UV-vis Spectroscopy

Dr. M. Subramanian

Assistant Professor

Department of Chemical Engineering

Sri Sivasubramaniya Nadar College of Engineering

Kalavakkam – 603 110, Kanchipuram (Dist)
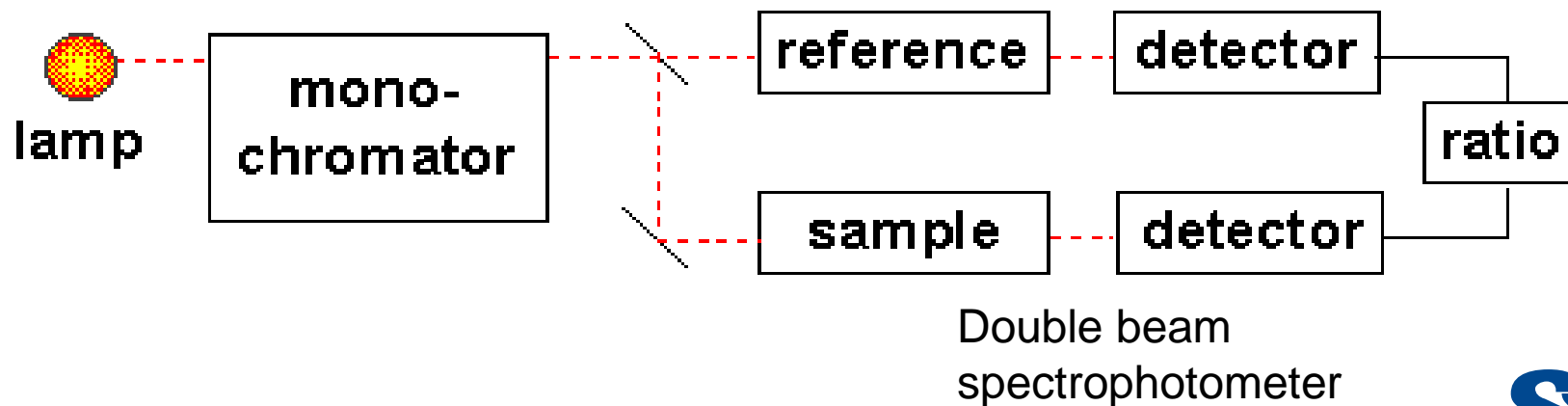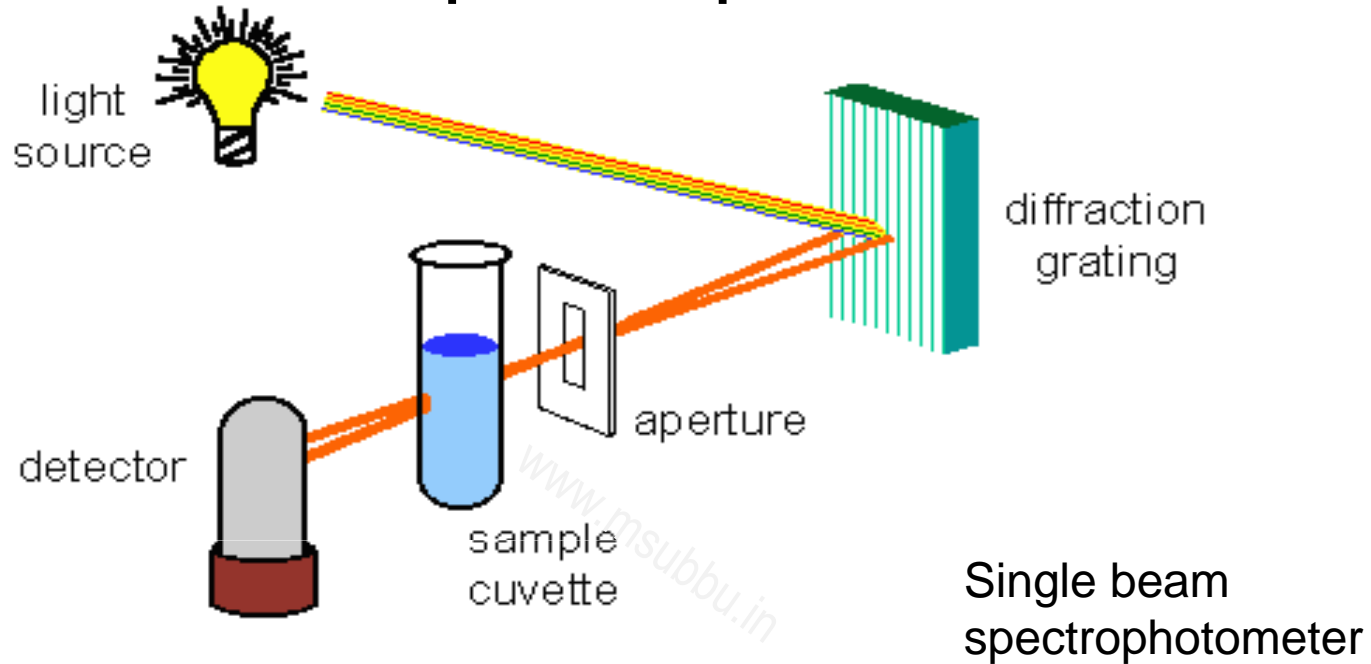
Tamil Nadu, India

msubbu.in@gmail.com
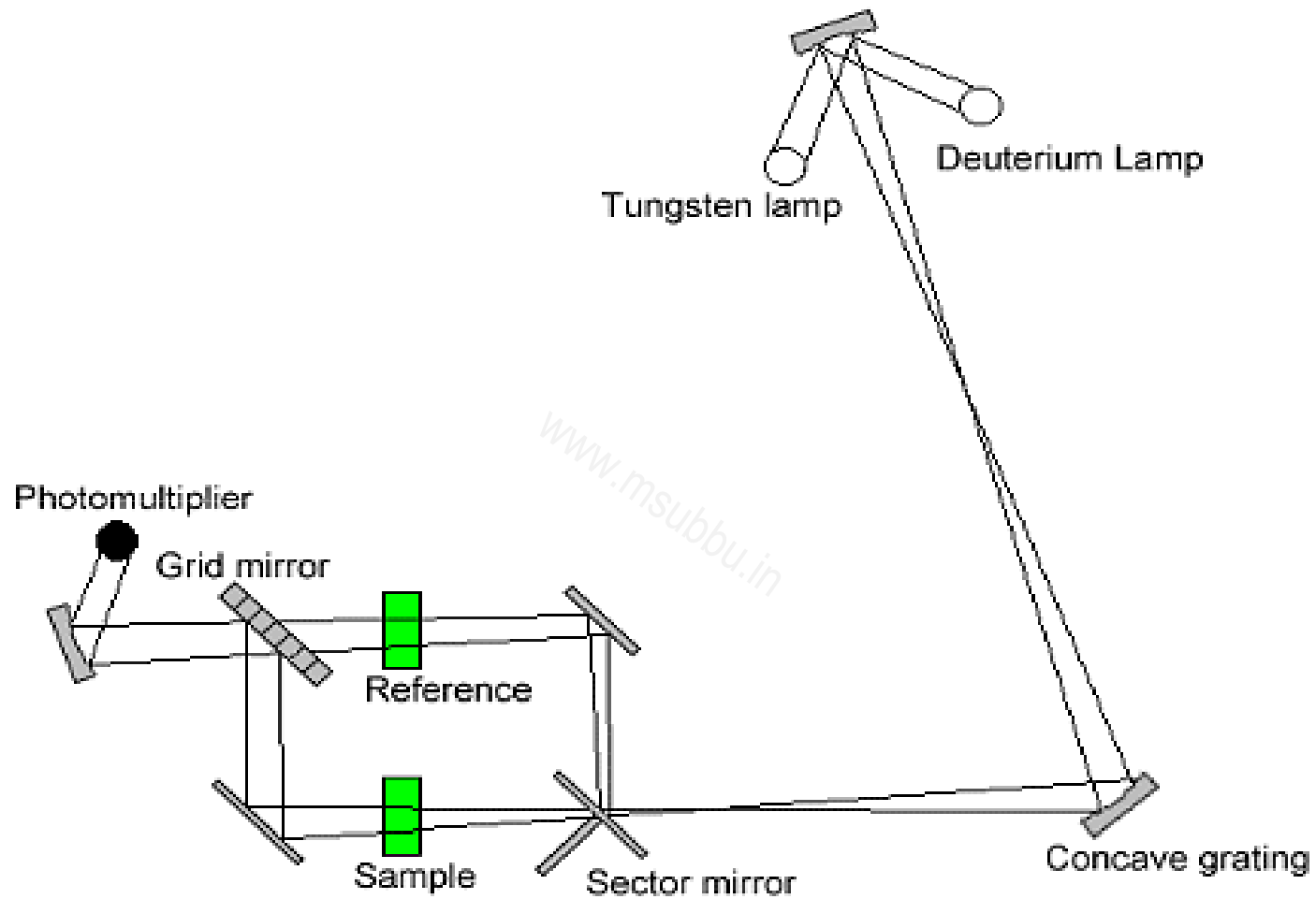
Contents

- Instrumentation (Source, Optical parts and Detectors)

- Estimation of inorganic ions such as Fe, Ni and Nitrite using Beer-Lambert's Law

UV-vis spectrophotometer

Single beam spectrophotometer

Double beam spectrophotometer

Tungsten lamp

Deuterium Lamp

Photomultiplier

Grid mirror

Reference

Sample

Sector mirror

Concave grating

Components of UV-vis

- Sources (UV and visible)

- Wavelength selector (monochromator)

- Sample containers

- Detector

- Signal processor and readout

Sources of light

- It is important that the power of the radiation source does not change abruptly over it's wavelength range.
- UV radiation:
  - Deuterium lamp
  - The electrical excitation of deuterium or hydrogen at low pressure produces a continuous UV spectrum. The mechanism for this involves formation of an excited molecular species, which breaks up to give two atomic species and an ultraviolet photon.
  - Both deuterium and hydrogen lamps emit radiation in the range 160 - 375 nm. Quartz windows must be used in these lamps, and quartz cuvettes must be used, because glass absorbs radiation of wavelengths less than 350 nm.
- Visible radiation
  - Tungsten halogen lamp
  - This type of lamp is used in the wavelength range of 350 - 2500 nm

Monochromator

Entrance slit   Reflection grating   Exit slit
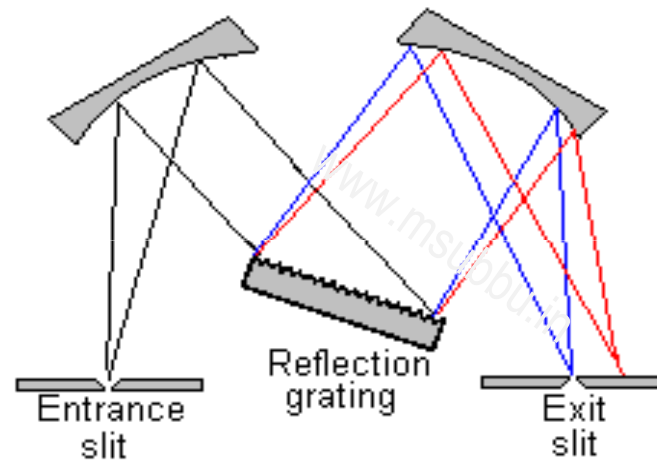
Sample Containers (Cuvettes)

- The containers for the sample and reference solution must be transparent to the radiation which will pass through them.

- Quartz or fused silica cuvettes are required for spectroscopy in the UV region. These cells are also transparent in the visible region.

- Silicate glasses can be used for the manufacture of cuvettes for use between 350 and 2000 nm.

Detectors

- Photomultiplier tube
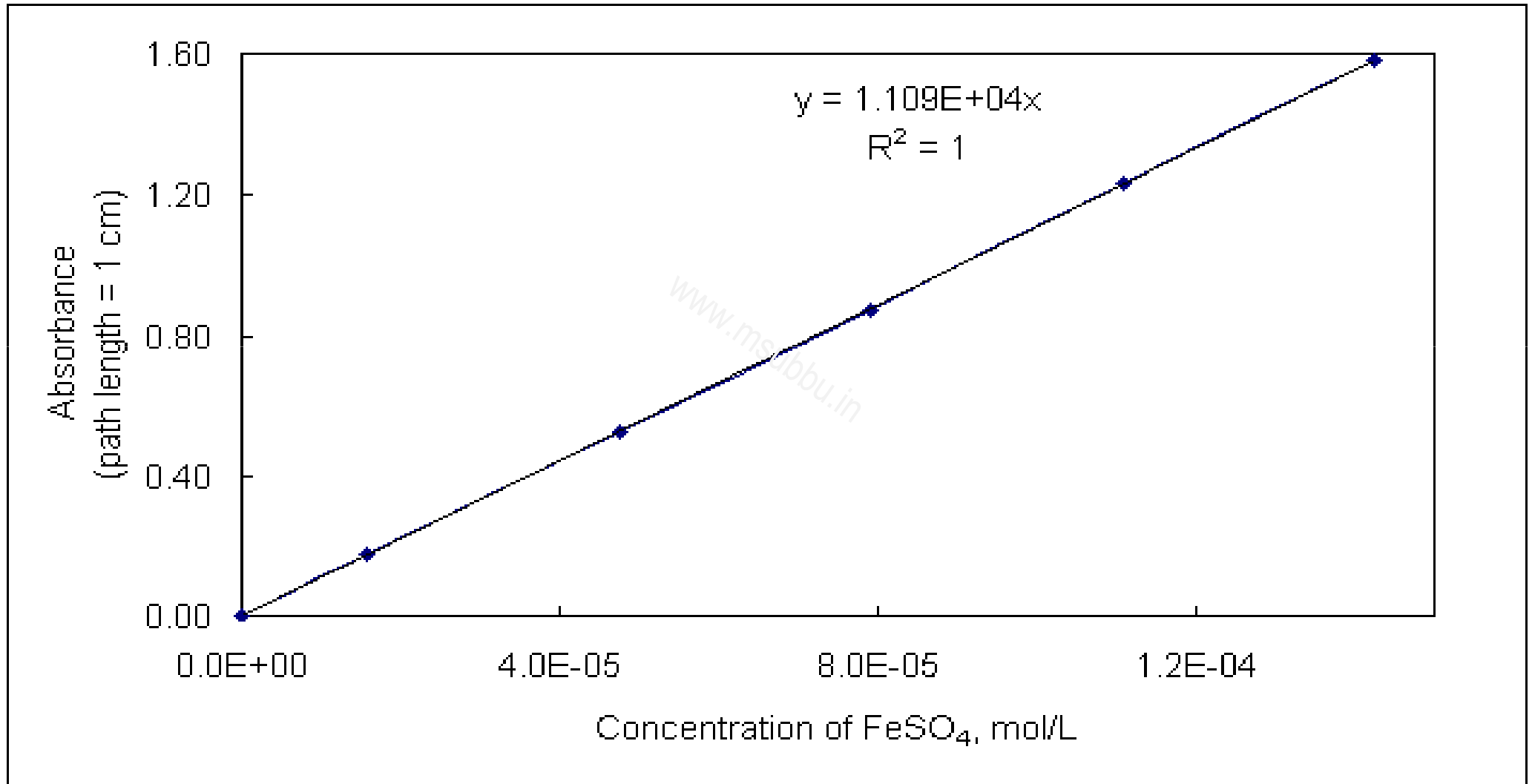
- Photodiode array

24 . 11 . 2007

Estimation of Iron

- Fe(II)
- Colouring complex: 1,10-phenonthroline
- Measurement at λ_{max} of 510 nm

Ferrous sulfate

Conc. Ferrous	Abs1	Abs2	AvgAbs
µmol/L	-		
0			0
15.8	0.1750	0.1764	0.176
47.5	0.5238	0.5236	0.524
79.2	0.8748	0.8750	0.875
111.0	1.2311	1.2309	1.231
143.0	1.5829	1.5828	1.583

Extinction Coefficient of Fe^{2+}-phenanthroline complex

$$y = 1.109\mathrm{E}{+}04x$$
$$R^2 = 1$$

Absorbance (path length = 1 cm) vs. Concentration of $FeSO_4$, mol/L

Spectrum of Fe(II)
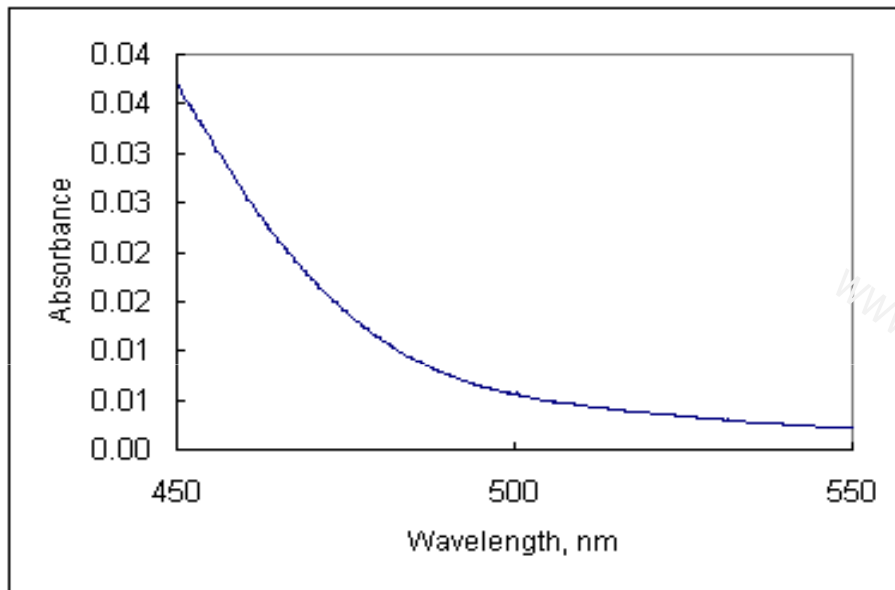
Blank solution
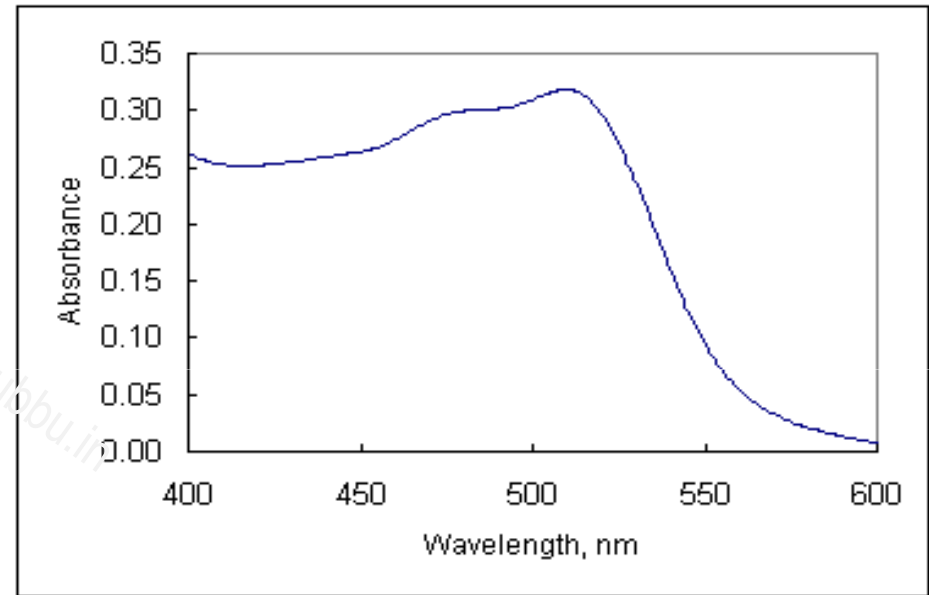
Fe(II)

Using: Jasco V-530 UV-Vis Spectrophotometer

Estimation of Ni

- $NiSO_4$ solution (Nickel (II) Sulfate)

Estimation of Ni (contd)

| S.No.	Wave length, nm	Absorbance at				
		Con 0.04 mol dm^{-3}	Con 0.05 mol dm^{-3}	Con 0.06 mol dm^{-3}	Con 0.07 mol dm^{-3}	Con 0.08 mol dm^{-3}
1	340	0.05	0.053	0.057	0.071	0.086
2	350	0.057	0.063	0.069	0.084	0.092
3	360	0.086	0.09	0.098	0.119	0.123
4	370	0.116	0.132	0.159	0.187	0.205
5	380	0.172	0.203	0.233	0.275	0.309
6	385	0.180	0.229	0.27	0.324	0.358
7	390	0.185	0.245	0.295	0.347	0.395
8	391	0.197	0.242	0.304	0.356	0.392
9	392	0.20	0.24	0.292	0.357	0.404
10	393	0.204	0.258	0.306	0.361	0.410
11	394	0.19	0.244	0.298	0.36	0.404
12	395	0.188	0.215	0.249	0.295	0.322
13	400	0.185	0.213	0.248	0.292	0.322
14	410	0.156	0.179	0.208	0.248	0.272
15	420	0.112	0.129	0.15	0.178	0.195
16	430	0.072	0.081	0.093	0.109	0.12
17	440	0.048	0.053	0.06	0.069	0.075

Mathpal, S., Kandpal, N.D., E-Journal of Chemistry, 6 (2009) 445-448
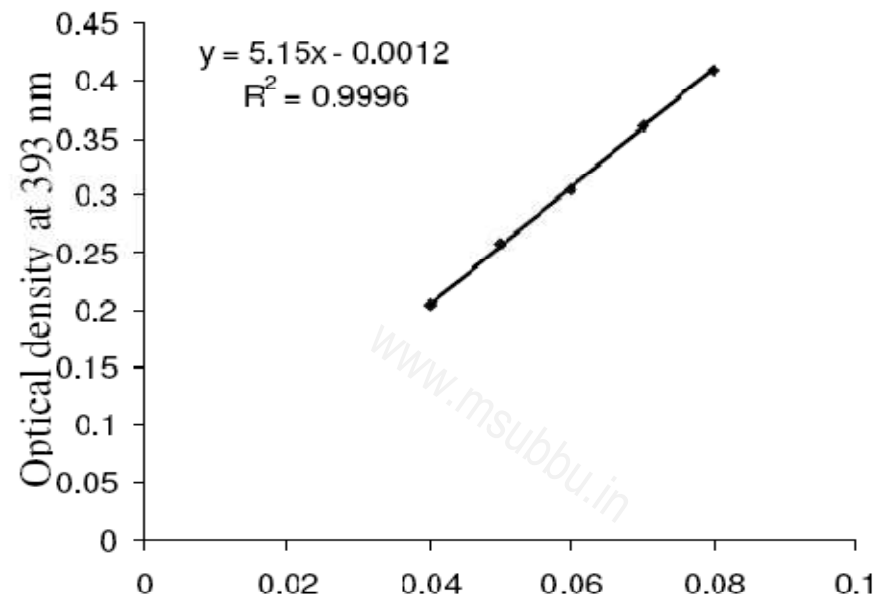
Figure 1. Concentration of nickel sulphate, mol dm^{-3}.