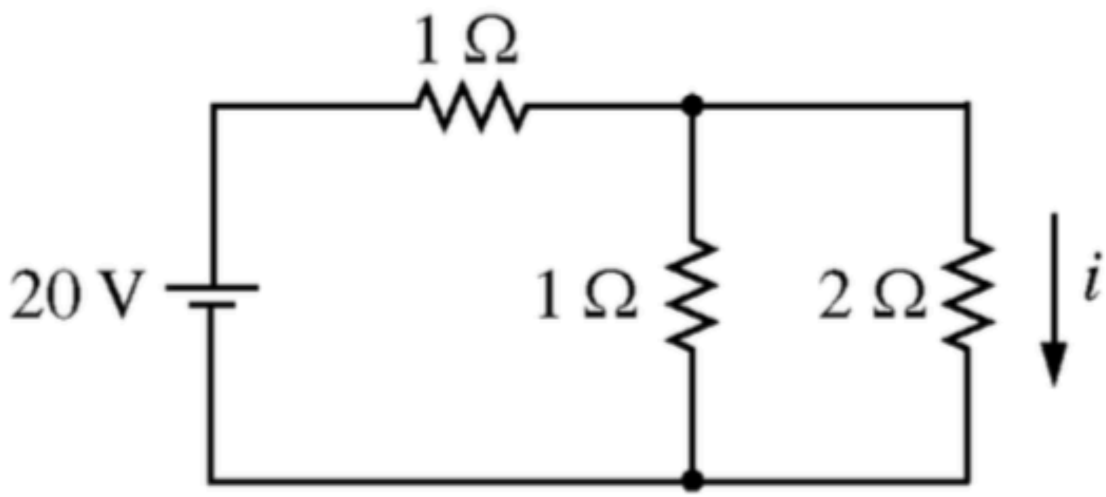


. For the circuit shown in the figure above, what is the current i through the $2\,\Omega$ resistor?

(A) 2 A
(B) 4 A
(C) 5 A
(D) 10 A
(E) 20 A

By definition, the electric displacement current through a surface S is proportional to the

(A) magnetic flux through S
(B) rate of change of the magnetic flux through S
(C) time integral of the magnetic flux through S
(D) electric flux through S
(E) rate of change of the electric flux through S

The electric field of a plane electromagnetic wave of wave number k and angular frequency ω is given by $\mathbf{E} = E_0(\mathbf{e_x} + \mathbf{e_y}) \sin(kz - \omega t)$. Which of the following gives the direction of the associated magnetic field $\mathbf{B}$?

(A) $\mathbf{e_z}$

(B) $-\mathbf{e_x} + \mathbf{e_y}$

(C) $-\mathbf{e_x} - \mathbf{e_y}$

(D) $\mathbf{e_x} - \mathbf{e_z}$

(E) $\mathbf{e_y} - \mathbf{e_z}$

The speed of light inside of a nonmagnetic dielectric material with a dielectric constant of 4.0 is

(A) 1.2×10^9 m/s
(B) 3.0×10^8 m/s
(C) 1.5×10^8 m/s
(D) 1.0×10^8 m/s
(E) 7.5×10^7 m/s

Fermat's principle of ray optics states, "A ray of light follows the path between two points which requires the least time." This principle can be used to derive which of the following?

I. Snell's law of refraction
II. The law of reflection
III. Rayleigh's criterion for resolution

(A) I only
(B) II only
(C) III only
(D) I and II
(E) II and III

What is the magnitude of the magnetic field at the center of a circular conducting loop of radius a that is carrying current I?

(A) $4\pi\mu_0 I a^2$

(B) $\mu_0 I a$

(C) 0

(D) $\dfrac{\mu_o I}{2a}$

(E) $\dfrac{\mu_o I}{4\pi a^2}$

A refracting telescope consists of two converging lenses separated by 100 cm. The eye-piece lens has a focal length of 20 cm. The angular magnification of the telescope is

(A) 4
(B) 5
(C) 6
(D) 20
(E) 100

If charge $+Q$ is located in space at the point ($x = 1$ m, $y = 10$ m, $z = 5$ m), what is the total electric flux that passes through the yz-plane?

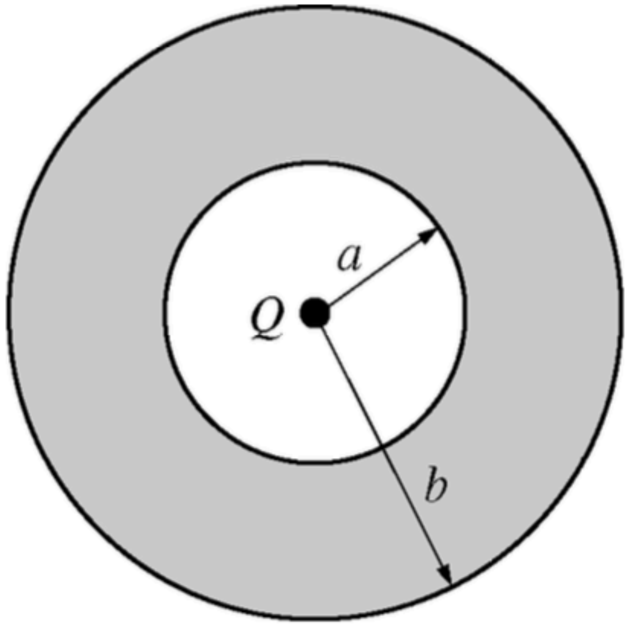
(A) ∞

(B) 1

(C) $\dfrac{Q}{\varepsilon_0}$

(D) $\dfrac{Q}{2\varepsilon_0}$

(E) 0



. A point charge Q is placed at the center of a hollow, conducting spherical shell of inner radius a and outer radius b, as shown above. A net charge q is placed on the conducting shell. If the electric potential is assumed to be 0 at infinity, the magnitude of the electric potential at r, where $a < r < b$, is

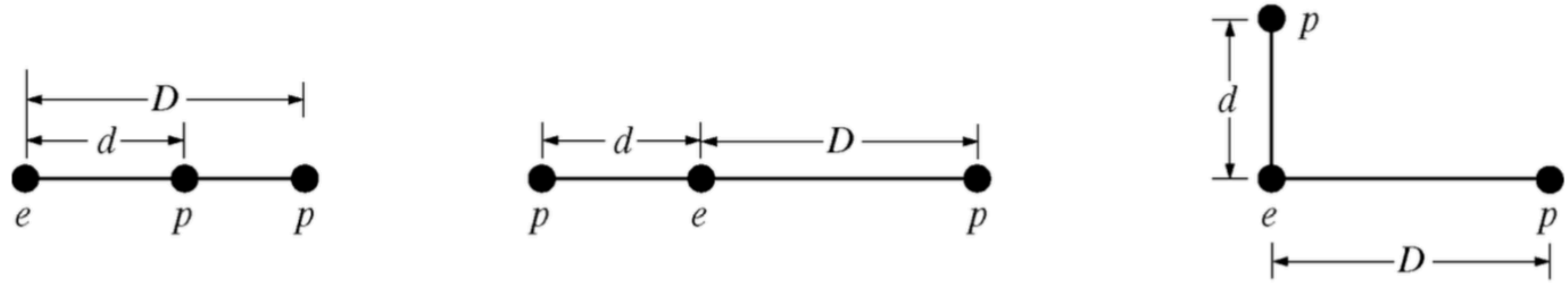
(A) 0

(B) $\dfrac{Q}{4\pi\varepsilon_0 r}$

(C) $\dfrac{Q+q}{4\pi\varepsilon_0 r}$

(D) $\dfrac{Q}{4\pi\varepsilon_0 a}$

(E) $\dfrac{Q+q}{4\pi\varepsilon_0 b}$



(1) (2) (3)

39. The figure above shows three arrangements of one electron (e) and two protons (p). Which of the following is true about the magnitude F of the net electrostatic force acting on the electron due to the protons?

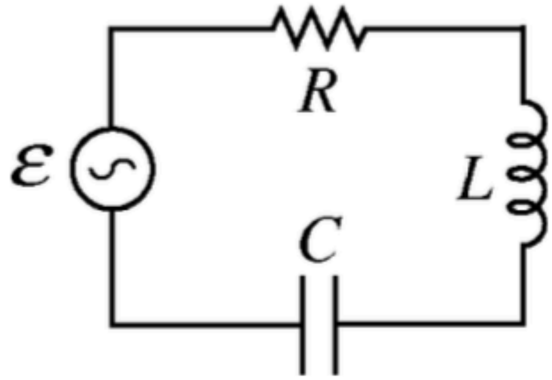
(A) $F_1 > F_2 > F_3$

(B) $F_1 = F_2 > F_3$

(C) $F_1 > F_3 > F_2$

(D) $F_2 > F_1 > F_3$

(E) $F_2 > F_3 > F_1$



). A series AC circuit with impedance Z consists of resistor R, inductor L, and capacitor C, as shown above. The ideal emf source has a sinusoidal output given by $\mathcal{E} = \mathcal{E}_{\max} \sin \omega t$, and the current is given by $I = I_{\max} \sin(\omega t - \phi)$. What is the average power dissipated in the circuit? (I_{rms} is the root-mean-square current.)

(A) $I_{rms}^2 R$

(B) $\frac{1}{2} I_{rms}^2 R$

(C) $\frac{1}{2} I_{rms}^2 Z$

(D) $\frac{1}{2} I_{rms}^2 R \cos \phi$

(E) $\frac{1}{2} I_{rms}^2 Z \cos \phi$

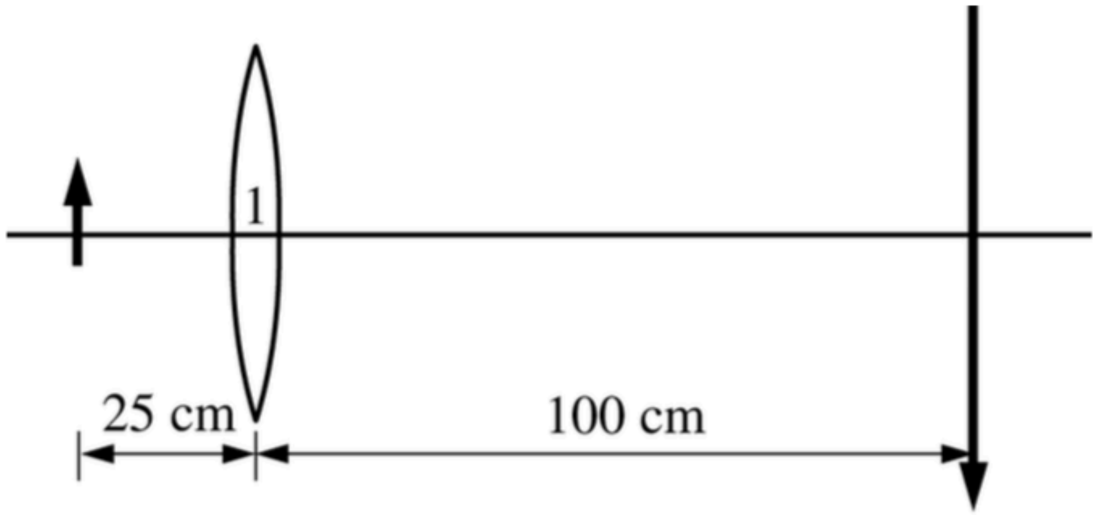


Figure 1

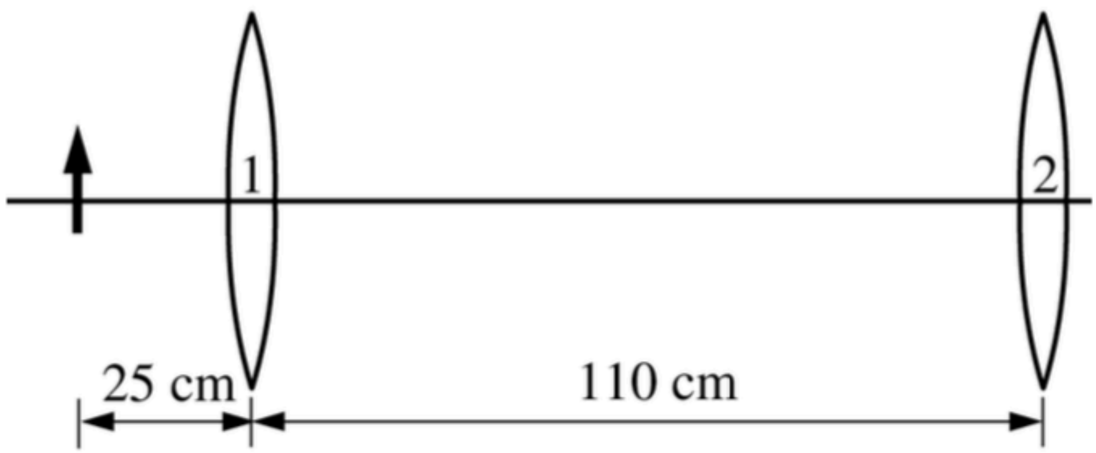


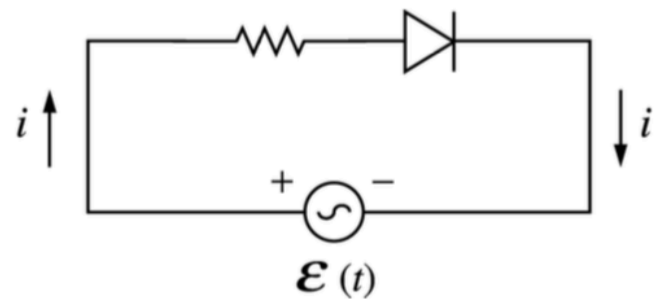
Figure 2

). When an object is located 25 cm from lens 1, an inverted image is produced 100 cm from the lens, as shown in Figure 1 above. A second lens with a focal length of +20 cm is placed 110 cm from the first lens, as shown in Figure 2 above. Which of the following is true of the image produced by lens 2 ?

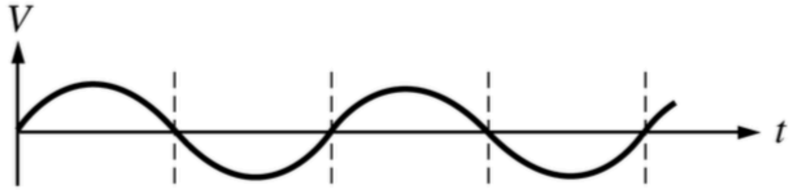
(A) It is real and inverted relative to the object.
(B) It is real and upright relative to the object.
(C) It is virtual and inverted relative to the object.
(D) It is virtual and upright relative to the object.
(E) An image cannot be produced in this situation.

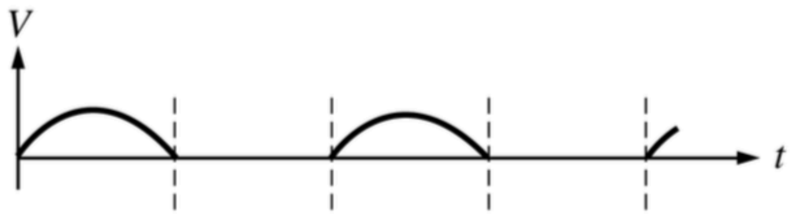
A grating spectrometer can just barely resolve two wavelengths of 500 nm and 502 nm, respectively. Which of the following gives the resolving power of the spectrometer?

(A) 2
(B) 250
(C) 5,000
(D) 10,000
(E) 250,000

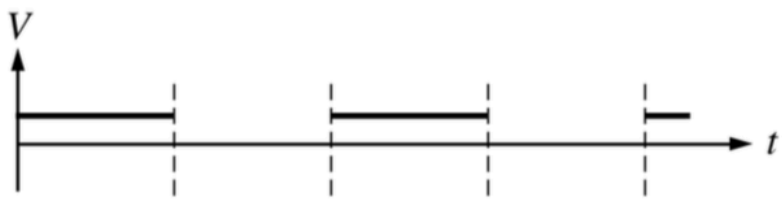


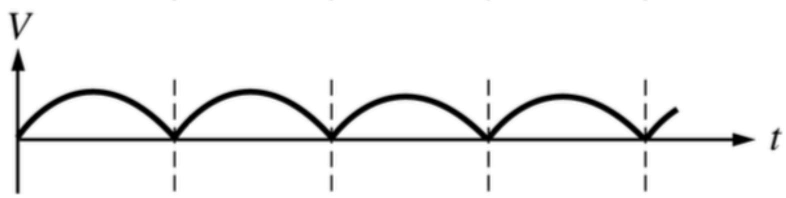
. The AC circuit shown above contains an ideal rectifying diode. If the function generator supplies $\mathcal{E}(t) = V_0 \sin \omega t$, which of the following describes the voltage across the resistor?

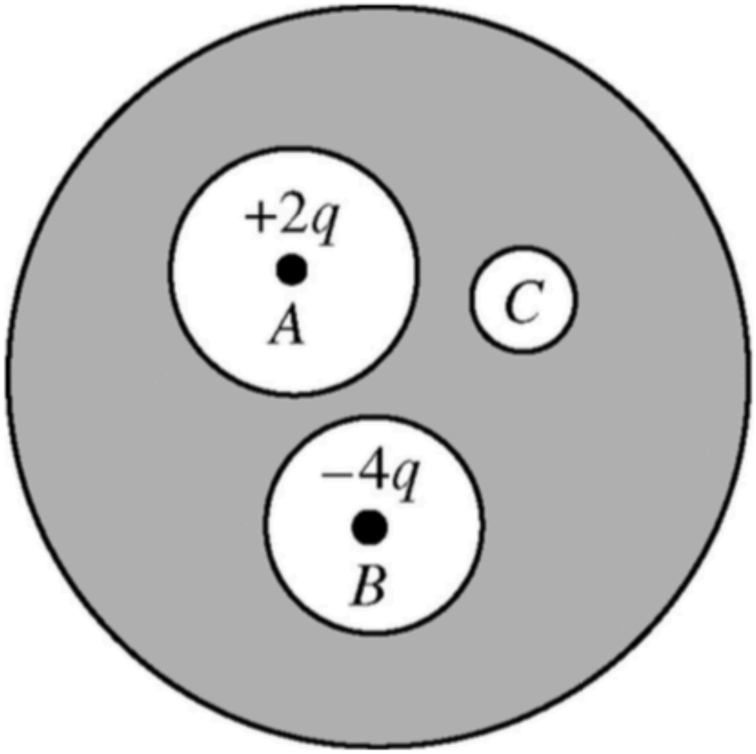
(A) 

(B) 

(C) 

(D) 

(E) 

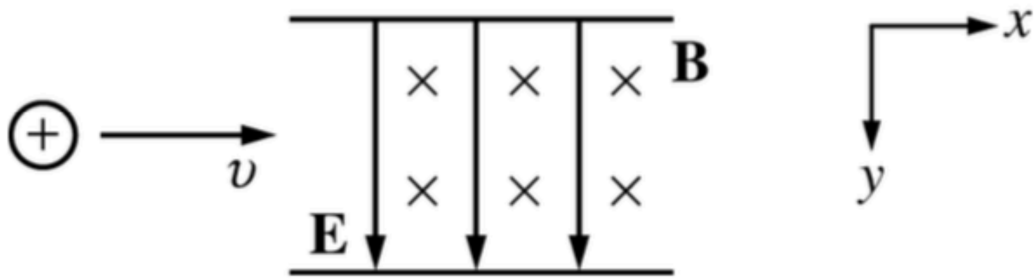


. A conducting sphere is solid except for three spherical cavities inside. Cavity A contains a point charge of $+2q$, cavity B contains a point charge of $-4q$, and cavity C is empty, as shown above. What charges are induced on the inner surfaces of the spherical cavities?

	Cavity A	Cavity B	Cavity C
(A)	$-2q$	$+4q$	0
(B)	$-2q$	$+4q$	$-2q$
(C)	$-2q$	$+4q$	$-6q$
(D)	$+2q$	$-4q$	0
(E)	$+2q$	$+2q$	$+2q$

A magnetic field is directed perpendicular to the plane of a circular coil of area 0.2 m^2 and 250 turns. If the magnetic field is increased from 0.01 T to 0.06 T during a time interval of 0.25 s, the average induced EMF in the coil is

(A) 0.04 V
(B) 0.1 V
(C) 2.5 V
(D) 10 V
(E) 50 V



A beam of positive ions is initially moving in the +x-direction with nonrelativistic velocity. The beam enters a velocity selector in which the electric field $\mathbf{E}$ is oriented along the +y-direction and the magnetic field $\mathbf{B}$ is oriented along the +z-direction, as shown above. Which of the following gives the critical speed v_c at which the ion beam is <u>not</u> deflected as it moves through the velocity selector?

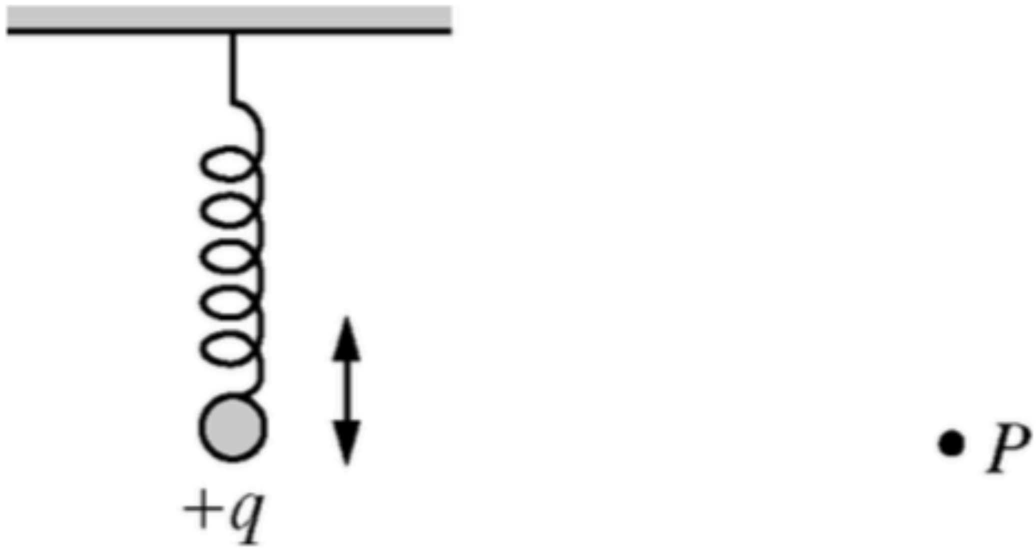
(A) $v_c = EB$

(B) $v_c = \dfrac{1}{EB}$

(C) $v_c = \dfrac{B^2}{E}$

(D) $v_c = \dfrac{B}{E}$

(E) $v_c = \dfrac{E}{B}$

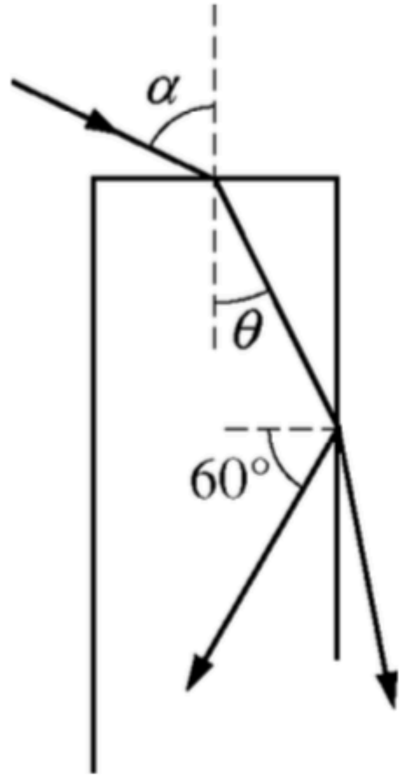


A positive charge, $+q$, oscillates up and down, as represented in the figure above. What is the direction of the Poynting vector $\mathbf{S}$ at point P ? (Assume P is located far to the right of $+q$.)

(A) Toward the left
(B) Toward the right
(C) Toward the top of the page
(D) Toward the bottom of the page
(E) Into the page

White light is normally incident on a puddle of water (index of refraction 1.33). A thin (500 nm) layer of oil (index of refraction 1.5) floats on the surface of the puddle. Of the following, the most strongly reflected wavelength is

(A) 500 nm
(B) 550 nm
(C) 600 nm
(D) 650 nm
(E) 700 nm



. As represented in the figure above, a light ray refracts from air into a rectangular block of plastic with an index of refraction $n > 1$. At a point on the side of the block, the ray partly reflects (at an angle of 60°) and partly refracts. The value of the angle α is

(A) 30°

(B) 60°

(C) $\cos^{-1} \frac{n}{2}$

(D) $\sin^{-1} \frac{n}{2}$

(E) $\tan^{-1} n$

Consider three identical, ideal capacitors. The first capacitor is charged to a voltage V_0 and then disconnected from the battery. The other two capacitors, initially uncharged and connected in series, are then connected across the first capacitor. What is the final voltage on the first capacitor?

(A) $\frac{V_0}{5}$

(B) $\frac{V_0}{3}$

(C) $\frac{V_0}{2}$

(D) $\frac{2V_0}{3}$

(E) V_0

A charge of –5.0 μC is distributed uniformly around a ring 1.0 m in radius. A point charge of +3.0 μC is at the center of the ring. The work required to move the point charge 1.0 m in a direction normal to the plane of the ring is most nearly

(A) 40 mJ
(B) 80 mJ
(C) 100 mJ
(D) 140 mJ
(E) 270 mJ

The magnetic field inside a long coil of wire (solenoid) has a certain magnitude and direction when the coil is air filled. If a diamagnetic material is inserted in the coil, how do the magnitude and direction of the magnetic field change?

	Magnitude	Direction
(A)	Increases	Same
(B)	Increases	Opposite
(C)	Decreases	Same
(D)	Decreases	Opposite
(E)	No change	Opposite