Ultra-Violet / Visible Spectroscopy

Some Keywords in UV Spectroscopy

- Spectroscopy:

✓ theoretical science of interaction of radiation & matter

- Spectrometry:

✓ practical measurement of spectra

- Spectrophotometer
- Electromagnetic radiation

- Transmittance: T
- Absorbance: A
- Optical Density (OD)

Electromagnetic Spectrum

- UV-Visible range: 200-800 nm

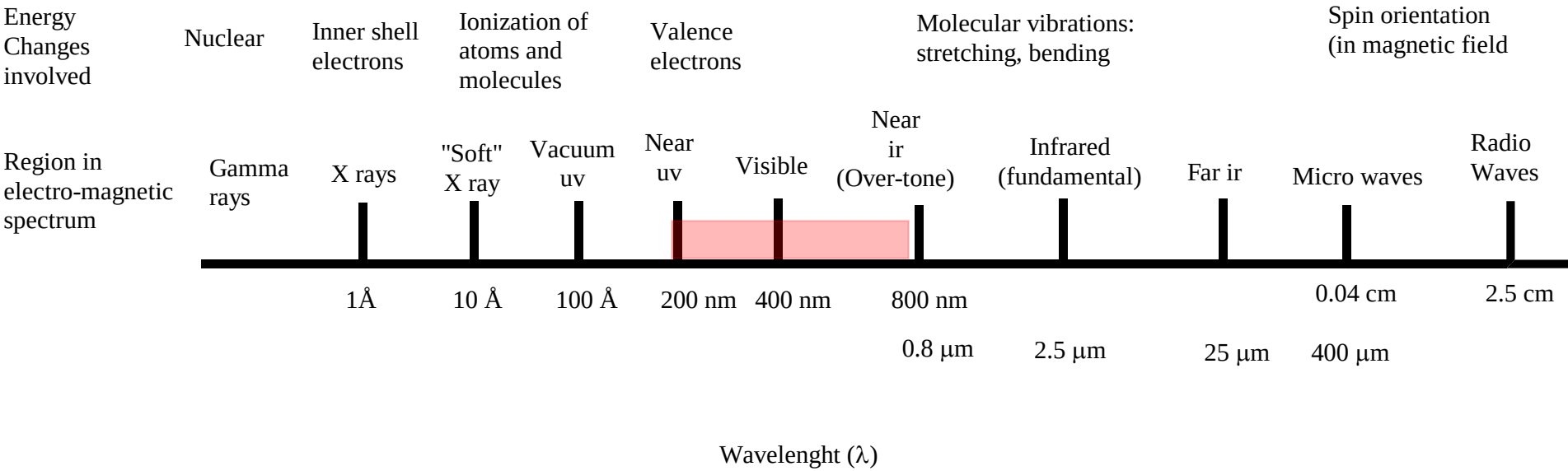
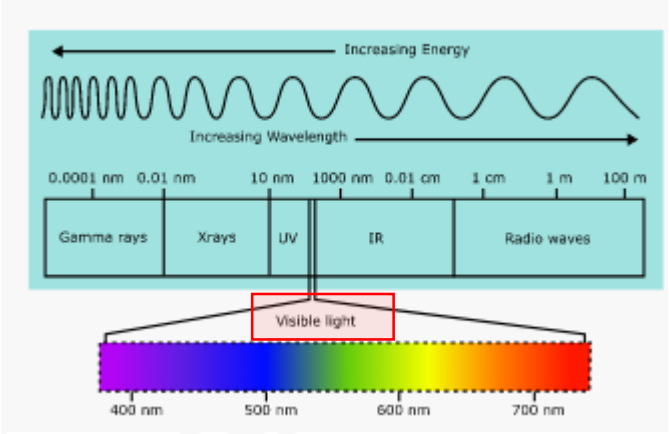


Chart of Electromagnetic Spectrum

- UV-Visible: 200-800n



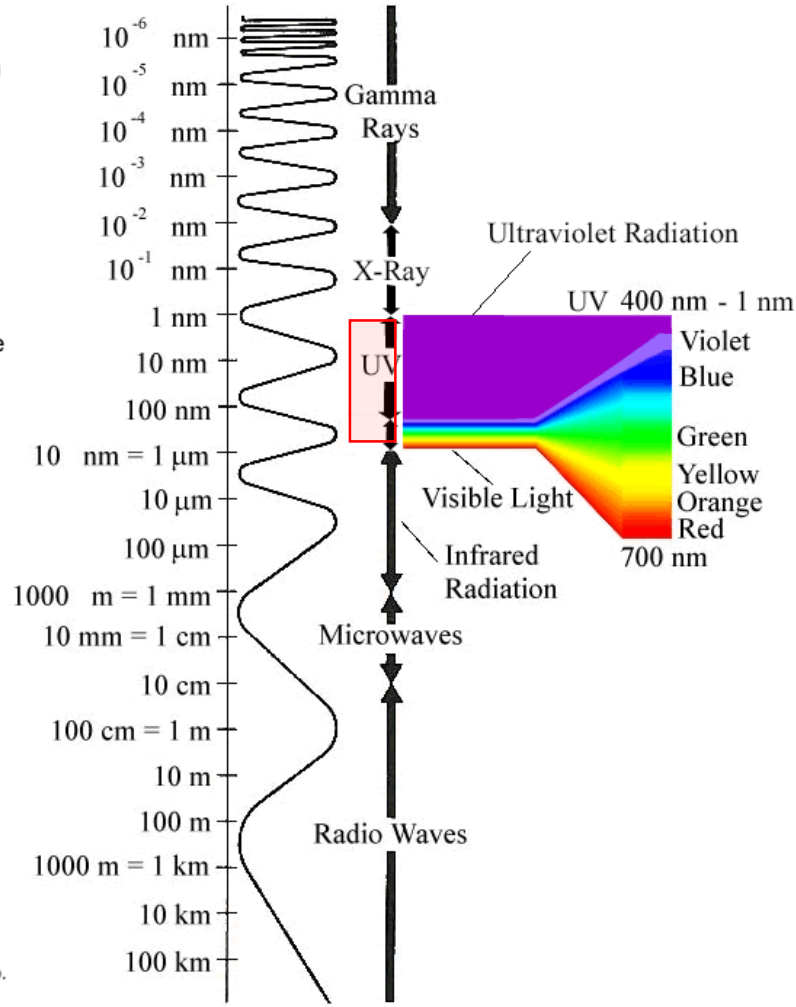
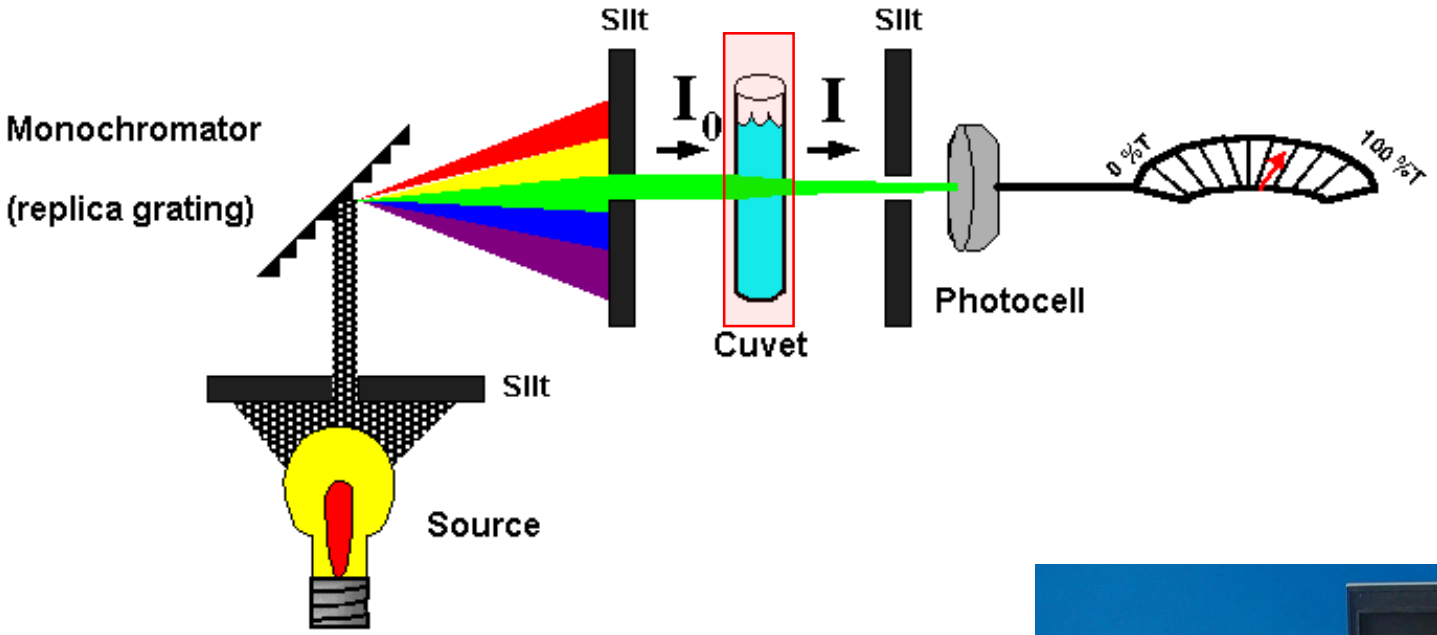


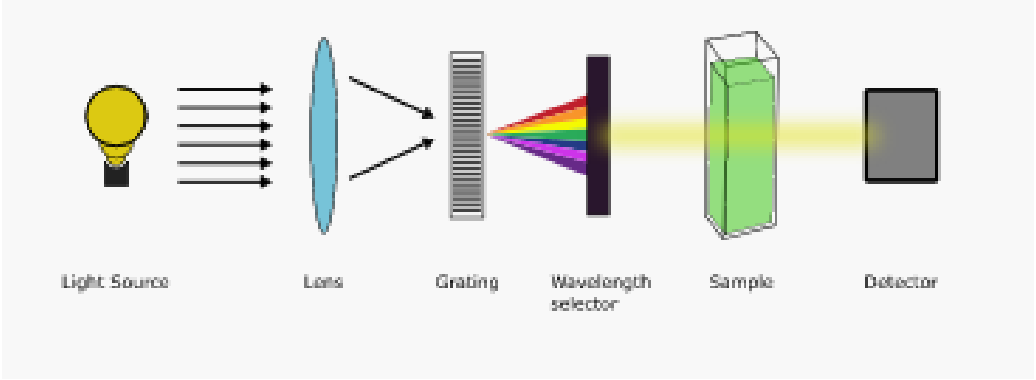
TABLE 7.13
RELATIONSHIP BETWEEN THE COLOR OF LIGHT ABSORBED BY A COMPOUND AND THE OBSERVED COLOR OF THE COMPOUND

Color of Light Absorbed	Wavelength of Light Absorbed (nm)	Observed Color
Violet	400	Yellow
Blue	450	Orange
Blue-green	500	Red
Yellow-green	530	Red-violet
Yellow	550	Violet
Orange-red	600	Blue-green
Red	700	Green

Simple Image of UV Spectrophotometer

- Consider concepts of Transmittance (T) & Absorbance (A)





Instrumentation of UV-Spectrophotometer

- Items:

✓ Source of radiation: 3 types of lamps

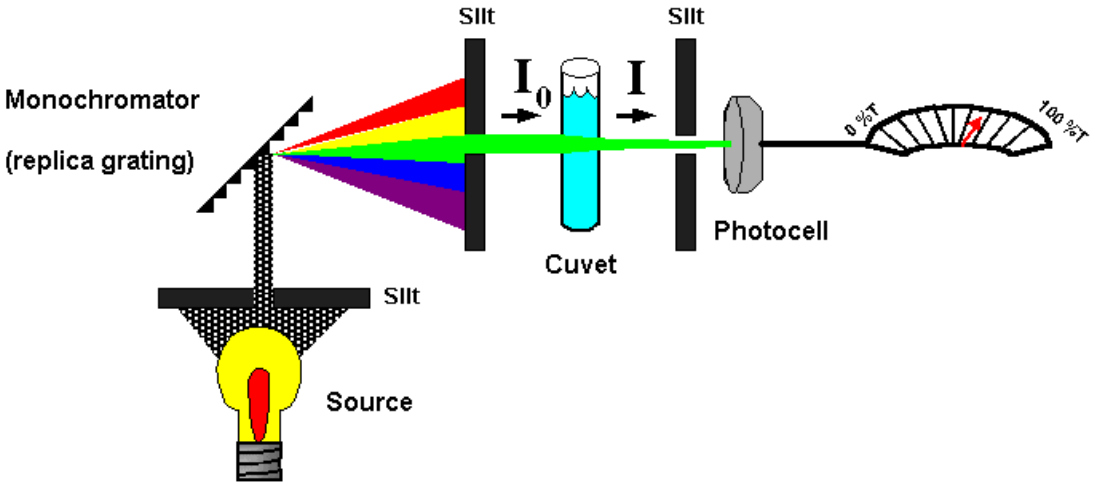
✓ wavelength selector: filter; monochromator or polychromator

✓ sample container: cell or cuvette

✓ detector: radiation transducer; photo-detector; photocell

✓ signal processor & amplifier

✓ readout device



UV Spectrophotometer: Source of Radiation

- D_2/H_2 lamp: $D_2/H_2 + E \longrightarrow D_2^*/H_2^* \longrightarrow D' + D'' + h\upsilon$

✓ 160 - 375 nm

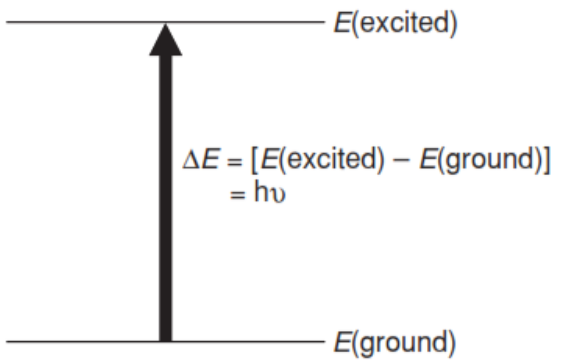


FIGURE 7.1 The excitation process.

- Tungsten (W) filament lamp: the most common:

✓ 350 - 2500 nm

- Xenon Arc lamp (XBO):

✓ 200 – 800 &1000 nm: continuous & uniform

❑ All should be connected to a stabilized voltage supply

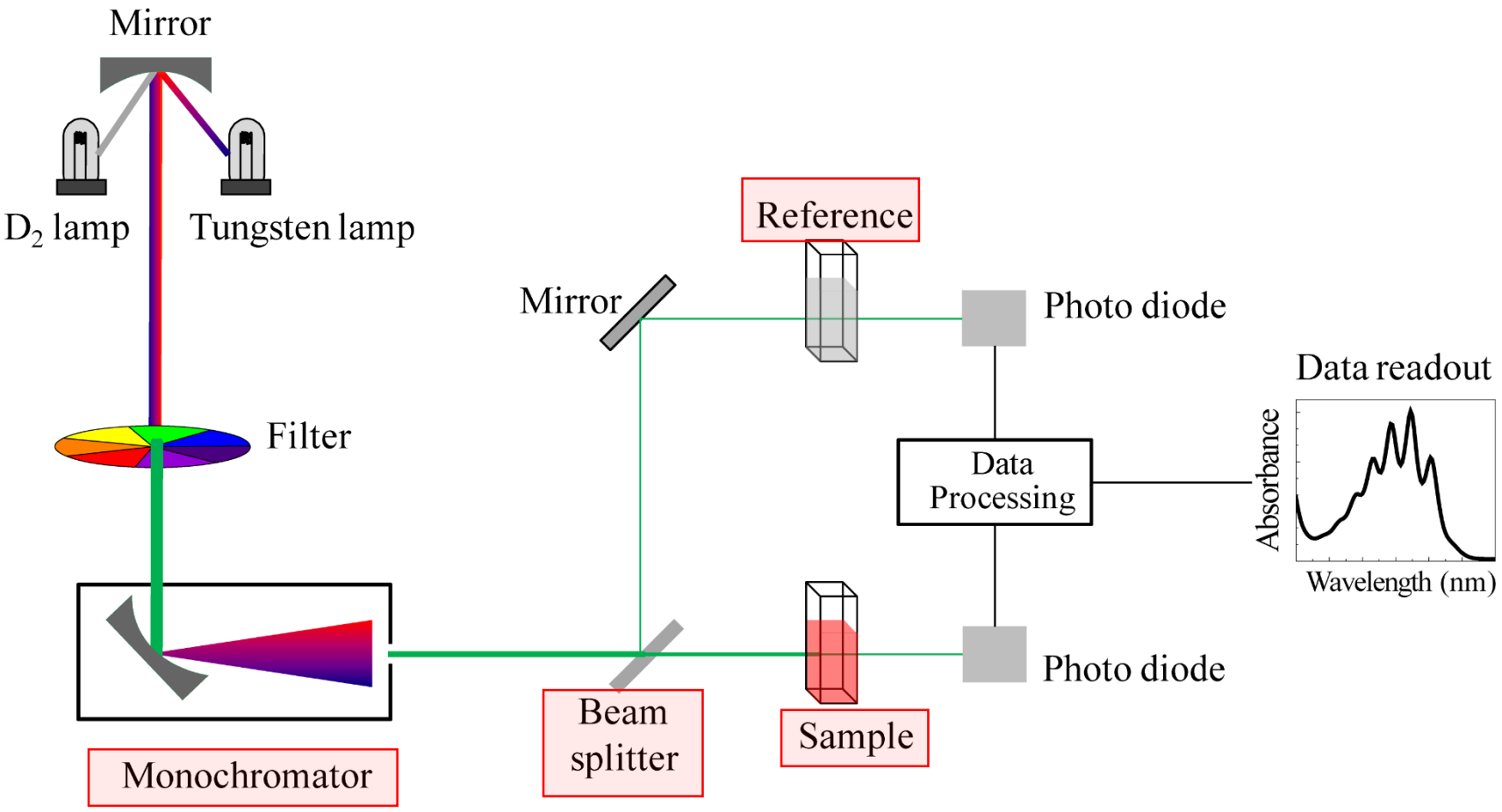
UV Spectrophotometer: Wavelength Selector

- Single wavelength is almost impossible:

- So band of wavelength is practically provided

- Filter
- Monochromator
- Polychromator

Instrument of Spectrophotometer in Schematic Image



UV Spectrophotometer: Wavelength Selector: Filter

- Colored glass filters: cutoff or band pass filters
- Broad wavelength in visible area:

✓ so give the chance of deviation from Beer-Lambert law

- Not suggested for research purposes

- Often used together with monochromators to narrow selected wavelength:

✓ more precise measurement

✓ improve signal to noise ratio

UV Spectrophotometer: Wavelength Selector: Monochromator

- Optical device: to select a narrow band of wavelength of light
- Spread the beam of light into component wavelengths
- Used for spectral scanning in UV-visible region

- Components of device:

✓ slit
✓ mirror
✓ lense
✓ prism or grating

- Polychromator: …

General Characteristics of UV-Spectrophotometer-1

- Single beam:

✓ equipped to filter or monochromator: set of individual filters

- Double beam: applied in many modern instruments:

✓ equipped to V-shaped mirror (beam splitter):

✓ to extinct upon sample beam & solvent (blank) beam

General Characteristics of UV Spectrophotometer-2: Multi-Channel

- The most recent type
- Single beam based upon diode array transducer
- Radiation raised from polychromatic source:

focused upon sample & solvent

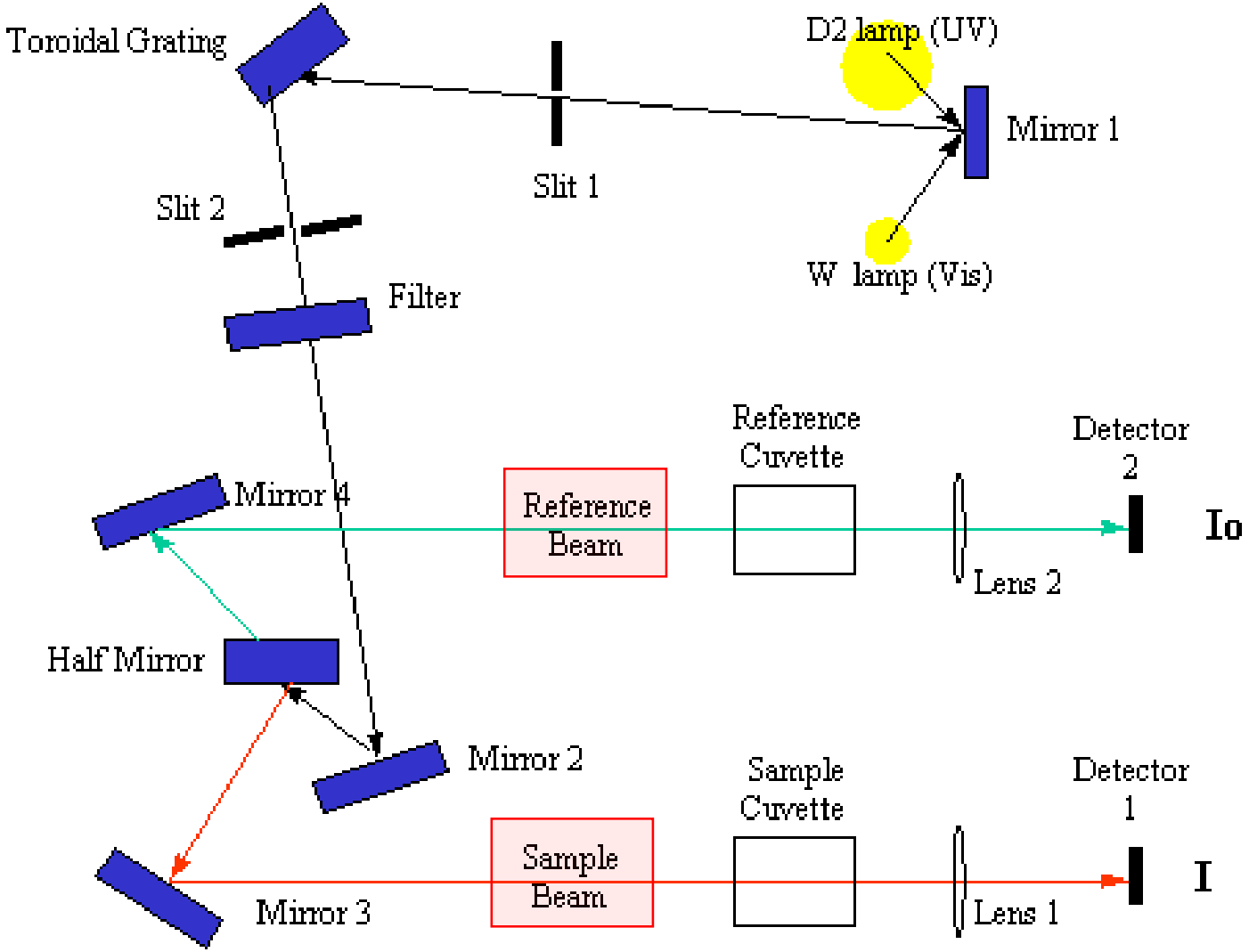
then

passes through a monochromator with a fixed grating

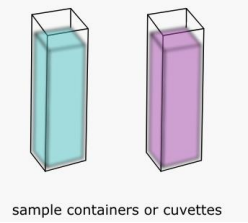
then

the dispersed radiation falls on a Photo-Diode Array (PDA)

Instrument of Double Beam Spectrophotometer



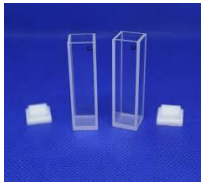
UV Spectrophotometer: Sample Cell or Cuvettes


sample containers or cuvettes

- Transparent for the transmitting light: 2 or 4 side transparent
- Dimensions: various regarding the sample volume

✓ 1.0 to 10cm: 1.0 cm is common

- Made of three types of material:



✓ quartz: expensive: suitable for UV-visible region

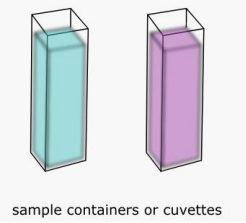
✓ plastic: disposable: suitable for visible region;

✓ not suitable for UV region

✓ not suitable for organic solvent

✓ glass: not suitable for UV region: due to the ability of light absorption

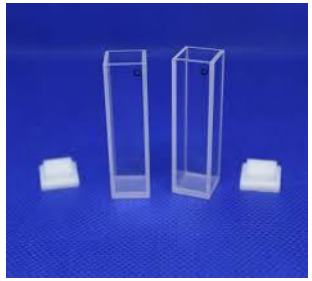
UV Spectrophotometer: Sample Cell or Cuvettes by Image



- Follow the position of light transmitting on the various types of cuvettes

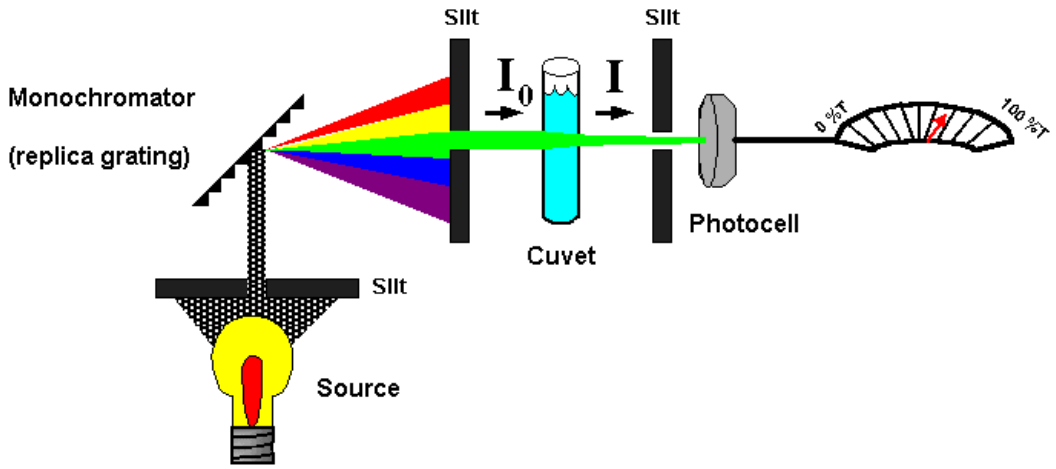
- Micro
- Semi-micro
- Ultra-micro

- Cylindered or conical



Types of UV-Spectrophotometers

- Single beam



- Double beam:

✓ simple double beam

✓ double beam in time

- Multichannel (multi-chromator)

UV Spectrophotometer: Detectors

- Transducers
- Photodetector:

✓ phototube: photo-emissive cells

✓ photomultiplier: sensitive

✓ silicon diode

✓ photovoltaic diode

- Photographic films
- Mercury level in thermometer
- Human eye