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Physics 235 — Winter 2012

Midterm Exam #1

February 2, 2012

This is a closed-book exam lasting one hour and 50 minutes. Calculators and a 3x5-inch notecard are allowed.



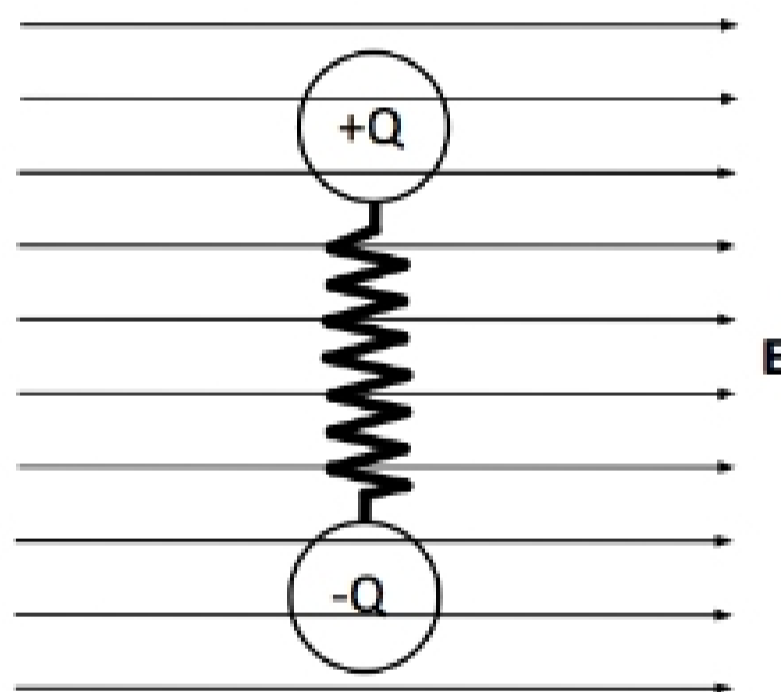
OHM NEVER FORGOT HIS DYING UNCLE'S ADVICE.

xkcd.com

Useful Physical Constants

Fundamental unit of charge	e	$1.602 \times 10^{-19} \text{ C}$
Permittivity of free space	ϵ_0	$8.85 \times 10^{-12} \text{ C}^2/\text{N m}^2$
Coulomb's Law constant	k	$8.99 \times 10^9 \text{ N m}^2/\text{C}^2$
Speed of light in vacuum	c	$3.00 \times 10^8 \text{ m/s}$
Electron mass	m_e	$9.11 \times 10^{-31} \text{ kg}$
Proton mass	m_p	$1.67 \times 10^{-27} \text{ kg}$
Acceleration due to gravity	g	9.8 m/s^2

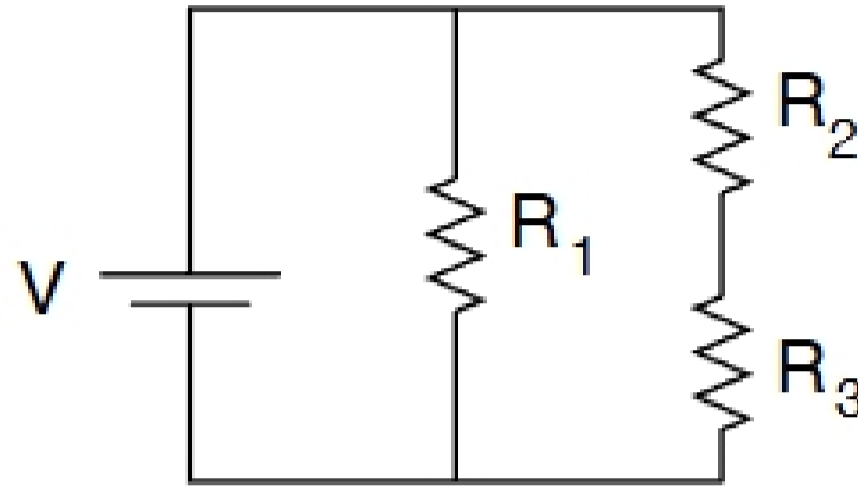
- Four positive charges Q are arranged at the corners of a square. Then a negative test charge $-q$ is placed at the center of the square. Which statement is true?
 - The test charge feels no net force and has zero potential energy.
 - The test charge feels a nonzero net force and has positive potential energy.
 - The test charge feels no net force and has a negative potential energy.
 - The test charge feels a nonzero net force and has negative potential energy.
 - The test charge feels no net force and has positive potential energy.
- A dipole consisting of two charges of equal magnitude, one positive and one negative, are attached to the ends of a non-conducting spring and placed in a uniform electric field as shown. The spring is initially at its equilibrium position. A viscous liquid surrounds the dipole.



After a long time has passed, what will happen?

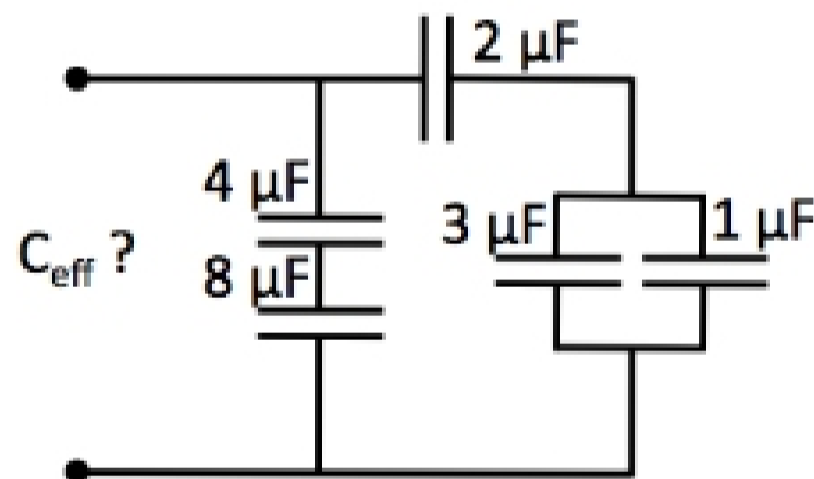
- The dipole will align itself parallel to the field with the positive charge to the right and the spring stretched.
- The dipole will align itself parallel to the field with the negative charge to the right and the spring stretched.
- The dipole will align itself parallel to the field with the negative charge to the left and the spring compressed.
- The dipole will align itself perpendicular to the field with the positive charge to the bottom and the spring at its original extension.
- The dipole will settle to a new equilibrium orientation at some angle between zero and 90 degrees to the horizontal and the spring will stretch slightly.

3. In the circuit shown here, $V = 3 \text{ V}$, $R_1 = 3\Omega$, $R_2 = 4\Omega$, and $R_3 = 2\Omega$.



How much current flows through R_3 ?

- A) 0.5 A
 - B) 0.67 A
 - C) 1.5 A
 - D) 1.0 A
 - E) 1.33 A
4. What is the effective capacitance of the circuit below?



- A) $1.8 \mu\text{F}$
- B) $4.0 \mu\text{F}$
- C) $2.2 \mu\text{F}$
- D) $6.7 \mu\text{F}$
- E) $18 \mu\text{F}$