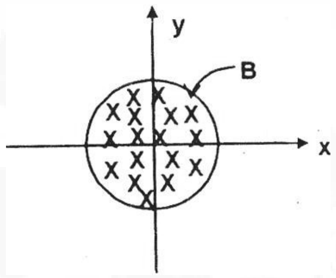
PHYSICS: **Max. Marks : 60**

SECTION – I
(MULTIPLE CORRECT CHOICE TYPE)

This section contains **8 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE is/ are correct**

1. A loop is kept so that its center lies at the origin of the coordinate system. A magnetic field has the induction B into the x - y plane as shown in the figure



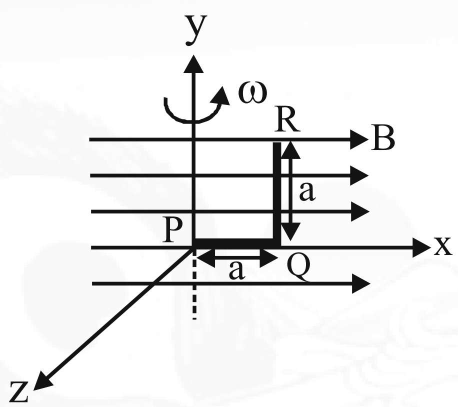
A) No emf and current will be induced in the loop if it rotates about Z axis

B) Emf is induced but no current flows, if the loop is a fiber and when it rotates about y axis

C) Emf is induced and induced current flows in the loop, if the loop is made of copper and is rotated about y-axis

D) If the loop moves along Z axis with constant velocity, no current flows in it.

2. In a region there exist a magnetic field B_0 along positive x-axis. A metallic wire of length 2a and one side along x-axis and one side parallel of y-axis is rotating about y-axis with a angular velocity ω. Then at the instant shown.



A) Potential difference across PQ is O

B) Potential difference across PQ is $\frac{1}{2}B_0\omega a^2$

C) Potential difference across QR is $\frac{1}{2}B_0\omega a^2$

D) Potential difference across QR is $B_0\omega a^2$

3. The magnetic flux ϕ linked with a conducting coil depends on time as $\phi = 4t^n + 6$, where n is positive constant. The induced emf in the coil is e

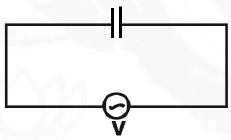
A) If $0 < n < 1$; $e \neq 0$ and $|e|$ decreases with time.

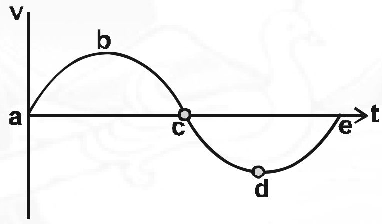
B) If $n = 1$; e is constant.

C)If $n > 1$; $|e|$ increases with time.

D) If $n > 1$; $|e|$ decreases with time.

4. For an AC circuit containing capacitor only, the applied AC voltage waveform is shown in figure. For this situation mark the correct statement.





A) As v increases from a to b, the charging of capacitor takes place.

B) As v increases from a to b, the current in circuit decreases from maximum to zero value.

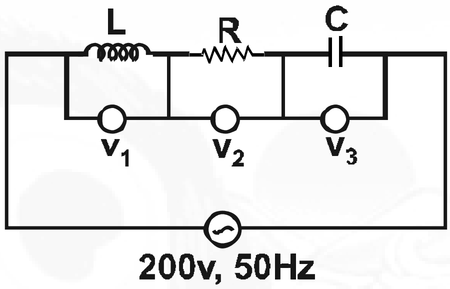
C) As v decreases from b to c, the capacitor discharges.

D) None of the above

5. A conducting rod is moved with a constant velocity in a magnetic field. No emf will appear across the two end of rod if

A) $\vec{v} \parallel \vec{I}$ B) $\vec{v} \parallel \vec{B}$ C) $\vec{B} \parallel \vec{I}$ D) $\vec{v} \perp \vec{B}$

6. For series RLC AC circuit shown in figure. The readings of v_1 and v_3 are same and each equal to 100 V. For the situation mark the correct statement(s).



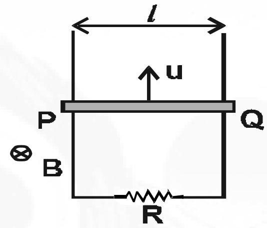
A) The reading of v_2 is 200 V.

B) The reading of V_2 is 0.

C) The circuit is in resonant mode and resonant frequency is 50 Hz.

D) The inductive and capacitive reactance are equal.

7. Two smooth conducting rails separated by distance l are fixed in vertical plane as shown in figure. The lower ends of the rails are connected by a resistor R. Another conducting rod PQ is allowed to move smoothly and vertically on conducting rails. The entire region is having horizontal uniform magnetic field B which is directed into the plane of paper. The rod is imparted an initial velocity v in upward direction. Assuming no resistance is present other than R and acceleration due to gravity is g. Mark the correct statement(s)



A) The speed of rod first decreases, becomes zero at an instant and then increases and finally attains a constant value.

B) The acceleration of rod is constant.

C) The magnitude of acceleration of rod is first decreasing, becomes minimum and then increases but direction of acceleration remains same.

D) The magnitude of acceleration of rod is continuously decreasing without any change in its direction and finally becomes zero.

8. In which of the following cases the emf is induced due to time varying magnetic field i.e., induced field emf?

A) A magnet is moving along the axis of a conducting coil.

B) A loop having varying area (due to moving jumper) is placed in a magnetic field.

C) The resistance of the coil is changing, which is connected to an ideal battery.

D) A current carrying wire is approaching a conducting ring.

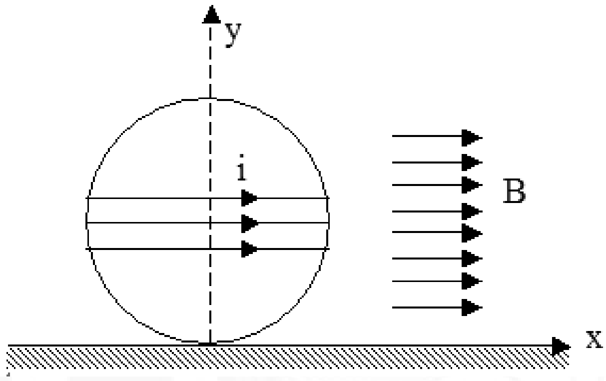
SECTION - II
(COMPREHENSION TYPE)

This section contains **4 groups of questions.** Each group has 2 multiple choice questions based on a paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE** is **correct.**

Paragraph for Questions 9 and 10

Paragraph-1

A person wants to roll a solid non-conducting spherical ball of mass m and radius r on a surface whose coefficient of static friction is μ. He placed the ball on the surface wrapped with n turns of closely packed conducting coils of negligible mass at the diameter. By some arrangement he is able to pass a current i through the coils either in the clockwise direction or in the anticlockwise direction. A constant horizontal magnetic field $\vec{B}$ is present throughout the space as shown in the fig. (Assume μ is large enough to help rolling motion)



9. Angular acceleration of the ball after it has rotated through an angle θ ($\theta < 180^o$), is

A) $\frac{5}{7}\frac{\pi niB}{m}\cos\theta$ B) $\frac{2}{5}\frac{\pi niB}{m}\cos\theta$ C) $\frac{7}{5}\frac{\pi niB}{m}\cos\theta$ D) $\frac{5}{2}\frac{\pi niB}{m}\cos\theta$

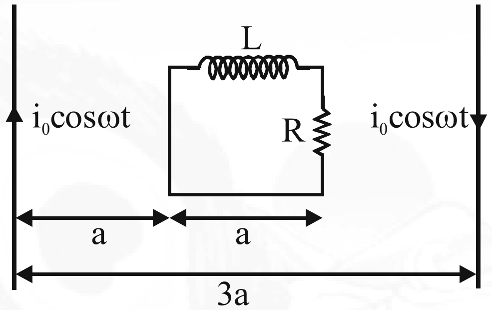
10. The minimum value of μ for which the rolling motion is possible, is

A) $\left(\frac{14\pi}{5g}\right)\left(\frac{niB}{m}\right)r$ B) $\left(\frac{5\pi}{7g}\right)\left(\frac{niB}{m}\right)r$ C) 0 D) $\left(\frac{7\pi}{5g}\right)\left(\frac{niB}{m}\right)r$

Paragraph for Questions 11 and 12

Paragraph-2

In figure, a square loop consisting of an inductor of inductance L and resistor of resistance R is placed between two long parallel wires. The two long straight wires have time varying current of magnitude $I = I_0 \cos\omega t$ but the direction of current in them are opposite.



11. Magnitude of emf in this circuit only due to flux change associated with two long straight current carrying wires will be

A) $\frac{\mu_0 a \ln 2\, I_0 \omega}{\pi} \sin\omega t$

B) $\frac{2\mu_0 a \ln 2\, I_0 \omega}{\pi} \sin\omega t$

C) $\frac{\mu_0 a \ln 2\, I_0 \omega}{2\pi} \cos\omega t$

D) $\frac{\mu_0 a \ln 2\, I_0 \omega}{\pi} \cos\omega t$.

12. The instantaneous current in the circuit will be

A) $\dfrac{2\mu_0 a \ln 2\ I_0\omega}{\pi\sqrt{R^2+\omega^2L^2}}\sin(\omega t-\phi)$

B) $\dfrac{2\mu_0 a \ln 2\ I_0\omega}{\pi\sqrt{R^2+\omega^2L^2}}\sin(\omega t+\phi)$

C) $\dfrac{\mu_0 a \ln 2\ I_0\omega}{\pi\sqrt{R^2+\omega^2L^2}}\sin\omega t$

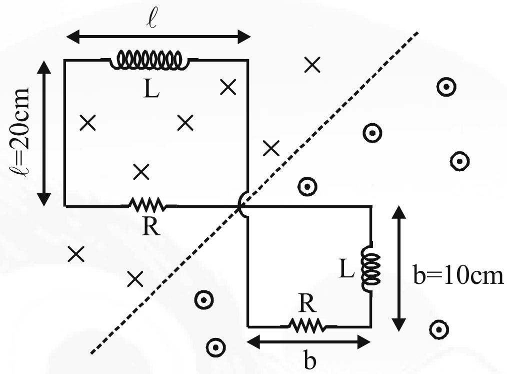
D) $\dfrac{\mu_0 a \ln 2\ I_0\omega}{\pi\sqrt{R^2+\omega^2L^2}}\sin(\omega t-\phi)$.

(where $\tan\phi=\dfrac{\omega L}{R}$).

Paragraph for Questions 13 and 14

Paragraph-3

. In figure there is a frame consisting of two square loops having resistors and inductors as shown. This frame is placed in uniform but time varying magnetic field is such a way that one of the loop is placed in crossed magnetic field and other is placed in dot magnetic field. Both magnetic fields are perpendicular to the planes of loops. If the magnetic field is given by $B = (20 + 10\ t)\ Wb/m^2$ in both regions [ℓ = 20 cm, b = 10 cm and R = 10Ω, L = 10 H).



13. The induced emf in the frame only due to the variation of magnetic field will be

A) 0.3 volt
B) 0.1 volt
C) 0.5 volt
D) 0.4 volt.

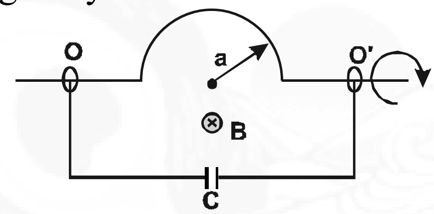
14.. The current in the frame as a function of time will be

A) $\frac{1}{20}(1-e^{-t})$ B) $\frac{1}{40}(1-e^{-t})$ C) $\frac{1}{20}e^{-t}$ D) $\frac{1}{10}e^{-t}$.

Paragraph for Questions 15 and 16

Paragraph-4

A copper rod is bent into a semi circle of radius a and at ends straight parts are bent along diameter of the semicircle and are passed through fixed smooth and conducting rings O and O' as shown in figure. An initially uncharged capacitor having capacitance C is connected to the rings. In the entire region an uniform magnetic field B is there which is directed into the plane of paper. Initially at t = 0 the plane of semi circle was perpendicular to field direction and then the semi-circle is set in rotation with constant angular velocity ω. Neglect resistance of the wires and coil and gravity.



Based on above information answer the following questions:

15. The charge on capacitor as a function of time is:(where $Q_0=\frac{B\omega a^2 \times \pi C}{2}$

A) Q_0 sinωt B) $-Q_0$ sinωt C) $\frac{Q_0}{2}$ cosωt D) $\frac{Q_0}{4}$ cosωt

16. The instantaneous power required to rotate the semi circular rod with constant angular velocity is

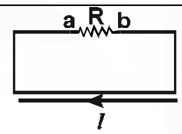
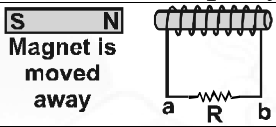
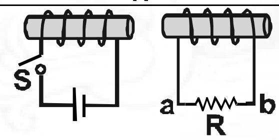
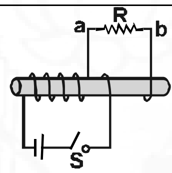
A) $Q_0^2\omega$sinωt cosωt B) $-Q_0^2\omega$sinωt cosωt

C) $-\frac{Q_0^2\omega}{4}$ sinωt cosωt D) $-\frac{Q_0^2\omega}{16}$ sinωt cosωt

SECTION – III
(MATRIX MATCH TYPE)

This section contains **4 multiple choice questions.** Each question has matching lists. The codes for the lists have choices (A), (B), (C), and (D) out of which **ONLY ONE** is correct.

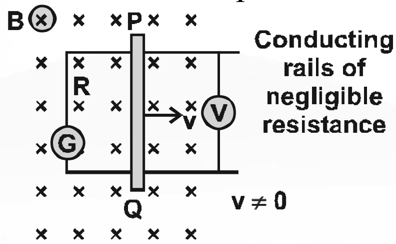
17. Match the entries of Column I with the entries of Column II.

	Column-I		Column-II
A)	The current in resistor R is from a to b	P)	 I decreases rapidly to zero
B)	The current in resistance R is from b to a	Q)	
C)	Magnetic flux linked with circuit containing resistor R is increasing.	R)	 When switch S is closed
D)	Magnetic flux linked with circuit containing resistor R is decreasing.	S)	 When switch S is closed

A) A→ P,Q,R; B→S; C→R,S ; D→P,Q B) A→ P,S; B→Q; C→P,Q,R; D→S

C) A→ Q; B→P,Q,R,S; C→P,Q; D→R D) A→P,Q; B→P,Q,R; C→P,Q,R,S; D→S

18. In the diagram shown PQ is rod which is moving in a magnetic field B. Assume meters are ideal. Some information about rod and B is given in Column I and the effects which may take place in circuit are provided in Column II. Match the entries



Column-I		Column-II	
A)	Rod is non-conducting	P)	Voltmeter may show deflection
B)	Rod is conducting	Q)	Galvanometer may show deflection
C)	B is non-uniform and constant	R)	Voltmeter shows zero deflection
D)	B is time varying	S)	Galvanometer shows zero deflection
		T)	Galvanometer shows non-zero deflection
		U)	Voltmeter shows non-zero deflection

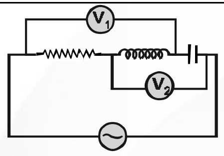
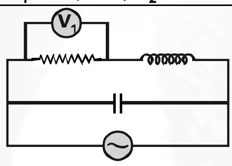
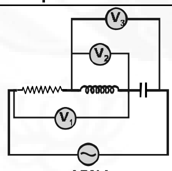
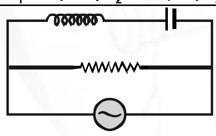
A) A→ P,Q,R; B→Q; C→P,Q,R; D→Q

B) A→ R,S; B→T,U; C→P,Q; D→Q,U

C) A→ P,Q; B→P,Q,R; C→P,Q; D→S

D) A→R,S; B→P,Q; C→P,Q,R,S; D→R

19. In Column I some AC circuits with meter readings are given and in Column II some circuit quantities are given. Match the entries of Column I with the entries of Column II.

Column-I		Column-II	
A)	 250V V_1=158, 11V; V_2 = 200V	P)	$V_R = 150V$
B)	 250V V_1=150V	Q)	$V_L = 50V$
C)	 250V V_1=158, 11V; V_2 = 291, 6V; V_3 =150V	R)	$V_C = 250V$
D)	 250V	S)	Power factor of the circuit is 3/5

A) A→ Q,R; B→P; C→P,Q,R,S; D→P B) A→ S; B→R; C→Q; D→P

C) A→ P,Q; B→R; C→P,Q,R,S; D→Q D) A→ P,Q,R,S; B→P,R; C→P,Q,R,S; D→R

20. Consider all possibilities (L,R,C are non-zero).

	Column-I		Column-II
A)	In L-R series AC circuit	P)	Current lags inductor voltage by $\pi/2$
B)	In R-C series AC circuit	Q)	Current lags voltage by an angle less than $\pi/2$
C)	In L-C-R series AC circuit.	R)	Current leads voltage by an angle less than $\pi/2$
D)	In purely resistive AC circuit	S)	Current and voltage are in Phase

A) A→ P,Q; B→R; C→P,Q,R,S; D→S

B) A→ Q,R,S; B→P; C→P,Q,; D→Q

C) A→ S,Q; B→P; C→R,Q,R,S; D→Q

D) A→ P,Q,R,S; B→S; C→P,Q; D→Q