

St John Baptist De La Salle Catholic School, Addis Ababa
Grade 10 Physics Midterm Examination
4th Quarter

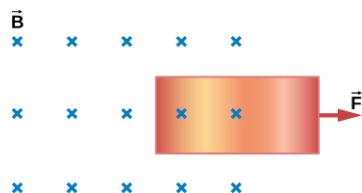
May, 2022

Notes, and use of other aids is **NOT** allowed. Read all directions carefully and **write your answers in the answer sheet**. To receive full credit, you must show all of your work.

Name: _____ Roll Number: _____ Section: _____ Time Allowed: **45 minutes**

Multiple Choice Questions

1. In which of the following cases is electricity not induced?
 - A. A conductor falling down parallel to a current carrying wire on the ground.
 - B. Inserting a bar magnet into a circular loop of conductor.
 - C. A flux change by a magnetic field perpendicular to the area vector of the surface passing through it. **[Correct Answer]**
 - D. A turbine rotating by changing its mechanical energy into electrical energy.
2. The copper sheet shown below is partially in a magnetic field. When it is pulled to the right, what do we expect to happen?



- A. Lenz' law tells us that the induced current will oppose the apparent magnetic field, thus the object will be pushed into the page.
 - B. Since it is just partially in the magnetic field, nothing happens because it needs to be full in.
 - C. Lenz' law tells us that the induced current will oppose the apparent motion, thus the object will be pulled into the magnetic field. **[Correct Answer]**
 - D. Lenz' law tells us that the induced current will support the apparent motion, thus the object will be pulled into the magnetic field.
3. The 4.00 A current through a 7.50 mH inductor is switched off in 8.33 ms. What is the emf induced opposing this?
A. 3.60 V **[Correct Answer]** B. 7.20 V C. 0 V D. 1.5 V
4. A solenoid is acting as an inductor. Initially, the current is I. The volume of the solenoid is decreased such that $V_f = \frac{1}{9}V_i$. If we want to keep the energy stored in the conductor the same, by how much should the current change?
A. $I_f = 9I_i$ B. $I_f = \frac{1}{3}I_i$ C. $I_f = \frac{1}{9}I_i$ D. $I_f = 3I_i$ **[Correct Answer]**
5. A jet airplane with a 75.0 m wingspan is flying at 280 m/s. What emf is induced between wing tips if the vertical component of the Earth's field is 3.00×10^{-5} T?
A. 1.0 V B. 0.37 V C. 0.63 V **[Correct Answer]** D. 100 V
6. What is the explanation behind Lenz's law?

- A. Faraday's Law.
 - B. The law of conservation of energy.[Correct Answer]
 - C. The law of conservation of charge.
 - D. The increase in the entropy of the field around the magnetic flux.
7. In Faraday's experiments, what would be the advantage of using coils with many turns?
- A. As the number of coils increase, the flux passing also increases which in turn increases the change and the induced EMF.[Correct Answer]
 - B. As the number of coils increase, the area of the coil increases and that will increase the flux.
 - C. The number of coils increasing will increase the overall.
 - D. There was no advantage to using many coils because the same flux passes through all.
8. A 6V battery is connected across the primary coil of a transformer having 50 turns. If the secondary coil of the transformer has 100 coils, what voltage appears at the secondary coil?
- A. 3V B. 6V C. 9V D. 12V[Correct Answer]
9. A coil formed by wrapping 50 turns of wire in the shape of a plane of the coil makes an angle of 37° with the direction of the field. When the magnetic field is increased uniformly from 2G to 6G in 4.00 seconds, an EMF of magnitude 0.160V is induced in the coil. What is the total length of the wire in the coil?
- A. 100 m B. 200 m C. 300 m D. 400m [Correct Answer :1131m]
10. Which of the following is true about electromagnetic induction?
- A. In motional EMF; the induced EMF, the velocity, and the magnetic field should all be parallel for the induction to take place.
 - B. Inductance is the generation of current while induction is the opposition to change in current.
 - C. The time constant of an RL circuit is given by $\tau_L = LR$.
 - D. Transformers transforms potential while a generator transforms energy.[Correct Answer]
11. A coil with 50 turns and area 1m^2 is oriented with its plane perpendicular to a 1-T magnetic field. If the coil is flipped over(*turned through 180°*) in 1s, what is the average EMF induced in it?
- A. 50 V B. 100 V C. 0 V[Correct Answer] D. 25 V
12. How does the self-inductance per unit length near the center of a solenoid (away from the ends) compare with its value near the end of the solenoid?
- A. The magnetic field will flare out at the end of the solenoid so there is less flux through the last turn than through the middle of the solenoid.[Correct Answer]
 - B. The magnetic field will flare out at the middle of the solenoid so there is less flux through the middle turn than through the end of the solenoid.
 - C. It is the same since we are talking about the same solenoid throughout the induction.
 - D. The magnetic field is the same at any radial distance from the solenoid, but since we are talking about a parallel distance, thus the flux stays the same.
13. A single-turn circular loop of wire of radius 50 mm lies in a plane perpendicular to a spatially uniform magnetic field. During a 0.10-s time interval, the magnitude of the field(*out of the page*) increases uniformly from 200 to 300 mT. What is the EMF induced and the direction of the current?
- A. $7.8 \times 10^{-3}\text{V}$, CW[Correct Answer] B. $7.8 \times 10^3\text{V}$, CW C. $7.8 \times 10^{-3}\text{V}$, CCW D. $7.8 \times 10^3\text{V}$, CCW
14. A rod of length 10 cm moves at a speed of 10 m/s perpendicularly through a 1.5-T magnetic field. What is the potential difference between the ends of the rod?
- A. 1.3 V B. 1.5 V[Correct Answer] C. 1.7 V D. 1.9 V
15. A large superconducting magnet, used for magnetic resonance imaging, has a 50.0 H inductance. If you want current through it to be adjustable with a 1.00 s characteristic time constant, what is the minimum resistance of system?
- A. 20Ω B. 210Ω C. 50Ω [Correct Answer] D. 20Ω

Problems

16. A straight wire 50 cm long is freely falling from a height of 1m. On the ground, there is a long straight wire carrying a current of $300\pi\text{A}$. ($\mu_0 = 4\pi \times 10^{-7}\text{H/m}$)

- Derive the induced EMF as a function of time.

$$\varepsilon = -\text{Blv}$$

$$B = \frac{\mu_0 I}{2\pi(1 - S)}$$

$$V = 10m/s^2 t$$

$$S = 5m/s^2 t^2$$

Thus, we have the following:

$$\varepsilon = -\left(\frac{\mu_0 I \times l \times 10t}{2\pi(1m - 5t^2)}\right)$$

$$\varepsilon = -\frac{(10m/s^2)\mu_0 I l t}{2\pi(1m - (5m/s^2)t^2)}$$

- Estimate the maximum voltage and deduce the induced voltage 0.5 seconds after the wire was released.

$$\varepsilon = -\frac{10m/s^2 \mu_0 (300\pi A)(0.5m)(0.5s)}{2\pi(1m - 5m/s^2(0.5s)^2)}$$

17. In a circuit powered by a 1.5V battery, there is a resistor of $R = 100\Omega$. Connected to the resistor in series is an inductor of $L=4\text{H}$. ($\ln 0.6 = -0.5108$)

$$\tau_L = \frac{L}{R} = \frac{4\text{H}}{100\Omega} = 0.04s$$

- When the current has reached 60 percent of its final value, what time will have passed?

$$I(t) = \frac{\varepsilon}{R}(1 - e^{-\frac{t}{\tau_L}})$$

$$0.6 \frac{\varepsilon}{R} = \frac{\varepsilon}{R}(1 - e^{-\frac{t}{\tau_L}})$$

$$0.6 = (1 - e^{-\frac{t}{\tau_L}})$$

$$0.4 = e^{-\frac{t}{\tau_L}}$$

$$\ln 0.4 = \frac{-t}{\tau_L}$$

$$t = -\ln 0.4 \tau_L$$

$$t = -0.04 \ln 0.4s$$

- How much energy will have been stored in the inductor after 40ms has passed?

$$I = 0.6 \frac{\varepsilon}{R} = 0.6 \frac{1.5V}{100\Omega} = 9.0 \times 10^{-4} A$$

$$E = \frac{1}{2} L I^2$$

$$E = \frac{1}{2} \times 4\text{H} \times 81 \times 10^{-8} A^2$$

$$E = 1.62 \times 10^{-6} J$$

18. How fast($\frac{\Delta I}{\Delta t}$) can a current through a 0.250 H inductor be shut off if the induced emf cannot exceed 75.0 V?

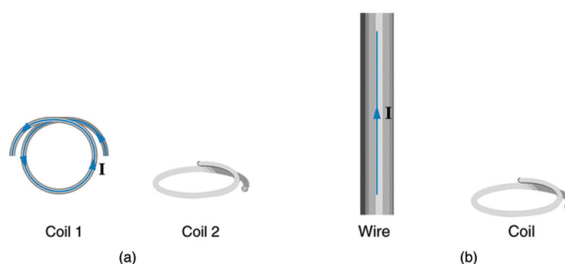
$$\varepsilon = -L \frac{\Delta I}{\Delta t}$$

$$\frac{\Delta I}{\Delta t} = \frac{\varepsilon}{L}$$

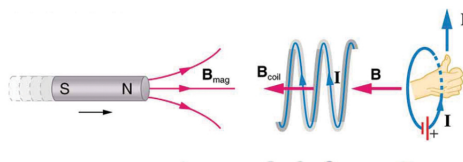
$$\frac{\Delta I}{\Delta t} = \frac{75.0V}{0.250H}$$

$$\frac{\Delta I}{\Delta t} = 300A/s$$

19. Look at the figure below and answer the questions that follow. When answering the amount of flux, answer in terms of **maximum**, **0**, or **in between**.



- (i) What is the flux through coil 2? **0**.
- (ii) What about the flux through coil 1? **Maximum**.
20. Calculate the magnitude of the induced emf when the magnet in the figure below is thrust into the coil, if the single loop coil has a radius of 4.00 cm and the average value of the magnetic field increases from 0.0500 T to 0.250 T in 0.100 s.



$$\varepsilon = -\frac{N\Delta\phi}{\Delta t}$$

$$\varepsilon = -\frac{0.200T \times \pi \times (4.0 \times 10^{-2}m)^2}{0.100s}$$

$$\varepsilon = -\frac{\pi \times 3.20 \times 10^{-4}Tm^2}{0.100s}$$

$$\varepsilon = -3.20\pi \times 10^{-3}V$$

Answer Sheet

1 (A) (B) (C) (D)

6 (A) (B) (C) (D)

11 (A) (B) (C) (D)

16 (A) (B) (C) (D)

2 (A) (B) (C) (D)

7 (A) (B) (C) (D)

12 (A) (B) (C) (D)

17 (A) (B) (C) (D)

3 (A) (B) (C) (D)

8 (A) (B) (C) (D)

13 (A) (B) (C) (D)

18 (A) (B) (C) (D)

4 (A) (B) (C) (D)

9 (A) (B) (C) (D)

14 (A) (B) (C) (D)

19 (A) (B) (C) (D)

5 (A) (B) (C) (D)

10 (A) (B) (C) (D)

15 (A) (B) (C) (D)

20 (A) (B) (C) (D)