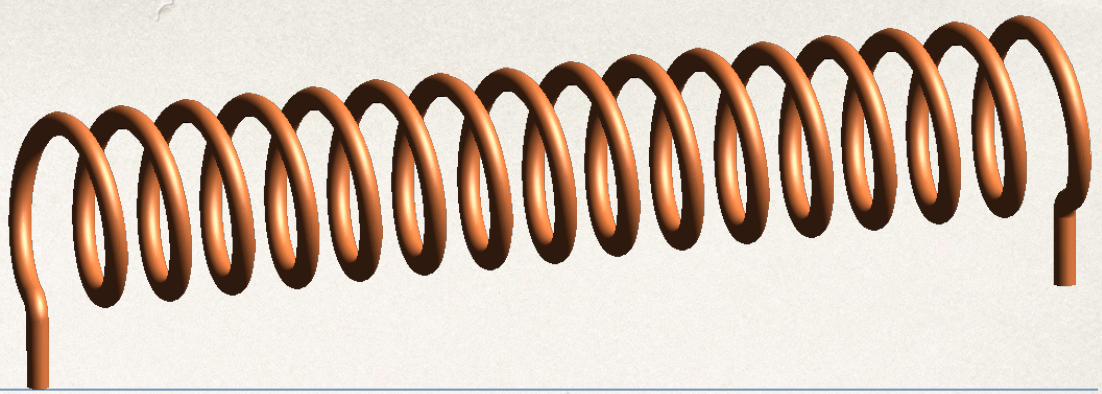
PHY 1120 - Dr. Rowley

Chapter 23 - Magnets

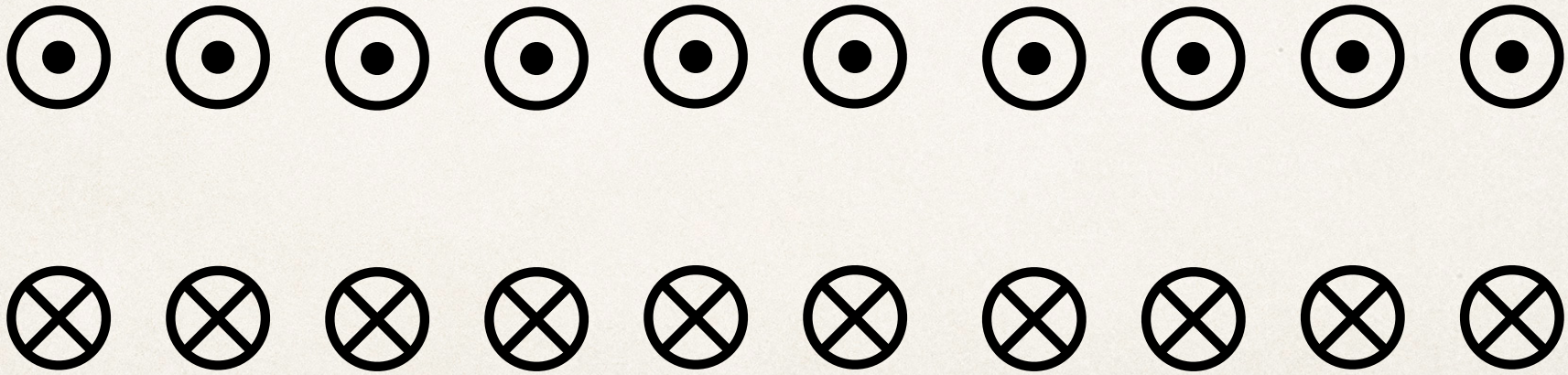
Summer 2020

Solenoid



What is the magnitude and direction of the magnetic field inside a solenoid that is 10.0 cm long, and 20 coils, and carries a current of 0.75A?

$$B = \frac{\mu_o N I}{\ell}$$



https://en.wikipedia.org/wiki/Solenoid

Solenoid

What is the magnitude and direction of the magnetic field inside a solenoid that is 10.0 cm long, and 20 coils, and carries a current of 0.75A?

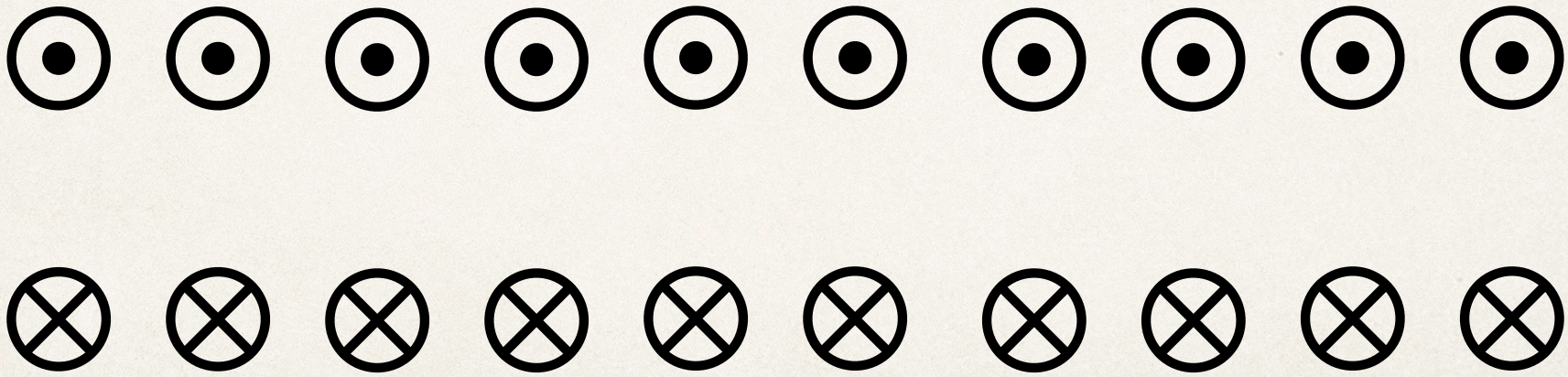
$$B = \frac{\mu_o NI}{\ell} = \frac{\left(4\pi x 10^{-7}\right)\left(20\text{ Coils}\right)\left(0.75\text{ A}\right)}{0.10\text{ m}}$$

$$\boxed{B = 0.000188\text{ T}}$$

Solenoid

What is the magnitude and direction of the magnetic field inside a solenoid that is 10.0 cm long, and 20 coils, and carries a current of 0.75A?

Which RHR? #1 !



Edge Effects

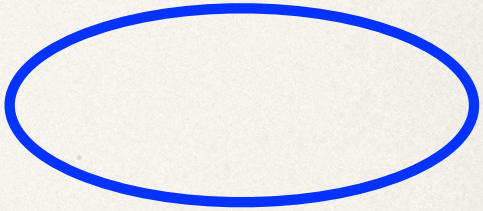
- Why $\ell >> r$?

Flux

- Flux = number of field lines "collected by" or "enclosed within" a wire loop.

$$\Phi_B = B_\perp A$$

$$\Phi_B = BA\cos\theta$$

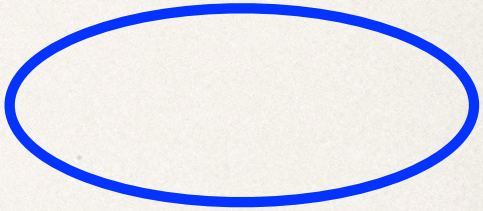


Flux

- What is the maximum flux through a wire loop (r = 50 cm), in a 0.75T magnetic field? Minimum flux?

$$\Phi_B = B_\perp A$$

Maximum



$$\Phi_B = \left(0.75T\right)\left(\pi r^2\right)\cos 0°$$

$$\Phi_B = 2.36 \text{ Wb}$$

Flux

- What is the maximum flux through a wire loop (r = 50 cm), in a 0.75T magnetic field? Minimum flux?

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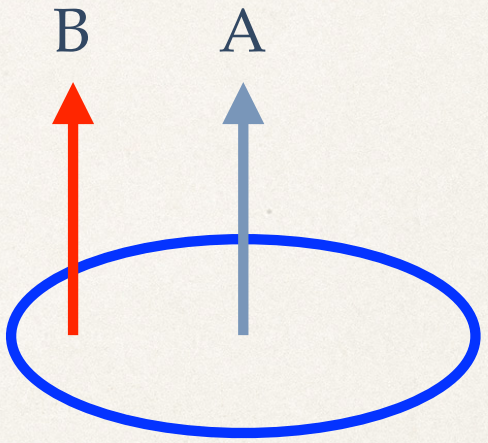
Maximum



$$\Phi_B = (0.75T)(\pi r^2)\cos 0°$$

$$\Phi_B = 2.36 \text{ Wb}$$

Flux

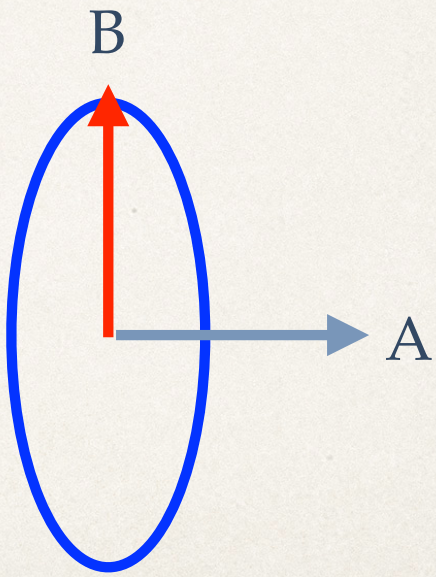
- What is the maximum flux through a wire loop (r = 50 cm), in a 0.75T magnetic field? Minimum flux?

$$\Phi_B = B_\perp A$$

Minimum

$$\Phi_B = \left(0.75T\right)\left(\pi r^2\right)\cos 90°$$

$$\Phi_B = 0 \text{ Wb}$$

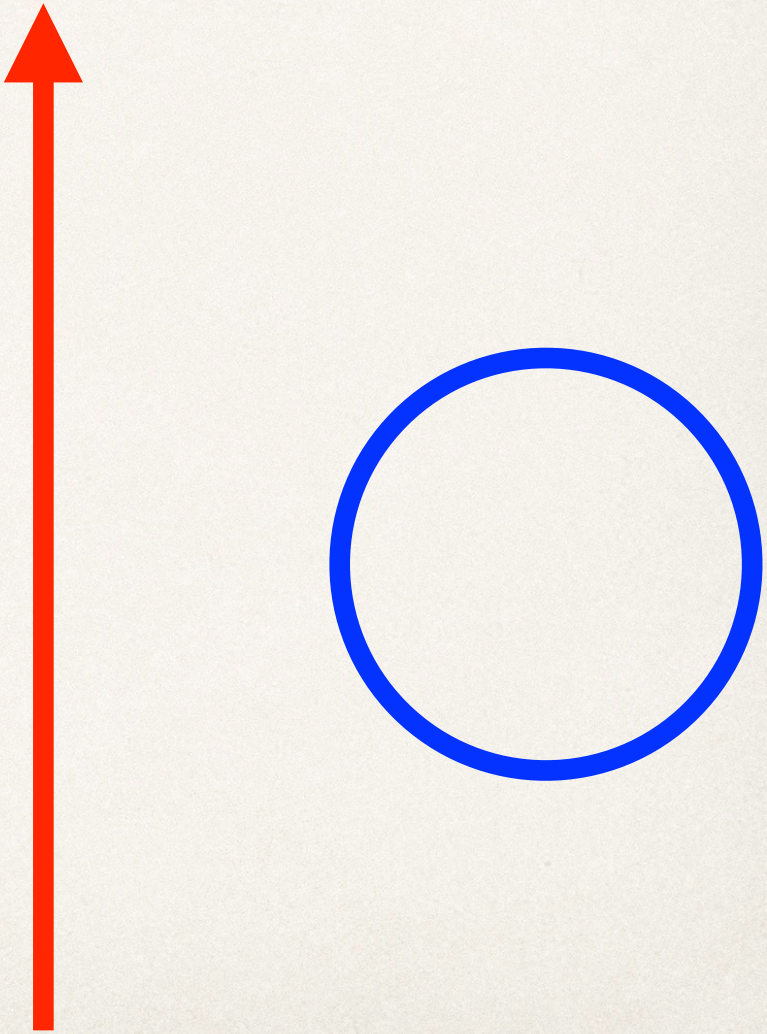


Flux and Induced Current

- Induced current will always be in a direction to counterbalance any **change** in flux.

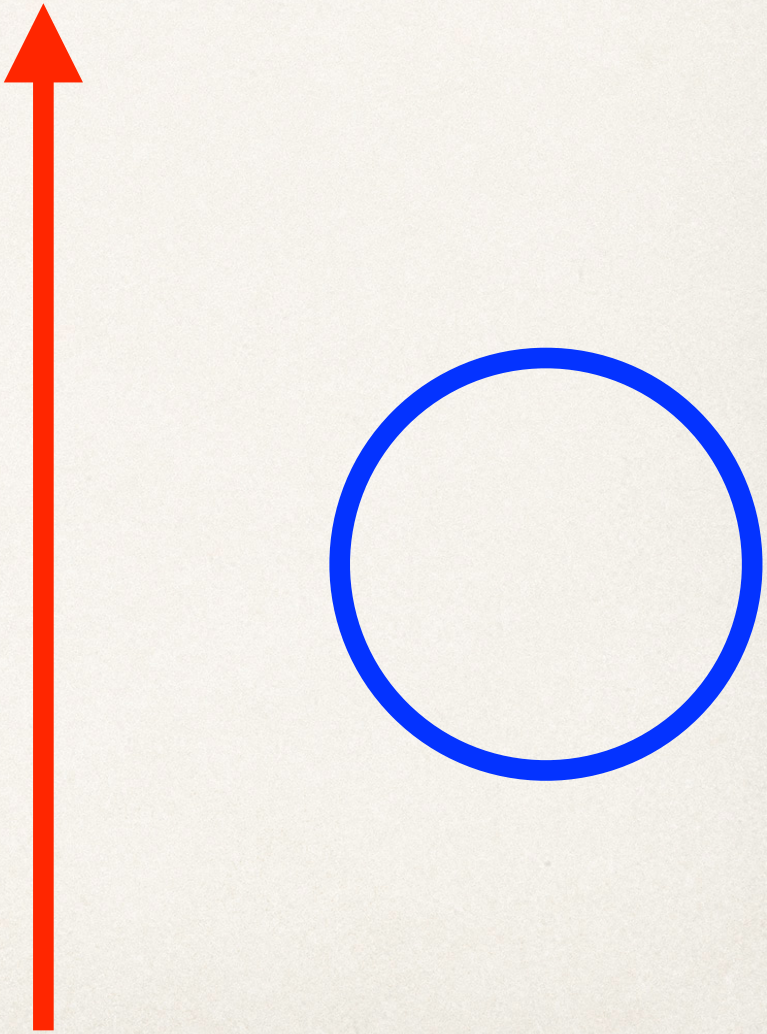
Direction of Induced Current?

- A constant current of 5 Amps is flowing in the straight wire, what is the change in flux through the loop? What is the induced current in the loop?



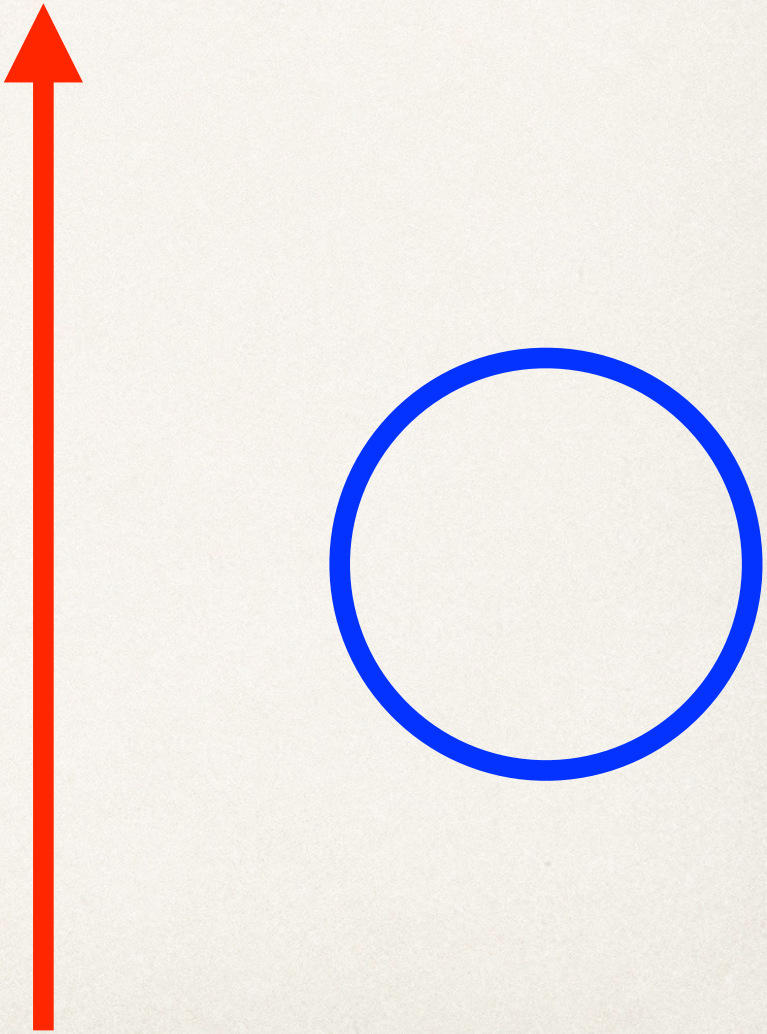
Direction of Induced Current?

- An increasing current of 0 A to 10 A is flowing in the straight wire, what is the change in flux through the loop? What is the induced current in the loop?



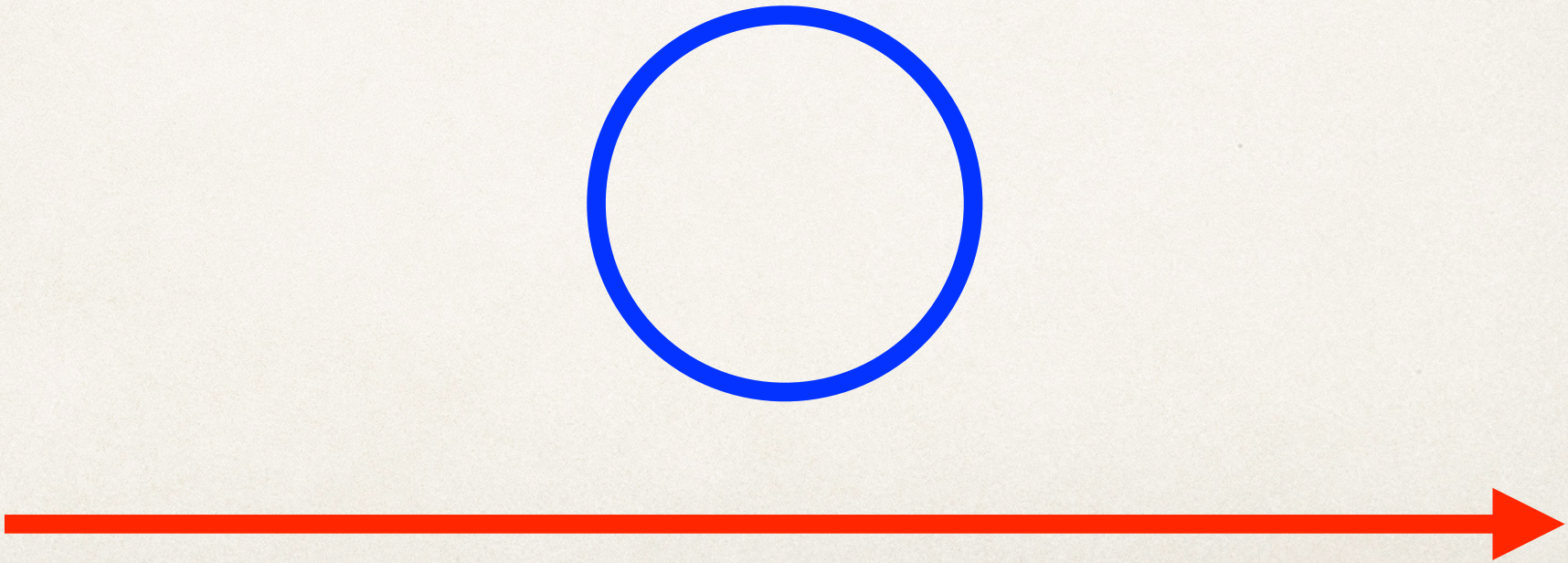
Direction of Induced Current?

- An decreasing current of 10 A to 0 A is flowing in the straight wire, what is the change in flux through the loop? What is the induced current in the loop?



Direction of Induced Current?

- An decreasing current of 5 A to -5 A is flowing in the straight wire, what is the change in flux through the loop? What is the induced current in the loop?



Direction of Induced Current?

- An constant current of 5 A flowing in the straight wire, what is the change in flux through the loop? What is the induced current in the loop?