9. An ideal transformer is connected to a 12 V ac power supply. The light bulb connected to the secondary of the transformer is lit (Figure A). The transformer is then connected to a 12 V dc battery (Figure B).

Figure A

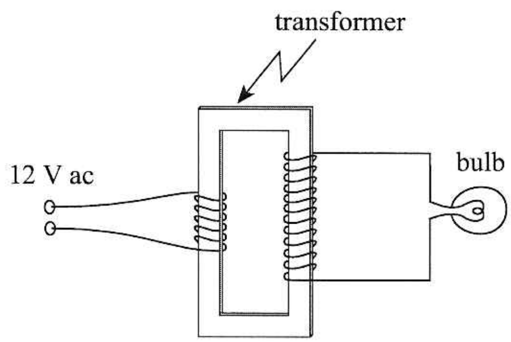
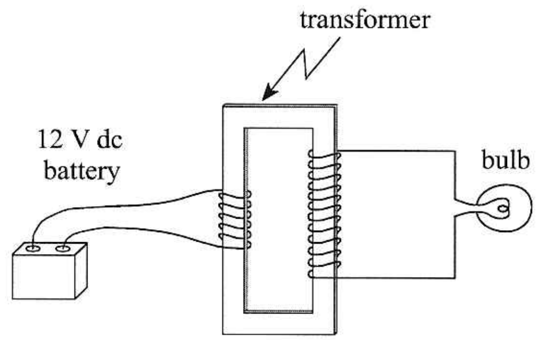


Figure B



a) The bulb will (check one response) **(1 mark)**

- ☐ not be lit.
- ☐ be dimmer.
- ☐ have the same brightness.
- ☐ be brighter.

b) Using principles of physics, explain your answer to a). **(3 marks)**

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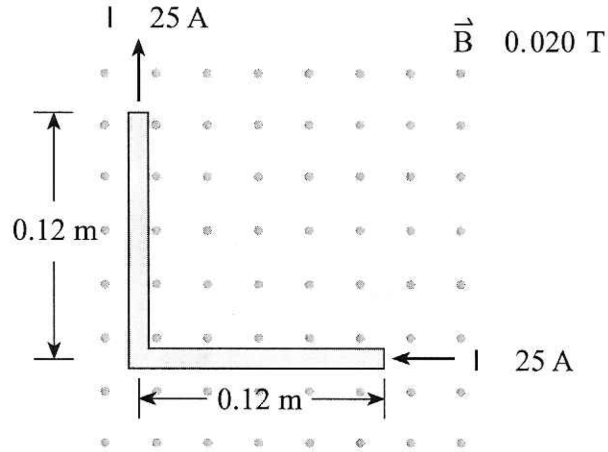
ELECTROMAGNETISM
PROVINCIAL EXAMINATION ASSIGNMENT
ANSWER KEY / SCORING GUIDE

PART A: Multiple Choice (each question worth ONE mark)

Q	K	Q	K
1.	C	30.	B
2.	B	31.	C
3.	A	32.	C
4.	C	33.	D
5.	C	34.	D
6.	D	35.	D
7.	C	36.	D
8.	D	37.	B
9.	A (omit)	38.	C
10.	B	39.	B
11.	D	40.	D
12.	C	41.	B
13.	B	42.	C
14.	B	43.	B
15.	D	44.	D
16.	C	45.	A
17.	B	46.	A
18.	B	47.	D
19.	A	48.	C
20.	B	49.	A
21.	A	50.	A
22.	A	51.	B
23.	A	52.	A
24.	A	53.	C
25.	C	54.	D (omit)
26.	C	55.	A
27.	A	56.	D
28.	A	57.	C
29.	D	58.	D
		59.	A

1. What is the magnitude and direction of the magnetic force on the L-shaped conductor? **(7 marks)**



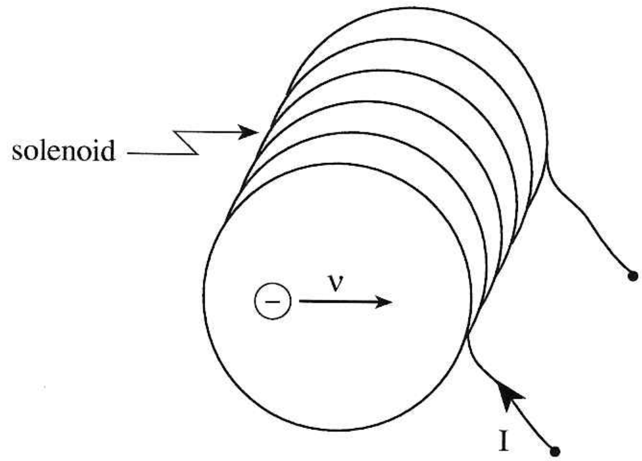
$F_{up} = IlB = (25\text{A})(0.12\text{ m})(0.020\text{ T}) = 0.06\text{ T}$ ← **1 mark**

$F_{right} = IlB = (25\text{A})(0.12\text{ m})(0.020\text{ T}) = 0.06\text{ T}$ ← **1 mark**

$\therefore\ F_{resultant} = \sqrt{(0.06\text{ T})^2 + (0.06\text{ T})^2} = 0.085\text{ T}$ ← **3 marks**

$\theta = 45^0$ above the horizontal to the right ← **2 marks**

2. A 0.400 m long solenoid has 6 720 turns of wire. A current of 14.5 A flows in the solenoid. An electron inside the solenoid travels perpendicular to the axis of the solenoid with a speed of 6.50×10^5 m/s . What is the magnitude of the magnetic force acting on the electron? **(7 marks)**



$F = Bqv$ **2 marks**

$= \left(\mu_0 \frac{N}{l} I\right) qv$ **2 marks**

$= \left(4\pi \times 10^{-7}\right)\left(\frac{6\ 720}{0.400}\right)(14.5)\left(1.6 \times 10^{-19}\right)\left(6.50 \times 10^5\right)$ **2 marks**

$F = 3.2 \times 10^{-14}$ N **1 mark**

OR

$B = \mu_0 \frac{N}{l} I$ **1 mark**

$= \left(4\pi \times 10^{-7}\right)\left(\frac{6\ 720}{0.400}\right)(14.5)$ **2 marks**

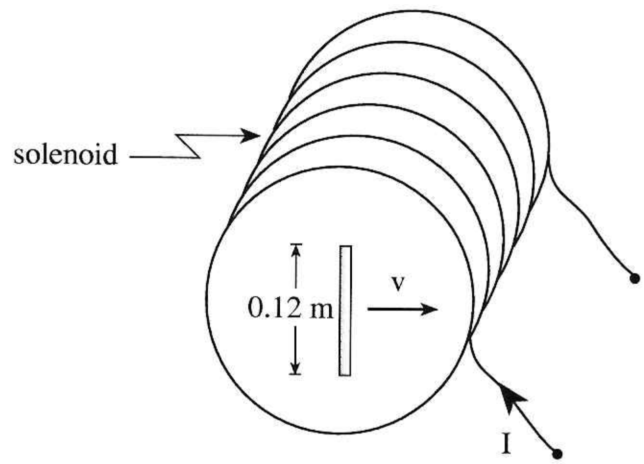
$= 0.306$ T **1 mark**

$F = qvB$ **1 mark**

$= \left(1.6 \times 10^{-19}\right)\left(6.50 \times 10^5\right)(0.306)$ **1 mark**

$F = 3.18 \times 10^{-14}$ N **1 mark**

3. A solenoid of length 0.85 m has a radius of 0.10 m. A current of 25 A flows through its 7 600 turns. Within this solenoid, a 0.12 m wire moves as shown and develops an emf of 0.055 V across its ends.



With what speed does the wire move perpendicular to the solenoid's magnetic field? **(7 marks)**

$\varepsilon = B\ell_w v$ $\quad\leftarrow$ **2 marks**

$$v = \frac{\varepsilon}{B\ell_w} = \frac{\varepsilon}{\underbrace{\left(\mu_0 \frac{N}{\ell_s} I\right)}_{\uparrow\ \textbf{3 marks}} \ell_w} = \frac{0.055}{\left(4\pi\times10^{-7}\right)\left(\frac{7\,600}{0.85}\right)(25)(0.12)} = 1.6\ \text{m/s} \quad \leftarrow \textbf{2 marks}$$

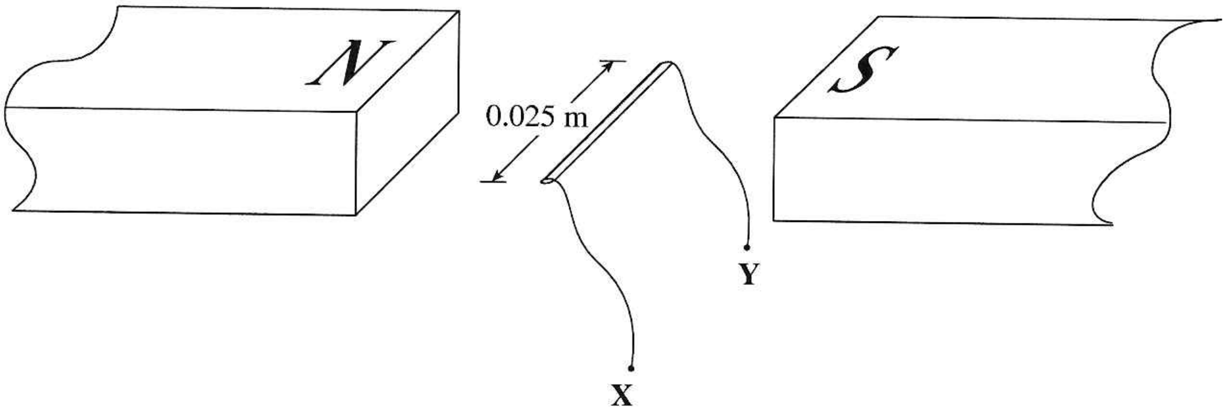
4. Electrons accelerated from rest through a potential difference of $300\ \text{V}$ enter a $4.1\times10^{-2}\ \text{T}$ magnetic field at right angles. What is the radius of curvature of the path taken by the electrons?

(7 marks)

$$\left.\begin{aligned} PE &= KE \\ qV &= \frac{1}{2}mv^2 \\ \left(1.6\times10^{-19}\right)(300) &= \frac{1}{2}\left(9.11\times10^{-31}\right)v^2 \\ v &= 1.0\times10^{7}\ \text{m/s} \end{aligned}\right\} \leftarrow \textbf{3 marks}$$

$$\left.\begin{aligned} net\ F_B &= Fc \\ Bqv &= \frac{mv^2}{r} \\ r &= \frac{mv}{Bq} = \frac{\left(9.11\times10^{-31}\right)\left(1.0\times10^{7}\right)}{0.041\times\left(1.6\times10^{-19}\right)} = 1.4\times10^{-3}\ \text{m} \end{aligned}\right\} \leftarrow \textbf{4 marks}$$

5. A 0.025 m wire segment is positioned in a 0.75 T magnetic field as shown in the diagram below. When a current is passed through this wire segment it experiences a 0.20 N force upwards.



a) What is the direction of the current? (Circle one.) **(2 marks)**

From **X** to **Y**   From **Y** to **X**

b) What is the magnitude of the current? **(5 marks)**

$F = BI\ell$ ← **1 mark**

$I = \frac{F}{B\ell}$ ← **1 mark**

$= \frac{0.20\text{ N}}{0.75\text{ T} \times 0.025\text{ m}}$ ← **2 marks**

$= 10.7\text{ A}$

$= 11\text{ A}$ ← **1 mark**

6. a) A 16.0 V power supply is used to run a dc motor. When the motor is jammed so that it cannot turn, it draws a current of 12.0 A. What is the back or counter emf when the motor runs freely, drawing a current of 2.50 A? **(5 marks)**

$$\left.\begin{aligned} R &= \frac{V}{I} \\ &= \frac{16\ \text{V}}{12\ \text{A}} \\ &= 1.\bar{3}\ \Omega \end{aligned}\right\} \leftarrow \textbf{2 marks}$$

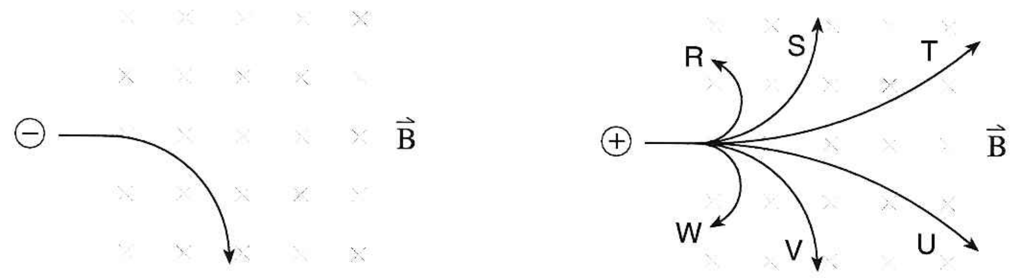
$$\left.\begin{aligned} V_b &= V_{app} - IR \\ &= 16\ \text{V} - \left(1.\bar{3}\ \Omega \times 2.5\ \text{A}\right) \end{aligned}\right\} \leftarrow \textbf{2}\tfrac{\mathbf{1}}{\mathbf{2}}\ \textbf{marks}$$

$$= 12.7\ \text{V} \qquad \leftarrow \tfrac{1}{2}\ \textbf{mark}$$

b) Using principles of physics, explain why the motor draws a much higher current when jammed than when running freely. **(4 marks)**

When running freely, the motor acts as a generator producing an emf that opposes the applied voltage **(1 mark)**. When the motor is jammed **(1 mark)**, there is no back emf **(1 mark)** and thus no opposition to the current **(1 mark)**, which is therefore larger.

7. An electron travelling at a high speed enters a magnetic field as shown. A proton travelling at the same speed then enters the magnetic field.



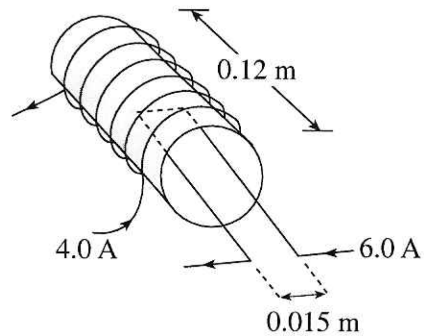
a) Which of the six possible paths shown does the proton follow? **(1 mark)**

Path T

b) Using principles of physics, explain why the proton takes the path selected in a). **(3 marks)**

Since a proton has a positive charge it will travel in the opposite direction as the electron. The proton is also more massive than the electron, therefore the F_B will cause a smaller a_C and hence a larger radius for its path.

8. The diagram below shows a 650-turn solenoid carrying a 4.0 A current.



What is the magnitude of the magnetic force on the 0.015 m segment of wire carrying a 6.0 A current inside the solenoid as shown? **(7marks)**

$$B = \mu_0 \frac{N}{l} \cdot I \qquad \leftarrow \textbf{1 mark}$$

$$\left.\begin{aligned} &= \mu_0 \cdot \frac{650}{0.12\ \text{m}} \cdot 4.0\ \text{A} \\ &= 0.0272\ \text{T} \end{aligned}\right\} \leftarrow \textbf{2 marks}$$

$$F = BIl \qquad \leftarrow \textbf{1 mark}$$

$$\left.\begin{aligned} &= 0.0272\ \text{T} \cdot 6.0\ A \cdot 0.015\ \text{m} \\ &= 2.4 \times 10^{-3}\ \text{N} \end{aligned}\right\} \leftarrow \textbf{3 marks}$$

9. An ideal transformer is connected to a 12 V ac power supply. The light bulb connected to the secondary of the transformer is lit (Figure A). The transformer is then connected to a 12 V dc battery (Figure B).

Figure A

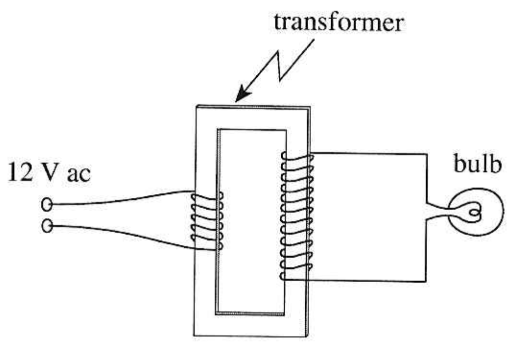
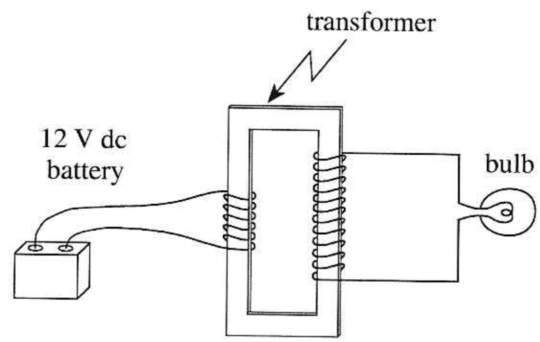


Figure B



a) The bulb will (check one response) **(1 mark)**

- [x] not be lit.
- [ ] be dimmer.
- [ ] have the same brightness.
- [ ] be brighter.

b) Using principles of physics, explain your answer to a). **(3 marks)**

Faraday's law states that an induced current is produced by a changing flux. Since a battery provides a dc current there is no flux change in the transformer. Therefore, there is no induced current.