Physical Chemistry Lab.
2019

Department of Materials and Life Sciences,
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I How to Write Reports

In general, reports are structured as follows. However, if instructions on how to describe the report are instructed for each experimental subject, follow it.

I Title of experiment
II Your name (student number), partner's name (student number)
III Submission date (dd/mm/yy)
IV Date of experiment, atmospheric temperature, and pressure on the day of experiment
Atmospheric temperature and pressure can affect the experimental data.
V Purpose of experiment
VI Principle of experiment
The theoretical background required to achieve the purpose of the experiment should be described by clarifying the data you will directly observe (measure) and the analysis method.
VII Experimental method
The apparatuses used and their operating procedures should be described concretely, focusing as much as possible on the important information related to experimental results.
VIII Measurement results
The directly measured data should be clearly organized and summarized in tables or graphs if necessary. The data should be analyzed and conclusions drawn on the basis of the purpose of the experiment.
IX Discussions
The results obtained should be discussed considering the accuracy of the apparatuses used and the precision of the experimental procedure and method of analysis. If possible, the relationship between the experimental results and items other than those described in the purpose should also be discussed.

II Units and Conversion Tables

II-1 SI base units

Quantity name	Quantity symbol	Unit name	Unit symbol
Length	l	metre	m
Mass	m	kilogram	kg
Time	t	second	s
Electric current	I	ampere	A
Thermodynamic temperature	T	kelvin	K
Amount of substance	n	mole	mol
Luminous intensity	Iv	candela	cd

II-2 SI prefixes

Multiple	Prefix	Symbol	Multiple	Prefix	Symbol
10	deca	da	10^{-1}	deci	d
10^{2}	hecto	h	10^{-2}	centi	c
10^{3}	kilo	k	10^{-3}	milli	m
10^{6}	mega	M	10^{-6}	micro	μ
10^{9}	giga	G	10^{-9}	nano	n
10^{12}	tera	T	10^{-12}	pico	p
10^{15}	peta	P	10^{-15}	femto	f
10^{18}	exa	E	10^{-18}	atto	a

II-3 SI derived units

Quantity name	Unit name	Unit symbol	Expressed in terms of SI base units
Frequency	hertz	Hz	s^{-1}
Force	newton	N	$m \cdot kg \cdot s^{-2}$
Pressure, stress	pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$
Energy, work, heat	joule	J	$m^{2} \cdot kg \cdot s^{-2}$
Power	watt	W	$m^{2} \cdot kg \cdot s^{-3}$
Electric charge	coulomb	C	$s \cdot A$
Electric potential	volt	V	$m^{2} \cdot kg \cdot s^{-3} \cdot A^{-1}$
Electric capacitance	farad	F	$m^{-2} \cdot kg^{-1} \cdot s^{4} \cdot A^{2}$
Quantity name	Unit name	Unit symbol	Expressed in terms of

			SI base units
Electric resistance	ohm	Ω	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
Electric conductance	siemens	S	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$
Magnetic flux	weber	Wb	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$
Magnetic flux density	tesla	T	$kg \cdot s^{-2} \cdot A^{-1}$
Inductance	henry	H	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-2}$
Celsius temperature	degree Celsius	°C	K
Plane angle	radian	rad	1
Solid angle	steradian	sr	1

II-4 Physical quantities

Quantity	Symbol	Value	Unit
Permeability of vacuum	μ_0	$4\pi \times 10^{-7}$	$N \cdot A^{-2}$
Speed of light in vacuum	c_0	299 792 458	$m \cdot s^{-1}$
Permittivity of vacuum	ε_0	$8.854\ 187\ 817 \times 10^{-12}$	$F \cdot m^{-1}$
Elementary charge	e	$1.602\ 176\ 53(14) \times 10^{-19}$	C
Planck constant	h	$6.626\ 0693(11) \times 10^{-34}$	$J \cdot s$
Avogadro constant	L, N_A	$6.022\ 1415(10) \times 10^{23}$	mol^{-1}
Rest mass of electron	m_e	$9.109\ 3826(16) \times 10^{-31}$	kg
Rest mass of proton	m_p	$1.672\ 621\ 71(29) \times 10^{-27}$	kg
Faraday constant	F	$9.648\ 533\ 83(83) \times 10^{4}$	$C \cdot mol^{-1}$
Hartree energy	E_h	$4.359\ 744\ 17(75) \times 10^{-18}$	J
Bohr radius	a_0	$5.291\ 772\ 108(18) \times 10^{-11}$	m
Bohr magneton	μ_B	$9.274\ 009\ 49(80) \times 10^{-24}$	$J \cdot T^{-1}$
Nuclear magneton	μ_N	$5.050\ 783\ 43(43) \times 10^{-27}$	$J \cdot T^{-1}$
Rydberg constant	R_∞	10 973 731.568 525(73)	m^{-1}
Gas constant	R	8.314 472(15)	$J \cdot K^{-1} \cdot mol^{-1}$
Boltzmann constant	k, k_B	$1.380\ 6505(24) \times 10^{-23}$	$J \cdot K^{-1}$
Gravitational constant	G	$6.6742(10) \times 10^{-11}$	$m^3 \cdot kg^{-1} \cdot s^{-2}$
Standard acceleration due to gravity	g_n	9.806 65	$m \cdot s^{-2}$
Triple point of water	$T_{tp}(H_2O)$	273.16	K
Zero of Celsius scale	$T(0°C)$	273.15	K
Molar volume of ideal gas (1 atm, 273.15 k)	V_m	$2.241\ 3996(39) \times 10^{-2}$	$m^3 \cdot mol^{-1}$

II-5 Greek alphabets

Letter		Name
Α	α	alpha
Β	β	beta
Γ	γ	gamma
Δ	δ	delta
Ε	ε	epsilon
Ζ	ζ	zeta
Η	η	eta
Θ	θ	theta
Ι	ι	iota
Κ	κ	kappa
Λ	λ	lambda
Μ	μ	mu
Ν	ν	nu
Ξ	ξ	xi
Ο	ο	omicron
Π	π	pi
Ρ	ρ	rho
Σ	σ	sigma
Τ	τ	tau
Υ	υ	upsilon
Φ	ϕ	phi
Χ	χ	chi
Ψ	ψ	psi
Ω	ω	omega

II-6 Conversion table for pressure units

Pa	bar	mbar	atm	Torr
1	10^{-5}	10^{-2}	9.86923×10^{-6}	7.50062×10^{-3}
10^{5}	1	10^{3}	0.986923	750.062
10^{2}	10^{-3}	1	9.86923×10^{-4}	0.75006
1.01325×10^{5}	1.01325	1013.25	1	760
133.3224	1.333224×10^{-3}	1.333224	1.31579×10^{-3}	1

1 mmHg ≈ 1 Torr (The difference between them is less than 0.000015%)

II-7 Conversion table for energy units

Wave number $\tilde{\nu}$	Frequency ν	Energy E			Molar energy E_m		Temperature T
cm^{-1}	MHz	J	eV	Hartree	$kJ \cdot mol^{-1}$	$kcal \cdot mol^{-1}$	K
1	2.997925×10^{4}	1.986445×10^{-23}	1.239842×10^{-4}	4.556335×10^{-6}	1.196266×10^{-2}	2.85914×10^{-3}	1.438775
3.33564×10^{-5}	1	6.626069×10^{-28}	4.135667×10^{-9}	1.519830×10^{-10}	3.990313×10^{-7}	9.53708×10^{-8}	4.79924×10^{-5}
5.03412×10^{22}	1.509190×10^{27}	1	6.241510×10^{18}	2.293713×10^{17}	6.022142×10^{20}	1.439326×10^{20}	7.24296×10^{22}
8065.54	2.417989×10^{8}	1.602176×10^{-19}	1	3.674933×10^{-2}	96.4853	23.0606	1.16045×10^{4}
219474.63	6.579684×10^{9}	4.359744×10^{-18}	27.2114	1	2625.500	627.510	3.15775×10^{5}
83.5935	2.506069×10^{6}	1.660539×10^{-21}	1.036427×10^{-2}	3.808799×10^{-4}	1	0.239006	120.272
349.755	1.048539×10^{7}	6.947694×10^{-21}	4.336410×10^{-2}	1.593601×10^{-3}	4.184	1	503.219
0.695036	2.08366×10^{4}	1.380650×10^{-23}	8.61734×10^{-5}	3.16682×10^{-6}	8.31472×10^{-3}	1.98721×10^{-3}	1

$E = h\nu = hc\tilde{\nu} = kT$, $E_m = LE$ (L is Avogadro constant.)

Report Submission Checklist
Physical Chemistry Lab., 2019

ID number	Name

Laboratory session	Start and end dates	Check for completion	Report submission date	Report receipt
1. Basis of mass spectrometry	～			
2. Identification of nuclides by radiation measurement and radioactivity	～			
3. Electron and vibrational spectra	～			
4. Computational Chemistry A	～			
5. Computational Chemistry B	～			
6. Qualitative and quantitative analyses by gas chromatography	～			

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ID number _____ Name _____