab rules and regulations as stated above. I agree to abide by all these rules, follow the demonstrator's instructions and act responsibly at all times.**

Signed : \_\_\_\_\_ Date : \_\_\_\_\_

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13. Wash your hands and arms with soap and water before you leave the lab, even if you have been wearing gloves.

**I understand that the laboratory situation is potentially dangerous. Therefore, I have read and understood the lab rules and regulations as stated above. I agree to abide by all these rules, follow the demonstrator's instructions and act responsibly at all times.**

Signed : \_\_\_\_\_ Date : \_\_\_\_\_

## PREFACE

This Laboratory Manual is designed for the Tamhidi Programme of Medicine (TM), Dentistry (TD) and Science and Technology (TST), Tamhidi Centre, USIM. The topics are arranged according to the syllabus of chemistry for foundation studies. The main objectives of the laboratory practices is to provide better understanding of the concepts of chemistry discussed in the lectures by conducting experiments.

This Laboratory Manual can also aid the student by clearly illustrating the principles and concepts involved. During this semester, students will be exposed to the mole concept, redox titration, molecular geometry, chemical and ionic equilibrium. It is critical for the students to read through the lecture notes on relevant topic prior to the laboratory sessions.

It is important for the students to read and sign the Laboratory Safety Rules and Agreement as the first task. Submission of this agreement is crucial as the students should take precautions and be very careful in the laboratory. Before the students start any activity, a briefing will be provided by the instructors and demonstrators.

The schedule of laboratory rotation will be provided in the course outline available online. Students should be able to log in individually using their own accounts in GOALS.

During laboratory sessions, students will be evaluated by the instructors and demonstrator with the help of lab assistants on dress code, apparatus handling, experimental procedures, behaviour during sessions, report submitted and team work.

Finally, we would like to welcome any comments from any parties especially academicians to improve this Laboratory Manual.

Chemistry Unit  
Tamhidi Centre, USIM  
13 January 2012

## ACKNOWLEDGEMENT

We would like to thank the Director of Tamhidi Centre, Dr Nurlida Basir for her encouragement and support. It was suggested for us to publish a manual which reflects the quality of experiments done by the Tamhidi students. A second workshop was held on 22 July 2011 and all the experiments were carried out and the procedures were improved.

Material supports and ideas are also contributed by the facilitator of the workshop, Dr Farah Wahidah Harun which is the coordinator of the Science Programme in Tamhidi Centre. Her effort during the workshop and her attention to Chemistry Unit in particular is a key to a strong teamwork.

Our teams in the lab are Puan Norfiza binti Zakaria, En Muhammad Fariz Mat Saad and En Mohd Yusuf bin Itam Abdullah. En Mohd Nazarali Ali, Cik Nurhafiza binti Abdul Ghafar and En Adib Yahya was also involved in this workshop. Thank you very much for the cooperation and hard work given not only during the workshop but also throughout the whole laboratory session with the students.

Last but not least, we would like to thank our parents and families for their unlimited support for our work and studies.

Latipah Mohd Noor  
Siti Rubaini Mat  
13 January 2012

## LIST OF APPARATUS AND CHEMICALS

Topic	Apparatus	Quantity	Chemical	Quantity
Experiment 1A Determination of Density of Water	Analytical balance	1	Tap water	100 mL
	100 mL graduated cylinder	1	Salt	2 g
	Glass rod	1		
	A dropper	1		
Experiment 1B Determine Concentrations of a Solution Using Titration	Glass rod	1	NaOH 1.0 M	25 mL
	Filter funnel	1	HCl 1.0 M	25 mL
	250 mL volumetric flask	1	Indicator	2 drops
	Burette	1	Distilled water	
	250 conical flask	2		
Measuring cylinder	1			
Experiment 2 Determination of the Formula Unit of a Compound	Crucibles	1	Zinc powder	25 g
	10 mL measuring cylinder	1	HCL 6 M	6 mL
	Analytical balance	1		
	Glass rod	1		
	Hot plate	1		
	Porcelain tiles	1		
Experiment 3 Redox Titration	50 mL beaker	1	Potassium iodate crystals	2 g
	Glass rod	1	Potassium iodide solids	2 g
	Analytical balance	1	H <sub>2</sub> SO <sub>4</sub> 1.0 M	100 mL
	Pipette filler	1	Starch solution	10 drops
	Filter funnel	1		
	250 mL volumetric flask	3		
	Burette	1	Sodium tiosulphate solution 0.1 M	100 mL
	25 mL pipette	1	Distilled water	
	250 mL conical flask	5		
	5 mL measuring cylinder	2		
	100 mL measuring cylinder	1		
100 mL beaker	1			

Topic	Apparatus	Quantity	Chemical	Quantity
Experiment 4 Molecular Geometry	3-D molecular model set	1		
Experiment 5 Chemical Equilibrium	Water bath Ice bath Burette 10 mL pipette Test tubes 100 mL beaker 100 mL conical flask 10 mL measuring cylinder 100 mL measuring cylinder	1 1 1 2 20 4 6 2 2	$\text{Fe}(\text{NO}_3)_3$ 1.1 M KSCN 0.1 M Distilled water 10% NaOH CoCl <sub>2</sub> 0.2 M Antimony chloride (0.5 SbCl <sub>3</sub> in 6.0 M HCl)	10 mL 10 mL 10 mL 10 mL 10 mL
Experiment 6 pH Measurement and Its Application	Burette Test tubes 25 mL pipette 250 mL conical flask pH meter pH paper	1 20 2 6 1 a box	NaCl 0.1 M NaOH 0.2 M NH <sub>4</sub> NO <sub>3</sub> 0.1 M CH <sub>3</sub> COONa 0.1M NH <sub>3</sub> 0.1 M NH <sub>3</sub> 1.0 M HCl 0.01 M HCl 1.0 M CH <sub>3</sub> COOH 0.1 M CH <sub>3</sub> COOH 1.0 M Universal indicator Phenolphthalein Methyl violet Methyl orange Alizarin yellow	

## POINTS ALLOCATION AND GRADING SYSTEM

The students should read through the lecture notes on relevant topic prior to the laboratory sessions. This is because only two hours is given for the students in groups of three to complete each experiment. At the end of the session, every group will have to submit the results and discussion as attached in this Laboratory Manual. Students do not have to write a full report on each experiment. Submission of a complete handout from this manual is a must.

At the beginning of the semester, students will be given the grouping name list and also the timetable for the laboratory sessions. The vacant week when the students are not going to have laboratory sessions will be filled with topical quizzes and revision classes.

Table A below represents allocated points for every experiment which will carry 10% of the grading for this subject, TMS 0424 Chemistry.

Table A: Allocated points for individual experiment.

Title of experiment	Allocated points	Psychomotor points	Total points
Experiment 1A: Determination of Density of Water	30	30	60
Experiment 1B: Determine Concentration of a Solution Using Titration			
Experiment 2: Determination of the Formula Unit of A Compound	15	30	45
Experiment 3: Redox Titration	15	30	45
Experiment 4: Molecular Geometry	30	10	40

Title of experiment	Allocated points	Psychomotor points	Total points
Experiment 5: Chemical Equilibrium	25	30	55
Experiment 6: pH Measurement and Its Applications	30	30	60

At the end of each session, students would have to submit the laboratory handout on time. One group will only submit one set of handout as the report of the day. The other two students should also fill in the handout in their respective laboratory manual as at the end of the semester, a laboratory theory exam will be carried out. The report submitted will not be returned back to the students.

Assessment component for this course is as given in Table B. The grading system which has been applied by Tamhidi Centre since Semester 1 Session 2008/2009 is as listed in Table C. Table D in the next page shows the rubric evaluation guidelines for psychomotor elements throughout the whole session.

Table B: Assessment component for the whole course.

Component	No. of papers	Type of question	Marks	Time allocated	Weightage
Continuous assessment	4	Topical Test	30	1 hour	10%
	6	Lab	40-60	2 hours	10%
	1	Evaluation Lab Test	30	1 hours	5%
Mid-Semester Exam	1	Structured	50	1½ hours	15%
Final Semester Exam	1	Objective	20	3 hours	60%
		Structured	40		
		Essay	40		
Total					100%

Table C: Tamhidi Grade System

Total Marks	Grade	Cumulative Points
80-100	A	4.00
75-79	A-	3.75
70-74	B+	3.50
65-69	B	3.00
60-64	B-	2.75
55-59	C+	2.50
50-54	C	2.00
45-49	C-	1.75
40-44	D+	1.00
0-39	E	0.00

Table D: Rubric Evaluation Guidelines for Psychomotor elements in Laboratory Session.

	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>A</b>	<p><b>Marks:</b></p> <p>Lab coat and shoes are not worn.</p>	<p>Lab coat are worn, but slipper / sandals are used.</p>	<p>Wear lab coat and shoes without socks.</p>	<p>Wear lab coat but inappropriate shoes.</p>	<p>Lab coat and full covered shoes are worn with socks.</p>
<b>B</b>	<p>Accidents happened. Glassware broken.</p>	<p>Not confident enough to touch the glass wares. Depend on friend to do lab works.</p>	<p>Quite confident to touch the glass ware. But the student uses it wrongly. Do not ask around to find out the proper way to use the apparatus.</p>	<p>Ask a lot of questions on how to use the lab apparatus. Show some effort to learn and use it for the first time.</p>	<p>Know how to use pipette filler properly. Do the titration correctly. Generally knowledgeable in handling apparatus. Handle the apparatus appropriately without being guided.</p>
<b>C</b>	<p>Experiment is not carried out.</p>	<p>Experiment procedures are not followed entirely. Results are not obtained.</p>	<p>Experiment procedures are not followed correctly. Result is obtained after consultation.</p>	<p>Experimental procedures are followed correctly but result is obtained after a few trials.</p>	<p>Students shown they have read the manual before entering the lab. Experimental procedure is followed correctly. Results are obtained first time correctly. Produce flow chart and mind map.</p>

	Marks:	1	2	3	4	5
<b>D</b>	<b>Behaviour in lab</b>	Naughty and very unmannered in lab. Use apparatus to play around.	Speaking loudly with each other. Making jokes and laugh. Disrespect for each other.	Talking about something other than the experiments and the theories.	Good manner in lab. Generally, will speak when spoken to.	Very professional. Start doing the experiment as soon as being told. Quiet and obedient.
<b>E</b>	<b>Team work</b>	Not good. One person job. Other members just sit down and write.	Bad participation. A lot of talking about other things. Commenting own member in group.	Medium.	Good participation. But at one or two times, a member did own thing.	Very good cooperation. Everybody participate and took part helping in all segment of the session.
<b>F</b>	<b>Pre and post laboratory session</b>	Did not do anything. Use apparatus from different beach. Leave the apparatus on bench and in sink.	Did not bring towel. Did not rinse nor clean before and after use.	Did not bring towel. Did not rinse anything before use. Clean after use.	Did not bring towel. Rinse apparatus but not in a correct way. Clean after use but not proper.	Apparatus were rinse appropriately before use. Glasswares are cleaned properly at the end of session. Brought towel.

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## APPENDIX A

### LIST OF SELECTED CONSTANT VALUES

Avogadro's number	$N_A$	=	$6.02 \times 10^{23} \text{ mol}^{-1}$
Density of water	$\rho$	=	$1 \text{ g cm}^{-3}$
Faraday constant	$F$	=	$9.65 \times 10^4 \text{ C mol}^{-1}$
Ionisation constant for water at 25°C $\text{dm}^{-16}$	$K_w$	=	$1.00 \times 10^{-14} \text{ mol}^2$
Molar of gases constant	$R$	=	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
		=	$0.08206 \text{ L atm}$
$\text{mol}^{-1} \text{ K}^{-1}$			
Molar volume of gasses STP	$V_m$	=	$22.4 \text{ dm}^3 \text{ mol}^{-1} \text{ at}$
		=	$24 \text{ dm}^3 \text{ mol}^{-1} \text{ at}$
room temperature			
Planck's constant	$h$	=	$6.6256 \times 10^{-34} \text{ J s}$
Rydberg constant	$R_H$	=	$1.097 \times 10^7 \text{ m}^{-1}$
		=	$2.18 \times 10^{-18} \text{ J}$
Specific heat of water	$c$	=	$4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$
		=	$4.18 \text{ J g}^{-1} \text{ K}^{-1}$
		=	$4.18 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$
Speed of light in vaccum	$c$	=	$3.0 \times 10^8 \text{ m s}^{-1}$
Vapour pressure of water	$P_{\text{water}}$	=	$23.8 \text{ torr}$

### UNIT OF CONVERSION FACTOR

Energy	$1 \text{ J} = 1 \text{ kg m}^2 \text{ s}^{-2} = 1 \text{ N m} = 10^7 \text{ erg}$ $1 \text{ calorie} = 4.184 \text{ Joule}$ $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$
Pressure	$1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr} = 101.325 \text{ kPa} = 101325 \text{ N m}^{-2}$
Volume	$1 \text{ liter} = 1 \text{ dm}^3$ $1 \text{ mL} = 1 \text{ cm}^3$
Others	$1 \text{ faraday (F)} = 96500 \text{ coulomb}$ $1 \text{ newton (N)} = 1 \text{ kg m s}^{-2}$

## APPENDIX B

### TABLE OF RELATIVE ATOMIC MASSES OF SELECTED ELEMENTS

Element	Symbol	Proton number	Relative Atomic Masses
Hydrogen	H	1	1.0
Helium	He	2	4.0
Lithium	Li	3	6.9
Beryllium	Be	4	9.0
Boron	B	5	10.8
Carbon	C	6	12.0
Nitrogen	N	7	14.0
Oxygen	O	8	16.0
Flourine	F	9	19.0
Neon	Ne	10	20.2
Sodium	Na	11	23.0
Magnesium	Mg	12	24.3
Aluminium	Al	13	27.0
Silicon	Si	14	28.1
Phosphorus	P	15	31.0
Sulphur	S	16	32.1
Chlorine	Cl	17	35.5
Argon	Ar	18	40.0
Kalium (potassium)	K	19	39.1
Calcium	Ca	20	40.1
Scandium	Sc	21	45.0
Titanium	Ti	22	48.0
Vanadium	V	23	51.0
Chromium	Cr	24	52.0
Manganese	Mn	25	54.9
Ferum (iron)	Fe	26	55.9
Cobalt	Co	27	58.9
Nickel	Ni	28	58.7

Copper	Cu	29	63.6
Zinc	Zn	30	65.4
Galium	Ga	31	69.7
Germanium	Ge	32	72.6
Arsenic	As	33	74.9
Selenium	Se	34	79.0
Bromine	Br	35	79.9
Krypton	Kr	36	83.8
Rubidium	Rb	37	85.5
Strontium	Sr	38	87.6
Ytrium	Y	39	88.9
Zirconium	Zr	40	91.2
Niobium	Nb	41	92.9
Molibdenum	Mo	42	95.9
Teknitium	Tc	43	98.0
Rutenium	Ru	44	101.1
Rodium	Ro	45	102.9
Paladium	Pd	46	106.4
Argentum (silver)	Ag	47	107.9
Cadmium	Cd	48	112.4
Indium	In	49	114.8
Stanum (tin)	Sn	50	118.7
Antimony	Sb	51	121.8
Telurium	Te	52	127.6
Iodine	I	53	126.9
Xenon	Xe	54	131.3
Caesium	Cs	55	132.9
Barium	Ba	56	137.3
Cerium	Ce	58	140.1

Tungsten	W	74	183.9
Platinum	Pt	78	195.1
Aurum (gold)	Au	79	197.0
Mercury	Hg	80	200.6
Plumbum (lead)	Pb	82	207.2
Bismuth	Bi	83	209.0
Radon	Rn	86	222.0
Radium	Ra	88	226.0
Protactinium	Pa	91	231.0
Uranium	U	92	238.0
Plutonium	Pu	94	242.0

# LABORATORY MANUAL

## CHEMISTRY I

## TMS 0424

This Laboratory Manual is a text book for the Tamhidi Programme of Medicine, Dentistry and Science and Technology of the Tamhidi Centre, USIM which whom undergoing the core subject TMS 0424 Chemistry I. There are six experiments carefully selected, which is arranged accordingly correlated to the syllabus of chemistry for foundation studies. The main objectives of the laboratory practices are to provide better understanding of the concepts of chemistry discussed in the lectures and tutorial sessions. During this semester, students will be exposed to the mole concept, redox titration, molecular geometry, chemical equilibrium and ionic equilibrium.

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