St John Baptist De La Salle Catholic School, Addis Ababa

Grade 10 Physics Final Examination Solutions

3rd Quarter

April, 2023

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: **2 hours**

Multiple Choice Questions

1. What is the SI unit of the inductance?
   A. Ω B. Π C. Πs D. Ωs

   Answer: D

2. Lenz's law tells us that the induced current acts to oppose the change in flux(& or the motion) that caused it. What is Lenz's law a result of?

   A. The law of conservation of energy

   B. The quantization of charge

   C. The dipole moment of the electron

   D. The law conservation of mass

   Answer: A

3. What is the direction of the force on a current carrying wire when it is in inserted into a region of external magnetic field?

   A. The force is always parallel to the direction of the current flow.

   B. The force is always parallel to the magnetic field.

   C. The force is sometimes parallel to the magnetic field.

   D. The force is always perpendicular to the magnetic field.

   Answer: D

4. Faraday and Henry both discovered electromagnetic induction independently. Which of the following is false about their observations?

   A. Current was induced when there was relative motion because flux changed.

B. Current was induced when the poles of the magnet were switched.

C. Current was induced when the area of the coil was changed.

D. Current was induced when flux was not changing.

Answer: D

5. Two charges are shot into the left in a uniform magnetic field going out of the page. One of the charges is an electron and has a circular trajectory radius r_e. If second charge has a charge to mass ratio greater than the electron, which of the following is true?

   A. The second charge has a helical trajectory unlike the electron.

   B. The second charge will have a greater radius of its trajectory than the electron.

   C. The second charge will have a lesser radius of its trajectory than the electron.

   D. The second charge will experience no force and will go straight through the field.

   Answer: C

6. In which of the following cases does self-inductance occur?

   A. When the current through a circuit changes.

   B. When a current carrying wire is moved in an external magnetic field.

   C. When a nearby circuit's current is changing.

   D. When a magnet is moved closer to a solenoid.

   Answer: A

7. What is the force of attraction per meter between two straight current carrying wires each carrying 2A of wire that are 1m apart?($\mu_0 = 4\pi \times 10^{-7}$H/m)
   A. 8×10^{-7}N B. 8×10^{-5}N C. $8\pi \times 10^{-7}$N D. $8\pi \times 10^{-5}$N
   Answer: A

8. A square loop of wire is placed in a uniform magnetic field perpendicular to the magnetic lines. The strength of the magnetic field is 2 T and the side length of the loop is 1m. What is the magnetic flux in the loop?
   A. $2Wb$ B. $0.5Wb$ C. $4Wb$ D. $0.25Wb$
   Answer: A

9. If the magnetic field strength in the question above was suddenly increased to 12 T in a span of 2 seconds, how much emf would be induced on average?
   A. 10V B. 2V C. 5V D. 5V
   Answer: C/D – A code error caused a typo in rendering. Apologies.

10. Which of the following factors does not affect the induced emf during electromagnetic induction?
    A. Flux B. Number of turns C. Field strength D. Type of magnet used in induction
    Answer: D

11. In the region just outside the north pole of a magnet, the magnetic field lines

A. point away(diverge) from the south pole

B. go around the south pole

C. are less concentrated than at the north pole

D. point toward(converge at) the south pole

Answer: D

12. What happens if a magnet is broken in to multiple pieces?

A. The pieces will be separate north and south poles

B. The pieces will be small magnets

C. The pieces will have north poles but no south poles

D. The pieces will have south poles but no north poles

Answer: B

13. We have seen in class that the induced emf during induction as a function of time can be expressed as $\varepsilon(t) = NBA\omega \sin(\omega t)$. How is the output emf of a generator affected if you halve the frequency of rotation of its coil?

A. The output emf will be doubled.

B. The output emf will be halved.

C. The output emf will be quadrupled.

D. The output emf will be tripled.

Answer: B

14. The plane of a square wire circuit with side 4.0 cm long is at an angle of 60^0 with respect to a uniform magnetic field of 1 T. The wires have a resistance of 0.1Ω. If the field drops to zero in 2 s, what magnitude current is induced in the square circuit?
A. 4 mA B. 3 μA C. 4 mA D. 3 μA
Answer: $4\sqrt{3}mA$ – A code error caused a typo in rendering. My apologies - answers A/C will be graded as correct.

15. A uniform magnetic field is perpendicular to the plane of a wire loop. If the loop accelerates in the direction of the field, will a current be induced in the loop?

A. No, because magnetic flux through the loop remains constant.

B. No, because magnetic flux through the loop changes continuously.

C. Yes, because magnetic flux through the loop remains constant.

D. Yes, because magnetic flux through the loop changes continuously.

Answer: A

16. Which of the following is true about the properties of a step down transformer?

A. It increases the output power of the transformer

B. It increases the output voltage of the transformer

C. It increases the output current of the transformer

D. It decreases the output power of the transformer

Answer: C

17. If the magnetic force on a current carrying wire is four folds smaller than the maximum possible force, what is the angle between the current carrying wire and the magnetic field?
A. $\sin^{-1}(\frac{1}{2})$ B. $\sin^{-1}(\frac{1}{4})$ C. $\sin^{-1}(\frac{1}{6})$ D. $\sin^{-1}(\frac{1}{8})$ **Answer:** B

18. The torque on a rectangular current carrying loop is $100Nm$. If we double the width of the wire, what will the new torque be?
A. $50Nm$ B. $100Nm$ C. $200Nm$ D. $250Nm$ **Answer:** C

19. If an electron is moving at a speed of $1.0 \times 10^6 m/s$ through a perpendicular magnetic field of $100T$, what is the magnitude of the magnetic force on the electron?($q_e = 1.6 \times 10^{-19}C$)
A. $1.6 \times 10^{-11}T$ B. $1.6 \times 10^{-9}T$ C. $1.6 \times 10^{-12}T$ D. $1.6 \times 10^{-10}T$
Answer: A

20. What is the magnetic field 2m to the right of a straight current carrying wire that has a current of 5A going upwards?
A. $5 \times 10^{-7}T\otimes$ B. $5 \times 10^{-7}T\odot$ C. $5 \times 10^{-6}T\otimes$ D. $5 \times 10^{-6}T\odot$
Answer: A

21. What is the inductive time constant for a circuit that has an inductor that has an inductance of 20 H and a resistor of 100Ω?
A. 0.5s B. 5s C. 200s D. 0.2s **Answer:** D

22. Which of the following is true about vectors and operation on vectors?

A. The sum of two vectors is always a vector.

B. The product of two vectors is always a vector.

C. The dot product of two vectors is usually a scalar but could be a vector sometimes.

D. Work is an example of the cross product between two vectors.

Answer: A

23. The curie temperature of Cobalt is $1,121^0C$. Which of the following is true?

A. We can heat Cobalt up to 1000^0C and it could still behave as a magnet.

B. We can heat Cobalt up to 2000^0C and it could still behave as a magnet.

C. The curie temperature of a ferromagnetic substance is irrelevant to its magnetic property.

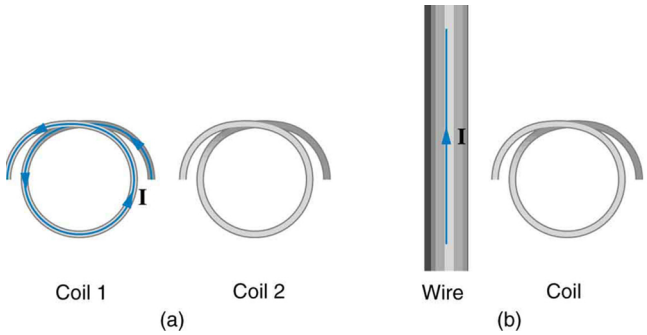
D. None of the above

Answer: A

24. What is the inductance of a conductor if a current changing at a rate of $3A/s$ produces an emf of 27mV?
A. 9 H B. 9 mH C. 0.011 H D. 0.011 mH **Answer:** B

25. A solenoid that has a self-inductance of 40H has 100 windings. When the number of turns has been increased to 300 while keeping all the other factors constant, what will the new self-inductance be?
A. 120 H B. $\frac{40}{3}$ H C. 360 H D. $\frac{40}{9}$ H **Answer:** C

26. According to the figure below, what will the direction of the induced current be in **coil 2** when the current in the wire(*which is going upwards*) is increased?



A. Clockwise B. Counterclockwise C. Into the page D. Upwards
Answer: A

27. If $\vec{A} = 2\hat{i} - 3\hat{k}$ and $\vec{B} = \hat{i} - 7\hat{j} - 9\hat{k}$, what is the value of $\mathbf{proj_A^B} \times \vec{A}$?
A. $3\hat{i} - 7\hat{j} - 12\hat{k}$ B. 1 C. $5\hat{i} - 7\hat{j} - 12\hat{k}$ D. 0
Answer: D

28. Which of the following is correct on the operation of the unit vectors below?
A. $\hat{n} \cdot \frac{1}{2}\hat{n} = \frac{1}{2}$ B. $\hat{i} \times \hat{j} = 1$ C. $\hat{i} \times \hat{j} = -\hat{k}$ D. $\hat{j} \cdot (-\hat{j}) = 0$
Answer: A

29. Which of the following is true about charges moving in a magnetic field?
    A. Magnetic force is exerted when the charge is static relative to the field.
    B. The trajectory of the particle does not depend on the entry angle of the charge and is always rectangular.
    C. The speed of the charge has no effect on the motion and/or the trajectory of the particle.
    D. The trajectory of the particle can be helical or circular depending on the entry angle of the charge.

    Answer: D

30. Which of the following is true about the difference between electric and magnetic fields?

A. Magnetic fields are closed loops while electric fields don't necessarily need to be like that.

B. Magnetic fields can exist only from monopoles while electric fields need both parities to emerge.

C. Electric fields give rise to conservative fields while magnetic fields give rise to dissipative fields.

D. Electric fields and magnetic fields are the same.

Answer: A

Workout Problems

31. Assume a 90-turn coil lies in the plane of the page in a uniform magnetic field that is directed out of the page. The coil originally has an area of $0.050m^2$. It is stretched to have no area in 0.300 s. What is the **direction** of the current and **magnitude** of the induced emf if the uniform magnetic field has a strength of 4.50 T?
First, we need to calculate the magnitude of the induced emf.

$$\mathcal{E} = -\frac{N\Delta\Phi}{\Delta t}$$

$$\Delta\Phi = B\delta A$$

$$\Delta\Phi = 4.50T(0 - 0.050m^2)$$

$$\Delta\Phi = 0.225Wb$$

$$\mathcal{E} = -\frac{90(-0.225Wb)}{0.3sec}$$

$$\mathcal{E} = 67.5V$$

The cause for the induction in here is the decrease in the area(or we can say the decrease in the out of the page flux), the current will be induced in such a way that it will oppose the cause - it will act to increase the out of the page field. That will be caused by a current that is going **counterclockwise** as seen from the top.

32. Calculate the Hall emf induced on a patient's heart while being scanned by an MRI unit if the conducting path on the heart wall is a wire 7.50 cm long that moves at 10.0 cm/s perpendicular to a 3.0-T magnetic field. If the hall probe has a resistance of 2Ω, what is current induced in the wire?

$$\mathcal{E} = Blv$$

$$\mathcal{E} = 3.0T \times 7.5 \times 10^{-2}m \times 10.0 \times 10^{-2}m/s$$

$$\mathcal{E} = 0.0225V$$

The current induced would be

$$I = \frac{\mathcal{E}}{R} = \frac{0.0225V}{2\Omega}$$

$$I = 0.01125A$$

33. A research solenoid at the Center for Magnetic Studies has a self-inductance of 40.0 H.

- What **induced emf** opposes shutting it off when 100 A of current through it is switched off in 10.0 ms?

$$\mathcal{E} = -L\frac{\Delta I}{\Delta t}$$
$$\mathcal{E} = -40.0H\frac{0 - 100A}{10 \times 10^{-3}s}$$
$$\mathcal{E} = 40V$$

- How much **energy** would be stored at full current? What about when the current was decreased to 50A?

$$E = \frac{1}{2}LI^2$$
$$E = \frac{1}{2}(40H)(100A)^2$$
$$E = 2 \times 10^5 J$$

When the current has decreased to 50A, the energy stored is

$$E = \frac{1}{2}LI^2$$
$$E = \frac{1}{2}(40H)(50A)^2$$
$$E = 5 \times 10^4 J$$

34. Find the **magnitude** of the magnetic field and **draw** the field lines around the following current carrying wires.

- 5m away from a vertical straight current carrying wire with 4A current going upwards.

$$B = \frac{\mu_0 I}{2\pi r}$$
$$B = \frac{4\pi \times 10^{-7} \times 4A}{2\pi(5m)}$$
$$B = 1.6 \times 10^{-7} T$$

The drawing will be available in class

- A 6-turn solenoid with a width of 0.50m while a current of 2A passes through it.

$$B = \mu_0 NI$$
$$B = \frac{4\pi \times 10^{-7} H/m \times 6 \times 2A}{0.50m}$$
$$B = 9.6 \times 10^{-6} T$$

The drawing will be available in class

35. The wires supplying electrical power(*the current in the wires are in opposite in directions*) to a commuter train in Addis carry 800 A and are separated by 80.0 cm. What is the magnitude and direction of the force between 50.0 m of these wires? Is there a risk of the wires touching?

First, we need to calculate the magnitude of the magnetic field by the wires. Since the wires carry identical currents, they will induce magnetic fields of the same magnitude.

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \frac{4\pi \times 10^{-7} H/m \times 800A}{2\pi(0.8m)}$$

$$B = 2 \times 10^{-4} T$$

The magnetic force between each wire is:

$$F = ILB$$

$$F = 800A \times 50.0m \times 2 \times 10^{-4} T$$

$$F = 8N$$

Since the current in the parallel wires is in the opposite directions, there is no risk of the wires touching because they will be repelling one another.

Extra Credit Problems

36. An RL circuit has an inductor of 20mH and a resistor of 20 Ω connected in series. If the circuit is connected to an emf source of 12.0 V.

- Write the current and emf as functions of time.

- Find the induced EMF 8.00 ms after the switch is turned on.

Answer Sheet

1._____	6._____	11._____	16._____	21._____	26._____
2._____	7._____	12._____	17._____	22._____	27._____
3._____	8._____	13._____	18._____	23._____	28._____
4._____	9._____	14._____	19._____	24._____	29._____
5._____	10._____	15._____	20._____	25._____	30._____