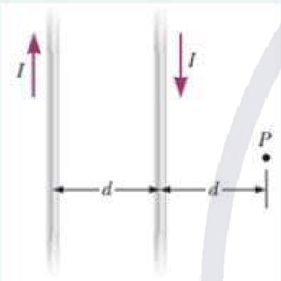
-----------------------------------------------------

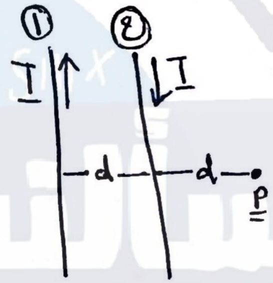
The figure shows two wires carrying currents of $I$ = 4.95 A in opposite directions, separated by a distance $d$. Given that $d$ = 11.5 cm, what are the magnitude (in μT) and direction of the net magnetic field at point $P$, 11.5 cm to the right of the wire on the right?




- a. 2.15 into the page
- b. 4.30 into the page
- c. 8.60 into the page
- d. 4.30 out of the page
- e. 2.15 out of the page

**Q1**

$B_{(total\ at\ P)} = B(wire\ 1) + B(wire\ 2)$




into the page by (rhr) ↘ ; out of the page by (rhr) ↗

$$= -\frac{\mu_0 I}{2\pi r_1} + \frac{\mu_0 I}{2\pi r_2}$$

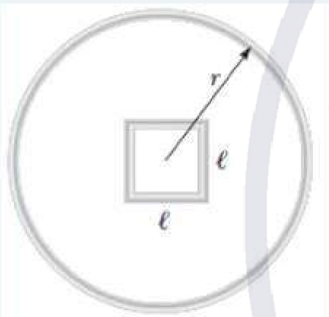
$$= \frac{-4\pi\times10^{-7}\times4.93}{2\pi\times11.5\times2\times10^{-2}} + \frac{4\pi\times10^{-7}\times4.93}{2\pi\times11.5\times10^{-3}}$$

$$= 4.3\times10^{-6}\ T = (4.3\ \mu T \text{ out of the page})$$

**d**

--------------------------------------------------------

The figure shows an end view of a single-turn square loop of metal wire in the center of and coaxial with a very long solenoid with a circular cross section. The solenoid is 15.0 cm long, has a radius $r$ = 3.00 cm, and consists of 120 turns of wire. The length of each side of the square loop is $l$ = 1.50 cm. The current in the solenoid decreases from 4.00 A to zero in 0.40 s. What is the magnitude of the average induced emf (in μV) in the square loop over this time?




- a. 2.3
- b. 4.5
- c. 6.3
- d. 1.5
- e. 3.0

**Q2**

$$emf = \frac{\Delta \phi_B}{\Delta t}$$

$$\phi = B \times A \times \sin\theta \;(\sin\theta \to 1) = \underbrace{\mu_0 \times n \times I}_{B} \times \underbrace{A}_{\ell^2}$$

$$\phi = 4 \times \pi \times 10^{-7} \times \frac{N}{l} \times I \times (\ell)^2$$

($l$ → Solenoid)

$$= 4\pi \times 10^{-7} \times \frac{120}{13 \times 10^{-2}} \times 4 \times (1.5 \times 10^{-2})^2$$

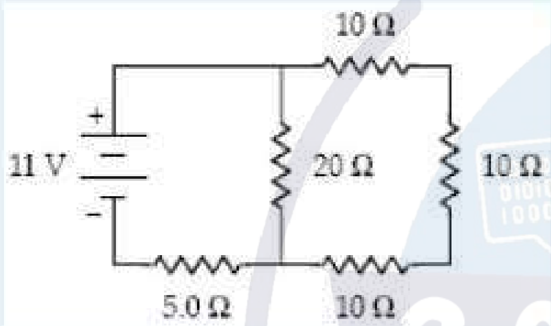
$$\phi = 9.047 \times 10^{-7} \; T \cdot m^2$$

$$emf = \frac{\phi - 0}{\Delta t} = \frac{9.047 \times 10^{-7}}{0.4} = 2.26 \times 10^{-6} \; V$$

$$\simeq 2.3 \; \mu V$$

**a**

What is the magnitude (in V) of the potential difference across the 20-Ω resistor?






- a. 3.2
- b. 7.8
- c. 11
- d. 5.0
- e. 8.6

3) $V_{20} = V_{30}$ (Parallel)

↳ $R_t = \frac{20 * 30}{20 + 30} = 12$

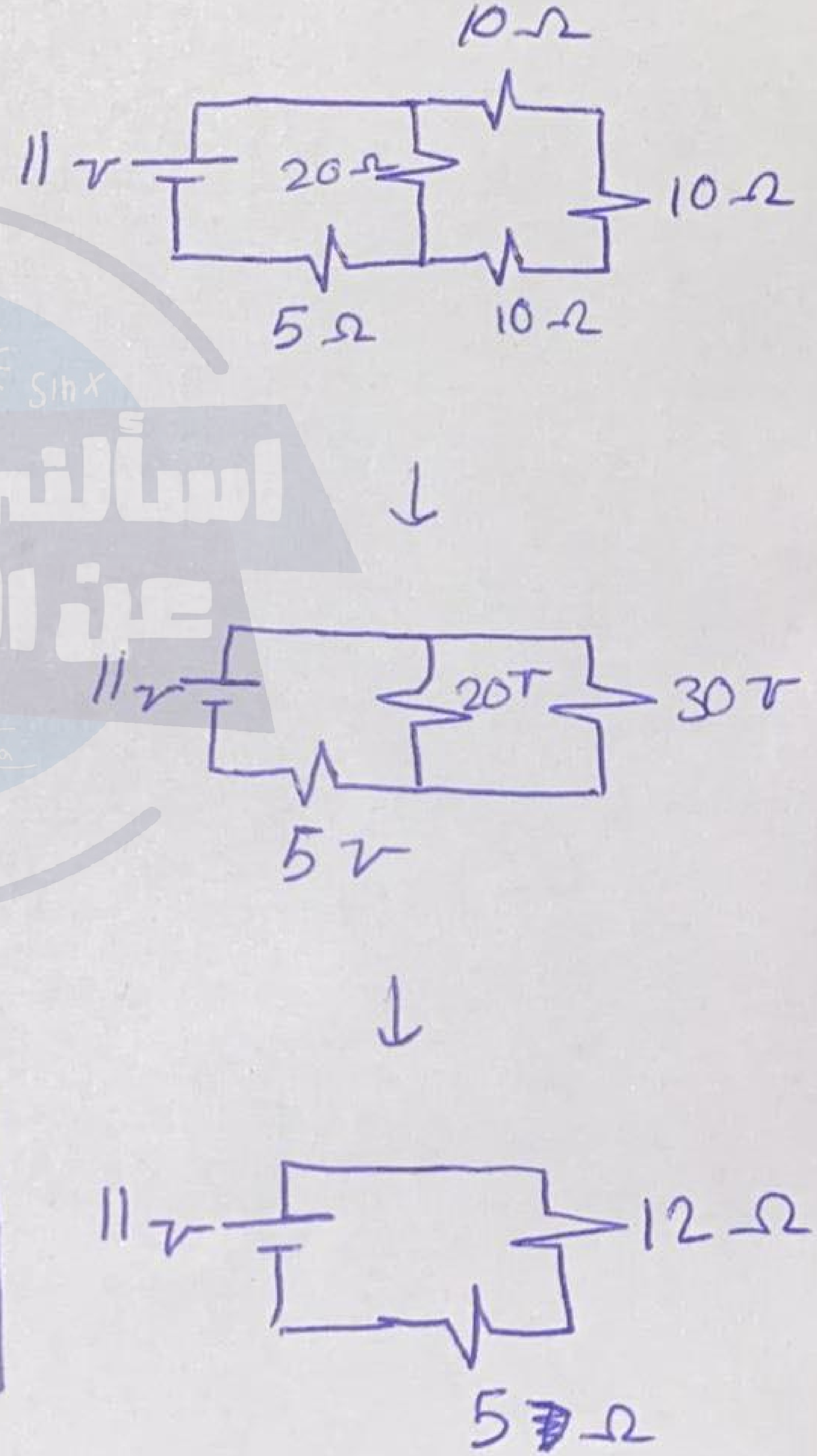
$V_{12} = V_{20}$

using voltage divider:

$V_{12} = V_{20} = \frac{12}{5+12} * 11$

$= 7.76 \cong 7.8 \text{ V}$

**ans : b**



Time left 0:27:43

Useful Constants

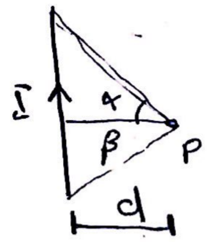
$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m²/C²; $\varepsilon_o = 8.85 \times 10^{-12}$ C²/N.m²; e = $1.6 \times 10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s², $\mu_o = 4\pi \times 10^{-7}$ T.m/A

---

A conducting loop in the shape of a square of edge length l = 0.460 m carries a current $I$ = 9.80 A as in the figure. What are the magnitude (in μT) and direction of the magnetic field at the center of the square?


- a. 12.1 into the page
- b. 24.1 into the page
- c. 24.1 out of the page
- d. 8.03 into the page
- e. 8.03 out of the page

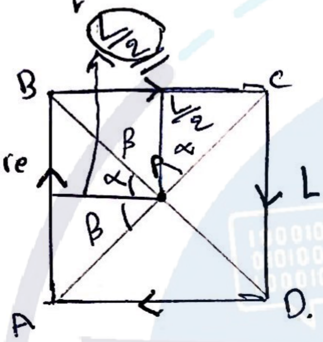
## Q4 | for a single wire:




$$B = \frac{\mu_0 I (\sin\alpha + \sin\beta)}{4\pi \times d}$$

for a square

* Because the shape is square $\alpha = \beta = 45^\circ$




for (AB) =>

$$B_p = \frac{\mu_0 I \times \left(\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right)}{4\pi \times \frac{L}{2}} = \frac{\mu_0 I}{\sqrt{2}\pi L} \text{ (into the page)}$$

( Note: $B_{AB \text{ at } p} = B_{BC \text{ at } p} = B_{CD \text{ at } p} = B_{DA \text{ at } p}$ ) due to symmetry

and they are all into the page by right hand rule

so $$B_{total \text{ at } p} = 4 \times \frac{\mu_0 I}{\sqrt{2} \times \pi \times L} = \frac{4\pi \times 4 \times 10^{-7} \times 9.8}{\sqrt{2} \times \pi \times 0.46}$$

$$= 24.1 \times 10^{-6}\ T = 24.1\ \mu T \text{ into the page}$$

**b**

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m$^2$/C$^2$; $\varepsilon_o = 8.85 \times 10^{-12}$ C$^2$/N.m$^2$; e = $1.6 \times 10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s$^2$, $\mu_o = 4\pi \times 10^{-7}$ T.m/A

-------------------------------------------------------------------

The area of an elastic circular loop decreases at a constant rate, $dA/dt = -4.0 \times 10^{-2}$ m$^2$/s. The loop is in a magnetic field $B$ = 0.2 T whose direction is perpendicular to the plane of the loop. At $t$ = 0 the loop has area $A$ = 0.285 m$^2$. The magnitude of the induced emf (in V) at $t$ = 2.0 s is

- a. $2.0 \times 10^{-2}$
- b. $1.6 \times 10^{-2}$
- c. $1.2 \times 10^{-2}$
- d. $8.0 \times 10^{-3}$
- e. $4.0 \times 10^{-3}$

Q5

$$\varepsilon = -\frac{d\phi_B}{dt} \quad (\phi_B = B \cdot A)$$

$$\varepsilon = -B\frac{dA}{dt} \quad \text{——— (1)}$$

$$\varepsilon\Big|_{t=0} = -(0.2) \times (-4.0 \times 10^{-2})$$

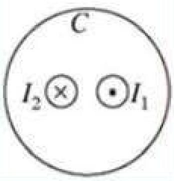
$$= 8 \times 10^{-3}\ V$$

Similarly for $t = 2.00$ sec, as the area has decreased but not reached to the zero value. So, emf will be the same.

the induced emf at $t=0$ and $t=2$ is $8 \times 10^{-3}$ volt **[d]**

The figure shows two parallel current-carrying conductors with currents $I_1$ = 8.0 A and $I_2$ = 5.0 A. For the closed path $C$, the magnitude (in μT.m) of the line integral

$\oint \vec{B}.d\vec{l}$ is




- a. 7.5
- b. 6.3
- c. 5.0
- d. 3.8
- e. 4.5

**Q6:**

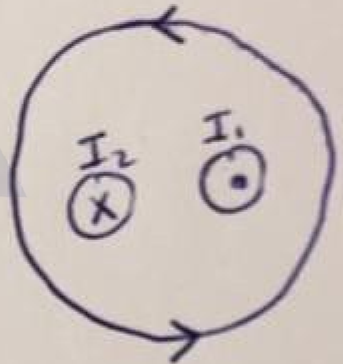
$$\oint_c \vec{B}\cdot\vec{dl} = \mu_0 \Sigma I$$

$$\oint_c \vec{B}\cdot\vec{dl} = \mu_0 (I_1 - I_2)$$

$$= 4\pi \times 10^{-7} (8-5)$$

$$= 3.8\ \mu T.m$$

**d**



Useful Constants

Time left 0:56:57

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m$^2$/C$^2$; $\varepsilon_o = 8.85 \times 10^{-12}$ C$^2$/N.m$^2$; e = $1.6 \times 10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s$^2$, $\mu_o = 4\pi \times 10^{-7}$ T.m/A

---

An alpha particle is moving with a speed of $5 \times 10^5$ m/s in a direction perpendicular to a uniform magnetic field of strength $5 \times 10^{-2}$ T. The charge on the alpha particle is $3.2 \times 10^{-19}$ C and its mass is $6.6 \times 10^{-27}$ kg. The time (in μs) it takes the alpha particle to complete one revolution around its path is

- a. 1.6
- b. 2.6
- c. 3.2
- d. 4.3
- e. 6.5

Q7:

$$r = \frac{mv}{Bq} = \frac{(6.6\times10^{-27})(5\times10^{5})}{(0.05)(3.2\times10^{-19})}$$

$$= 0.20625 \text{ m}$$

$$T = \frac{2\pi r}{v} = \frac{2\pi(0.20625)}{5\times10^{5}} = 2.59\times10^{-6} \text{ sec}$$

$$\approx 2.6 \text{ MS}$$

b

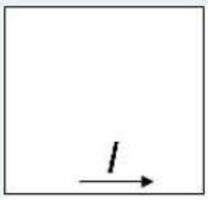
Time left 0:59:51

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m$^2$/C$^2$; $\varepsilon_o = 8.85 \times 10^{-12}$ C$^2$/N.m$^2$; e = $1.6 \times 10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s$^2$, $\mu_o = 4\pi \times 10^{-7}$ T.m/A

---

A square coil of $N$ = 100 closely wrapped turns has sides of length $L$ = 20 cm. A current $I$ = 10 A flows in the coil in the direction shown in the figure. The magnetic dipole moment $\boldsymbol{\mu}$ (in A.m$^2$) of the coil is




- a. 20 out of the page
- b. 20 into the page
- c. 10 out of the page
- d. 40 out of the page
- e. 40 into the page

Q8 | $\vec{\mu} = I \times \vec{A} \times N = 10 \times (20 \times 10^{-2})^2 \times 100$

$= 40$ out of the page **d**

A current of 4.0 A is maintained in a single circular loop having a circumference of 80 cm. An external magnetic field of 1.0 T is directed so that the angle between the field and the plane of the loop is 20°. Determine the magnitude of the torque (in N.m) exerted on the loop by the magnetic forces acting upon it.



- a. 0.38
- b. 0.19
- c. 0.29
- d. 0.48
- e. 0.77

Q[9]

$\tau = B\,I\,A\,N\,\sin\theta \rightarrow 90+20$

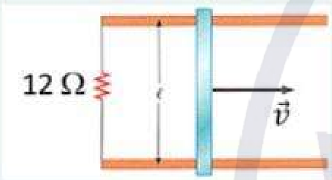
$S = 2\pi r \rightarrow 80\times10^{-2} = 2\pi r \rightarrow r = 0.1273\ m$

$A = \pi r^2 = 0.0509\ m^2$

$\tau = 1\times4\times0.0509\times1\times\sin(110) = 0.19$

[b]

A rod of length $l$ = 10 cm moves on two horizontal frictionless conducting rails, as shown. The magnetic field in the region is directed perpendicularly to the plane of the rails and is uniform and constant. If a constant force of 0.60 N moves the bar at a constant velocity of 4.0 m/s, what is the current (in A) through the 12-Ω load resistor?




- a. 0.32
- b. 0.53
- c. 0.39
- d. 0.22
- e. 0.45

Q10: $F_B = iLB$

$F = F_B \Rightarrow 0.6 = iLB$

$iB = \frac{0.6}{0.1} = 6$ $\qquad iB = 6$ — (1)

$E = BVL$

$i = \frac{BVL}{R}$ — (2)

$i = \left(\frac{6}{i}\right)\frac{(4)(0.1)}{12}$ $\qquad i^2 = 0.2$

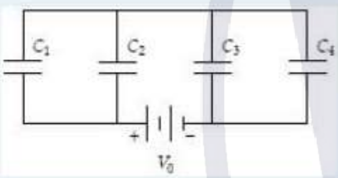
$i = 0.447\ A$ [e]

**Useful Constants**

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m$^2$/C$^2$; $\varepsilon_o = 8.85\text{x}10^{-12}$ C$^2$/N.m$^2$; e = $1.6\text{x}10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s$^2$

---

What is the energy (in mJ) stored by $C_3$ when $C_1 = 50\ \mu F$, $C_2 = 30\ \mu F$, $C_3 = 36\ \mu F$, $C_4 = 12\ \mu F$, and $V_0 = 30$ V?




- a. 6.3
- b. 25
- c. 57
- d. 1.6
- e. 14

**Q11:**

$$C_{net} = (C_1 + C_2) \parallel (C_3 + C_4)$$

$$= 80 \parallel 48$$

$$= \frac{(80 * 48)}{128}$$

$$= 30 \ \mu F$$

$$Q_{net} = CV \Rightarrow Q_{net} = 30 * 30 = 900 \ \mu C$$

$$\text{Total Energy} = \frac{1}{2} C_{net} * V^2$$

$$= 0.5 * 30 * 30^2$$

$$= 0.0135 \ J$$

$$\text{Voltage accross } C3 = 30 - \frac{900}{80} = 18.75 \ V$$

$$\text{Total Enargy in } C3 = \frac{1}{2} C_3 V^2$$

$$= \frac{1}{2} * 36 * (18.75)^2$$

$$= 6.33 \ mJ$$

**[a]**

Time left 0:29:42

Useful Constants

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m$^2$/C$^2$; $\varepsilon_o = 8.85 \times 10^{-12}$ C$^2$/N.m$^2$; e = $1.6 \times 10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; g = 9.8 m/s$^2$, $\mu_o = 4\pi \times 10^{-7}$ T.m/A

---

A proton moves with a velocity of **v** = (3.0**i** + 4.0**j**) m/s in a region in which the magnetic field is **B** = (6.0**k**) T. What is the magnitude of the magnetic force (in N) this proton experiences? (Note: **i**, **j**, and **k** are the cartesian unit vectors.)

- a. $2.6 \times 10^{-18}$
- b. $3.2 \times 10^{-18}$
- c. $2.0 \times 10^{-18}$
- d. $1.2 \times 10^{-18}$
- e. $4.8 \times 10^{-18}$

proton

Q 12) $F = q\,\vec{v} \times B = 1.6\times10^{-19} \times (3\hat{i} + 4\hat{j}) \times 6\hat{k}$

$$= 1.6\times10^{-19} \times \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 4 & 0 \\ 0 & 0 & 6 \end{vmatrix}$$

$$= 1.6\times10^{-19} \times (24\hat{i} - 18\hat{j} + 0\hat{k})$$

$$= 1.6\times10^{-19} \times \sqrt{(24)^2 + (18)^2} = 4.8\times10^{-18}$$

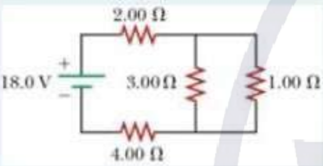
(e)

**Useful Constants**

$k_e = 1/4\pi\varepsilon_o = 9 \times 10^9$ N.m$^2$/C$^2$; $\varepsilon_o = 8.85\times10^{-12}$ C$^2$/N.m$^2$; $e = 1.6\times10^{-19}$ C; $m_{electron} = 9.11 \times 10^{-31}$ kg; $m_{proton} = 1.67 \times 10^{-27}$ kg; $g = 9.8$ m/s$^2$

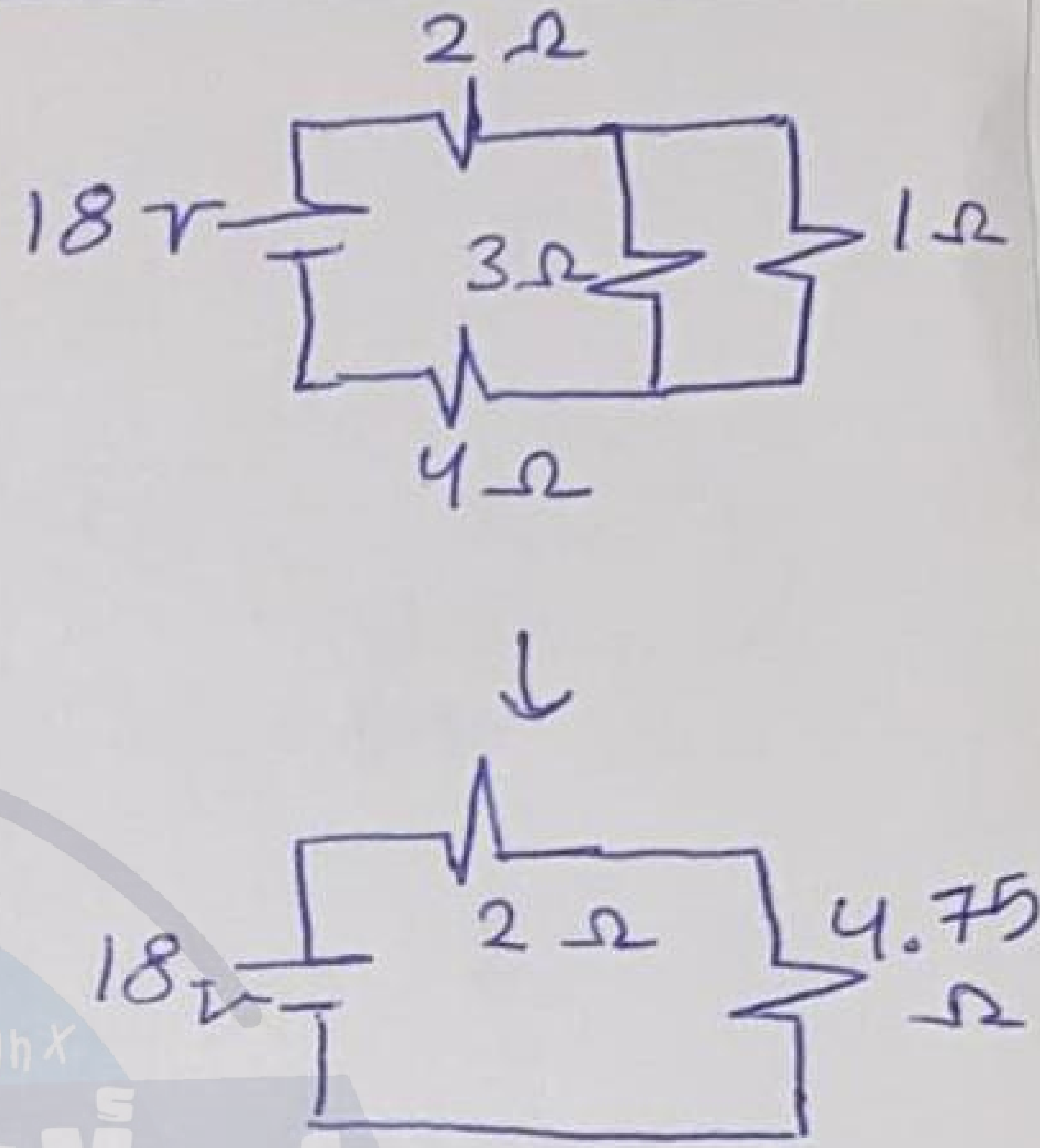
----------------------------------------------------------------

The power (in W) delivered to the 2 Ω resistor in the circuit shown in the Figure is




- a. 1.33
- b. 14.2
- c. 4
- d. 28.4
- e. 18.0

13) $P = VI$




$R_1 \parallel R_3$ (Parallel)

$$R_t = \frac{1 * 3}{4} = 0.75$$

$R_{0.75} + R_4$ (series)

$$0.75 + 4 = 4.75$$

to find $V_2$ → voltage divider

$$V_2 = \frac{2}{4.75+2} * 18 \rightarrow V_2 = 5.33\ V$$

$$I = \frac{V}{R_T} = \frac{18}{2+4.75} = 2.67\ A$$

$$P = VI = 5.33 * 2.67$$

$P = 14.23$ → **ans = b**

A 20-cm long wire carries a current of 12 A in a direction that makes an angle of 10° with a uniform magnetic field of magnitude 20 mT. The magnitude of the magnetic force (in N) on the wire is

Q 14

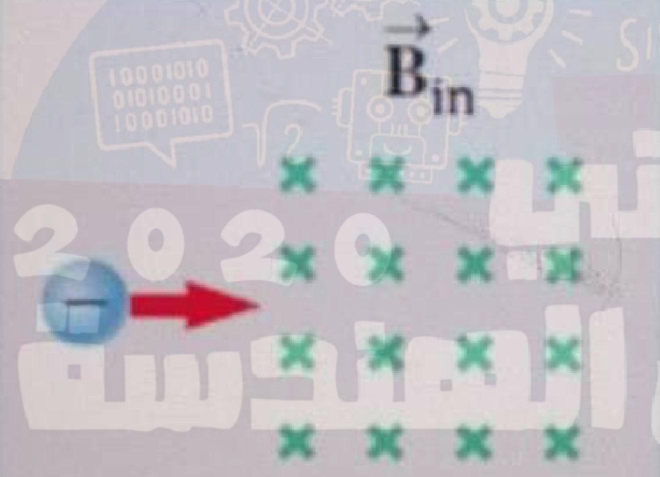
$F = I \times L \times B \times \sin\theta$

$= 12 \times 20 \times 10^{-2} \times 20 \times 10^{-3} \times \sin 10$

$= 8.335 \times 10^{-3}$ N

Time left 0:56:45

What is the initial direction of the deflection of the charged particle as it enters the magnetic field shown in the figure?






- a. up
- b. down
- c. into the page
- d. out of the page
- e. no deflection

**The answer is b**

Time left 0:49:07

If a potential difference of 10 V is applied across a 10-Ω resistor, then the current (in A) flowing in the resistor is

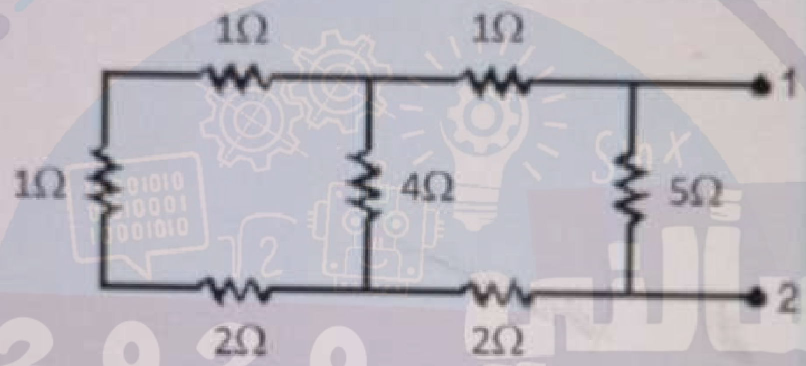


- a. 1
- b. 2
- c. 3
- d. 4
- e. 5

Q16 | $I = \frac{\Delta V}{R} = \frac{10}{10} = 1\ A$ [a]

Time left 0:42:25

The equivalent resistance (in Ω) between points 1 and 2 of the circuit shown is






a. 2.5

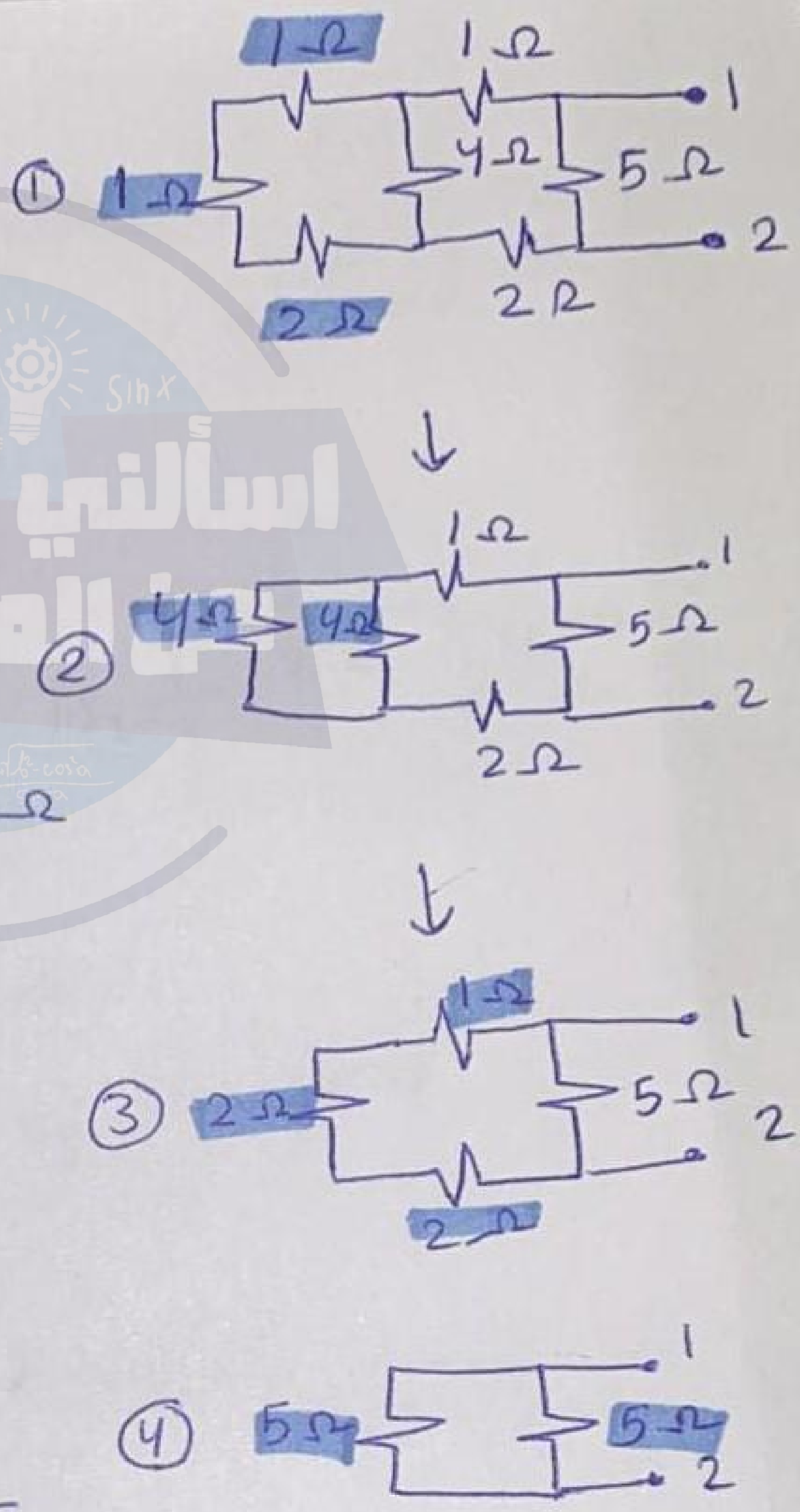
b. 4.0

c. 5.0

d. 6.5

e. 16

17




1) In series :

$$1 + 1 + 2 = 4\ \Omega$$

2) In Parallel :

$$\frac{4 * 4}{4 + 4} = \frac{16}{8} = 2\ \Omega$$

3) In series:

$$1 + 2 + 2 = 5\ \Omega$$

4) In Parallel :

$$\frac{5 * 5}{5 + 5} = \frac{25}{10} = 2.5$$

**ans = a**

Time left 0:26:49

A potential difference of 2.0 V is applied across a cylindrical conductor. The conductor is 20.0 m long, and has a radius of 0.5 mm and a resistivity of 5.6 $\times 10^{-8}$ Ω.m. The current flowing in the conductor (in A) is

a. 1.4

b. 2.5

c. 4.2

d. 4.9

e. 6.1

**Q 18**

$$I = \frac{\Delta V}{R}$$

$$R = \frac{\rho L}{A} = \frac{5.6 \times 10^{-8} \times 20}{\pi (0.5 \times 10^{-3})^2} = 1.426$$

$$I = \frac{2}{1.426} = 1.4 \ \text{A}$$