KATHMANDU UNIVERSITY
End Semester Examination
September 2024

Marks Scored:

Level : B.E./B.Sc.
Year : I

Course : PHYS 102
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 15

Registration No.:

Date : 26 SEP 2024

SECTION "A"
[15Q. × 1 = 15 marks]

***Choose and circle the most appropriate answers. The symbols, unless mentioned otherwise, have their usual meanings.***

1. Each of two vectors, $\vec{D}_1$ and $\vec{D}_2$, lies along a coordinate axis in the *xy*-plane. Each vector has its tail at the origin, and the dot product of the two vectors is $\vec{D}_1 \cdot \vec{D}_2 = 0$. Which possibility is **CORRECT**?
   a. $\vec{D}_1$ and $\vec{D}_2$ both lie along the positive *y*-axis.
   b. $\vec{D}_1$ lies along the positive *x*-axis, $\vec{D}_2$ lies along the positive *y*-axis.
   c. $\vec{D}_1$ and $\vec{D}_2$ both lie along the positive *x*-axis.
   d. $\vec{D}_1$ lies along the positive *x*-axis , $\vec{D}_2$ lies along the negative *x*-axis.

2. Two charged particles, $Q_1$ and $Q_2$, are a distance *r* apart with $Q_2 = 5Q_1$. Compare the forces they exert on one another when $\vec{F}_1$ is the force $Q_2$ exerts on $Q_1$ and $\vec{F}_2$ is the force $Q_1$ exerts on $Q_2$.
   a. $\vec{F}_2 = 5\vec{F}_1$ b. $5\vec{F}_2 = \vec{F}_1$ c. $\vec{F}_2 = -\vec{F}_1$ d. $\vec{F}_2 = -5\vec{F}_1$

3. A spherical Gaussian surface surrounds a point charge Q. In which one of the following cases does the electric flux through the surface change?
   a. The charge Q is tripled.
   b. The radius of the sphere is doubled.
   c. The surface is changed to a cube.
   d. The charge Q is moved to another location inside the surface.

4. Three charges are situated at three corners of a square (side $a$), as shown in Figure A-1. How much work does it take to bring in another charge, $+q$, from far away and place it in the fourth corner?
   a. $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{a}\left[-2+\frac{1}{\sqrt{2}}\right]$ b. $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{a}\left[-4+\frac{2}{\sqrt{2}}\right]$
   c. $\frac{q^2}{a}\left[-2+\frac{1}{\sqrt{2}}\right]$ d. $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{a^2}\left[-2+\frac{1}{\sqrt{2}}\right]$

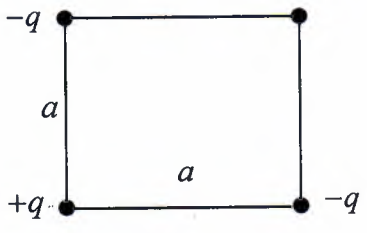

Figure A-1

5. The primitive model for an atom consists of a point nucleus ($+q$) surrounded by a uniformly charged spherical cloud ($-q$) of radius $a$. The atomic polarizability of such an atom is
   a. $\alpha = 4\varepsilon_0 a^3$ b. $\alpha = 3\varepsilon_0 a$ c. $\alpha = 4\pi\varepsilon_0 a^2$ d. $\alpha = 4\pi\varepsilon_0 a^3$

6. By using a compass to measure the magnetic field direction at various points adjacent to a long straight wire, you can show that the wire's magnetic field lines are
   a. straight lines in space that go from one magnetic charge to another.
   b. straight lines in space that are parallel to the wire.
   c. circles that have their centers on the wire and lie in planes perpendicular to the wire.
   d. circles that have the wire lying along a diameter of the circle.

7. A physicist claims that she has found a new particle with a mass 200,000 times the mass of the proton ($1.67 \times 10^{-27}$ kg) and a charge of $3.20 \times 10^{-19}$. If she is correct, such a particle traveling in a circle in a uniform 5.00 T magnetic field at a velocity of 2500 m/s will have a radius of
   a. 0.261 m  b. 0.522 m  c. 1.04 m  d. 3.27 m

8. The _____ is the SI unit used to measure magnetization, which represents the magnetic dipole moment per unit volume of a material.
   a. ampere per meter.  b. ampere per meter squared.
   c. ampere meter squared.  d. ampere per meter cubed.

9. Experiments conducted by Michael Faraday in England in 1831 and independently by Joseph Henry in the United States that same year showed that an emf can be induced in a circuit by a changing _____. The results of these experiments led to a very basic and important law of electromagnetism known as *Faraday's law of induction.*
   a. electric field  b. magnetic field  c. gravitational field  d. resistance

10. If a radioactive nuclide ${}^{A}_{Z}X$ decays by emitting a gamma ray, what happens?
   a. The resulting nuclide has a different Z value.
   b. The resulting nuclide has the same A and Z values.
   c. The resulting nuclide has a different A value.
   d. Both A and Z decrease by one.

***Fill the following blanks with appropriate answers.***

11. The divergence of a curl of a vector function $\vec{A} = x^2\hat{i} + 3xz^2\hat{j} - 2xz\hat{k}$ is _____ .

12. A perfect conductor would be a material that contains an unlimited supply of completely free charges. Although perfect conductors do not exist in real life, many substances come very close. In such materials, the electric field inside the conductor is _____ .

13. All ferromagnetic materials are made up of microscopic regions called _____, within which all magnetic moments are aligned.

14. The _____ states that the work done on charges by the electromagnetic force is equal to the decrease in energy stored in the electromagnetic field, minus the energy that flows out through the surrounding surface. This theorem is crucial for understanding the conservation of energy in electromagnetic systems.

15. The Raman effect, named after the Nobel Prize-winning Indian physicist C.V. Raman, is the phenomenon where light is inelastically scattered by molecules, leading to a shift in its _____ . This shift reveals important information about the vibrational energy levels of the molecules and is widely used in spectroscopy to identify and analyze different substances.