FACULTY OF SCIENCE

DEPARTMENT OF APPLIED PHYSICS AND ENGINEERING MATHEMATICS

MODULE CODE	**PHY2ZAT**
MODULE	**NATIONAL DIPLOMA: ANALYTICAL CHEMISTRY**
CAMPUS	**DFC**

JUNE EXAM

DATE: 11/06/2014	**SESSION 08:30**
ASSESSOR(S)	**DR P NAIR / DR L REDDY**
INTERNAL MODERATOR	**DR L REDDY / DR P NAIR**
DURATION 3 HOURS	**MARKS 100**

NUMBER OF PAGES: 5 PAGES AND 3 ANNEXURES

INSTRUCTIONS: CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT)

REQUIREMENTS: 2 ANSWER SCRIPTS PER STUDENT

SECTION A

QUESTION 1

1.1 State the conditions necessary for interference of light waves to take place. (3)

1.2 Two narrow slits are separated by a distance of 0,03 cm. An interference pattern is produced on a screen 1,5 m away. The fourth bright fringe is obtained at 1,0 cm from the central point on the screen. Determine the wavelength of light used. (3)

1.3 A beam of light consisting of two wavelengths which differ by 160 nm passes through a diffraction grating having 2,5 x 10^3 lines.cm^{-1}. In the diffracted light, the third order of one wavelength coincides with the fourth order of the other.

1.3.1 What are the two wavelengths? (3)
1.3.2 At what angle of diffraction does this coinciding occur? (3)

1.4 How far apart are the diffracting planes in a NaCℓ crystal for which x-rays of wavelength 15,4 nm make a diffraction angle of 16° in the first order? (3)

1.5 Specific rotation of sugar solution in 0,5 deg.m^2.$kg.^{-1}$. A sample solution is taken in a polarimeter tube of length 20 cm. The optical rotation is found to be 19°. Determine the concentration of the solution. (3)

[18]

QUESTION 2

2.1 State the law of radioactive decay. (2)

2.2 A freshly prepared radioactive source of half-life 2,0 h emits nuclear radiation of intensity which is 64 times the permissible safe level. Calculate the minimum time after which it would be possible to work safely with this source. (3)

2.3 A fossil bone has ^{14}C, which is $\frac{1}{16}$ of that in a living animal bone. If the half-life of ^{14}C is 5 730 year, calculate the age of the fossil. (3)

2.4 Define:

2.4.1 Attenuation of radiation (1)
2.4.2 Half-Value-Layer (HVL) (1)

2.5 If the maximum permissible dosage for radiographers working with x-rays is 10% of the incident intensity, what thickness of lead is necessary to make a laboratory coat for radiation protection?

(Absorption coefficient for x-rays in lead = 1 593 cm^{-1}) (2)

[12]

QUESTION 3

3.1 State the postulates of theory of relativity. (4)

3.2 At what speed a spaceship has to travel for its apparent length to be 99% of its real length?

(4)

3.3 Calculate the rest mass energy of electron. (2)

[10]

QUESTION 4

4.1 State Bernoulli's theorem. (2)

4.2 A horizontal pipeline carries water in a streamline flow. At a point along the pipe where cross-sectional area is 10 cm^2, the velocity of water is 1 $m.s^{-1}$ and pressure is 2 000 Pa. What is the pressure of water at another point where cross-sectional area is 5 cm^2? [density of water = 10^3 $kg.m^{-3}$]

(8)

[10]

SUB-TOTAL : SECTION A = 50

SECTION B

QUESTION 1

1.1 State or define

1.1.1 Photoelectric effect
1.1.2 Compton effect
1.1.3 Heisenberg's Uncertainty Principle (6)

1.2 In the lungs there are tiny sacs of air, which are called alveoli. The average diameter of one of these sacs is 0,25 mm. Consider an oxygen molecule (mass = 5.3 x 10^{-26} kg) trapped within the sac. What is the minimum uncertainty in the velocity of this oxygen molecule?

(4)

1.3 X-rays of wavelength 0,2 nm are scattered from a block of material. The scattered X-rays are observed at an angle of 45° to the incident beam. Calculate the wavelength of the X-rays scattered at this angle.

(4)

[14]

QUESTION 2

2.1 State the 4 quantum numbers used to describe the state of the hydrogen atom. Also state the allowed range of each of these numbers.

(4)

2.2 For a hydrogen atom, determine the number of allowed states corresponding to the principal quantum number n = 2 and calculate the energies of these states. (5)

2.3 In the line spectrum of atomic hydrogen, there is also a group of lines known as the Pfund series, these lines are produced when electrons excited to high energy levels, make a transition to the n = 5 energy level. Determine the

2.3.1 longest wavelength, and
2.3.2 shortest wavelength of this series (4)

[13]

QUESTION 3

3.1 "When a charge is placed in a magnetic field, it experiences a magnetic force". State two conditions for which the above statement is valid.

(2)

3.2 An ion source in a mass spectrometer produces deuterons (A deuteron is a particle that has twice the mass of a proton, but the same charge). Each deuteron is accelerated from rest through a potential difference of 2 x 10^3 V, after which it enters a 0,6 T magnetic field. Find the radius of its curved path.

(4)

3.3 An electron in a television picture tube moves towards the front of the tube with a speed of 8 x 10^6 m/s along the x-axis. The neck of the tube is surrounded by a coil of wire that creates a magnetic field of magnitude 0,025 T, directed at an angle of 60° to the x-axis and lying in the xy plane. Calculate the magnetic force and acceleration of the electron.

(4)

3.4 A charged body, moving with a velocity of 8 x 10^4 m/s at an angle of 30° with respect to the magnetic field of strength 5.6 x 10^{-5} T, experiences a force of 2 x 10^{-4} N. What is the magnitude of the charge?

(3)

[13]

QUESTION 4

4.1 State Faraday's law of electromagnetic induction (2)

4.2 A hand is held flat and placed in a uniform magnetic field of magnitude 0.35 T. The hand has an area of 0,0160 m^2 and negligible thickness. Determine the magnetic flux that passes through the hand when the normal to the hand is

4.2.1 parallel, and
4.2.2 perpendicular to the magnetic field (4)

4.3 A magnetic field is perpendicular to a 0,04 m x 0,06 m rectangular coil of wire that has 100 turns. In a time of 0,050 s, an average emf of magnitude 1,5 V is induced in the coil. What is the magnitude of the charge in the magnetic field?

(4)

[10]

SUB-TOTAL : SECTION B = 50

TOTAL = 100