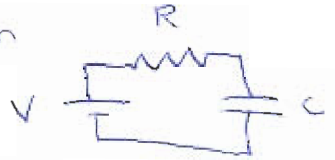
1B Quiz 4

1. When $t \to \infty$, the capacitor is fully charged. The voltage across it is the voltage across the battery (since no current flows, the voltage drop across the resistors is zero). $\boxed{V_c = 1.5\,V}$

2. For a circuit of the form



, $\tau = RC$. The equivalent resistance of R_1 and R_2 in our circuit is $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$. Now our circuit is of the desired form, so

$$\tau = R_{eq} C$$
$$= (142.8\,\Omega)(7 \times 10^{-6}\,F)$$
$$\boxed{\tau = 1 \times 10^{-3}\,s}$$

3. Applying rhr #1, we see the force on a positive charge would be in the $-\hat{y}$ direction. Since we are considering a particle with negative charge, the direction of force is opposite that for a positive particle. $\boxed{\therefore F \text{ points towards } +\hat{y}.}$
The magnitude of the force is given by

$F = qvB\sin\theta$,

q = magnitude of charge $= 1.6 \times 10^{-19}$ C
v = " " velocity $= 1.0 \times 10^{6}$ m/s
B = " " mag. field $= 1.0$ T
θ = angle btwn $\vec{v}$ and $\vec{B}$ = 90°

$\boxed{\therefore F = 1.6 \times 10^{-13}\,N}$

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4. Since the particle is negatively charged, the electric force is in the direction opposite the electric field: F_{elec} points to $-\hat{y}$. As for the magnetic force, rhr #1 shows the force on a positive particle would be towards $+\hat{y}$. Since our particle is negatively charged, F_{mag} points to $-\hat{y}$. Therefore the net force on the particle is downward $(-\hat{y})$, so the particle is deflected downward regardless of its velocity.

5 The magnetic force on a straight wire is $F_{mag} = I l B \sin\theta$. We are told $\theta = 90°$, $B = 5\times10^{-4}$ T, $l = 3.0$ m, and $I = 200$ A.

$$\boxed{\therefore F_{mag} = 0.3 \text{ N}}$$

(magnitudes are always positive and don't include direction)

IB Quiz 4

6. Ignoring fields caused by supporting wires and considering only the external, uniform magnetic field, rhr #1 shows the force on the current segment would be up.

For the wire not to fall, its acceleration must be zero.

$$\Sigma F = F_{mag} - F_g = m\cancel{a}^{0} = 0$$

$$F_{mag} = F_g$$

$$F_{mag} = I \ell B \sin\theta$$

$$F_g = mg$$

$$\therefore I = \frac{mg}{\ell B \sin\theta}$$

$$= \frac{(1.0\times10^{-3}\,kg)(9.8\,m/s^2)}{(10\times10^{-2}\,m)(2.0\,T)\sin 90^\circ}$$

$$\boxed{I = 4.9\times10^{-2}\,A}$$

7. $F_{mag} = I\ell B\sin\theta$ shows that the force on the current segment is 0 since θ, the angle between the current and the magnetic field, is 0.

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8. Using rhr #2, we see that at the position of the bottom wire, the field due to the top wire is into the page $\otimes$.
Using rhr #1 on the bottom wire in the mag. field of the top wire, we see F points up. $\boxed{\therefore \text{The force is attractive}}$

The magnetic field of a long wire is $B = \frac{\mu_0 I}{2\pi r}$.
The force on a wire in a magnetic field is $F = I \ell B \sin\theta$. Substituting and solving for F/ℓ,

$$\frac{F}{\ell} = I \frac{\mu_0 I}{2\pi r} \sin\theta \qquad (\theta = 90° \text{ since } \vec{I} \perp \vec{B})$$

$$= \frac{(4\pi\times10^{-7}\ \mathrm{T\cdot m/A})(10\ \mathrm{A})^2}{2\pi(2\times10^{-3}\ \mathrm{m})}$$

$$\boxed{\frac{F}{\ell} = 1\times10^{-2}\ \mathrm{N/m}}$$

9. Using rhr #2, we see the fields due to both wires point $\boxed{\text{into the page}}$ at A. The magnitude of this field is just the sum of the two:

$$B = B_{top} + B_{bottom}$$

both terms identical

$$= \frac{\mu_0 I}{2\pi(d/2)} + \frac{\mu_0 I}{2\pi(d/2)} = \frac{(4\pi\times10^{-7}\ \mathrm{T\cdot m/A})(100\times10^{-6}\ \mathrm{A})}{2\pi(1\times10^{-6}\ \mathrm{m}/2)} \times 2$$

$$\boxed{\vec{B} = 8\times10^{-5}\ \mathrm{T}\ \text{into page}}$$

10. Using rhr #2, B_{top} points out of page, $r_{top} = d/2$; B_{bot} points into page, $r_{bot} = 3d/2$. Letting out of page be $+\hat{x}$,

$$\vec{B} = \vec{B}_{top} + \vec{B}_{bot} = \frac{\mu_0 I}{2\pi(d/2)}\hat{x} + \frac{\mu_0 I}{2\pi(3d/2)}(-\hat{x}) = \frac{\mu_0 I}{2\pi(d/2)}\hat{x}\left(1 - \frac{1}{3}\right)$$

$$\boxed{\vec{B} = 2.7\times10^{-5}\ \mathrm{T}\ \text{out of page}}$$