BRAC UNIVERSITY
Inspiring Excellence

MNS Department
Summer Semester 2015
Final Examination
Course No: PHY 112
Course Title: Principles of Physics II

Time: 3 hours
Total Marks: 90

Date: August 13, 2015

Insturctions:

- Answer any **FIVE** questions from **Section A** and **TEN** questions from **Section B**.
- Write your Name and ID# above and middle of the **Section B**.
- Answer **Section A** in the answer script.
- Circle the write answer in **Section B** in the question paper.

[Marks]

1. Figure-1 shows that four particles form a square of edge length a = 5.0 cm and have charges $q_1 = +10.0$ nC, $q_2 = -20.0$ nC, $q_3 = +20.0$ nC and $q_4 = -10.0$ nC. **[6+8+2]**
   a. Calculate the net force on the charged particle q_2 due to all other charged particles in unit vector notation.
   b. Find out the magnitude and direction of the electric field at the centre of the square.
   c. What force does an electron experience if it is placed at the centre of the square?

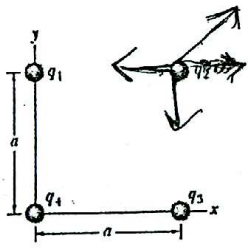

Figure-1

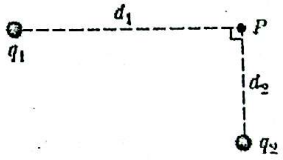

Figure-2

2. In Figure-2, the point P is at a distance of $d_1 = 4.00$ m from the particle 1 ($q_1 = -2e$) and distance $d_2 = 2.00$ m from particle 2 ($q_2 = +2e$), with both particles fixed in place. **[4+6+6]**
   Given that the value of $e = 1.6\times10^{-19}$ C.
   a. What is the potential at the point P?
   b. How much work has to be done to bring a particle of charge $q_3 = +2e$ from infinity to point P by the applied force and the electric field?
   c. What is the potential energy of the three-particle system?

3. The number of radioactive nuclei present at the start of an experiment is 4.60×10^{15}. The number present twenty days later is 8.14×10^{14}. **[4+8+4]**
   a. Find out the decay constant and half-life of the radionuclide.
   b. How much of it will decay between t = 14.0 days and t = 16.0 days?
   c. Calculate the activity of the material at t = 16.0 days.

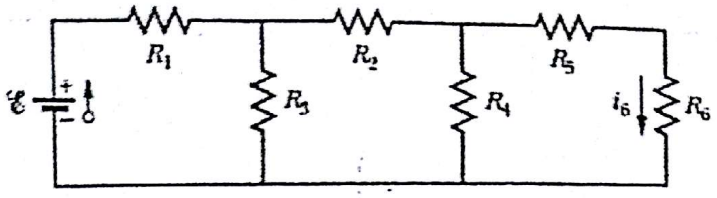

Figure-3

4. In Figure-3, the current in resistance 6 is $i_6 = 1.40$ A and the resistances are $R_1 = R_2 = R_3 = 2.00\ \Omega$, $R_4 = 16.0\ \Omega$, $R_5 = 8.00\ \Omega$ and $R_6 = 4.00\ \Omega$. [5+8+3]
   a. Calculate the equivalent resistance of the circuit. 3.63 Ω
   b. Find out the current through each resistor. $I_1 = 13.3A$, $I_2 = 2.45A$, $I_3 = 10.85A$, $I_4 = 1.05A$, $I_5 = 1.4A$, $I_6 = 1.4A$
   c. What is the emf of the battery? 48.3 V

5. In Figure-4, a particle moves along a circle in a region of uniform magnetic field of magnitude B = 4.00 mT. The particle is either a proton or an electron which experiences a magnetic force of magnitude 3.2×10^{-15} N. [2+4+4+6]
   a. Which type of particle (proton or electron) is revolving around the circle? electron
   b. Calculate the speed of the particle. 5×10^6 m/s.
   c. Calculate the radius of the circle and also the radius if another type of particle is revolving around the circle. $r_p = 13.05$ m, $r_e = 7.1\times10^{-3}$ m.
   d. What are the frequencies of the electron and proton for their respective revolving circles? $f_e = 1.12\times10^8$ Hz, $f_p = 6.36\times10^4$ Hz.

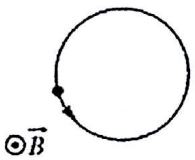

Figure-4

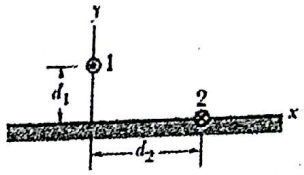

Figure-5

6. Figure-5, shows the cross section of a long and strait wire 1, carries a current of 4.00 mA out of the page, and is at a distance $d_1 = 2.40$ cm from a surface. A second long and straight parallel wire 2 is at horizontal distance $d_2 = 5.00$ cm from wire 1 carrying a current of 6.80 mA into the page. [6+4+6]
   a. Calculate the x-component of magnetic field on wire 1 due to wire 2 and y-component of magnetic field on wire 2 due to wire 1. $B_{12} = 1.04\times10^{-8}$ T, $B_{21} = 1.2\times10^{-8}$ T
   b. Find out the magnitude of net magnetic field at the mid-point of the line connecting the wires 1 and 2. $B_{mid} = 2\times10^{-8}$ T
   c. If a third parallel wire 3 is placed at the mid-point of the line connecting the two wires 1 and 2 which carries a current of 2.4 mA out of the page, find the force per unit length of the third wire. $F_3 = 4.8\times10^{-11}$ N.

7. The magnetic flux through the loop increases according to the relation $\phi_B = 6.0t^2 + 7.0t$, where ϕ_B is in milliwebers and t in seconds. The diameter of the circular loop is 10 cm formed from wire of diameter 2.5 mm and resistivity $1.69\times10^{-8}\ \Omega$-m. [4+4+4+4]
   a. Calculate the change in magnetic field through the loop when t = 2.0 s. 4.84 Tesla
   b. What is the magnitude of induced emf in the loop when t = 2.0 s? 31 mV
   c. What is flow of maximum current in the coil in t = 2.0 s? 28.7 A
   d. Calculate the self-inductance of the loop. 1.3 Henry

8. [6+6+4]

a. An astronaut is standing in a spacecraft parallel to its direction of motion. An observer on the earth finds that the spacecraft's speed is 0.60c and the astronaut is 1.3 m tall. What is the astronaut's height as measured in the spacecraft? 1.63 m.

b. A proton and an electron, both at rest initially, combine to form a hydrogen atom in the ground state. A single photon is emitted in this process. What is its wavelength? 9.12×10^{-8} m.

c. Find the wavelength of the spectral line that corresponds to a transition in hydrogen from n = 6 state to n = 3 state. Rydberg constant, $R = 1.097 \times 10^7\ m^{-1}$. 1.09×10^{-6} m.

Student Name:..... **Student ID:**.....

Section B: Multiple Choice Questions ____/ 10

Each question in section B carries one mark:

1. Electric charges A and B are attracted to each other. Electric charges B and C attract each other too. If A and C are held close together they will:

   a. attract b. repel
   c. not affect each other d. more information is needed to give an answer

2. If a positive test charge q moves towards an increasing electric potential energy its velocity will:

   a. increase b. decrease c. remain the same d. none of these

3. A certain wire has resistivity ρ. Another wire, of the same material, has half the length and half the diameter of the first wire. The resistivity of the second wire is:

   a. $\rho/2$ b. 2ρ c. 4ρ d. ρ

4. Two particles (proton and electron) travel at the same speed (Figure-6) in a uniform magnetic field along the circular paths shown in the figure. Which particle follows the larger circle and what is its direction of motion?

   a. Electron and anticlockwise
   b. Proton and anticlockwise
   c. Electron and clockwise
   d. Proton and clockwise

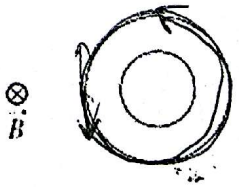

Figure-6

Student Name:..... Student ID:.....

5. The Figure-7 shows four directions for the velocity vector of a positively charged particle moving through a uniform electric field which is directed out of the page and a uniform magnetic field directed in the leftward direction. Which of the following ranking for net force on the proton is correct?

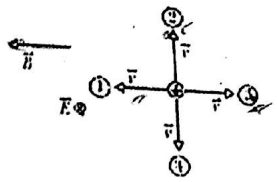

Figure-7

a. 1>2>3>4 b. 2>4>1=3 c. 2>3>1>4

d. 4>2>1=3

2>1=3>4

$\textcircled{2} = q\vec{E} + qvB$

$\textcircled{3} = \textcircled{1} = qE$

$\textcircled{4} = qE - qvB$

6. The direction of induced emf can be found by:

a. Gauss' law b. Kirchhoff's law c. Lenz's law d. Fleming's right hand rule

7. Beta particles from various radioactive sources all have:

a. the same mass b. the same speed c. the same charge

b. the same energy in magnetic field

8. A square loop of wire lies in the plane of the page. A decreasing magnetic field is directed into the page. The induced current in the loop is

a. counterclockwise b. clockwise c. through the middle of the page d. zero

9. Which one of the following quantities will two observers always measure to be the same, regardless of the relative velocity between the observers?

a. The time interval between two events b. The length of an object

c. The speed of light in a vacuum d. The relative speed between the observers

10. Above Curie temperature the ferromagnetic material becomes:

a. diamagnetic b. paramagnetic c. ferrimagnetic d. none of these

11. What type of light would be emitted if an electron moves from n = 4 to n = 2 energy level?

a. Ultraviolet b. Infrared c. Visible d. Microwave

12. According to Bohr's atomic model the angular momentum of the electron in the n-th orbit is equal to:

a. $h/2\pi$ b. $2\pi/h$ c. $nh/2\pi$ d. nh/π

13. Most of the energy produced by the sun is due to:

a. nuclear fission b. nuclear fusion c. chemical reaction d. gravitational collapse