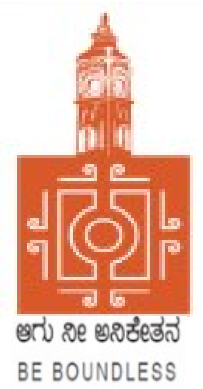

BENGALURU CITY UNIVERSITY

CHOICE BASED CREDIT SYSTEM

(As per SEP)

Syllabus for Chemistry

2024-25

PROCEEDINGS OF THE MEETING OF THE BOARD OF STUDIES IN CHEMISTRY (UG) HELD ON 11TH JUNE 2024 IN THE DEPARTMENT OF CHEMISTRY, JNANA JYOTHI - CENTRAL COLLEGE CAMPUS, BENGALURU CITY UNIVERISTY, BANGALORE - 560001.

A meeting of the Board of Studies in Chemistry (UG) was held today Tuesday the 11th June **2024 starting** at 10.30 am in the Department of Chemistry for framing syllabus for the first and second semesters of the three year B.Sc., course under State Education Policy, Government of Karnataka - 2024.

The Chairman welcomed the members and as per the agenda below, discussion was prompted.

1. **Item one: Framing of syllabus for the 1st and 2nd semester B.Sc., course with Chemistry under SEP and**
2. **Providing framework for the entire 3 years course.**

The members carefully discussed the agenda and recommended the syllabi and framework.

The Chairman finally thanked all the members for their presence and their valuable inputs for the deliberations of the day.

The following BOS members were present.

Name	Signature
1. Dr. Kantharaju S	
2. Mr. Shiva Prakash M	
3. Dr. Prasanna Kumar S G	
4. Dr. Ramakrishna Reddy. K	
5. Dr. Ronald J Mascarenhas	11/06/2024
6. Mr. Srivatsa L K Vijaya College	11/06/2024
7. Dr. Sanjeevarayyappa C GFGC Yelahanka	
8. Dr. Sujatha M MES	Sujatha.M
9. Mr. Siddaraju	
10. Dr. Chinnadevi C N MES	
11. Mr. Harish K M SJRC	
12. Ms. Chandrima Dutta MES	
13. Dr. Balasubramani K J (Industry)	
14. Prof. Chethana P R	11/06/24
15. Prof. Devaraj V R	11/6/2024
16. Prof. Hariprasad. S.	11.06.2024

Professor and Chairman.

Dr. Hari Prasad. S.
Senior Professor and Chairman
DOS in Chemistry, Central College Campus
Bengaluru City University
BENGALURU - 560 001

Proposed Structure for I Semester to VI Semester B.Sc., Chemistry Syllabus from 2024 onwards

I Semester		II Semester		III Semester		IV Semester		V Semester		VI Semester	
Topics	No. of Hours	Topics	No. of Hours	Topics	No. of Hours	Topics	No. of Hours	Topics	No. of Hours	Topics	No. of Hours
Unit 1		**Unit 1**		**Unit 1**		**Unit 1**		**P 5 (Physical chemistry)**		**P 7 (Organic chemistry)**	
Atomic structure	5	Quantum mechanics	8	Chemical kinetics	7	Phase equilibria	7	Molecular spectroscopy	20	Stereochemistry	10
Periodic Table and Periodic properties	8	Photochemistry	5	Nuclear and Radiochemistry	6	Solid state	6	Electrochemistry - II	6	Industrial organic chemistry	5
Unit 2		**Unit 2**		**Unit 2**		**Unit 2**		**Analytical methods in chemistry**	14	Spectroscopy of simple organic compounds	10
Elementary aspects of Analytical chemistry	13	Chemical bonding	13	Thermodynamics - I	7	Electrochemistry - I	8	**P 6 (Inorganic chemistry)**		Chemistry of Natural products	10
Unit 3		**Unit 3**		Thermodynamics - II	6	Ionic equilibria	5	Industrial materials	13	Heterocyclic compounds	5
Gaseous state	7	Polymers	4	**Unit 3**				Chemistry of newer materials	10	**P 8 (Biochemistry)**	
Liquids and Solutions	6	Chromatography	9	Metallurgy	5	**Unit 3**		Bio-inorganic chemistry	3	**Carbohydrates & carbohydrates metabolism**	7
Unit 4		**Unit 4**		Powder metallurgy and Steel	6	Coordination chemistry	13	Industrial gases and Inorganic chemicals	10	Lipids & lipid metabolism	6
Basic concepts in Organic chemistry	4	Aromatic hydrocarbons	9	Non-aqueous solvents	2	**Unit 4**		**synthetic and modification of inorganic solids**	2	Amino acids and proteins and Protein metabolism	7
Aliphatic hydrocarbons	9	Organic halogen compounds	4	**Unit 4**		Aldehydes and Ketones	4	Explosives	2	Enzymes	3
				Alcohols, Phenols, Thiols and ethers	11	Carboxylic acids and their derivatives	5			Nucleic acids	3
				Organometallic compounds	2	Amines	4			Information flow in biological systems	4
										Bioenergetics and Biological oxidation	6
										Vitamins and Harmones	4
No. of credits: 3	52	**No. of credits: 3**	52	**No. of credits: 3**	52	**No. of credits: 3**	52	**No. of credits: 6**	80	**No. of credits: 6**	80

Practicals

I Semester

1. Volumetric analysis (Performance & Procedure writing)

II Semester

Determination of density and viscosity/surface tension of a liquid (Performance)

Determination of CST of phenol - water system (Procedure writing)

Determination of percentage of NaCl by finding the CST of phenol - water system (Performance)

Determination of distribution coefficient of benzoic acid between water and toluene. (Performance)

Determination of molar mass of a non-electrolyate solute by Walker-Lumsden method. (Procedure writing)

III Semester

1. Prepartion of organic compounds - Single step (Performance)
2. Prepartion of organic compounds - Two steps (Procedure writing)

IV Semester

1. Qualitative analysis of a mixture of two simpe inorganic salts
2. Chromatographic experiments/separation techniques (Procedure writing)

V Semester

1. Qualitative analysis of mono functional organic compounds (Performance)
2. Quantitative analysis of amino acids/sugars/oils & fats (Procedure writing)
3. Colorimetric estimation of reducing sugars/phosphate/copper/iron (Procedure writing)

VI Semester

1. Conductometric & Potentiometric titrations (Performance)
2. pH metry (Performance/Procedure writing)

I Semester B.Sc.

Chemistry Paper – I

Instructions per week	Total contact hours	Marks		Duration of Examination	Total marks	Credits
		Internal assessment	End Semester Examination		100	3
4 Hours	52	20	80	3 Hours		

UNIT - I

Atomic Structure 5 hours

Review of Bohr's atomic model. Derivation of expressions for radius, energy and ionization energies of hydrogen and hydrogen like species. Numerical Problems. Hydrogen spectrum - Rydberg equation. Calculation of wavenumber of spectral lines and ionization energy.

Quantum numbers (only qualitative): definition and significance. Calculation of *l*, *m* and *s* values for a given values of *n* (1, 2 and 3). Rules for filling electrons in various orbitals: Aufbau principle and its limitations, Pauli's exclusion principle and Hund's rule of maximum multiplicity. Electronic configuration of elements (up to atomic number 30). Stability of half-filled and completely filled orbitals. Concept of exchange energy. Relative energies of atomic orbitals. Anomalous electronic configurations.

Periodic Table and Periodic properties 8 hours

Review of the modern periodic table (with respect to classification of elements based on outer electronic configuration)

Periodic properties: Atomic and ionic radii, ionization energy, electron affinity and electronegativity-definitions. Trends in the periodic properties- across the period and down the group. Applications in predicting and explaining chemical behavior - reactivity and reducing power. Factorsaffecting the values of ionization energy. Determination of electronegativity by Pauling's method. Diagonal relationship and its influence on the properties on beryllium and aluminium.

Comparative study of elements of alkali and alkaline earth metals; chalcogens and halogens - with respect to electronic configuration, atomic and ionic radii, ionisation energy and electronegativity.

Halides, oxides and carbonates of alkali and alkaline earth metals.

Hydrides of chalcogens and halogens-comparative study of all these with respect to their reactivity.

UNIT - II

Elementary aspects of Analytical chemistry 13 hours

Errors: Classification - determinate and indeterminate types, minimization of determinate errors, accuracy and precision-definitions. Significant figures-definition. Rules for computing significant figures and their computations with an example.

Avogadro number and mole concept. Equivalent weights of acids-definition, examples for a monobasic and a dibasic acid. Equivalent weights of bases-definition, sodium hydroxide and barium hydroxide as examples. Equivalent weights of salts-definition with sodium carbonate as an example. Methods of expressing concentration of solutions in terms of normality and molarity

and their definitions. (The method of preparation of 1 N and 1 M solutions are to be emphasized). Numerical problems on normality and molarity.

Types of acid – base titrations and titration curves.

Oxidation numbers: Definition, rules, calculation of oxidation numbers of elements in molecules and ions. Balancing of red-ox reactions by ion-electron method. Equivalent weights of oxidizing and reducing agents-definitions, examples of potassium dichromate, potassium permanganate, ferrous ammonium sulphate.

UNIT - III

Gaseous state 7 hours

Introduction: Need for Maxwell-Boltzmann distribution law, mathematical expression for Maxwell-Boltzmann distribution law both in terms of mole and molecule – explanation of the terms only. Explanation of velocity distribution curves based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation. Definitions and expressions for *rms* velocity and average velocity (no derivations), relationships between them. Problems on *rms* velocity and average velocity. Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Derivation of critical constants T_c, P_c and V_c from van der Waal's equation. Problems on the calculation of T_c, P_c and V_c, van der Waal's constants *a* and *b*.

Law of corresponding states – statement, reduced equation of state and explanation.

Joule - Thomson effect: Statement with explanation. Joule - Thomson co-efficient, inversion temperature-definition (no derivation). The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

Liquids and Solutions 6 hours

Liquid Mixture: Review of Raoult's law of dilute solutions. Ideal and non-ideal solutions. Completely miscible liquids - theory of fractional distillation of binary liquids with diagram. T-C curves for all the three types. Azeotropic mixtures -examples.

Partially miscible liquids: Critical solution temperature-definition with any one example for each type - explanations with curves (three types). Effect of addition of salt on CST of phenol-water system. Immiscible liquids, examples. Theory of Steam distillation with derivation for the expression of ratio proportion of liquid mixtures and its applications.

Distribution law: Statement, partition coefficient and condition for validity of distribution law. Application-solvent extraction (no derivation)

Dilute solutions: Review of colligative properties. Determination of molecular mass of a solute by (i) Berkeley-Hartley's method (ΔT_b) (ii) Beckmann's method (ΔT_f) and (iii) Landsberger's method. Numerical problems on determination of molar mass. Abnormal molar mass, van't Hoff factor *i* and its significance.

UNIT - IV

Basic concepts in organic chemistry 4 hours

Nomenclature of organic compounds.

Bond cleavage - Homolytic and heterolytic cleavages - Explanation with examples for each type – curved arrow notations. Types of reagents: Electrophilic and nucleophilic reagents-meaning, examples for each type.

Reactive intermediates - generation and relative stabilities of carbocation, carbanion, carbon free radicals and carbenes - explanation of relative stability and reactivity based on inductive, resonance and hyperconjugative effects. Types of reactions: addition, substitution and elimination-explanation with examples for each type of reaction.

Aliphatic Hydrocarbons 9 hours

Alkanes: Sources and Nomenclature of alkanes. Preparation of symmetrical and unsymmetrical alkanes: Wurtz reaction. Conformational analysis of ethane and *n*-butane, Sawhorse and Newman projection formulae to be used – Energy profile diagram.

Cycloalkanes: Methods of preparation of cyclopropane to cyclohexane from respective terminal dihalides. Explanation for stability based on heat of hydrogenation data. Baeyer's strain theory and its limitations, Sachse - Mohr theory of strainless rings.

Alkenes: Preparation of alkenes by (i) dehydrohalogenation and (ii) dehalogenation. Reactions of alkenes - addition of (i) X_2 and (ii) HX. Markownikov's rule and anti Markownikov's addition with mechanisms. Epoxidation - with an example of ethene and propene.

Oxidation with $KMnO_4$ and OsO_4. Ozonolysis and its importance.

Dienes: Classification - isolated, conjugated and cumulated-one example for each type. Structure of allene and butadiene. Reactions: 1,2-addition and 1,4 addition reactions. Diels-Alder reaction:1,3-butadiene with maleic anhydride as an example.

Cycloalkenes (C_nH_{2n}): Introduction with examples.

Alkynes: Methods of preparation: dehydrohalogenation of vicinal and geminal dihalides. Reactions of alkynes – (i) Catalytic hydrogenation, (ii) Oxidation with $KMnO_4$, (iii) acidic nature of terminal alkynes with example of reaction with ammoniacal solutions of silver nitrate and cuprous chloride.

Cyclolkynes (C_nH_{2n-2}): Introduction with examples. Relative stability of cycloalkynes (in brief).

I Semester B.Sc. (DSC 1) - Question Paper Blue Print

Paper - I

Sl. No.	Topic	No. of Teaching Hours	Marks per Teaching hour, 116/52 = 2.24	Part A		Part B		Part C		Total Marks
				No. of questions	Marks	No. of questions	Marks	No. of questions	Marks	
UNIT I										
1	Atomic structure	5	11	1	2		0	1	**10**	12
2	Periodic table and periodic properties of elements	8	18	1	2	1	5	1	**10**	17
UNIT II										
3	Elementary aspects of analytical chemistry	13	29	4	8	2	10	1	**10**	28
UNIT III										
4	Gaseous state	7	16	2	4		0	1	**10**	14
5	Liquids and solutions	6	13	2	4		0	1	**10**	14
UNIT IV										
6	Basic concepts in Organic chemistry	4	9	1	2	1	5	0.5	**5**	12
7	Alphatic hydrocarbons	9	20	2	4	2	10	0.5	**5**	19
		52	**116**	**13**	**26**	**6**	**30**	**6**	**60**	**116**

Part A			Part B			Part C		
2 Marks Questions			5 Mark questions			10 Mark questions = (5 + 5) or (6 + 4) Pattern		
No. of questions		Total Marks	No. of questions		Total Marks	No. of questions		Total Marks
To set	To answer		To set	To answer		To set	To answer	
13	**10**	**10 × 2 = 20**	**6**	**4**	**4 × 5 = 20**	**6**	**4**	**40**

Chemistry Practical - I Semester B.Sc.

Instructions per week	Marks		Total marks	Duration of Examination	Credits
	Internal assessment marks	End Semester Examination	50		2
3 Hours	10	40		3 Hours	

Safety Data Sheet

1. Calibration of glass wares: (i) Pipettte, (ii) Burette, (iii) Volumetric flask.
2. Estimation of potassium permanganate using standard sodium oxalate solution.
3. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with diphenyl amine as an internal indicator.
4. Estimation of sodium thiosulphate using standard potassium dichromate solution.
5. Estimation of zinc in the solution using standard EDTA solution.
6. Standardisation of EDTA solution and the estimation of total hardness of a sample of water.
7. Determination of percentage of iron in haematite using standard potassium dichromate solution with diphenyl amine as an internal indicator.
8. Estimation of carbonate and bicarbonate in a given mixture.
9. Determination of chloride by Mohr's method using potassium chromate as an adsorption indicator.
10. Determination of percentage of available chlorine in a sample of bleaching powder.

Note: *Standard solutions to be prepared for experiments 2 to 4.*

Different volumes of the solutions to be given in volumetric flask for estimation for experiments 5 and 6.

II Semester B.Sc.

Chemistry Paper – II

Instructions per week	Total contact hours	Marks		Duration of Examination	Total marks	Credits
		Internal assessment	End Semester Examination		100	3
4 Hours	52	20	80	3 Hours		

UNIT - I

Quantum Mechanics 8 hours

Limitations of classical mechanics. Wave particle duality, de Broglie equation. Heisenberg's uncertainty principle. Sinusoidal wave equation (explain sinusoidal wave and classical wave mechanics); Schrodinger wave equation. Derivation of time independent Schrodinger wave equation. Postulates of quantum mechanics.

Concept of operators. Significance of: (i) Laplacian operator, (ii) Hamiltonian operator (iii) Eigen values and Eigen functions. Significance of ψ and ψ^2. Application of Schrodinger equation to a particle in one dimensional box (derivation).

Radial probability distribution and angular probability distribution curves. Orbitals-definition and difference between an orbit and orbital. Nodes or nodal planes for *s* and *p* orbitals. Shapes of *s*, *p*, *d* and *f* orbitals.

Photochemistry 5 hours

Laws of photochemistry. Grotthus-Draper law, Stark-Einstein law – Statements, differences between photophysical and photochemical processes with examples.

Comparison of photochemical and thermal reactions with an example each. Quantum yield-definition. Magnitude of Quantum yield of photochemical combination of (i) H_2 and Cl_2 (ii) H_2 and Br_2 (iii) dissociation of HI (iv) dimerisation of anthracene: reason for low, high and medium quantum yields.

Singlet and triplet states – definitions. Fluorescence, phosphorescence – basic Jablonski diagram. Luminescence, bioluminescence and chemical sensors – definitions of all these with suitable examples.

Photosensitization-definition with example. Photo stationary equilibrium – definition and example.

Beer-Lambert's law-statement and its application in colorimetric estimations. Numerical problems on absorption coefficient and molar extinction coefficient.

UNIT - II

Chemical bonding 13 hours

Ionic bond: Lattice energy: definition and significance. Born-Haber cycle for NaCl and MgO. Calculation of lattice energy. Born - Lande equation (derivation not required). Problems on Born-Lande equation. Effect of lattice energy on solubility of ionic compounds.

Covalent bond: Valence bond approach - postulates of valence bond theory. Hybridization-definition and directional characteristics of *sp*, sp^2, sp^3, sp^3d, sp^3d^2 hybridisations. Formation and shapes of $BeCl_2$, BF_3, $SiCl_4$, PCl_5 and SF_6 molecules.

VSEPR theory: Illustration with reference to shapes of CH_4, NH_3, NH_4^+, H_2O, BrF_3 and ICl^-.

Molecular orbital theory: Bond order, stability and magnetic properties to be discussed for: $H_2, He_2^+, Be_2, N_2, O_2, O_2^-, O_2^{2-}, O_2^+$, CO, NO and NO^+. Polarization concept: Fajan's rules, explanation with examples, bond length, bond angle and bond energy-definitions. Polar and non-polar molecules- examples. Dipole moment-definition and unit.

Hydrogen bond: Intra-molecular and Inter-molecular types with examples - HF, H_2O, NH_3, alcohols, carboxylic acids, nitro phenols and biomolecules. Anomalous properties of water. van-der Waal's forces: Noble gases, molecular crystals (dry ice, iodine and solid SO_2) and clathrates.

Metallic bond: Band theory and electrical properties of metals. Semiconductors and insulators.

UNIT - III

Polymers 4 hours

Introduction and classification. Polymerization - definition. Types of polymerisation: (i) Addition polymerization: (ii) Condensation polymerization.

Resins: Synthesis and uses of: (1) Thermoplastic resins – (i) Polyethenic or Vinyl resins *Ex*: (a) Polymethyl methacrylate or Lucite or Plexiglass, (b) TEFLON. (2) Thermosetting resins – (i) Phenolic resins or phenoplasts *Ex*: (a) Novalac, (b) Bakelite (ii) Polyurethanes,(iii) epoxy resins.

Chromatography 9 hours

General description, definition, terms and parameters used in chromatography. Classification of chromatographic methods, criteria for selection of stationary and mobile phases. Nature of adsorbents and R_f value.

Paper chromatography: Principle and applications.

Thin layer chromatography: Principle, mechanism, efficiency of TLC plates, methodology – selection of stationary and mobile phases, plate development, spray reagents, identification of analytes and qualitative applications.

Column chromatography: Principle - Column efficiency, factors affecting the column efficiency, van Deemter's equation and its modern version.

Ion exchange chromatography: Principle. Resins - types with examples- cation exchange and anion exchange resins. Mechanism of cation and anion exchange process and applications of ion-exchange chromatography (softening of hard water, separation of lanthanides, industrial applications).

UNIT - IV

Aromatic hydrocarbons 9 hours

Nomenclature, structure of benzene - using molecular orbital theory. Huckel's rule. Stability based on Huckel's rule of aromaticity. (*Ex*: naphthalene, anthracene, phenanthrene, cyclopentadienyl anion and cycloheptatrienyl cation). Anti-aromaticity: definition and examples.

Aromatic electrophilic substitution: General mechanism of aromatic electrophilic substitution. Mechanism of: (i) nitration of benzene - evidence for the formation of nitronium ion, energy profile diagram and isotopic effect, (ii) sulphonation of benzene.

Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol towards electrophilic substitutions reactions.

Benzyne – Introduction and stability based on Huckel's rule of aromaticity. Generation of benzyne with mechanism.

Aromatic nucleophilic substitution: *Ipso* substitution - *Ex*: conversion of 2,4-dinitrochlorobenzene to 2,4-dinitrophenylhydrazine.

Oxidation of naphthalene to (i) phthalic anhydride and (ii) 1,4-napthaquinone. Anthracene to anthraquinone and phenanthrene to phenanthraquinone.

Diels-Alder reaction between anthracene with 1,2-dichloroethene.

Alkenyl benzenes: Styrene, *cis*- and *trans*-stilbenes - structures and their preparations. Biphenyl: Preparation by Ullmann reaction.

Organic halogen compounds 4 hours

Alkyl halides: Nomenclature.

Nucleophilic substitution reactions – Substitution nucleophilic unimolecular (S_N1) and Substitution nucleophilic bimolecular (S_N2) mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups (ii) nature of leaving groups (iii) nucleophiles and (iv) solvents.

Elimination reactions – Elimination unimolecular (E1) and Elimination bimolecular (E2) mechanisms; Hofmann and Saytzeff eliminations-explanation with mechanism.

Alkenyl halides: Types with examples.

Aryl and aralkyl halides: Preparation by halogenation.

Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

II Semester B.Sc. (DSC 2) - Question Paper Blue Print

Paper - 2

Sl. No.	Topic	No. of Teaching Hours	Marks per Teaching hour, 116/52 = 2.23	Part A		Part B		Part C		Total Marks
				No. of questions	Marks	No. of questions	Marks	No. of questions	Marks	
UNIT I										
1	Quantum Mechanics	8	18	1	2	1	5	1	**10**	17
2	Photochemistry	5	11	1	2		0	1	**10**	12
UNIT II										
3	Chemical bonding	13	29	5	10	2	10	1	**10**	30
UNIT III										
4	Polymers	4	9		0		0	1	**10**	10
5	Chromatography	9	20	2	4	1	5	1	**10**	19
UNIT IV										
6	Aromatic hydrocarbons	9	20	4	8	1	5	0.5	**5**	18
7	Organic halogen compounds	4	9		0	1	5	0.5	**5**	10
		52	**116**	**13**	**26**	**6**	**30**	**6**	**60**	**116**

Part A			Part B			Part C		
2 Marks Questions			5 Mark questions			10 Mark questions = (5 + 5) or (6 + 4) Pattern		
No. of questions		Total Marks	No. of questions		Total Marks	No. of questions		Total Marks
To set	To answer		To set	To answer		To set	To answer	
13	**10**	**10 × 2 = 20**	**6**	**4**	**4 × 5 = 20**	**6**	**4**	**40**

Chemistry Practical - II Semester B.Sc.

Instructions per week	Marks		Total marks	Duration of Examination	Credits
	Internal assessment marks	End Semester Examination	50		2
3 Hours	10	40		3 Hours	

1. Determination of density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
3. To study the variation of viscosity of sucrose solution with concentration of the solute.
4. Determination of percentage composition of a binary liquid mixture by viscosity method.
5. Determination of critical solution temperature of phenol-water system.
6. Determination of percentage of sodium chloride solution by finding out the CST of phenol-water system.
7. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
8. Determination of distribution coefficient of benzoic acid between water and toluene.
9. Determination of distribution coefficient of acetic acid between water and butanol.
10. To study the effect of surfactants on the surface tension of water (Stock solution to be given).