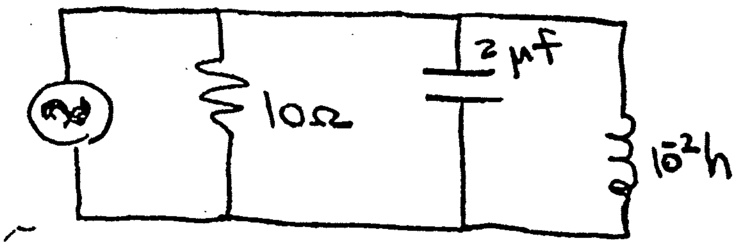
II. ELECTRICITY & MAGNETISM

1. Given the circuit in the diagram.

voltage source: 30 volts
peak to peak, 50 cps



the rms current through the inductance is:

a) 3.4 amps.

b) 3.0 amps.

c) 5.3 amps.

d) 6.8 amps.

2. A closed wire loop is in a magnetic field of 1 Weber per square meter. The wire loop is withdrawn from the field to a region of zero field. The resistance of the wire is one ohm. The mechanical work done in removing the wire from the field is:

a) exactly one joule

b) exactly zero joules

c) neither a) nor b), but independent of path.

d) Dependent upon the rate at which flux is decreased through the loop.

3. Two infinite parallel wires at a distance r carry constant currents i_1 and i_2, respectively. The force per unit length on the second wire is:

a) equal to $i_1/ 2\pi r$

b) proportional to $i_1 i_2/r$

c) zero

d) proportional to $i_1 i_2 /r^2$

The force acting on a charge q at a distance d from a perfectly conducting plate is (in c.g.s. units)

a) q^2/d^2

b) $q^2/2d^2$

c) $2q^2/d^2$

d) $q^2/4d^2$

Three charges, each + q and mass M, are held at the vertices of an equilateral triangle, of side a. At time t = 0, they are released. What is their root mean square velocity a long time later?

a) $\bar{v} = \sqrt{3q^2/ma}$

b) $\bar{v} = 3\sqrt{2q^2/ma}$

c) $\bar{v} = \sqrt{2q^2/ma}$

d) $\bar{v} = \sqrt{4q^2/ma}$

Two oscillating electric dipoles are placed parallel to one another and are spaced apart by a distance equal to one-half of the wave-length. If the dipoles are excited out of phase, then, to a good approximation:

a) The radiation will be circularly polarized.

b) There will be no radiation emitted in the plane normal to the dipoles.

c) The angular distribution of the radiation emitted is that emitted by an electric quadrupole.

d) The angular distribution of the radiation emitted is that emitted by an electric dipole.

In the usual conditions of operation of a triode vacuum tube, the grid is maintained at a:

a) negative potential with respect to the cathode.

b) zero potential with respect to the cathode.

c) positive potential with respect to the cathode, but negative with respect to the plate.

d) positive potential with respect to the plate.

8. The force on one condenser plate of a parallel plate condenser of capacitance C and separation a, when charged to a potential difference V is

a) $\frac{C^2V}{2a}$

b) $\frac{V^2}{aC}$

c) $\frac{CV^2}{a}$

d) $\frac{CV^2}{2a}$

A resistance was measured in the student laboratory using the arrangement shown:

The ammeter reading was 0.50 amps on the 1-ampere scale which had a resistance of 0.1 ohms, and the voltmeter reading was 4.0 volts on the 5 volt scale which had a resistance of 500 ohms. If the meters are accurate to 1 percent, which of the following is the most likely value of the resistance?

a) 8.1 ohms.

b) 8.0 ohms.

c) 7.9 ohms.

d) 8.2 ohms.

A particle of mass m and charge q moves under the influence of parallel, uniform electric and magnetic fields, E and B, which are directed along the z -axis. The particle starts at the origin with initial momentum P_0 directed along the x-axis. The maximum distance from the z-axis reached by the particle is:

a) infinity

b) $2P_oc/qB$

c) P_oc/qB

d) $\dfrac{P_o^2/m}{q\left(E + \dfrac{P_o}{mc}B\right)}$

11. The energy density of a classical electromagnetic wave is proportional to:

a) the sum of the squares of the maximum amplitudes of the electric and magnetic vectors.

b) the frequency.

c) the temperature of the medium through which is passes.

d) none of the above.

12. The magnetic field strength outside a long wire carrying current, at a distance r from the center, is:

a) inversely proportional to r

b) proportional to r

c) independent of r

d) inversely proportional to r^2

13. The fields B and H, associated with a permanent bar magnet, point in the same direction

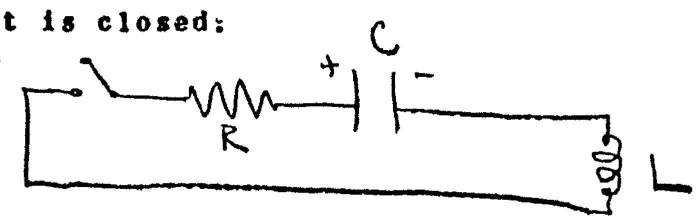
a) everywhere.

b) everywhere outside the magnet.

c) everywhere inside the magnet.

d) nowhere.

14. At t = 0, the capacitor is charged as shown and the switch in the following ciruuit is closed:



At time t = 10RC, the current in the circuit

a) flows clockwise.

b) flows counterclockwise.

c) flows in a sense which depends on the values of R, L, C.

d) is zero.

15. Two perfectly conducting concentric spheres of radii R_1 and R_2 ($R_1 < R_2$) have charges Q_1 and Q_2 on them respectively. The electric field between the spheres at a distance R from the center is:

a) zero.

b) Q_1/R^2

c) $\frac{Q_1 - Q_2}{R^2}$

d) ~~$\frac{Q_1}{R_1^2} + \frac{Q_2}{R_2^2}$~~ $\frac{Q_1}{R_1^2} - \frac{Q_2}{R_2^2}$

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16. Is the fact that electromagnetic waves are transverse indicated by the existence of

    a) diffraction

    b) interference

    c) polarization

    d) absorption offects.

17. Two insulated square capacitor plates, l on a side, are separated by a distance d l and are given equal and opposite electric charges. The force on each plate is

    a) an attraction independent of d

    b) an attraction inversely proportional to the square of the separation

    c) a repulsion independent of d

    d) zero

18 Light of energy U carries:

    a) a magnetic moment U/H where H is the magnetic intensity of the light.

    b) electric dipole moment U/E where E is the electric field of the light.

    c) momentum 2U/c, where c is the speed of light

    d) momentum U/c.

19. A point charge - q is interacting with a charge of the same size and kind on a conducting sphere. The interaction is

    a) always repulsive

    b) always attractive

    c) attractive when the point charge is near the sphere

    d) repulsive when the point charge is near the sphere

20. Compare two situations

(i) Point charge, a distance d from an infinite grounded conducting plane.

(ii) Same point charge a distance d from a semi infinite slab of dielectric.

(a) the charge is attracted to the plane equally in (i) and (ii).

(b) the charge is attracted to the plane more strongly in (i) than (ii).

(c) the charge is attracted to the plane more strongly in (ii) than (i).

(d) the charge is repelled from the plane in both cases (i) and (ii).

21. The basic principle of betatron operation is most clearly described by:

(a) Lenz' Law

(b) Faraday's Law

(c) Bethe's Law

(d) Gauss' Law

22 An inductor is made by winding a wire N times around a dielectric cylinder. The inductance will be proportional to:

(a) N

(b) N^2

(c) $1/N$

(d) $1/N^2$

23. The primary purpose of the suppressor grid in a pentode vacuum tube is

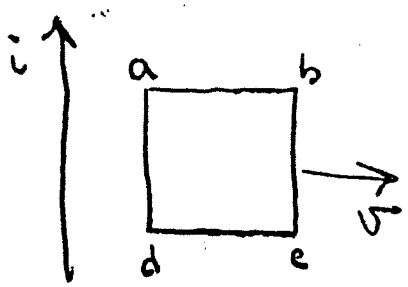
(a) to suppress electron flow from plate to screen grid

(b) to suppress electron flow from screen grid to plate

(c) to suppress unwanted oscillations caused by capacity between plate and control grid cont. 23.

(d) to suppress positive ion flow.

A closed loop with resistance R and area A is moved with velocity V away from an infinitely long wire carrying a current i



a) induced current flows clockwise

b) induced current flows counterclockwise

c) no current is induced because there is not change in flux through the loop

d) no current flows but <u>a</u> is a higher potential than <u>d</u>.

The units of the constant ϵ_0 are:

a) coul ^{2}/n - m^2

b) coul ^{2}/n - m

c) coul/n - m^2

d) n - m^2/coul

Suppose you have a magnetic field such that the magnitude of its strength is proportional to the distance from some straight axis in space. Into this field is placed an object which has an induced magnetic moment proportional to the external field strength. The force on the object is proportional to:

a) B^3

b) B^2

c) B

d) a constant

An electrified particle is moved along the axis of symmetry of a uniformly charged ring of radius R. The force on the particle is a maximum at a distance from the center of the ring which is

a) πR

b) 0

c) $R/\sqrt{2}$

d) R/...

A parallel plate capacitor has a slab of dielectric pushed in between its plates in two cases

1) with its plates connected to a constant voltage V

2) with its plates carrying a constant charge q.

The dielectric slab will be

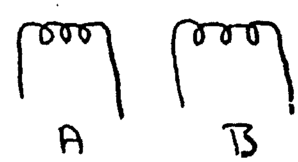
a) repelled in both cases

b) repelled in 1) and attracted in 2)

c) repelled in 2) and attracted in 1)

d) attracted in both cases

Coils A and B are identical to each other and fixed in place (see figure). A one ampere sinosidal current of frequency $(2\pi)^{-1}$mc/sec. (angular frequency = 10^6/sec.) is passed through coil A. With coil B open-circuited, this results in a back emf of 3 volts across A and an induced emf of 2 volts in coil B. When coils A and B are connected in series, the net inductance of the combination is



a) necessarily 6 microhenries

b) necessarily 8 microhenries

c) necessarily 10 microhenries

d) either 10 or 2 microhenries

An infinitely long circular copper wire carries a steady current I amperes and is of radius A meters. The magnetic intensity inside the wire is

a) $\frac{Ir}{2\pi A^2}$ where r is the radial distance from the center of the wire.

b) zero

c) $1/2\pi A$

d) $Ir^2/2\pi A^3$

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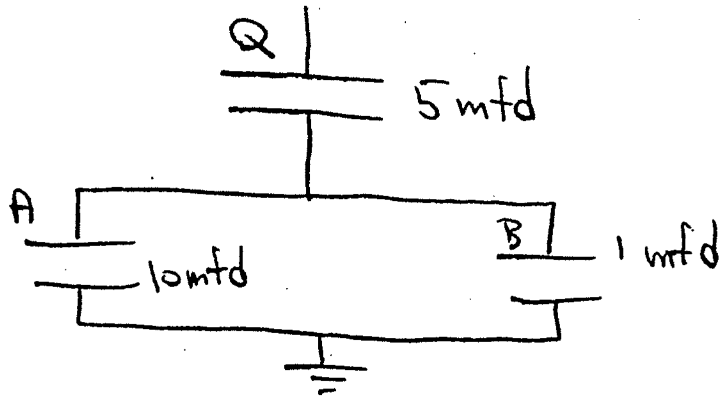
A charge Q is added to the top plate of the 5 mfd capacitor. What are the charges, A and B, that this operation adds to the plates of the 10 mfd, and 1 mfd capacitors, respectively?



a) A = Q and B = Q

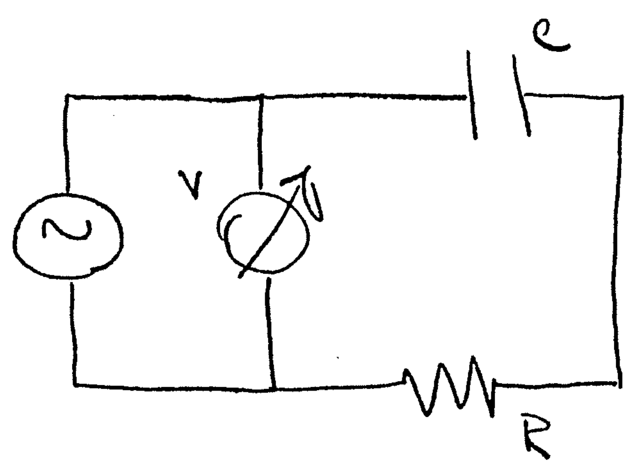
b) A = 1/2 Q and B = 1/2 Q

c) A = 2 Q and B = 1/5 Q

d) A = 10/11 Q and B = 1/11 Q

32.

I_0 Sin wt



A current generator with negligible internal resistance is connected in series with a capacitor and a resistor. A meter calibrated for r.m.s. voltage is connected across the generator. What value will the voltmeter read if its impedance is much larger than that of any of the other elements in the circuit?

32 continued

a) Close to zero

b) $I_o \sqrt{\frac{R^2}{2} + \frac{1}{2\omega^2 C^2}}$

c) $I_o \sqrt{R^2 + \frac{1}{\omega^2 C^2}}$

d) $\frac{I_o \sin \omega t}{C + R}$

33. Which of the following quantities is connected with the electric charge through Gauss' law?

a) electric potential

b) magnetic field strength

c) displacement vector

d) resistance

34. In an arbitrary electrostatic field the lines of force are_______________ to the equipotential surfaces.

a) orthogonal

b) tangential

c) inverse

d) in no special relation

35. The electric field due to a spherical shell of positive charge of uniform density is______________________inside the shell.

a) zero

b) directed radially inward

c) directed radially outward

d) tangential to the charge surface

36. Given a sphere of radius α filled with a homogeneous charge distribution of density p. The potential difference between the center and the surface of the sphere in M.K.S. units is

a) $\frac{p\,\alpha^2}{3\,\epsilon_o}$

c) $\frac{p\,\alpha^2}{6\,\epsilon_o}$

b) $\frac{p\,\alpha^2}{\epsilon_o\,4\sqrt{3}}$

d) $\frac{p\,\alpha^2}{4\,\epsilon_o}$

37. The electric displacement in a dielectric is

a) always parallel to the electric field intensity and proportional to it.

b) may be parallel or may be in a different direction from the electric field intensity

c) always in the same direction as the polarization

d) always in the opposite direction to the polarization

38. A proton moves under the influence of the following electric and magnetic fields:

$$\underline{E} = (-kx, 0, 0) \quad . \quad \underline{B} = (0, B, 0)$$

where k and B are constants and the indicated components are the x, y, z components of the fields. At time t = 0 the proton is at rest at the point x = A, y = 0. The trajectory of the proton can best be described as

a) simple harmonic motion along the x-axis with amplitude A

b) cycloid in the xy plane

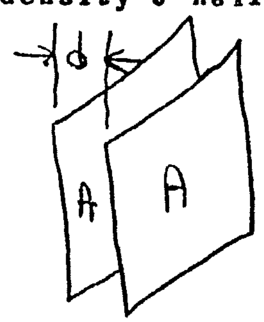
c) cycloid in the xz plane

d) helix of elliptical cross section and axis parallel to the z-axis

39. A special diode tube has parallel plates of area A, as shown. For small currents, the potential will vary linearly between the plates. Neglect the initial velocity of the electrons leaving the cathode. If the total current I is passing through the diode what is the current density J halfway between the plates?

Cathode

(-)



cathode potential =0

anode potential V

Anode (+)

a) $J = I/(2A)$

b) $J = I/(A\sqrt{2})$

c) $J = I/A$

d) $J = I/(dA)$

40. A long cylinder of iron with permeability, μ, has a uniform magnetic field of 80 oersted parallel to its axis. A small hole is drilled down the axis. The induction field, B, in the hole is approximately:

a) 80 gauss

b) 80 gauss

c) $80/\mu$ gauss

d) 40 oersted

41. The Faraday effect concerns

a) conductors moving in magnetic fields

b) time-varying magnetic fields

c) electromagnetic polarization effects

d) induced emfs in rotating bodies

42. Consider a field described by a vector A. If A is a radially directed vector whose magnitude at the point (x,y,z) is $x^2 + y^2 + z^2$, then

a) div A = 0; curl A = 0

b) div A = 3; curl A = 0

c) div A = 0; curl A = r x A

d) div A = 3; curl A = 3 r

43. Radio waves emitted by a distant galaxy are thought to

a) take a much longer time to reach the earth than light emitted by the same galaxy

b) take a much shorter time to reach the earth than light emitted by the same galaxy

c) take about the same time to reach the earth as light emitted by the galaxy

d) in most cases will never reach the earth because of the inter-stellar magnetic field

44. An antenna of resistance R carrying an average current I radiates energy at a rate P. The radiation resistance is equal to

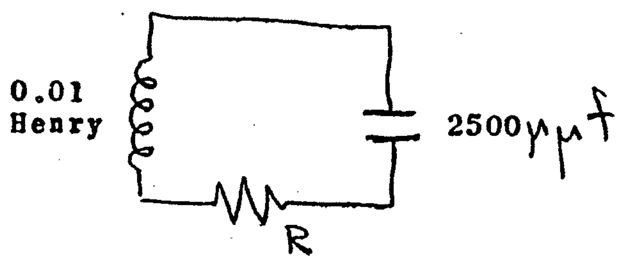
a) R

b) P/I^2

c) P/I

d) IR

45.



The circuit shown

a) has a resonant frequency of 2×10^5 cycles/sec

b) has a resonant frequency of $4\pi \times 10^5$ cycles/sec

c) has a resonance frequency that depends on the size of the resistor

d) will not show an oscillatory behavior if the resistance R is very large