EM Induction Practice [34 Marks]

1. A circular coil of wire moves through a region of uniform magnetic field directed out of the page. What is the direction of the induced conventional current in the coil for the marked positions? [C]
2. X and Y are two plane coils parallel to each other that have a common axis. There is a constant direct current in Y. X is first moved towards Y and later is moved away from Y. What, as X moves, is the direction of the current in X relative to that in Y? [C]
3. The graph below shows the variation with time of the magnetic flux through a coil. Which of the following gives three times for which the magnitude of the induced emf is a maximum? [B]
4. The diagram shows a bar magnet near an aluminum ring. The ring is supported so that it is free to move. The ring is initially at rest. In experiment 1 the magnet is moved towards the ring. In experiment 2 the magnet is moved away from the ring. For each experiment what is the initial direction of motion of the ring? [B]
5. Three conducting loops, X, Y and Z, are moving with the same speed from a region of zero magnetic field to a region of uniform non-zero magnetic field. Which loop(s) has/have the largest induced electromotive force (emf) at the instant when the loops enter the magnetic field? [A]
6. Two identical circular coils are placed one below the other so that their planes are both horizontal. The top coil is connected to a cell and a switch. The switch is closed and then opened. What is the force between the coils when the switch is closing and when the switch is opening? [C]
7. The current I flowing in loop A in a clockwise direction is increasing so as to induce a current both in loops B and C. All three loops are on the same plane. What is the direction of the induced currents in loop B and loop C? [C]
8. A rectangular flat coil moves at constant speed through a uniform magnetic field. The direction of the field is into the plane of the paper. Which graph shows the variation with time t, of the induced emf ε in the coil as it moves from P to Q? [A]
9. What are the units of magnetic flux and magnetic field strength? [B]

10. A conducting square coil is placed in a region where there is a uniform magnetic field. The magnetic field is directed into the page. There is a clockwise current in the coil. What is a correct force that acts on a side of the coil? [D]

11. An aircraft with a wing span of 50 m flies horizontally at a speed of 200 m s−1. The vertical component of the Earth's magnetic field at the plane's position is 10 μT. What electromotive force (emf) is induced between points A and B on the aircraft? [A]

12. A coil and a magnet can move horizontally to the left or to the right at the same speed. In which of the following will a conventional current be induced in the direction shown in the diagram when both the magnet and the coil are moving? [A]

13. A length of copper wire PQ is moved downwards through the poles of two horizontal bar magnets as shown below. [A]

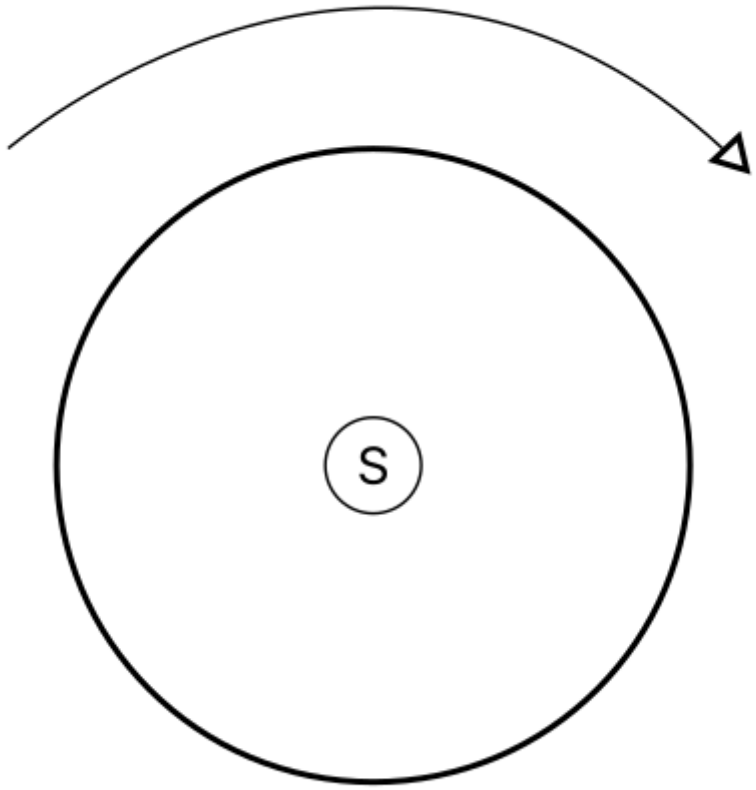
14. The diagram shows the view from above as an airplane flies horizontally through the Earth's magnetic field. The airplane is made of conducting material. [B]

15. A small magnet is dropped from rest above a stationary horizontal conducting ring. The south (S) pole of the magnet is upwards.

    1. While the magnet is moving towards the ring, state why the magnetic flux in the ring is increasing.

       The magnetic field increases as the magnet is moving towards the ring because magnetic has an inverse square relationship with distance. Since magnetic flux is directly proportional to magnetic field, the flux will increase as well.

    2. While the magnet is moving towards the ring, sketch, using an arrow on Diagram 2, the direction of the induced current in the ring.



3. **While the magnet is moving towards the ring, deduce the direction of the magnetic force on the magnet.**

   The magnetic force will be pointing towards the center. When I use the right-hand rule, the magnetic force and the counter-clockwise current will both be pointing towards the center.

16. **A bar magnet falls vertically from rest through a coil of wire. The potential difference across the coil is recorded by a data-logger.**

    1. **Explain, with reference to Faraday's and Lenz's Laws, the shape of the graph.**

       Faraday's law:

       $$EMF = \frac{-n\Delta\phi}{\Delta t}$$

       Therefore, the EMF will be directly proportional to the change in rate of flux. Lenz's law:

       $$\epsilon = -N\frac{\alpha\Phi_B}{\alpha t}$$

       Therefore, the EMF will oppose the change. And lastly, the magnet will enter the coil since the EMF is in the opposite direction when the magnet leaves.

2. The coil has 1500 turns. Calculate the magnitude of the maximum rate of change of magnetic flux.

$$0.8 = 1500x$$

$$x = \boxed{0.00053 \text{ WB/s}}$$