**RYERSON UNIVERSITY**

**FACULTY OF SCIENCE**

**DEPARTMENT OF PHYSICS**

**PCS 130 Mid-Term Test**

Please insert in the circle the **first** letter of your family name

**DURATION: 65 minutes** **Version A** **DATE: February 15, 2019**

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|---|---|---|---|
| | | | |
| **Student Number** | **Section** | **PRINT first name** | **PRINT family name** |

**Who is your instructor: Check the appropriate box**

**Dr. T. Antimirova** ☐ **Dr. M.J. Carvalho** ☐

**INSTRUCTIONS**

- This test consists of 14 multiple-choice questions.
- For the multiple-choice questions select the option that is closest to the correct answer. Circle it in this booklet **and** fill in the appropriate bubble on the Scantron sheet. The bubbles must be filled using a pencil. If multiple answers are circled in one question, the mark for this question is zero.
- This is a closed book test; pens, pencils, erasers, calculators (Sharp EL-546 and the Casio FX-991 only) and your Ryerson University ID are the only allowed items on your desk.
- Show all your work in this booklet. We may check your work for the numerical multiple-choice questions, and if your choice is not justified by the work done on this booklet, credit will not be given.
- **All electronic devices must be turned off and** placed **out of reach.**
- Coats, jackets and bags must be placed out of reach (under the seats).
- Your Ryerson photo ID must be on your desk at all times.
- **Bubble your version of the exam (A or B) into question 100 of your bubble sheet.**

Please sign here indicating you have read and understood the above instructions.

Student signature: _____

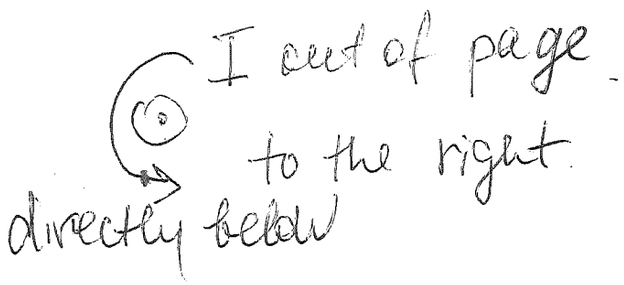
(no signature, no mark!)

## DO NOT OPEN THE EXAM UNTIL YOU ARE TOLD TO DO SO.

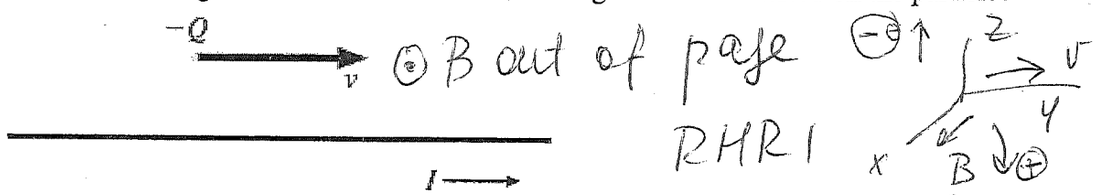
**Test Questions**

**1.** A horizontal wire carries a current straight toward you. From your point of view, the magnetic field at a point directly below the wire points

A) directly away from you.
B) to the left.
C) to the right.
D) directly toward you.
E) vertically upward.




**2.** A **negatively** charged particle is moving to the right, directly above a wire having a current flowing to the right, as shown in the figure. In which direction is the magnetic force exerted on the particle?




A) into the page
B) out of the page
C) downward
D) upward
E) The magnetic force is zero since the velocity is parallel to the current.

**3.** An electron moving perpendicular to a uniform magnetic field of $3.2 \times 10^{-2}$ T moves in a circle of radius 0.40 cm. How fast is this electron moving? ($m_e = 9.11 \times 10^{-31}$ kg, $e = 1.60 \times 10^{-19}$ C).

A) $2.2 \times 10^{7}$ m/s
B) $1.9 \times 10^{-2}$ m/s
C) $1.9 \times 10^{-30}$ m/s
D) $3.0 \times 10^{6}$ m/s
E) $8.0 \times 10^{6}$ m/s

$$\frac{mv^2}{R} = evB$$

$$v = \frac{eBR}{m} = \frac{1.6\times10^{-19}\,C \times 3.2\times10^{-2}\,T \times 0.004\,m}{9.11\times10^{-31}}$$

$$= 2.24\times10^{7}\ m/s$$

**4.** A straight wire that is 0.60 m long is carrying a current of 2.0 A. It is placed in a uniform magnetic field of strength 0.30 T. If the wire experiences a force of 0.18 N, what angle does the wire make with respect to the magnetic field?

A) 25°
B) 30°
C) 35°
D) 60°
E) 90°

$$|\vec{F}| = I\vec{\ell}\times\vec{B} = I\ell B\sin\theta$$

$$\sin\theta = \frac{0.18\,N}{0.6m \times 2A \times 0.3T} = 0.5$$

$$\theta = 30^\circ$$

**5.** A wire carries a 4.0-A current along the +$x$-axis through a magnetic field $\vec{B} = (5.0\,\hat{i} + 7.0\,\hat{j})$ T. If the wire experiences a force of 30 N $\hat{k}$ as a result, how long is the wire?

A) 1.1 m
B) 0.87 m
C) 1.5 m
D) 0.63 m
E) 1.48 m

$$I = 4A$$

$$\vec{F} = I\vec{\ell}\times\vec{B}$$

$$30N\,\hat{k} = 4A \cdot \vec{\ell}\times\vec{B} = 4A\,\ell\hat{i}\times(0.5\hat{i} + 7\hat{j})T$$

$$30N\,\hat{k} = 4A(\ell)\cdot 7\,\hat{i}\times\hat{j} = 4(A)\cdot 7\hat{k}\,\ell$$

$$\ell = \frac{30}{28} \approx 1.08\,m$$

**6.** At what distance from the central axis of a long straight thin wire carrying a current of 5.0 A is the magnitude of the magnetic field due to the wire equal to the strength of the Earth's magnetic field of about $5.0 \times 10^{-5}$ T? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) 1.0 cm
B) 2.0 cm
C) 3.0 cm
D) 4.0 cm
E) 5.0 cm

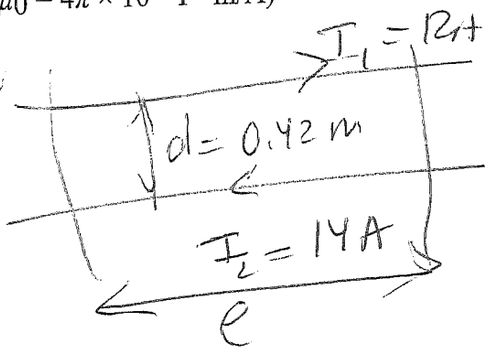
$$B_w = \frac{\mu_0 I}{2\pi d} = B_{earth}$$

$$d = \frac{\mu_0 I}{2\pi B_{earth}} = \frac{4\pi \times 10^{-7}\,Tm/A \times 5A}{2\pi \times 5\times 10^{-5}\,T} =$$

$$= 2\times 10^{-2}\,m = 2\,cm$$

**7.** A very long straight wire carries a 12-A current eastward and a second very long straight wire carries a 14-A current westward. The wires are parallel to each other and are 42 cm apart. Calculate the force on a 6.4 m length of one of the wires. ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) $8.0 \times 10^{-7}$ N
B) $5.1 \times 10^{-4}$ N
C) $8.0 \times 10^{-5}$ N
D) $5.1 \times 10^{-6}$ N
E) $2.2 \times 10^{-4}$ N




$$|\vec{F}_{12}| = \frac{\mu_0}{2\pi d} I_1 I_2$$

$$|\vec{F}_{12}| = \frac{4\pi \times 10^{-7}\ mT/A \times 6.4\,m \times 14\,A \times 12\,A}{2\pi \times 0.42\,m} = 5.12 \times 10^{-4}\ N$$

**8.** A wire carrying a current is shaped in the form of a circular loop of radius 3.0 mm. If the magnetic field strength that this current produces at the center of the loop is 1.1 mT, what is the magnitude of the current that flows through the wire? ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)

A) 5.3 A
B) 16 A
C) 9.1 A
D) 23 A
E) 4.1 A

$$B_{loop} = \frac{\mu_0}{2} \frac{IR^2}{(z^2+R^2)^{3/2}} \hat{i} \quad \text{for } z=0 \quad B = \frac{\mu_0 I}{2R}$$

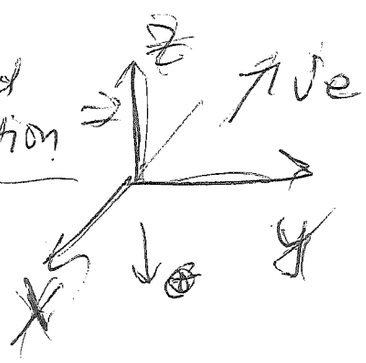
$$I = \frac{2RB}{\mu_0} = \frac{2 \times 3 \times 10^{-3}\,m \times 1.1 \times 10^{-3}\,T}{4\pi \times 10^{-7}\,m \cdot T/A} = 5.3\,A$$

9. An **electron**, moving in the negative $x$-direction, enters a uniform magnetic field. Because of this field the electron curves towards the positive $z$-direction. The direction of the magnetic field is

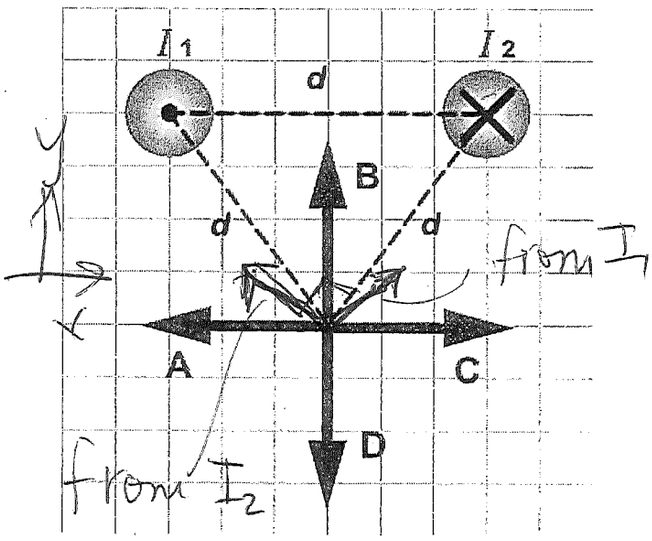
A) in the positive $y$-direction
B) in the negative $y$-direction
C) in the positive $x$- direction
D) in the positive $z$-direction
E) in the negative $z$-direction

The positive particle would curve toward the negative z direction

B must be in +y direction



**10.** The figure shows two long wires carrying equal currents $I_1$ and $I_2$ flowing in opposite directions. Which of the arrows labeled A through D correctly represents the direction of the magnetic field due to the current-carrying wires at a point located at an equal distance d from each wire, as shown below?




the resultant force is along +y (B)

A) A
B) B
C) C
D) D
E) The magnetic field is zero at that point.

**11.** In simple harmonic motion, the speed is greatest at that point in the cycle when

A) the magnitude of the acceleration is a maximum.
B) the displacement is a maximum.
C) the magnitude of the acceleration is zero.
D) the potential energy is a maximum.
E) the kinetic energy is a minimum.

greatest speed is when going through the equilibrium ⇒ the displacement is zero ⇒ the restoring force is zero ⇒ the acceleration is zero

12. An object of mass 8.0 kg is attached to an ideal massless spring and allowed to hang in the Earth's gravitational field. The spring stretches 3.6 cm before it reaches its equilibrium position. If this system is allowed to oscillate, what will be its frequency?

A) 2.6 Hz
B) 0.0045 Hz
C) 0.67 Hz
D) 2.1 Hz
E) 4.6 HZ

$k\Delta y = mg$ $\quad \frac{k}{m} = \frac{g}{\Delta y}$ $\quad \omega = \sqrt{\frac{k}{m}}$; $\quad f = \frac{1}{2\pi}\omega = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

$f = \frac{1}{2\pi}\sqrt{\frac{g}{\Delta y}} = \frac{1}{6.28}\sqrt{\frac{9.8\ m/s^2}{3.6\times10^{-2}\ m/s^2}} = 2.62\ Hz$

13. The position $x$ of an object varies with time $t$. For which of the following equations relating $x$ and $t$ is the motion of the object simple harmonic motion?

A) $x = 5 \sin^2 3t$
B) $x = 8 \cos 3t^3$
C) $x = 4 \tan 2t$
D) $x = 5 \cos^2 (3t - 1)$
E) $x = 2 \cos(3t - 1)$

14. The position of an object that is oscillating on an ideal spring is given by the equation $x = (12.3 \text{ cm}) \cos[(1.26 \text{ s}^{-1})t]$.
At time $t = 0.815$ s, what is the magnitude of the acceleration of the object?

A) 0.1 cm/s$^2$
B) 0.8 cm/s$^2$
C) 16.4 cm/s$^2$
D) 0 cm/s$^2$
E) 4.6 cm/s

$a = -x\omega^2 = -A\omega^2 \cos \omega t$

$a = -0.123 \text{ m} \times (1.26 \text{ s}^{-1})^2 \cos(1.26 \text{ s}^{-1} \times 0.815 \text{ s})$

$\approx 0.1 \text{ m/s}^2$

**THE END**