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Magnetism and electromagnetism

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CONCEPT REVIEW 22
Complete this concept review handout and keep it as a record of what you have learned..

Definitions

- A magnet is *an object that can attract other objects containing iron, cobalt or nickel.*
- Magnetism describes *all the phenomena caused by magnets.*
- The north pole of a magnet is *the end that naturally seeks the Earth's magnetic pole near the geographic North Pole. The other end of the magnet is its south pole.*
- A magnetic field is *the area of space in which the magnetic force of a magnet can act on another magnet.*
- Electromagnetism describes *all the phenomena resulting from the interaction between electricity and magnetism.*
- A solenoid is *a cylindrical coil of live wire.*

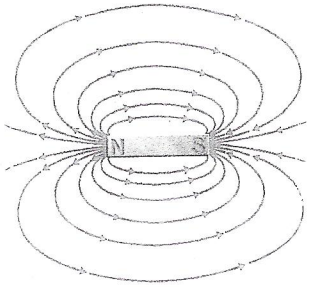
Magnetic forces of attraction and repulsion

Opposite magnetic poles *attract each other.*

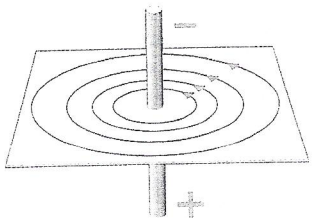
Like magnetic poles *repel each other.*

Magnetic fields

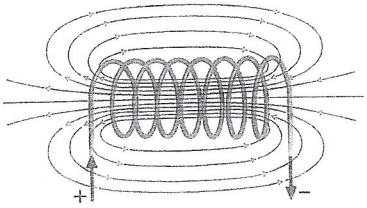
Magnetic field of a bar magnet



Magnetic field of a live wire



Magnetic field of a solenoid



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INTEGRATION QUESTIONS

Magnetism and electromagnetism

1. True or false? If a statement is false, correct it.

a) Opposite magnetic poles repel each other.

False. Opposite magnetic poles attract each other. It is poles of the same sign that repel each other.

b) Magnetic force can act over a distance.

True.

c) A charged comb can generate a magnetic field.

False. To generate a magnetic field, there must be magnetic charges in motion.

d) A magnetic field produced by an electric current can be switched on and off at will.

True.

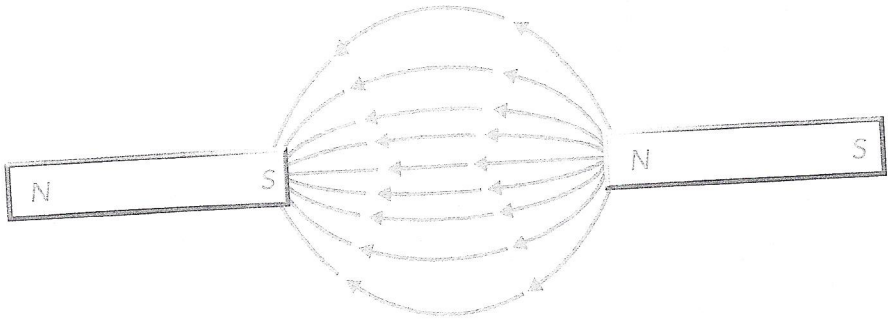
e) An electromagnet is a cylindrical coil of live wire.

False. This is the definition of a solenoid.

2. If you allowed a bar magnet to move freely, by suspending it from a thread, for instance, how would it behave?

Its north pole would naturally seek the Earth's ~~geographic~~ magnetic North Pole.

3. Name the poles of the magnets in the following illustration.



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ADDITIONAL QUESTIONS

Electricity and electrical charges • Static electricity • Electric current and electrical power • Electrical circuits • Magnetism and electromagnetism

1. True or false? If a statement is false, correct it.

a) When a charged object shares its charge with an uncharged object, this is called charging by friction.

False. It is charging by conduction.

b) Conductors and insulators alike transport dynamic electricity.

False. Insulators impede the flow of charges.

2. Two charged objects are placed 1.5 cm apart. The first carries a positive charge of 5×10^{-6} C, and the second, a negative charge of 2×10^{-5} C.

a) Calculate the electrical force between the two objects.

$$F_e = \frac{kq_1q_2}{r^2} = \frac{9 \times 10^9\ Nm^2/C^2 \times 5 \times 10^{-6}\ C \times 2 \times 10^{-5}\ C}{(0.015\ m)^2} = 4000\ N$$

The electrical force between the two objects is 4000 N.

b) Is the force acting on the two objects a force of attraction or repulsion? Explain your answer.

It is a force of attraction because charges of opposite signs attract each other. The first object is positively charged, while the second is negatively charged.

3. A piece of gold jewellery captures 4×10^{19} electrons after being rubbed with a cloth.

a) What is its charge in coulombs?

$1\ C = 6.25 \times 10^{18}$ electrons

$?\ C = 4 \times 10^{19}$ electrons

$$\frac{1\ C \times 4 \times 10^{19}e^-}{6.25 \times 10^{18}e^-} = 6.4\ C$$

The charge of the piece of jewellery is 6.4 C.

b) Is the charge positive or negative? Explain your answer.

The charge is negative because the piece of jewellery has gained electrons.

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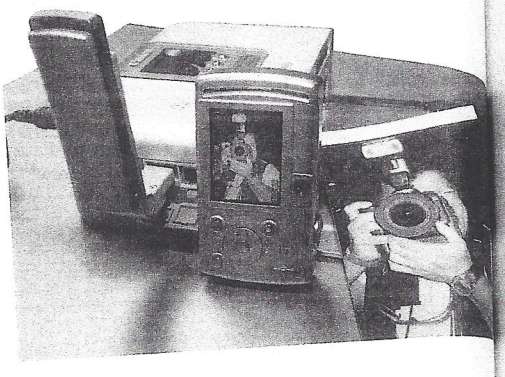
4. In the following situations, is static electricity (S) or dynamic electricity (D) involved?

a) When a toaster's cord is plugged into a wall socket, the appliance works. D

b) A plastic object rubbed on the carpet becomes charged. S

c) In summer, you can get an electrostatic discharge by touching a car door. S

d) A digital camera lets you take multiple photos. D



5. A current of 20 A flows through an element in an electrical circuit. What charge would be necessary to make the element run for 15 minutes?

$15\ min = 900\ s$

$q = I \times \Delta t = 20\ A \times 900\ s = 18000\ C$

The charge necessary to make the element run for 15 minutes would be 18 000 C.

6. What amount of energy provides a charge of 15 C in a circuit where there is a potential difference of 3 V?

$E = U \times q = 3\ V \times 15\ C = 45\ J$

A charge of 15 C and a potential difference of 3 V provide 45 J of energy.

7. Calculate the amount of energy used by a 60 W bulb in 1 hour.

$1\ h = 3600\ s$

$E = P_e \times \Delta t = 60\ W \times 3600\ s = 216000\ J$

After an hour of use, the bulb will have used 216 000 J of energy.

8. What amount of energy will a 1200 W vacuum cleaner have consumed after running for 20 minutes?

$20\ min = 1200\ s$

$E = P_e \times \Delta t = 1200\ W \times 1200\ s = 1440000\ J$

After 20 minutes of use, the vacuum cleaner will have consumed 1 440 000 J.

9. Why is the number of positive charges created when matter is charged always equal to the number of negative charges created?

It is a consequence of the law of conservation of charge.

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10. Indicate whether the following substances are conductors (C) or insulators (I).

a) The threaded end of an incandescent bulb. C

b) The sheath of a electrical wire. I

c) The ends of a battery. C

d) The outside casing of a television. I

11. Specify whether each of the following cases is an example of static electricity (S) or dynamic electricity (D).

a) A Van de Graaff generator that retains a surplus of charges for a certain period of time. S

b) The formation of a lightning bolt during a storm. S

c) A house's electrical circuit that transports current to all the rooms. D

d) Nerve impulses that transmit information perceived by our senses to the brain. D

12. Here is the diagram of an electrical circuit.

a) What is the potential difference measured by each of the voltmeters?

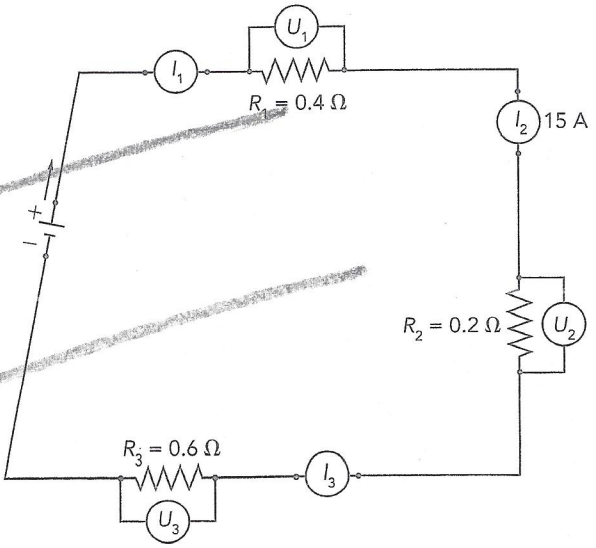
$I_{tot} = I_1 = I_2 = I_3 = 15\ A$

$U = RI$

$U_1 = 0.4\ \Omega \times 15\ A = 6\ V$

$U_2 = 0.2\ \Omega \times 15\ A = 3\ V$

$U_3 = 0.6\ \Omega \times 15\ A = 9\ V$



b) What is the circuit's total potential difference?

$U_{tot} = U_1 + U_2 + U_3 = 6\ V + 3\ V + 9\ V = 18\ V$

The total potential difference of the circuit is 18 V.

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c) Calculate the circuit's electrical power.

$P = UI = 18\ V \times 15\ A = 270\ W$

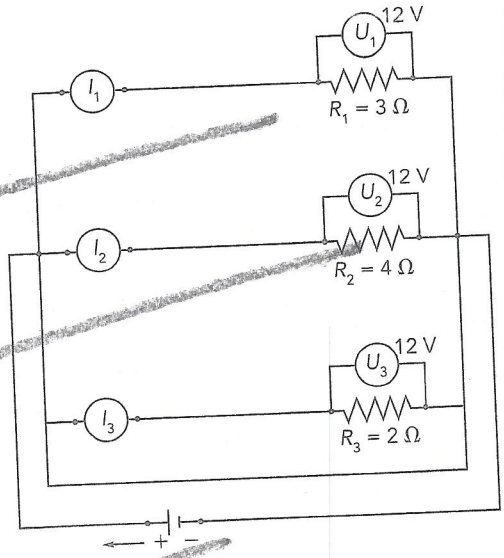
The circuit's electrical power is 270 W.

d) Calculate the circuit's equivalent resistance.

$R_{eq} = R_1 + R_2 + R_3 = 0.4\ \Omega + 0.2\ \Omega + 0.6\ \Omega = 1.2\ \Omega$

The circuit's equivalent resistance is 1.2 Ω.

13. Here is the diagram of an electrical circuit.



a) What is the current intensity measured by each of the ammeters?

$I_1 = \frac{U_1}{R_1} = \frac{12\ V}{3\ \Omega} = 4\ A$

$I_2 = \frac{U_2}{R_2} = \frac{12\ V}{4\ \Omega} = 3\ A$

$I_3 = \frac{U_3}{R_3} = \frac{12\ V}{2\ \Omega} = 6\ A$

b) What is the circuit's total intensity?

$I_{tot} = I_1 + I_2 + I_3 = 4\ A + 3\ A + 6\ A = 13\ A$

The circuit's total intensity is 13 A.

c) Calculate the circuit's electrical power.

$P = UI = 12\ V \times 13\ A = 156\ W$

The circuit's electrical power is 156 W.

d) Calculate the circuit's equivalent resistance.

$R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{1}{\frac{1}{3\ \Omega} + \frac{1}{4\ \Omega} + \frac{1}{2\ \Omega}} \simeq 0.92\ \Omega$

The circuit's equivalent resistance is approximately 0.92 Ω.