Physics 2

Set no. 4

1. A flat (parallel) capacitor has covers of area S spaced d apart. A battery charges the covers to the potential difference U_0. Then the battery is disconnected and a dialectic plate of thickness d is inserted between the covers. Please calculate the ratio of the energy contained in the capacitor before and after insert the plate.

2. A rectangular carbon bar for dimensions 10x10x50cm. What will be the resistance measured between
   a) two square sides of the bar ;
   b) between the opposite rectangular walls of the bar?
   The resistivity of carbon at 20 degrees is $3.5 \cdot 10^{-5}$ Ωm

E 3. A wire with a length of $l = 150$m and a radius of $r = 0.15$mm carries a current with a uniform current density of $j = 2.8 \times 10^7$ A/m^2. Please determine the current in this wire.

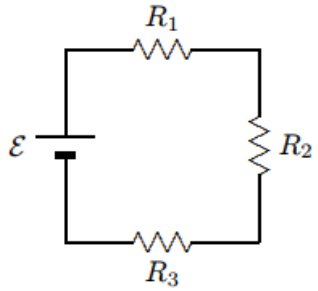
E 4. A $R = 10\Omega$ resistor has a constant current. Please find the current if $q = 1200$C of charge flow through it in $t = 4$ minutes.

5. Please deduce the replacement (equivalent) resistant for
   - n resistors connected in series,
   - n parallel-connected resistors.

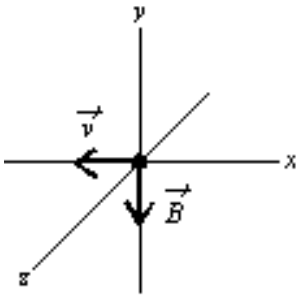
E 6. An ordinary light bulb is marked “60W, 120V”. Please calculate its resistance and the total charge passing through it in $t = 1$ hour.

7. We have 6m of a heating wire of resistance 24Ω. Is it possible to obtain more heat (power) by winding the wire in one spiral or by dividing the wire in half and winding two separate spirals? In both cases the spirals are connected separately to a 110V network.

E 8. In the diagram R1 > R2 > R3. Please rank the resistors according to the voltage dropping across them, least to greatest.



9. An electron moves in the negative *x* direction, through a uniform magnetic field in the negative y direction. Please determine the direction of magnetic force on the electron and calculate its magnitude if $v = 10^6$ m/s, $B = 0.1$ T



10. Since the velocity **v** is perpendicular to the field **B** then the path of the particle with charge q and mass *m* is a circle lying in the plane perpendicular to the field **B**. Please calculate the radius of this circle and the frequency with which the charge circulates.

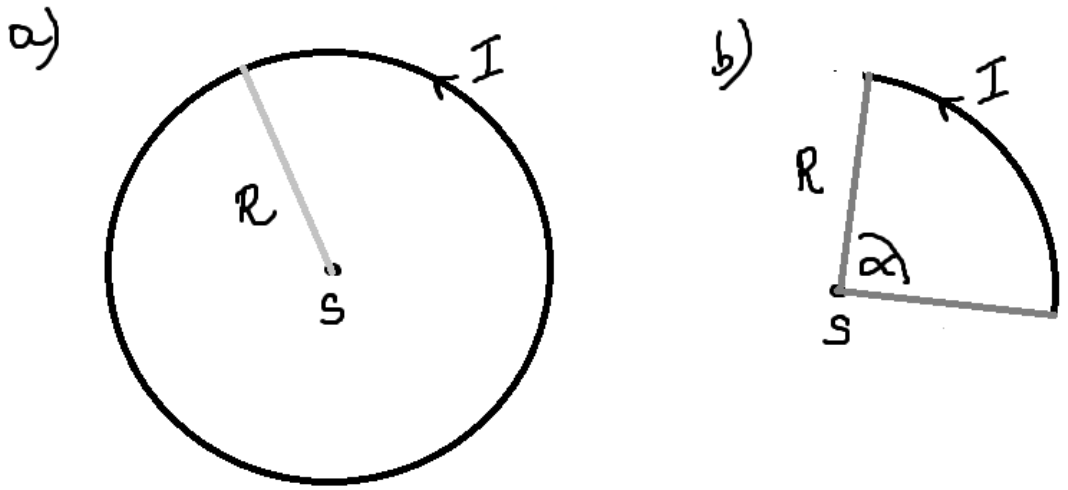
E 11. At any point the magnetic field lines are in the direction of:
- A) the magnetic force on a moving positive charge
- B) the magnetic force on a moving negative charge
- C) the velocity of a moving positive charge
- D) the velocity of a moving negative charge
- E) none of the above

E 12. The magnetic force on a charged particle is in the direction of its velocity if:
- A) it is moving in the direction of the field
- B) it is moving opposite to the direction of the field
- C) it is moving perpendicular to the field
- D) it is moving in some other direction
- E) never

E 13. Magnetic field CANNOT:
- A) exert a force on a charge
- B) accelerate a charge
- C) change the momentum of a charge
- D) change the kinetic energy of a charge
- E) exist

14. A particle with a positive charge falls into a magnetic field with induction B and moves in a circle of radius R. Then it gets into an electric field (magnetic field is turned off) in which it moves along the field lines and overcomes the potential difference U. As a result, the velocity of the particle has increased n times. Please calculate the value v_f of the final velocity of the particle.

15. Please find the magnetic field produced at point S by a current flowing in:
a) a circular conductor,
b) an arc-shaped conductor.



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16. In Ampere's law, $\oint \vec{B} \cdot \overrightarrow{dS} = \mu_0 i$, $= \mu_0 i$, the integration must be over any:

A) surface
B) closed surface
C) path
D) closed path
E) closed path that surrounds all the current producing 4

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17. In Ampere's law $\oint \vec{B} \cdot \overrightarrow{dS} = \mu_0 i$, the symbol $\overrightarrow{dS}$ is:

A) an infinitesimal piece of the wire that carries current *i*
B) in the direction of $\vec{B}$
C) perpendicular to $\vec{B}$
D) a vector whose magnitude is the length of the wire that carries current *i*
E) none of the above

18. Two long parallel wires, *d* apart, in which currents I_1 and I_2 flow, exert forces on each other. Please find the force that the first wire acts on the second wire if the directions of the currents are (a) compatible, (b) opposite.

19. Two long straight wires enter a room through a window. One carries a current of 3.0 A into the room while the other carries a current of 5.0 A out. Please calculate the path integral $\oint_L \vec{B} d\vec{l}$ around the window frame.

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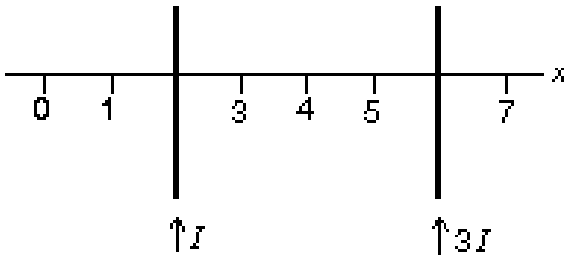
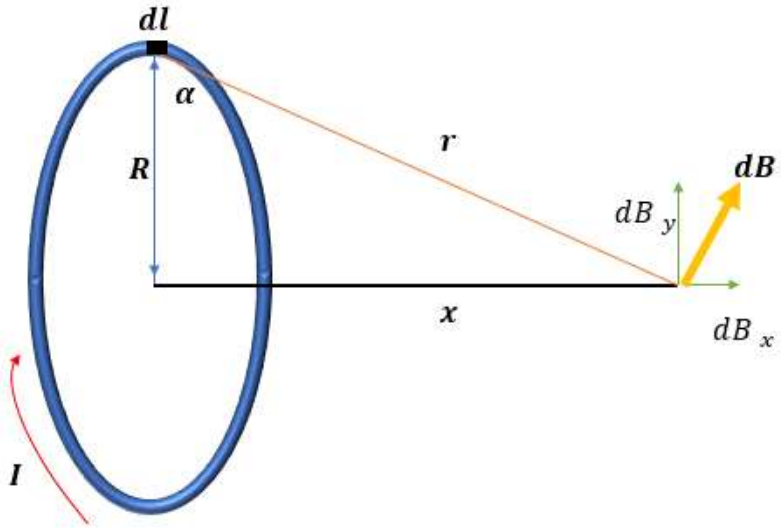
20. Two long straight current-carrying parallel wires cross the x axis and carry currents I and 3I in the same direction, as shown. At what value of x is the net magnetic field zero?



21. Please calculate the magnetic field B on the axis of a circular conductor with a current at point P (at distance x)



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22. Faraday's law states that an induced *emf* is proportional to:
    A) the rate of change of the magnetic field
    B) the rate of change of the electric field
    C) the rate of change of the magnetic flux
    D) the rate of change of the electric flux
    E) zero

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23. The *emf* that appears in Faraday's law is:
    A) around a conducting circuit
    B) around the boundary of the surface used to compute the magnetic flux
    C) throughout the surface used to compute the magnetic flux
    D) perpendicular to the surface used to compute the magnetic flux
    E) none of the above

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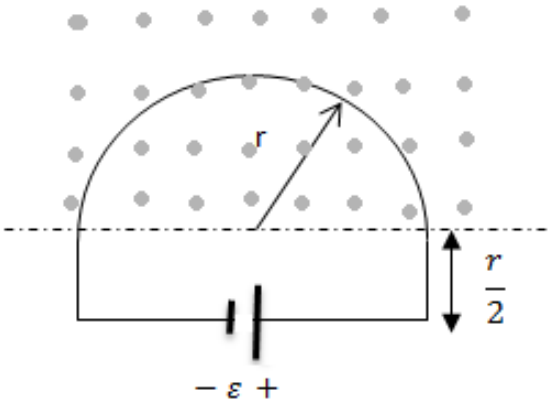
24. If the magnetic flux through a certain region is changing with time:
    A) energy must be dissipated as heat
    B) an electric field must exist at the boundary
    C) a current must flow around the boundary
    D) an *emf* must exist around the boundary
    E) a magnetic field must exist at the boundary

25. A conductive loop with resistance R = 2Ω consists of a semicircle of radius r and three segments. It is located in a field of magnetic induction **B** marked with dots . The magnitude of magnetic vector is given by the formula B = $4t^2+2t+3$ [T] A perfect source with ε = 2V is connected to the loop. Please calculate



the value and direction of the *emf* induced by the field at time t =10s and the current flowing in the loop at time t=10s.

26. A rectangular wire frame is placed in an inhomogeneous magnetic field **B** with magnitude $B=4t^2$. The vector is perpendicular to the surface of the frame (with dimensions W = 2 cm by H= 3 cm). What is the direction and value of the *efm* induced in the time t = 0.1s

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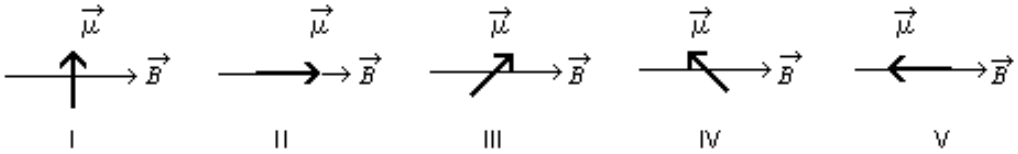
27. The diagrams show five possible orientations of a magnetic dipole ± in a uniform magnetic field **B**. For which of these does the magnetic torque on the dipole a) have the greatest magnitude, b) have the greatest magnitude?



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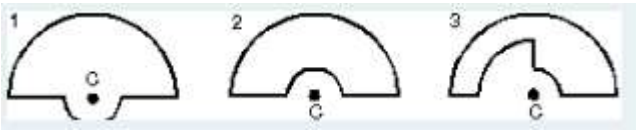
28. The diagrams show three circuits consisting of concentric circular arcs (either half or quarter circles of radii r, 2r, and 3r) and radial lengths. The circuits carry the same current. Please rank them according to the magnitudes of the magnetic fields they produce at C, least to greatest.



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29. A 10 turn conducting loop with a radius of 3.0 cm spins at 60 revolutions per second in a magnetic field B= 0.50 T. Please calculate the maximum *emf*