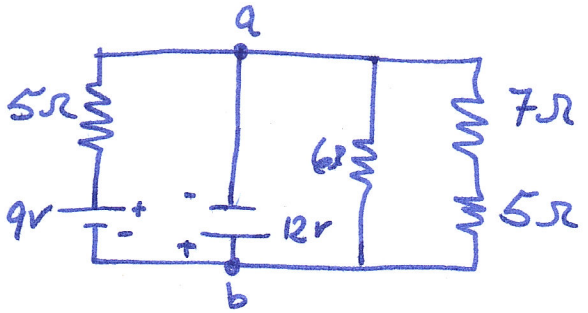
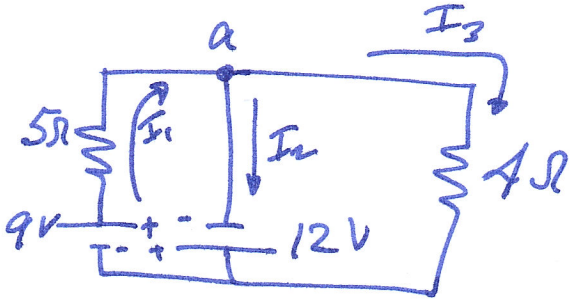
① works ∴ no battery w/ 6Ω and no R w/ 12V!

→ * shortcut: must have $V_a - V_b = 12V$
⇒ 12V across 6Ω too! so $I = \frac{12}{6} = 2A$



Longway
- combine 5 & 7 (series) ⇒ 12Ω
- combine that w/ 6 (par.) ⇒ 4Ω

||



- assign currents
- our choice, w/ conv. chg @ a gives $I_1 = I_2 + I_3$
- note I_2 will not matter, goes thru no resistor!

Now walk loops.

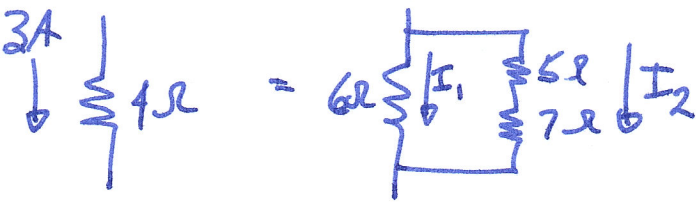
(1) LHS loop, from a, CW

$+12V + 9V - 5I_2 = 0$ or $5I_2 = 21$ $I_2 \simeq 4.2A$

(2) RHS loop, from a, CW

$-4I_2 - 12 = 0 \Rightarrow I_3 = -3A$ (di. was wrong)

4Ω is really 3 resistors

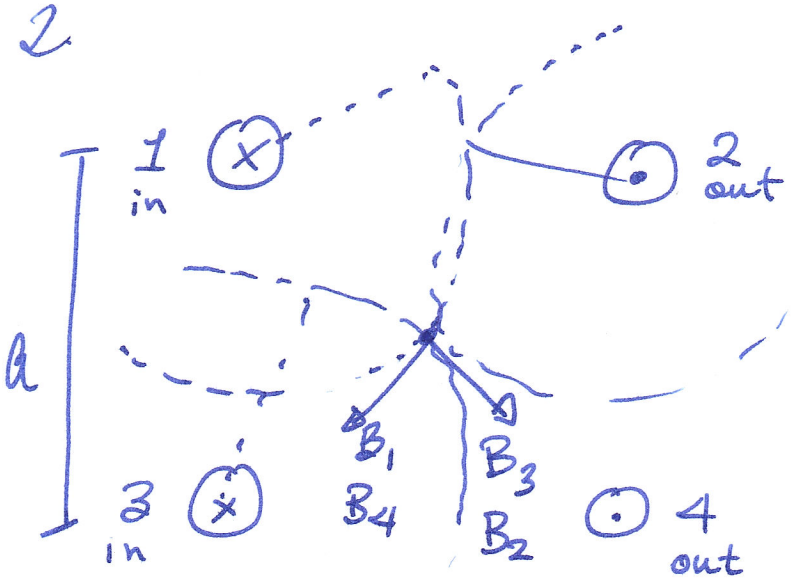


$\Delta V_4 = 3A \cdot 4\Omega = 12V = \Delta V$ on 6Ω

I_1 = thru 6Ω = $\frac{12V}{6\Omega} = 2A$

2A thru 6Ω

2



- draw circles on wires that intersect center
- field is tangent to circle & follows RH rule

- Do this: B_1, B_4 point down & to left at 45°
  B_2, B_3 point down & to right at 45°

- by symmetry, all cancels in horiz. direction - equal & opposite

- magn same for all, $B = B_2 = B_3 = B_4 = \frac{\mu_0 I}{2\pi(a\sqrt{2}/2)} = B$

vertical component of any one is $B\sin 45 = B\frac{\sqrt{2}}{2}$
we have 4 of these

$$B_{net} = 4B\sin 45 = \frac{4\mu_0 I}{2\pi a\sqrt{2}/2}\cdot\frac{\sqrt{2}}{2} = \frac{2\mu_0 I}{\pi a}$$

$$\sim 4.4\,\mu T$$

3.

a) if proton moves CCW in circle, $\vec{B}$ must be <u>into</u> page (RH rule)

b) radius given by force balance $F_B = F_{centr}$ for either

$$qvB = \frac{mv^2}{r} \Rightarrow r = \frac{mv}{qB}$$

$$r_e = \frac{m_e v_e}{eB} = r_p = \frac{m_p v_p}{eB}$$

$$\Rightarrow \boxed{\frac{v_e}{v_p} = \frac{m_p}{m_e}}$$

4.) b, a) inductors pass low freq, cap shorts high freq

⇒ this passes low freq speech

c) $L_{tot} = 10.26\,mH$ $C = 22\,nF$

cutoff: $X_L = X_C$ ~ $\omega L = \frac{1}{\omega C} \Rightarrow \omega = \frac{1}{\sqrt{LC}}$

$$\Rightarrow f = \frac{1}{2\pi\sqrt{LC}} \simeq 10\,kHz$$ nicely btw voice and data

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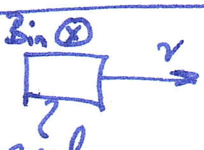
5) 

88 kph = 24.4 m/s

a) motional: $qE = qvB = q\frac{\Delta V}{l}$

$\Rightarrow \Delta V = Blv \simeq \underline{2.55\,mV}$

b) top view at left... F on ⊕ is up

⇒ driver's side is ⊕