This print-out should have 19 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 (part 1 of 2) 10.0 points

A solenoid has 103 turns of wire uniformly wrapped around an air-filled core, which has a diameter of 15 mm and a length of 6.1 cm.

The permeability of free space is 1.25664×10^{-6} N/A^2.

Calculate the self-inductance of the solenoid.

Answer in units of H.

002 (part 2 of 2) 10.0 points

The core is replaced with a soft iron rod that has the same dimensions, but a magnetic permeability of 800 μ_0.

What is the new inductance?

Answer in units of H.

003 10.0 points

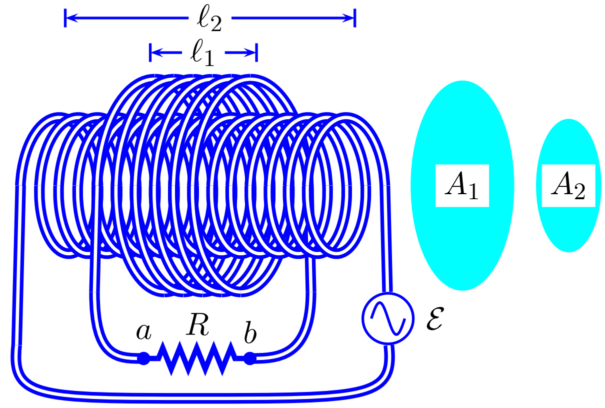
A child (approximately 4 years old) takes her metal "slinky Toy" (a flexible coiled metal spring) and does various tests to determine that the Slinky has an inductance 135 μH, when it has been stretched to a length of 2 m.

The permeability of free space is $4\pi \times 10^{-7}$ N/A^2.

If a slinky has a radius of 5 cm, what is the total number of turns in the Slinky?

004 10.0 points

A coil with $N_1 = 6.38$ turns and radius $r_1 = 15.4$ cm surrounds a long solenoid of radius $r_2 = 2.79$ cm and $\dfrac{N_2}{\ell_2} = n_2 = 1100\ \text{m}^{-1}$ (see the figure below). The current in the solenoid changes as $I = I_0 \sin(\omega\, t)$, where $I_0 = 5$ A and $\omega = 120$ rad/s.



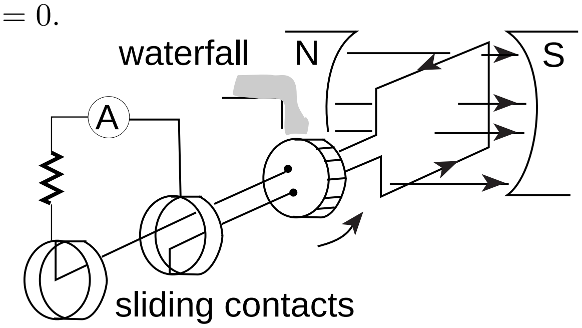
Inside solenoid has N_2 turns
Outside solenoid has N_1 turns

What is the magnitude of the induced *emf*, $\mathcal{E}_{AB}$, across the 6.38 turn coil at $t = 1000$ s?

Answer in units of V.

005 (part 1 of 3) 10.0 points

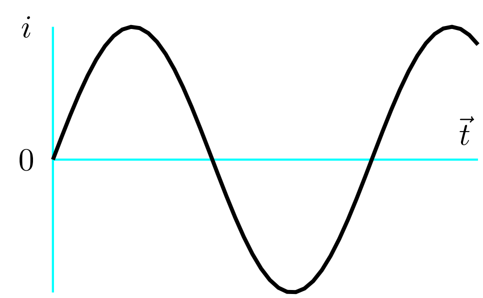
In an AC electric generator, a rigid loop of wire rotates in an external magnetic field. Say the loop is positioned as shown at time $t = 0$.



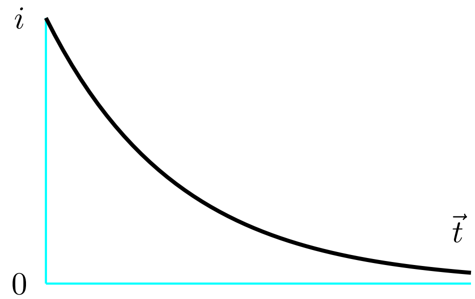
Which graph best represents the induced current $i(t)$ at later times?

Take $i > 0$ for current flowing in direction shown by arrows.

1.



2.



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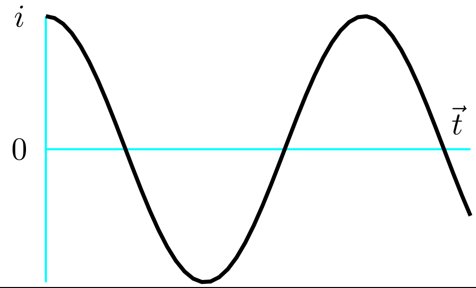

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006 (part 2 of 3) 10.0 points

The AC generator consists of $N = 9$ turns of wire each of area $A = 0.109\ \text{m}^2$ and total resistance 9.14 Ω. The loop rotates in a magnetic field $B = 0.69$ T at a constant frequency of 62.3 Hz.

Find the maximum induced emf.

Answer in units of V.

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007 (part 3 of 3) 10.0 points

What is the maximum induced current?

Answer in units of a.

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008 10.0 points

Does the voltage output increase when a generator is made to spin faster?

1. No; the voltage output increases only when the magnetic field gets stronger.

2. Yes; the faster a generator spins, the stronger the magnetic field it produces.

3. None of these

4. Yes; according to Faraday's law of induction, the faster the change of magnetic field in a coil, the greater the induced voltage.

5. No; it will only increase the output current of the generator.

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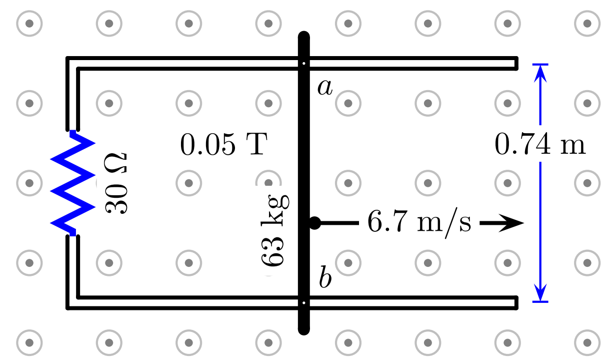
009 (part 1 of 6) 10.0 points

A force $\vec{F}$ is applied to a conducting rod so that the rod slides with constant speed 6.7 m/s over a frictionless pair of parallel conducting rails that are separated by a distance 0.74 m. The rod and rails have negligible resistance, but the rails are connected by a resistance 30 Ω. There is a uniform magnetic field 0.05 T perpendicular to and directed out of the the plane of the paper.



What is the direction of the induced current in the resistor R.

1. Going up through the resistor

2. Going down through the resistor

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010 (part 2 of 6) 10.0 points

Determine the magnitude of the induced *emf* in the rod.

Answer in units of V.

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011 (part 3 of 6) 10.0 points

Determine the electric field in the rod.

Answer in units of V/m.

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012 (part 4 of 6) 10.0 points

Determine the magnitude of the induced current in the resistor R.

Answer in units of A.

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013 (part 5 of 6) 10.0 points

Determine the power dissipated in the resistor as the rod moves in the magnetic field.

Answer in units of W.

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014 (part 6 of 6) 10.0 points

Determine the magnitude of the external force applied to the rod to keep it moving with constant speed 6.7 m/s.

Answer in units of N.

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015 (part 1 of 4) 10.0 points

A solenoid has a length of 40 cm, a radius of 3 cm, 500 turns, and carries a 5 A-current.

The permeability of free space is $4\pi \times 10^{-7}$ T · m/A.

Find the magnetic field on the axis at the center of the solenoid.

Answer in units of mT.

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016 (part 2 of 4) 10.0 points

Find the flux through the solenoid, assuming B to be uniform.

Answer in units of Wb.

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017 (part 3 of 4) 10.0 points

Find the self-inductance of the solenoid.

Answer in units of mH.

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018 (part 4 of 4) 10.0 points

Find the magnitude of the induced *emf* in the solenoid when the current changes at 180 A/s.

Answer in units of mV.

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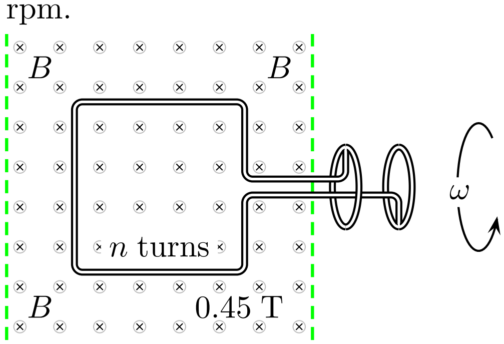
019 10.0 points

Prior to 1960, magnetic field strength was measured by means of a rotating coil gaussmeter. This device used a small loop of many turns rotating on an axis perpendicular to the magnetic field at fairly high speed, which was connected to an AC voltmeter by means of slip rings, like those shown in figure. The sensing coil for a rotating coil gaussmeter has 350 turns, an area of 1.4 cm^2 and rotates at 240 rpm.



If the mangetic field strength is 0.45 T, find the maximum induced *emf* in the coil.

Answer in units of V.