($2\,{}^{1}/_{2}$ Hours) **[Total Marks : 60]**

N.B. : (1) **All** questions are **compulsory**.
(2) **Figures** to the **right** indicate **full** marks.
(3) Draw **neat** diagrams wherever **necessary**.
(5) Symbols have usual meaning unless otherwise stated.
(5) Use of **log-table** and **non-programmable** calculator is allowed.

1. (a) Attempt any **one:---**

(i) What is Random error and Systematic error? Explain in brief the different sources of random error. **8**

(ii) Write short notes on **8**
a. T Distribution
b. Poisson Distribution
c. Binomial Distribution

(b) Attempt any one:---

(i) The data given below is of the lattice dimension c of the unit cell of 8 crystals created by an experimenter in a lab. At $\alpha = 0.05$ level of significance, determine whether the sample mean of the values differs significantly from the published value of $c = 1.1693\ nm$ **4**

$c\ (in\ nm)$	1.1685	1.1665	1.1672	1.1675	1.1695	1.1692	1.1702	1.1683

The t values for different confidence levels at n-1 degrees of freedom are as follows

No. of Values n	Degrees of Freedom	$t_{68\%}$	$t_{90\%}$	$t_{95\%}$	$t_{99\%}$
8	7	1.0703	1.8946	2.3647	3.4995
9	8	1.0602	1.8595	2.3060	3.3554
10	9	1.0525	1.8331	2.2622	3.2498

(ii) Find the mean and standard deviation for the following probability distribution function. **4**

$$f(x) = \begin{cases} 0, & x < 0 \\ Ax^4 e^{-4x}, & 0 \leq x < \infty \end{cases}$$

2. (a) Attempt any one:---

(i) With the help of a neat diagram explain the construction and working of a diffusion pump. **8**

(ii) With the help of a neat diagram explain the construction and working of Pirani gauge. What is the ultimate pressure measured by Pirani gauge? **8**

(b) Attempt any one:---

(i) Get the expression for conductance when pipes are connected in series. **4**

(ii) What is desorption and outgassing? Explain both the phenomena. **4**

3. (a) Attempt any one:---

(i) Explain the principle, construction and working of a linear drift tube accelerator. **8**

(ii) Explain the working mechanism of Geiger Muller counter. Also describe the quenching phenomenon. **8**

(b) Attempt any one:---

(i) Distinguish between an electron synchrotron and proton synchrotron. **4**

(ii) What are the advantages of semiconductor detectors over gas filled detectors? **4**

4. (a) Attempt any one:---

(i) With the help of energy level diagram explain the principle of Mossbauer spectroscopy. Describe its use in materials characterization. **8**

(ii) What is X-ray diffraction? With the help of neat labeled diagram, explain the construction and working of X-ray diffractometer. Discuss the θ-2θ scan. **8**

(b) Attempt any one:---

(i) What is the principle of photoelectron spectroscopy? Hence explain XPS as a characterization technique. **4**

(ii) What do you mean by Rutherford Backscattering? Discuss its use in Rutherford Backscattering Spectrometry (RBS) with the applications. **4**

5. Attempt any four:---

(a) The assembly of a hybrid circuit requires the soldering of 58 electrical connections. If 0.2% of the electrical connections are faulty, what is the probability that an assembled circuit will have: **3**

a. No faulty connection
b. More than one faulty connection.

(b) Explain the terms briefly: **3**

a. True Value
b. Population Mean
c. Sample Mean

(c) Explain briefly any three leak detection methods. **3**

(d) Draw a schematic diagram of a vacuum system neatly labeling all the parts. **3**

(e) The pole pieces of a cyclotron are 1.6 m in diameter and provide a magnetic field of 2Wb/m^2. What will be the energy of the protons and deuterons? **3**
Given: $m_p = 1.67 \times 10^{-27} Kg$ *and* $q = 1.6 \times 10^{-19} C$.

(f) A Gieger Muller counter has a dead time of 400 μsec. What is the true counting rate if the observed counting rate is 1000 per minute? **3**

(g) Scanning of FCC cubic sample of InSb by X-rays with wavelength 0.154 nm exhibit a peak at $2\theta = 62.3^{o}$. If the diffraction is first order diffraction from the {3 3 1} planes, calculate the lattice constant. **3**

(h) Explain principal of UV-visible spectroscopy. State its advantages. **3**
