ABU DHABI POLYTECHNIC

Answer Sheet cover page

PHYSICS 112 A

Final Exam: 2 Hrs
2019/20 Semester 1

Instructors
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Information

EXAM IS ON PAPER; MULTIPLE CHOICE AND WRITTEN QUESTIONS.

STUDENTS MUST COMPLETE THE TABLE FOR THE MULTIPLE CHOICE QUESTIONS

- Students answer the written questions on this paper
- Calculators, drawing kits and dictionaries are allowed
- No additional materials are required

Student Name									
Student Number	A								
CRN					Department	ASD			

READ THESE INSTRUCTIONS CAREFULLY
Write your name, number, CRN and department clearly in the boxes above.
Answer **all** questions.
Show all your working and use appropriate units. Otherwise, you may lose marks.
You may use a pencil for all your work.
Answers which are not clearly readable, if any, will not be marked.

Multiple choice	/20
Long questions	/20
Total	**/40**

Formula Sheet

Electric Charge and Electric Field

Coulomb's Law: $F = k\,\frac{|q_1||q_2|}{r^2}$

Electric Field: $E = \frac{F}{q}$

Electric Field: $E = k\,\frac{q}{r^2}$

Flux/Gauss's Law: $\Phi = \sum E_{\perp} A = \frac{Q_{encl.}}{\epsilon_0}$

Charge: $q = ne$

$k = 9 \times 10^{9} \mathrm{N.m^2/C^2}$

$\epsilon_0 = 8.854 \times 10^{-12} \mathrm{C^2/(N.m^2)}$

$m_e = 9.11 \times 10^{-31}\mathrm{kg}$

$m_p = 1.67 \times 10^{-27}\mathrm{kg}$

$e = \pm 1.6 \times 10^{-19}\mathrm{C}$

$1\mathrm{eV} = 1.6 \times 10^{-19}\mathrm{J}$

Electric Potential and Capacitance

Electric Potential Energy: $U = k\,\frac{q\,q'}{r} = q'V$

Electric Potential: $V = \frac{U}{q'} = k\,\frac{q}{r}$

E-field between plates: $E = \frac{V}{d}$

Electric force: $F = qE$

Work done: $W = Fd = qEd\cos\theta$

Energy Conservation: $KE_i + U_i = KE_f + U_f$

Kinetic energy KE: $KE = \frac{1}{2}mv^2$

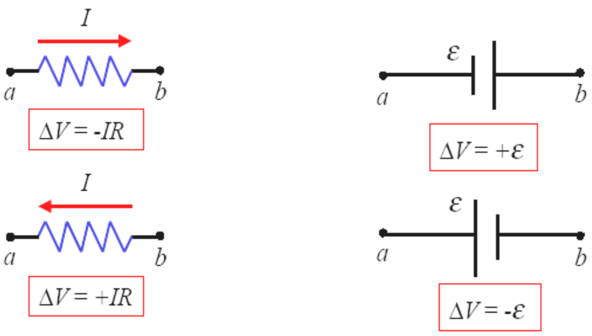
Capacitance: $C = \frac{Q}{V} = \varepsilon_0\,\frac{A}{d}$

Capacitors in Series: $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$

Capacitors in Parallel: $C_{eq} = C_1 + C_2 + \cdots$

Electric Field Energy: $U = W_{total} = \frac{1}{2}QV = \frac{Q^2}{2C} = \frac{1}{2}CV^2$

YOU MAY REMOVE THE FORMULA SHEET FROM THE EXAM BOOKLET



For all these we are traversing a loop in the direction from point *a* to point *b*.

Current, Resistance, and Direct-Current Circuits

Ohm's law: $V = IR \quad where \quad I = \frac{Q}{t}$

Resistance: $R = \rho\, \frac{\boldsymbol{L}}{\boldsymbol{A}}$

Source/battery with internal resistance: $V_{ab} = \varepsilon - Ir$

Electrical Energy: $E = QV$

Power dissipated: $P = VI$

Resistors in Parallel: $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$

Resistors in Series: $R_{eq} = R_1 + R_2 + \cdots$

Temp dependence: $R = R_0[1 + \alpha(T - T_0)]$

Junction/Loop rule: $\sum I = 0 \quad / \quad \sum V = 0$

Magnetic Field and Magnetic Forces

Magnetic Force on a charge in motion: $\mathrm{F} = |q|\mathrm{vB}\sin\theta$

Magnetic force in circular motion: $\mathrm{F} = |q|\mathrm{vB} = \frac{\mathrm{mv}^2}{\mathrm{r}}$

Period of revolution: $\mathrm{T} = \frac{1}{\mathrm{f}} = \frac{2\pi\mathrm{r}}{\mathrm{v}} = \frac{2\pi\mathrm{m}}{\mathrm{qB}}$

Force on a current carrying wire $\mathrm{F} = \mathrm{BIL}\sin\theta$

Magnetic Field of a Long conductor: $\mathrm{B} = \frac{\mu_0 \mathrm{I}}{2\pi\mathrm{r}}$

Force between two parallel conductors: $\frac{\mathrm{F}}{\mathrm{L}} = \mathrm{B}_2\mathrm{I}_1 = \frac{\mu_0 \mathrm{I}_1 \mathrm{I}_2}{2\pi\mathrm{d}}$

Field inside solenoid magnet: $\mathrm{B} = \mu_0 \mathrm{nI} = \mu_0 \frac{\mathrm{N}}{\mathrm{L}}\mathrm{I}$

Magnetic field at centre of circular loop: $\mathrm{B} = \frac{\mu_0 \mathrm{N\,I}}{2\mathrm{R}}$

Biot-Savart's Law: $B = \frac{\mu_0}{4\pi}\frac{I\Delta l\sin\theta}{r^2}$

Permeability of vacuum: $\mu_0 = 4\pi \times 10^{-7} T.m/A$

Electromagnetic Induction

Magnetic flux: $\Phi_B = \mathrm{B}_\perp A = BA\cos\theta$

Mutual inductance: $\varepsilon_1 = N_1 \left|\frac{\Delta\Phi_1}{\Delta t}\right| \quad and \quad \varepsilon_2 = N_2 \left|\frac{\Delta\Phi_2}{\Delta t}\right| \qquad M_{tesla\ coil} = \frac{\mu_0 A N_1 N_2}{l}$

Faraday's Law of Induction: $\varepsilon = \mathrm{N}\left|\frac{\Delta\Phi_B}{\Delta \mathrm{t}}\right|$

Motional emf in a circuit: $\varepsilon = \mathrm{BLv}$

Self Inductance: $\varepsilon = L\left|\frac{\Delta i}{\Delta t}\right| \quad where \quad L = \frac{\mu_0 A N^2}{l}$

Ideal Transformer: $\frac{V_2}{V_1} = \frac{N_2}{N_1}$

Section 1: Multiple Choice

Complete the following table for the multiple choice questions. **ONLY** answers in this table will be marked.

For example if you think the answer to question 1 should be C and the answer to question 2 should be A then complete as follows

Question	Answer
1	C
2	A

YOUR answers

Question	Answer
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	Draw the current

Section 1: Multiple Choice Questions

Question 1 (1 mark)

Choose the phrase which best describes the resistance in a circuit.

A. The rate at which the potential energy changes

B. The ratio of potential difference with respect to the current

C. The ratio of electric charge with respect to time

D. The rate at which the capacitance changes with respect to charge

E. The rate at which energy density changes with respect to charge

Question 2 (1 mark)

Consider a resistor which has some value R and is connected to a battery with potential difference V. If the battery is replaced with another with double the voltage, what will the new current be?

A. $\frac{1}{4}I$

B. $\frac{1}{2}I$

C. $4I$

D. I

E. $2I$

Question 3 (2 marks)

If 2.8×10^{13} protons pass through a cross section of a conductor in 0.03 μs, what is the current?

A. 10 A

B. 150 A

C. 2 A

D. 60 A

E. 320 A

Question 4 (1 mark)

A length of copper wire with a diameter of 1.0 mm and a cross-sectional area of 8.20×10^{-6} m^2 has a resistance of 1.1 Ω at a temperature of 20°C. Find the resistance of the same copper wire at 100°C. The temperature coefficient of resistivity of copper is 0.00391 $C^{\circ -1}$.

A. 1.22 Ω

B. 0.88 Ω

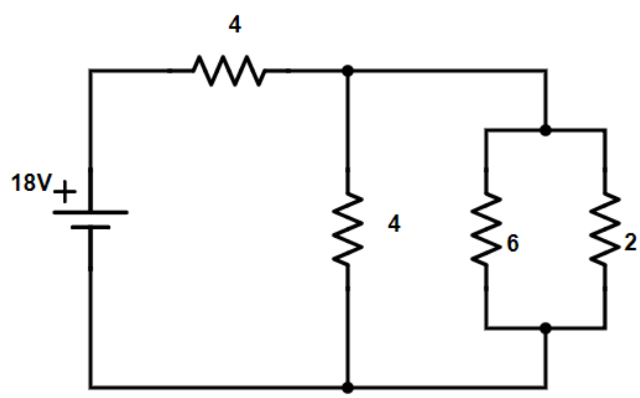
C. 1.44 Ω

D. 0.22 Ω

E. 0.44 Ω

Question 5 (2 marks)

Calculate the total current in the circuit shown below. All resistance values are in Ohms (Ω).



A. 1.8 A B. 6.2 A C. 2.2 A D. 3.5 A E. 5.1 A

Question 6 (1 mark)

A charged particle is moving with a velocity in a magnetic field. Which statement is true?

A. The particle loses potential energy

B. The particle feels an electric force

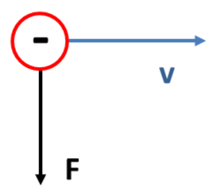
C. The particle will continue to move with a constant velocity in a straight line

D. The particle gains potential energy

E. The particle feels a magnetic force

Question 7 (2 marks)

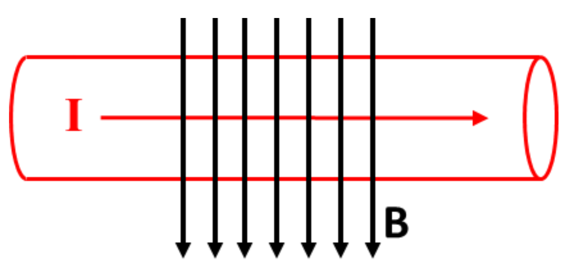
A particle is moving with a velocity and feels a magnetic force as indicated by the diagram below. What must be the direction of the magnetic field?



A. ↓ B. • • • C. → D. × × × E. . ←

Question 8 (1 mark)

A current carrying wire is in a magnetic field as shown below. What is the direction of the magnetic force which the wire feels?



A. • • • B. × × × C. → D. ↓ E. ←

Question 9 (2 marks)

An alpha particle (two protons and two neutrons) enters a magnetic field of 50.0 mT with a velocity perpendicular to the direction of the field. The particle begins to move in a circular path. What is the frequency of the alpha particle?

A. 7.6×10^5 Hz

B. 6.6×10^5 Hz

C. 5.6×10^5 Hz

D. 4.6×10^5 Hz

E. 3.6×10^5 Hz

Question 10 (2 marks)

A circular coil is used to produce a magnetic field for an electron beam experiment. It has 400 turns and a radius of 140 mm. What current is required to produce a magnetic field with a magnitude of 3.0 mT at the centre of the coil?

A. 0.7 A

B. 1.7 A

C. 2.7 A

D. 5.7 A

E. 8.7 A

Question 11 (1 mark)

Electromagnetic induction occurs:

A. Between a stationary magnet and a stationary coil of wire

B. Between a moving magnet and a stationary coil of wire

C. When a charge is moving in an electric field

D. When a charge is stationary in an electric field

E. All of the above

Question 12 (1 mark)

Magnetic field lines pass through a circular cross sectional area resulting in a magnetic flux, Φ_1. The field lines make a 90 degree angle with the surface. The magnetic field is now increased by a factor of four and the radius of the circle is decreased by a factor of four. Φ_2 is equal to:

A. $4\Phi_1$ B. $2\Phi_1$ C. Φ_1 D. $\frac{1}{2}\Phi_1$ E. $\frac{1}{4}\Phi_1$

Question 13 (1 mark)

A closed square loop conductor with one side equal to 0.2 m is located in a changing magnetic field. If the maximum emf induced in the loop is 4.0 V what is the maximum rate at which the magnetic field strength is changing if the magnetic field is oriented perpendicular to the plane in which the loop lies?

A. 0.25 T/s B. 2.0 T/s C. 50.0 T/s D. 25.0 T/s E. 100.0 T/s

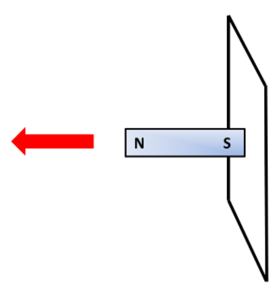
Question 14 (1 mark)

A 12.0 m length of wire is formed into a square and placed in the horizontal x-y plane. A magnetic field is oriented 40° above the horizontal with a strength of 2.0 T. What is the magnetic flux through the conductor?

A.13.8 Tm^2 B. 11.6 Tm^2 C. 2.4 Tm^2 D. 16.5 Tm^2 E. 2.8 Tm^2

Question 15 (1 mark)

A rectangular conducting loop of wire is placed beside a bar magnet as shown in the diagram below. The magnet is moved to the left, away from the loop of wire (as shown by the red arrow), inducing an *emf.* Show the direction of the induced current on the diagram below.



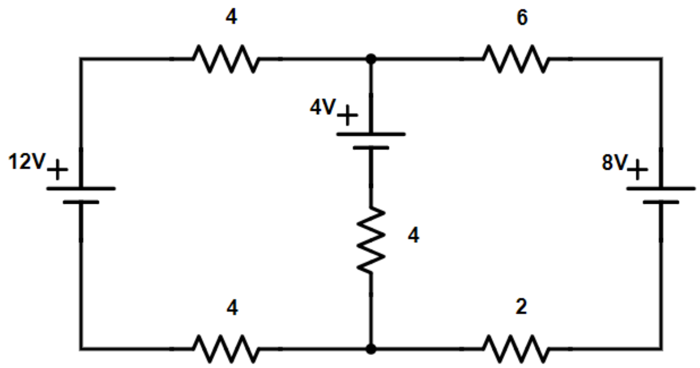
DO NOT FORGET TO FILL IN THE TABLE WITH YOUR ANSWERS

Section 2: Written Questions

Complete your answers in the space provided. **Show all working**, you will get marks for your method.

Question 16

a) Using Kirchhoff's rules, calculate the value of the current in each part of the circuit shown below. All resistance values are in Ohms (Ω). (4 marks)



b) The maximum allowable resistance for an underwater cable is one hundredth of an ohm per metre. If the resistivity of copper is $1.54 \times 10^{-8}\ \Omega m$, Find the minimum diameter of copper cable that could be used (1 mark)

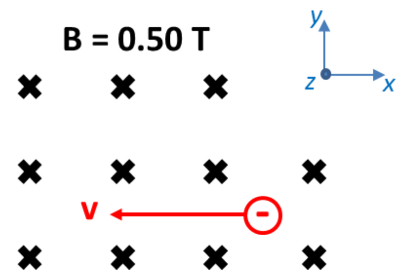
c) A 24 V battery is connected across two resistors in parallel. The resistors have resistances of 60.0 Ω and 30.0 Ω. Draw this circuit and show the voltage drop across the 30.0 Ω resistor. (1 mark)

Question 17

a) An electron is moving in a uniform magnetic field. The velocity, v, of the electron is to the left. The magnetic field, B, is pointing out of the page. Draw a diagram for this situation and show the direction of the magnetic force, F_B, exerted on the electron. Label your vectors appropriately and clearly. (2 marks)

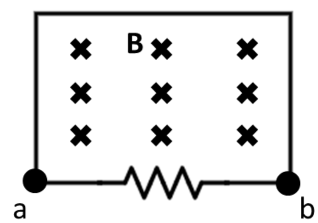
b) Draw a straight current carrying wire and the magnetic field lines associated with the wire. Show clearly the direction of the current and direction of the field lines. (1 mark)

c) A uniform magnetic field of magnitude 0.50 T pointing in the negative z-direction is present in a region of space and shown in the figure below. A uniform electric field is also present. The electric field is set at 3200 V/m in the positive y-direction. An electron is projected with an initial velocity of 1.5×10^4 m/s in the negative x-direction. Calculate the y-component of the initial force on the electron. (4 marks)

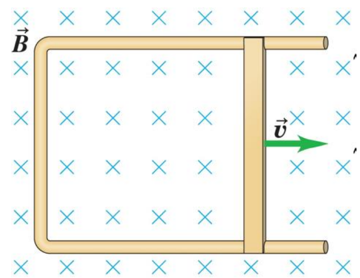


Question 18

a) A wire and a 40.0 Ω resistor are used to form a circuit in the shape of a rectangle with dimensions 20.0 cm by 10.0 cm. A uniform but non-steady magnetic field is directed into the plane of the circuit as shown in the diagram below. The magnitude of the magnetic field is decreased from 1.80 T to 0.40 T in a time interval of 20.0 ms. Calculate the induced current and state its direction through the resistor. (3 marks)



b) A slide wire rod with length *l*, moving with a velocity, *v*, in a uniform magnetic field, *B*, induces an *emf* in the loop of wire. If the velocity of the sliding rod is increased by a factor of four and the magnetic field is also increased by a factor of four, what is the new *emf*, ε_2 in terms of ε_1? (2 marks)



c) An ideal transformer consists of 8000 primary windings and 300 secondary windings. If the potential difference across the primary coil is 6400 V, what is the voltage across the secondary coil? (2 marks)