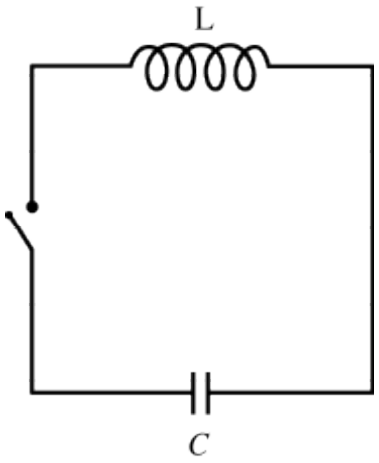
Physics 2B, Electricity and Magnetim -- Spring 2009 Instructor: B. Grinstein
Final Exam

INSTRUCTIONS: Fill, tear and return the bottom strip of the front page with your scantron. Keep the top portion of the front page and the rest of the quiz. Use a pencil #2 to fill your scantron. Write your code number and bubble it in under "EXAM NUMBER". Bubble in the quiz form (see letter A--D at bottom of page) in your scantron under "TEST FORM"

Useful numbers: $K = 9.0 \times 10^9\ Nm^2/C^2$, $\varepsilon_o = 8.85 \times 10^{-12}\ C^2/Nm^2$, $e = 1.60 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg
$\mu_o = 4\pi \times 10^{-7}$ T m/A

1) A capacitor, initially having a charge Q on the left plate and a charge $-Q$ on the right plate, is connected to a switch and an inductor, as shown below.



Assuming the resistance of the circuit is zero, when the switch is closed,

A) current will flow until the left plate of the capacitor has a charge $-Q$, and then current will flow in the opposite direction, reversing again when the left plate has a charge of $+Q$. The cycle will then repeat over and over.
B) Current will flow through the inductor back and forth, with the magnitude of the current decreasing and eventually going to zero.
C) charge will flow out of the capacitor until the left plate is no longer charged, and then all current ceases.
D) None of the above

2) A current density of J is flowing in a resistor of resistivity ρ. We can thus recognize $J^2\rho$ as the

A) electric field in the resistor.
B) electrical energy stored in the resistor.
C) heat generated per unit volume in the resistor.
D) potential drop across the resistor.
E) total power dissipated in the resistor.

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3) The direction in which the electric potential increases at the greatest rate is

A) perpendicular to the gradient of the potential.

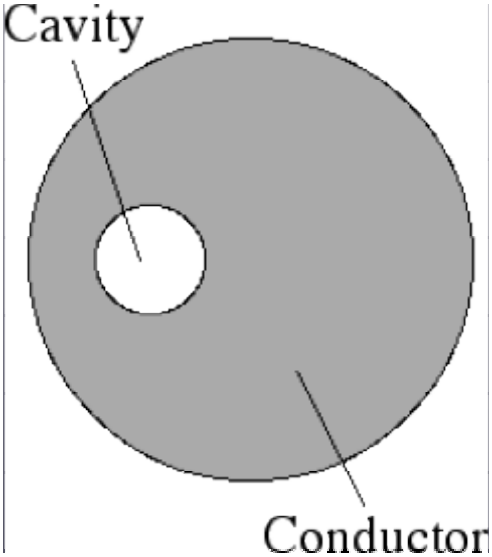
B) along the electric field.

C) along the the partial derivative with respect to x.

D) opposite the electric field.

E) perpendicular to the electric field.

4) A solid spherical conductor has a spherical, completely empty cavity in its interior. The cavity is not centered on the center of the conductor.



If a positive charge is placed on the conductor, the electric field in the cavity

A) not enough information given to decide

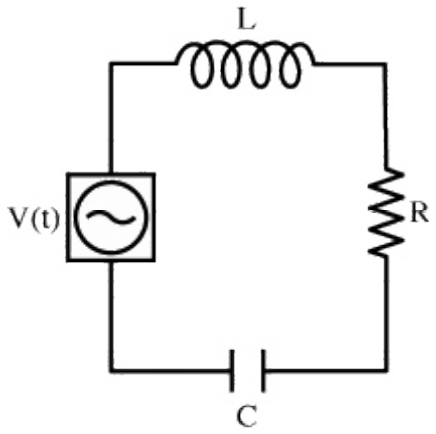
B) points generally away from the outer surface of the conductor

C) points partly away from the outer surface of the conductor and partly towards it, in such a way that the total electric flux through the surface of the cavity vanishes

D) points generally toward the outer surface of the conductor

E) is zero

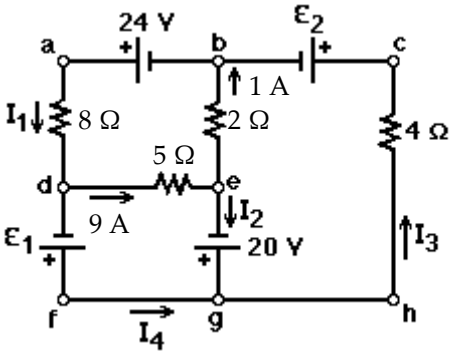
5) An LRC circuit is driven by a AC voltage source [where V(t) = Vo sin(ω t)], as shown below. The rate that energy is dissipated by the resistor



A) is zero
B) does not depend on the value of R.
C) will always increase if the angular frequency is increased.
D) will always increase if the angular frequency is decreased.
E) None of the above

6) If you were to cut a small permanent bar magnet in half,
A) each piece would in itself be a smaller bar magnet with both north and south poles.
B) one piece would contain two magnetic north poles and the other piece would contain two magnetic south poles
C) neither piece would be magnetic.
D) one piece would be a magnetic north pole and the other piece would be a south pole.
E) None of these statements is true.

7) A multiloop circuit is given.



It is not necessary to solve the entire circuit. The current I_1 is closest to:
A) zero B) 3 A C) –3 A D) 9 A E) –9 A

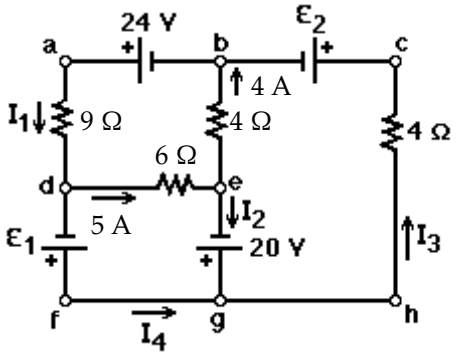
8) Electrons in an electric circuit pass through a source of emf. The wire has the same diameter on each side of the source of emf. Compared to the drift speed of the electrons before entering the source of emf, the drift speed of the electrons after leaving the source of emf is

A) faster
B) slower
C) the same
D) not enough information given to decide

9) A charged particle moving within a static magnetic field

A) may experience a magnetic force which will cause its speed to change.
B) will always experience a magnetic force, regardless of its direction of motion.
C) may experience a magnetic force, but its speed will not change.
D) None of the above statements are true.

10) A multiloop circuit is given.



It is not necessary to solve the entire circuit. The current I_2 is closest to:

A) –1 A
B) 9 A
C) 1 A
D) zero
E) –9 A

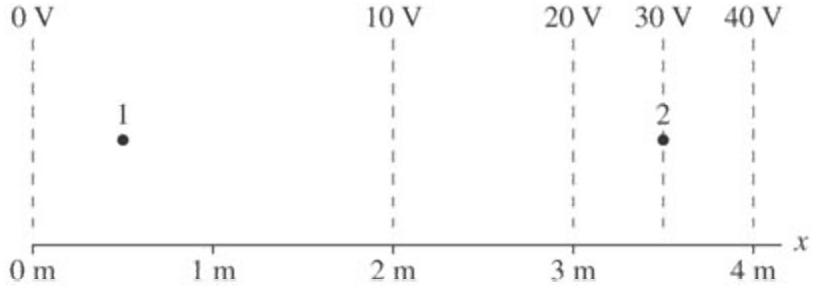
11) When there is a net static charge present on a perfect conductor, and no other charges are present

A) every point throughout the entire conductor will be at zero potential.
B) the electric field inside the conductor need not be zero if the conductor is hollow.
C) every point throughout the entire conductor will be at a constant potential, but not necessarily at zero potential.
D) the surface charge density will be greatest where the conductor is flat and smallest where there are sharp protuberances or points.
E) the charge will be uniformly distributed over the outside of the conductor (i.e., the surface charge density will be constant).

12) A series RLC circuit is hooked up to an AC voltage source [$V(t) = V_o \sin(\omega t)$]. For such a circuit

A) the current in the inductor will not necessarily be in phase with the current in the other two elements.
B) at resonance the voltage across the capacitor will be in phase with the voltage aross the inductor
C) the voltage across the resistor will always be in phase with the applied emf.
D) equal amounts of power will be dissipated in the resistor, the inductor and the capacitor only when the circuit is at resonance.
E) None of these is true.

13) The figure bellow shows a contour map of electric potential.



Estimate the electric field strength at point 2

A) 10 V/m B) 0 V/m C) 5 V/m D) 20 V/m E) 8.6 V/m

14) A hydrogen nucleus, which has a charge e, is situated to the left of a carbon nucleus, which has a charge 6e. Which statement is true?

A) The electrical force experienced by the hydrogen nucleus is to the right, and the magnitude is equal to the force exerted on the carbon nucleus.

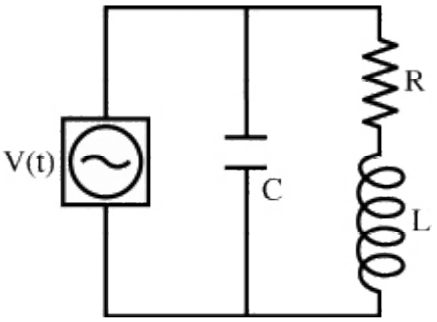
B) The electrical force experienced by the hydrogen nucleus is to the right, and the magnitude is equal to the force exerted on the carbon nucleus.

C) The electrical force experienced by the hydrogen nucleus is to the left, and the magnitude is less than the force exerted on the carbon nucleus.

D) The electrical force experienced by the hydrogen nucleus is to the left, and the magnitude is equal to the force exerted on the carbon nucleus.

E) The electrical force experienced by the hydrogen nucleus is to the left, and the magnitude is greater than the force exerted on the carbon nucleus.

15) An AC voltage source drives the circuit shown below with an angular frequency ω. For which of the following frequencies will the time–averaged magnitude of the current flowing through the resistor be the highest?



A) the frequency L/R

B) the frequency $\sqrt{1/LC - (L/2R)^2}$

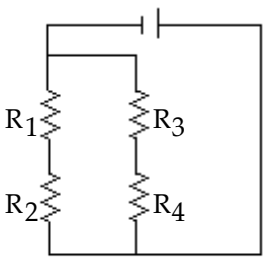
C) the frequency $\omega = (1/LC)^{1/2}$

D) very high frequencies

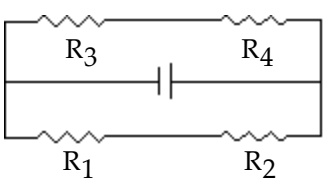
E) very low frequencies

16) Draw a circuit with a battery connected to four resistors, R_1, R_2, R_3, and R_4. Resistors R_1 and R_2 are connected in parallel, resistors R_3 and R_4 are connected in parallel, and both parallel pairs of resistors are connected in series.

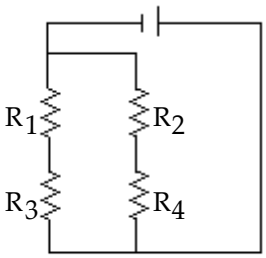
A)



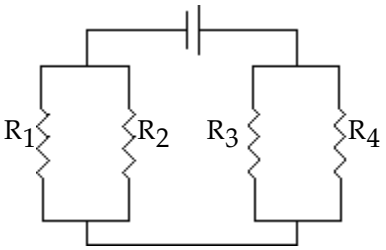
B)



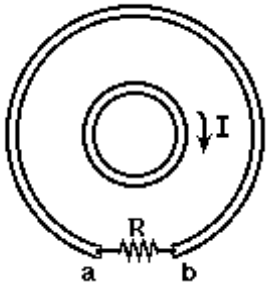
C)



D)



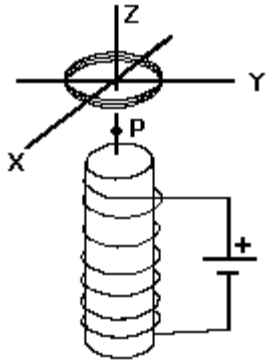
17) In the figure below the inner loop carries a current I that is increasing.



The resistor R is in the outer loop. The induced current through the resistor R is:

A) zero B) from a to b C) from b to a

18) In the figure below a coil of wire is placed on the axis of a solenoid carrying a DC current.



Which of the following will NOT result in an EMF being induced in the coil?

A) Move the coil toward point P.

B) Rotate the coil about the z–axis.

C) Rotate the coil about the x–axis.

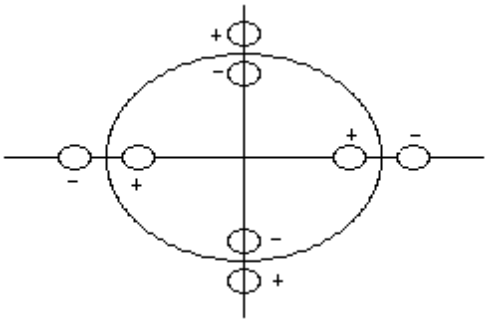
D) Rotate the coil about the y–axis.

E) Change the current in the solenoid.

19) A charged capacitor is connected to an inductor. At time t = 0 the charge on the capacitor is Q = 5μC. At time t = 2 ms the charge on the capacitor is zero for the first time. What is the amplitude of the current at that same instant?

A) 3.93 mA B) 0.87 mA C) 1.78 mA D) 0.65 mA E) 2.21 mA

20) Four protons and four electrons are arranged as shown. A 3–dimensional surface encloses them. What is the value of flux Φ through the surface?



A) 0.72 $N \cdot m^2/C$

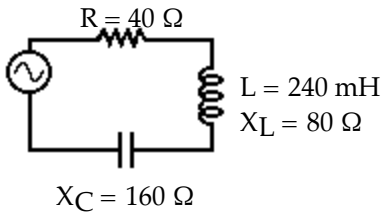
B) 0.38 $N \cdot m^2/C$

C) 6.4×10^{-19} $N \cdot m^2/C$

D) 3.8×10^{-19} $N \cdot m^2/C$

E) 0 $N \cdot m^2/C$

21) A series ac circuit is shown.



The inductor has a reactance of 80 ohms and an inductance of 240 mH. A 40 ohm resistor and a capacitor whose reactance is 160 ohms, are also in the circuit. The rms current in the circuit is 2.1 A. The rms voltage of the source is closest to:

A) 140 V B) 160 V C) 84 V D) 190 V E) 110 V

22) A current of $I(t) = 8\sqrt{t} + 30$, where t is time in seconds and I is current in Amperes, flows through an inductor. If the self–inductance is 50 H, what is the emf across the inductor (in Volts)?

A) $-200\, t^{-1/2} - 1500$

B) $-266\frac{2}{3}\, t^{3/2}$

C) $-200\ \ t^{-1/2}$

D) $-266\frac{2}{3}\, t^{3/2} - 1500\, t$

23) A charge Q distributed uniformly along the edge of a ring of radius R. What is the electric potential due to this charge at a distance x = R from the center the ring along its axis?

A) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{R2}$ B) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{\sqrt{2}R}$ C) 0 D) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{2R}$ E) $\frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$

24) A copper wire of length L and radius b is attached to another copper wire of length L and radius $2b$, forming one long wire of length $2L$. This long wire is attached to a battery, and a current is flowing through it. Relative to the electric field within the wire of radius b, the magnitude of the electric field within the wire of radius $2b$ is

A) four times weaker.
B) four times stronger.
C) two times weaker.
D) two times stronger.
E) equal.

25) The figure below represents three hollow, concentric spherical conductors.

They are charged as follows:
The inner sphere carries charge Q
The middle sphere carries charge –2Q
The outer sphere carries charge –Q .
What is the charge on the outer surface of the middle sphere?

A) –Q B) –2Q C) zero D) +2Q E) +Q

26) Alpha particles (charge = +2e, mass = 6.68 x 10–27 kg) are accelerated in a cyclotron to a final orbit radius of 0.30 m. The magnetic field in the cyclotron is 0.10 T. The centripetal acceleration of the alpha particles in the final orbit radius is closest to:

A) 1.4×10^{13} m/s2

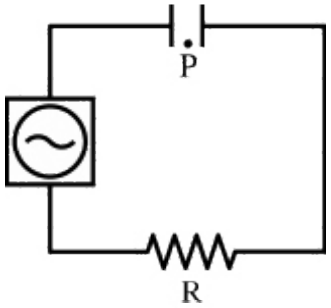
B) 2.1×10^{13} m/s2

C) 9.9×10^{12} m/s2

D) 2.8×10^{13} m/s2

E) 6.9×10^{12} m/s2

27) A capacitor is hooked up to a resistor and an AC voltage source [V(t) = Vo sin(ωt)], as shown below.



The plates of the capacitor are disks with a radius R. The plates are separated by a distance d. Directly between the two plates (a distance d/2 from each plate), a distance R/2 from the center axis, is location P. At location P,

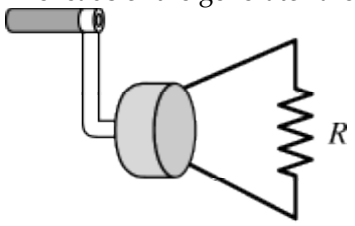
A) there is a time–varying magnetic field.

B) there is no magnetic field.

C) there is a constant magnetic field.

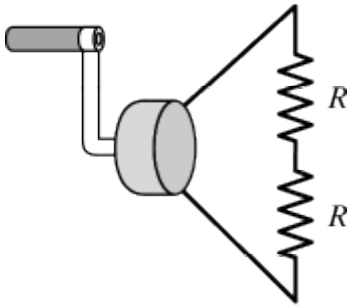
28) A hand–held generator produces an EMF across the two leads when the handle is turned, which causes a solenoid to rotate within a magnetic field produced by a small magnet. Suppose you are to rotate the handle 20 times per minute. For which scenario would you have to exert the highest torque on the handle?

A) The leads of the generator are connected to one light bulb with a resistance R.



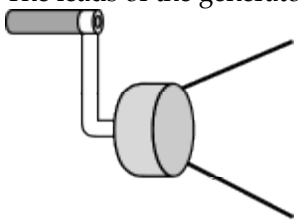
a

B) The leads of the generator are connected to two light bulbs, each with a resistance R, connected in series.



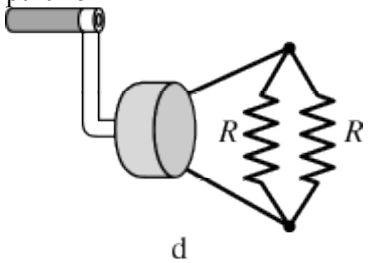
b

C) The leads of the generator are not connected to anything.



c

D) The leads of the generator are connected to two light bulbs, each with a resistance R, connected in parallel.

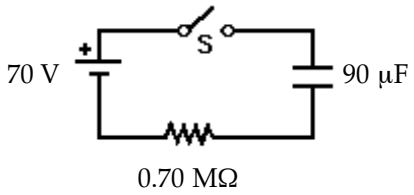


d

29) An RL circuit consists of a switch, an emf source E_0, a 4.0 kΩ resistor, and a 2.0 H inductor. If the potential across the resistor is 41.0 V 9.0 ms after the switch is closed, find the source emf, E_0.

A) 99 V B) 17 V C) 21 V D) 41 V

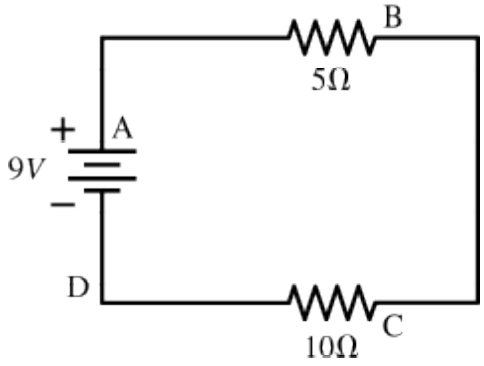
30) Initially, for the circuit shown, the switch S is open and the capacitor is uncharged.



The switch S is closed at time t = 0. When the charge on the capacitor is 900 μC, the current in the circuit, in μA, is closest to:

A) 77 B) 69 C) 60 D) 94 E) 86

31) A 9 Volt battery is hooked up to two resistors in series. One has a resistance of 5 Ohms, and the other has a resistance of 10 Ohms. Through which resistor is energy being dissipated at the higher rate? (Ignore the letters A–D along the circuit that mark several locations).



A) Cannot be determined without knowing the material of which the resistors are made.

B) The 10 Ohm resistor.

C) Energy is being dissipated by both resistors at the same rate.

D) The 5 Ohm resistor.

32) Three negative charges of equal magnitudes are positioned along the x–axis at x = –a, x=0, and x = +a respectively. The charge located at x=0 is moved away along the y–axis to a position (x,y) = (0, +a). How does the potential energy of the system of charges change as a result?

A) The potential energy decreases.

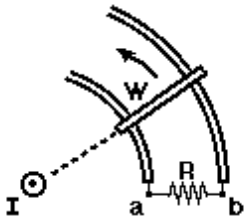
B) The potential energy may increase or decrease depending on the magnitude of the charges.

C) The potential energy stays the same.

D) The potential energy increases.

E) More information is needed to answer the question.

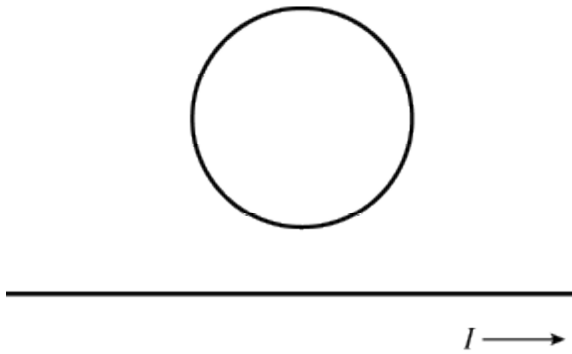
33) In the figure below a straight wire carries a steady current I.



A bar is in contact with a pair of circular rails, and rotates about the straight wire. The induced current through the resistor R is:

A) zero B) from b to a C) from a to b

34) A circular wire ring is situated above a long straight wire, as shown below. The straight wire has a current flowing to the right, and the current is increasing in time at a constant rate. Which statement is true?

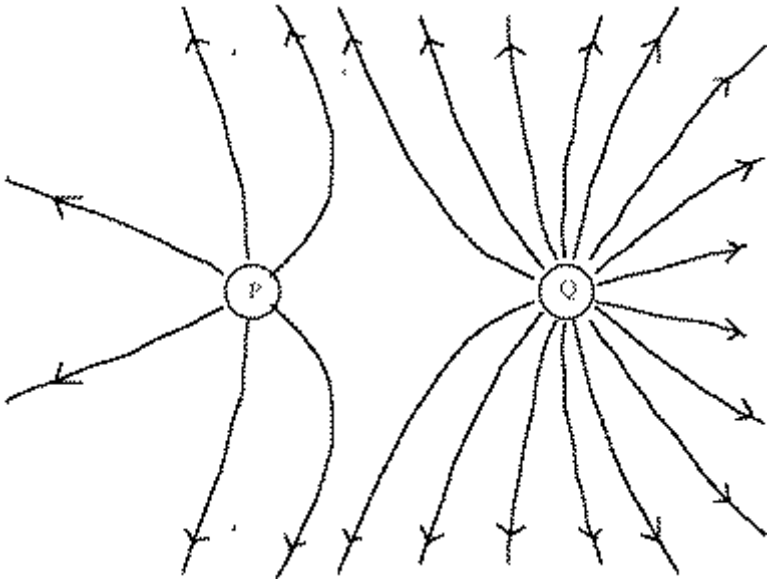


A) There is an induced current in the wire ring, directed in clockwise orientation.

B) There is an induced current in the wire ring, directed in a counter–clockwise orientation.

C) There is no induced current in the wire ring.

35) The diagram shows electric field lines arising from two small charged particles P and Q.



Consider the following two statements:

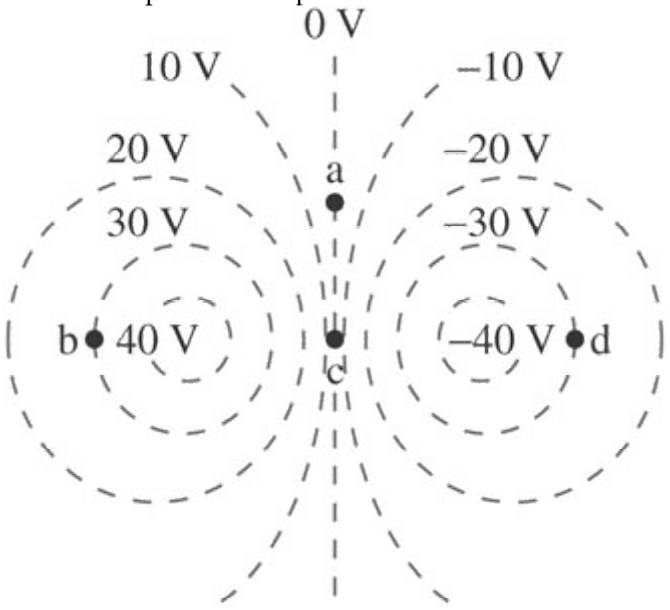
i. The charge on P is smaller than the charge on Q.

ii. The electrostatic force on P is smaller than that on Q.

Which of the above statements are true?

A) Only ii. B) Only i. C) Neither i nor ii. D) Both i and ii.

36) The figure bellow shows a contour map of electric potential.



Rank order from smallest to largest, the electric field strengths E_a through E_d at the four indicated points.

A) $E_b < E_a = E_c < E_d$

B) $E_b = E_d < E_a = E_c$

C) $E_d < E_a = E_c < E_b$

D) $E_a = E_c < E_b = E_d$

E) $E_b = E_d < E_a < E_c$

Answer Key
Testname: FINAL

1) A
2) C
3) D
4) E
5) E
6) A
7) C
8) C
9) C
10) A
11) C
12) E
13) D
14) D
15) E
16) D
17) B
18) B
19) A
20) E
21) D
22) C
23) B
24) A
25) A
26) E
27) A
28) D
29) D
30) E
31) B
32) A
33) A
34) A
35) B
36) E

Name_____ Quiz ID_____