

M.Sc.(Materials Science) Programme

Model Question Paper

Time: 2 Hours

Max. Marks : 75

Some Useful Constants

Speed of light in free space	$c = 3 \times 10^8$ m/s
Boltzmann constant	$k_B = 1.380 \times 10^{-23}$ J/K
Planck's constant	$h = 6.626 \times 10^{-34}$ J.s
Electron charge	$e = 1.602 \times 10^{-19}$ C
Permittivity of free space	$\epsilon_0 = 8.854 \times 10^{-12}$ C <sup>2</sup> /N.m <sup>2</sup>
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H/m
Gas constant	: 8.314 J K <sup>-1</sup> mol <sup>-1</sup>

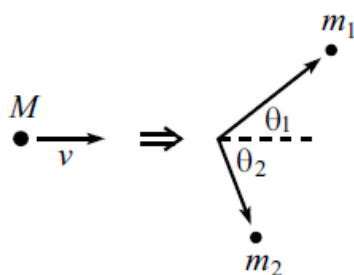
**NOTE:**

- Answer the following questions in the space provided.
  - Please write your Application Id and name on the Answer sheets.
  - Choose the correct answer and WRITE IN CAPITAL LETTER viz., A, B, C, D or E for the multiple choice questions. Each MCQ carries one mark and there will be **negative marking** for each wrong answer.
  - Write detailed answer as required for other questions.
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**SAMPLE QUESTIONS**

- If  $\mathbf{a} = [4 \ -1 \ 5]$  and  $\mathbf{b} = [2 \ 5 \ 8]^T$ , the inner product of these vectors is given by ( )  
A) 43 (B) 23 (C) -52 (D) 52
- One of the Eigen vectors of the above matrix are ( )  
A)  $\begin{bmatrix} 2 \\ 1 \end{bmatrix}$  (B)  $\begin{bmatrix} 1 \\ 3 \end{bmatrix}$  (C)  $\begin{bmatrix} 1 \\ 2 \end{bmatrix}$  (D)  $\begin{bmatrix} 2 \\ 3 \end{bmatrix}$
- The angle between the vectors  $\mathbf{a} = [1, 2, 0]$  and  $\mathbf{b} = [3, -2, 1]$  is ( )  
A)  $96.865^\circ$  (B)  $85.865^\circ$  (C)  $75^\circ$  (D)  $90^\circ$
- If  $\mathbf{v} = yz \mathbf{i} + 3zx \mathbf{j} + z \mathbf{k}$ , then  $\nabla \times \mathbf{v}$  is ( )  
A)  $-x \mathbf{j} + 3x \mathbf{k}$  (B)  $-y \mathbf{j} + 2z \mathbf{k}$   
C)  $-x \mathbf{i} + y \mathbf{j} + 3z \mathbf{k}$  (D)  $-3x \mathbf{i} + y \mathbf{j} + 2z \mathbf{k}$

5. The coefficient of  $x^n$  in the exponential series for  $e^x$  is \_\_\_\_\_. (1M)
6. Evaluate  $\int (x + 2)^{500} dx$  (1M)
7. Show that a rectangle having maximum area for a given perimeter must be a square. (3M)
8. Write the Maclaurin series of  $e^{2x}$ . (3M)
9. The shortest wavelength present in the radiation from an X-ray machine whose accelerating potential is 50,000 V is ( )
- A) 100 nm                      B) 10 nm                      C) 2.14 nm                      D) 0.0248 nm
10. The Brewster angle for a medium with refractive index  $n$  and air is approximately ( )
- A)  $\tan^{-1}(n)$                       B)  $\tan^{-1}(1/n)$                       C)  $\sin^{-1}(n)$                       D)  $\sin^{-1}(1/n)$
11. A crystal plane cuts intercepts of  $a$ ,  $b/3$  and  $3c/2$  along  $x$ ,  $y$  and  $z$  directions. The Miller indices of the plane are ( )
- A) (392)                      B) (362)                      C) (123)                      D) (121)                      E) (122)
12. Two radioactive samples S1 and S2 have half-lives 3 hours and 7 hours respectively. If they have the same activity at a certain instant  $t$ , what is the ratio of the number of atoms of S1 to the number of atoms of S2 at the instant  $t$ ? (3M)
13. A mass  $M$  moves with speed  $V$  in the  $x$ -direction. It explodes into two pieces that go off at angles  $\theta_1$ ,  $\theta_2$  as shown in figure. What are the magnitudes of the momenta of the two pieces? (3M)



14. State LeChatelier's principle. (2M)
15. Deduce the oxidation states of Cl and N in the ions  $\text{ClO}^-$ ,  $\text{NO}_2^-$  and  $\text{NO}_3^-$ . (2M)
16. When 1 mole of ice melts at  $0^\circ\text{C}$  and at a constant pressure of 1 atm, 1440 cal of heat are absorbed by the system. The molar volumes of ice and water are 0.0196 and 0.0180 liter, respectively. Calculate  $\Delta H$  and  $\Delta E$ . (3M)
17. A sample of pure calcium metal weighing 1.35 gm was quantitatively converted to 1.88 gm of pure CaO. If the atomic weight of oxygen is taken to be 16.0, what is the atomic weight of calcium? (4M)

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