Homework, Chapter 13

13.16

The deuterium lamp gives a continuum spectrum in the UV/Visible region of the electromagnetic spectrum because the emission originates from a deuterium molecule. Because it originates from a molecule, the excited state energy of the Deuterium is distributed among vibrational and rotational energy levels of the excited electronic state. This results in a wide range of energies from which the emission can occur.

In the deuterium lamp, excitation generates an excited state deuterium molecule (D_2^*). This excited state molecule dissociates into deuterium atoms and gives off a photon. The excess energy of the excited state deuterium molecule is released in the form of the kinetic energy of the atoms and the energy of the photon.

13.19

Infrared radiation has a long wavelength (micrometers) and a low energy. Most materials used as the photocathode of a photomultiplier tube require higher energy photons to overcome the work function of the photocathode (and release an electron). Photomultiplier tubes, therefore, are not used to detect infrared radiation simply because infrared photons do not have enough energy to overcome the work function of the photocathode.

13.22

A spectrometer used in an absorption experiment has all of its components along the optical axis. That is, the source beam of light follows a path from the source to the detector, and all other components of the measurement (sample, monochromator, and associated optics) are all along that path.

A spectrometer used in an emission experiment does not have to have the detector along the optical path established by the source radiation. Emission from an excited state analyte occurs in all directions (e.g. the emission radiation is incoherent); therefore, the detector can be placed anywhere surrounding the sample. Generally, the detector is placed 90^o away from the optical path. This allows for greater analytical sensitivity because the detector sees only the emission radiation and not the source radiation. In the absence of an emission signal, the detector sees no intensity; consequently, it is easier for the detector to measure a small response from an emission experiment because the background response has no influence on the detector output.

13.24

a. Dark Current – the current that occurs in the absence of radiation impinging on the active area of the detector.

b. Transducer - an instrument that converts a response from one domain into another domain. For example it converts a chemical response into the electrical domain for measurement.

c. Scattered Radiation - Radiation that traverses the monochromator without being dispersed by either the grating or the prism. This generally occurs by reflections off some imperfect optics.

d. n-type semiconductor- A semiconductor in which the base material has been replaced (doped) with another atomic species that has more electrons in its valence shell than the base material. As a consequence, the semiconductor has more electrons available in the conduction band than there would be if it were made of the pure base material.

e. majority carrier - in a semiconductor, the majority carrier is the component of the conduction band of a doped semiconductor that is present in excess relative the conduction band of a semiconductor prepared from a pure material. If there are an excess of electrons, then the majority carrier is the excess electrons. If there is a deficit of electrons, then the majority carrier is the "hole" or absence of electron.

f. depletion layer - This is the layer within a diode that develops at the interface between an n-type and a p-type semiconductor. It is formed by the natural diffusion of the majority charge carriers in the n-type and p-type semiconductors due to the concentration gradient of these majority carriers across the boundary. After a period of time, this diffusion establishes a charge separation that results in an internal bias within the semiconductor.