The LNM Institute of Information Technology
Department of Physics
M. Sc. Admission Entrance Exam, 2018

Date: 16th July 2018 | Time: 9.30AM -11.00 AM | Total Marks: 40

Name: **Application ID:**

Instructions:

1. Use of calculator is allowed.
2. Tick mark the correct answer with **ball pen** only and not with pencil.

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1. If $\vec{A}$ is a constant vector and $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ is the position vector, then $\vec{\nabla}(\vec{A}\cdot\vec{r})$ is given as: [5]

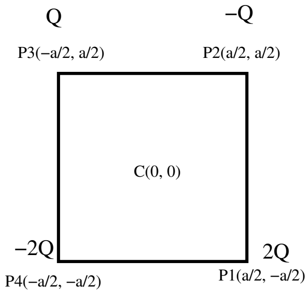
   (a) Null vector (b) $3\vec{A}$ (c) $\vec{A}$ (d) $\vec{r}$

2. An ideal gas undergoes through the process defined by $p = p_0 e^{-V/V_0}$. The maximum attainable temperature of it is given as: [5]

   (a) $\frac{p_0}{enk_BV_0}$ (b) $\frac{p_0}{nk_BV_0}$ (c) $\frac{p_0}{enk_B}$ (d) $\frac{nk_B}{p_0}$

   Hint: Along with the given relation, use the equation of state for ideal gas ($pV = nk_BT$) to find a relation between the temperature and volume or pressure.

3. Four point charges of amount $\pm Q$ and $\pm 2Q$ are placed at the four corners $P1, P2, P3$ and $P4$ of a square of length a as follows.



   The electric field generated by them at the centre C with coordinate (0,0) is directed along: [5]

   (a) $\hat{i}$ (b) $\hat{j}$ (c) $\hat{i} + \hat{j}$ (d) None of the above

4. The energy of an one dimensional anharmonic oscillator as a function of its position can be written as $E(x) = -ax^2 + bx^4$, where a and b are positive constants. The equilibrium position of the oscillator is given as: **[5]**

   (a) $x = 0$ (b) $x = \pm\sqrt{a/2b}$

   (c) $x = \pm\sqrt{a/b}$ (d) None of the above

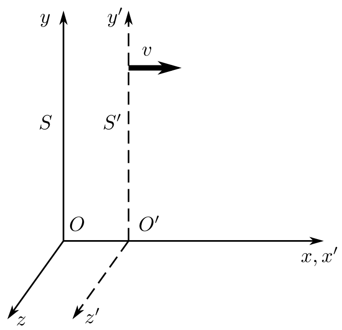
5. If a simple cubic unit cell is maximally occupied by spherical atoms at it's corner. Then the fraction of of the space occupied by the atoms in an unit cell is given as: **[5]**

   (a) 52.4% (b) 52.3%

   (c) 51.4% (d) 53.6%

6. For an observer O, two events (A and B) occur simultaneously 600 km apart. Observer O' measures the distance between the same two events to be 1200 km. What is the velocity of the observer O'? **[5]**

   Note: We use the standard inertial frames S (laboratory frame) and S' (rest frame of any event) which are set up such that the x and x' axes coincide and the y, y' axes and z, z' axes are parallel. Seen from S, S' moves in the positive x-direction with speed v. Clocks in both frames are set to zero when the origins O and O' coincide.



7. A quantum particle is confined in an one dimensional box defined by the coordinates $(-L/2, L/2)$. It's momentum expectation value $< p >= \int_{-L/2}^{L/2} \psi_n^*(x)\hat{p}\psi_n(x)dx$, where $\psi_n(x)$ is the normalised eigen function of the confined particle for the n-th energy state, is given as: **[5]**

   (a) 0 (b) $n\hbar/L$ (c) $\hbar/nL$ (d) $0.5\hbar/L$

8. Two light rays of amplitudes a and $2a$ interfere at a point where they have a phase difference ϕ. Then the resultant intensity I_{tot} is given as: **[5]**

   (a) $I_{tot} = a^2(5 + 4\cos\phi)$ (b) $I_{tot} = a^2(5 - 4\cos\phi)$

   (c) $I_{tot} = a^2(5 + 4\sin\phi)$ (d) $I_{tot} = a^2(5 - 4\sin\phi)$

Rough works

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