P12 Name: KEY

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Electromagnetism Practice

1. What is the magnitude of the <u>force per meter</u> of length of a straight wire carrying an 8.40-A current when perpendicular to a 0.90-T uniform magnetic field? What if the angle between the wire and the filed is 45.0° ?

G: $\ell = 1.0m$
$I = 8.40 A$
$B = 0.90 T$
[A] $\theta = 90°$
[B] $\theta = 45°$

R: $F = ? [N]$

A: $F = BI\ell$
$F = BI\ell \sin\theta$

S: [A] $F = (0.90)(8.40)(1)$
$= 7.56 N$

[B] $F = (0.90)(8.40)(1)(\sin 45°)$
$= 5.345 N$

S: The force is 7.6 N/m and 5.3 N/m.

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2. How much current is flowing in a wire 4.80m long if the maximum force on it is 0.750 N when placed in a uniform 0.0800-T field?

G: $\ell = 4.80m$
$F = 0.750N$
$B = 0.0800T$

R: $I = ? [A]$

A: $F = BI\ell$
$\rightarrow I = \frac{F}{B\ell}$

S: $I = \frac{0.750}{(4.80)(0.0800)}$

$I = 1.9531 A$

S: 1.95 A of electric current is flowing in the wire.

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3. **The force on a wire carrying 8.75 A is a maximum of 1.28 N when placed between the pole faces of a magnet. If the pole faces are 55.5 cm in diameter, what is the approximate strength of the magnetic field?**

$F = 1.28 N$

$I = 8.75 A$

$l = 55.5 cm \rightarrow 0.555 m$

$B = ? [T]$

A: $F = BIl$

$B = \frac{F}{Il}$

S: $B = \frac{1.28}{(8.75)(0.555)}$

$B = 0.2636\ T$

S: The strength of the magnetic field is 2.64×10^{-1} T.

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4. **Alpha particles of charge $q = +2e$, and mass $m = 6.6 \times 10^{-27}\ kg$ are emitted from a radioactive source at a speed of $1.6 \times 10^{7}\ m/s$. What magnetic field strength would be required to bend them into a circular path of radius $r = 0.25m$?**

G: $q = +2e$

$\rightarrow 2(1.6 \times 10^{-19})C$

$m = 6.6 \times 10^{-27} kg$

$v = 1.6 \times 10^{7} m/s$

$r = 0.25 m$

R: $B = ? [T]$

A: $F = qvB$

$F_c = m\frac{v^2}{r}$

$qvB = m\frac{v^2}{r}$

$B = \frac{mv}{rq}$

S: $B = \frac{(6.6 \times 10^{-27})(1.6 \times 10^{7})}{(0.25)(3.2 \times 10^{-19})}$

$B = 1.32\ T$

S: The required magnetic field is 1.3 T.

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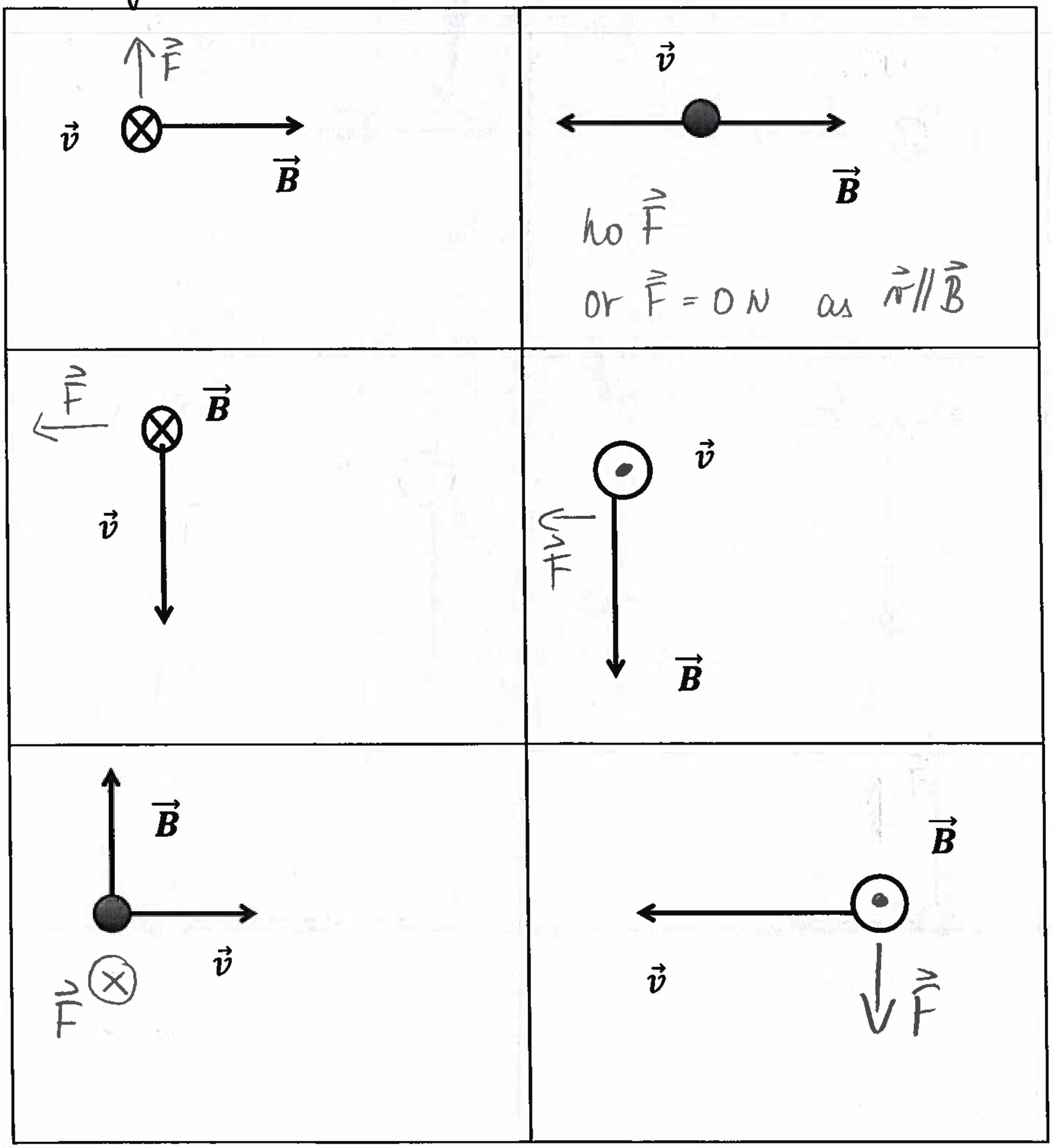
Back of your hand

5. Find the direction of the force on a negative charge for each diagram shown below.

Right hand Rule # 4 Palm Rule



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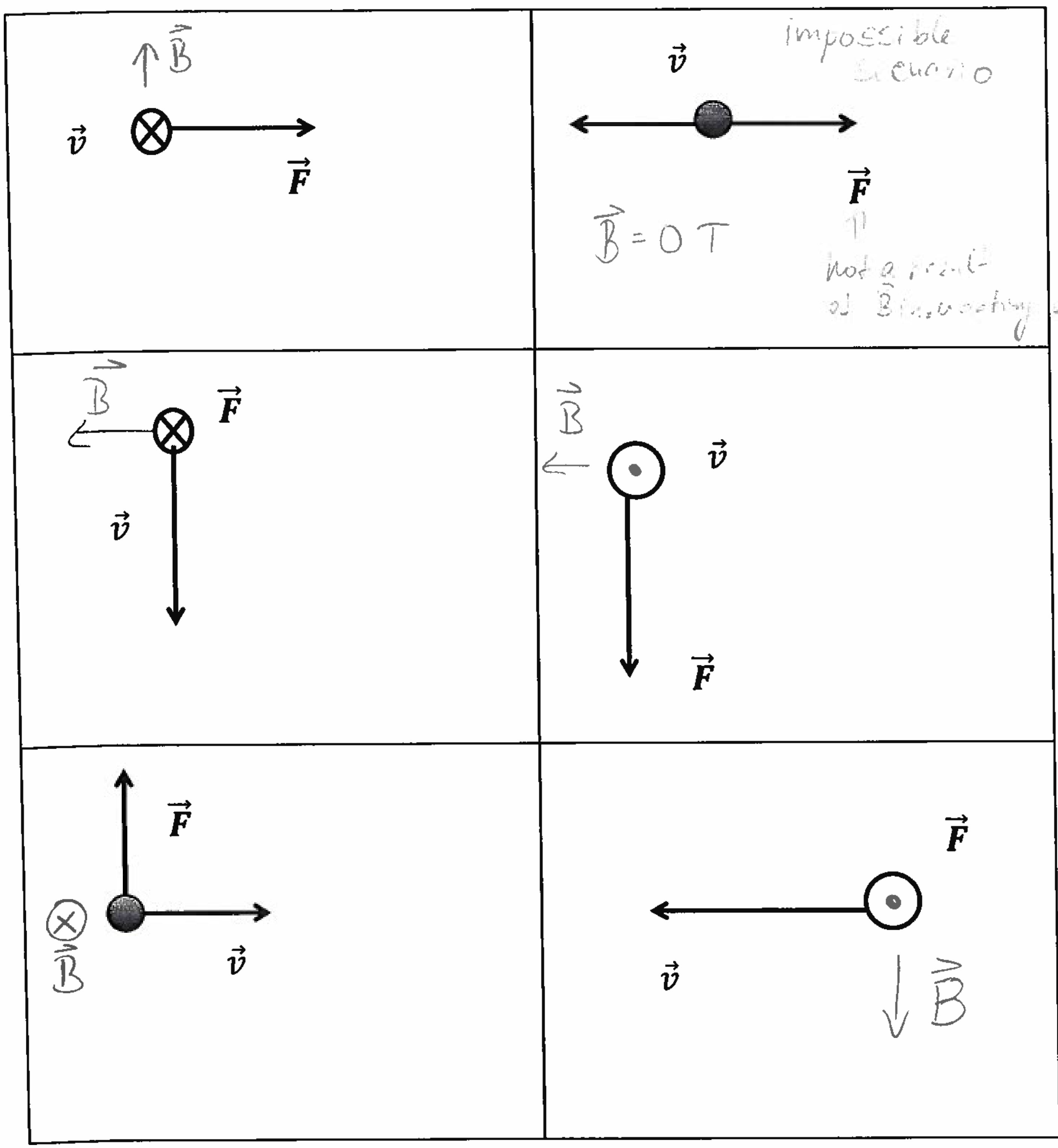
6. Determine the direction of the magnetic field for diagram below, where the force vector represents the maximum magnetic force on a positively charged particle moving with the velocity vector.



$1 eV = 1.6 \times 10^{-19} J$ $MeV = 10^6 eV$

7. **A 5.0-MeV (kinetic energy) proton enters a 0.20-T field in a plane perpendicular to the field. What is the radius of its path?**

G: $KE = 5.0\ MeV$
$p^+ \rightarrow m = 1.67 \times 10^{-27} kg$
$B = 0.20\ T$
$\vec{v} \perp \vec{B}$

R: $r = ?\ [m]$

A: $F_c = F_B$
$m\frac{v^2}{r} = qvB$
$r = \frac{mv}{qB}$

A: v: $KE = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2KE}{m}}$

$\frac{5.0\ MeV}{1} \times \frac{10^6\ eV}{1\ MeV} \times \frac{1.6 \times 10^{-19} J}{1\ eV} = 8.0 \times 10^{-13}$

S: $v = \sqrt{\frac{2(8.0 \times 10^{-13})}{1.67 \times 10^{-27}}}$

$v = 3.0953 \times 10^7\ m/s$

$r = \frac{(1.67 \times 10^{-27})(3.0953 \times 10^7)}{(1.6 \times 10^{-19})(0.20)}$

$r = 1.6\ m$ S: ∴ The path's radius is 1.6m

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8. **A thin 12-cm-long solenoid has a total of 420 turns of wire and carries a current of 2.0A. Calculate the field inside near the center.**

G: $l = 12\ cm \rightarrow 0.12\ m$
$N = 420$
$I = 2.0\ A$

R: $B = ?\ [T]$

A: $B = \mu_0 \frac{N}{l} I$

S: $= (4\pi \times 10^{-7})\left(\frac{420}{0.12}\right)(2.0)$

$= 8.8 \times 10^{-3} T$

S: The strength of the magnetic field is $8.8 \times 10^{-3} T$.

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9. You have 1.0 kg of copper and want to make a practical solenoid that produces the greatest possible magnetic field for a given voltage. Should you make your copper wire long and thin, short and thick, or something else? Consider other variables, such as solenoid diameter, length, and so on.

$B = \mu_0 \frac{N}{l} I$

To maximize B → increase N, decrease diameter, have the turns close to each other to decrease l.

∴ The wire should be long and thin.

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10. A long thin solenoid has 430 loops of wire <u>per meter</u>, and 25-A current flows through the wire. If the permeability of the iron is $3000\mu_0$, what is the total field B inside the solenoid?

G: $n = 430$

$I = 25$ A

$\mu = 3000\mu_0$

R: $B = ?$ [T]

A: $B = \mu n I$

S: $B = 3000(4\pi \times 10^{-7})(430)(25)$

$= 40.5265$ T

S: The magnetic field inside the solenoid is 41 T.

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11. An iron-core solenoid is 38 cm long and 1.8 cm in diameter, and has 640 turns of wire. The magnetic field inside the solenoid is 2.2 T when 48 A flows in the wire. What is the permeability μ at this high field strength?

G: $l = 38$ cm → 0.38 m

$B = 2.2$ T $N = 640$

$I = 48$ A

R: $\mu = ?$

A: $B = \mu \frac{N}{l} I$

→ $\mu = \frac{Bl}{NI}$

S: $\mu = \frac{(2.2)(0.38)}{(640)(48)}$

$\mu = 2.7 \times 10^{-5}$

S: The permeability is 2.7×10^{-5} T·m/A.

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