F) Manufacture of heating elements for electric stoves:

Material(s)

Reason(s) for your choice

2. The following statements pertain to alternating and direct current. Which of them pertain specifically to alternating current? Which of them pertain specifically to direct current? (3 marks)

A) This current always travels in the same direction.
B) The voltage oscillates between a maximum and a minimum value.
C) It is used to operate a Walkman and certain toys.
D) Its value is constant.
E) Batteries produce this type of current.
F) This type of current changes direction regularly.
G) Its frequency is 60 hertz in the Hydro-Québec network.
H) It is used to operate electric household appliances.
I) The effective value of its intensity is used when making calculations.

AC: B, F, G, H, I

DC: A, C, D, E

3. Arrange in chronological order, from the earliest to the most recent, the following events taken from the history of electricity, magnetism and electromagnetism: (3 marks)

A) Oersted observed that electric current will deflect the needle of a compass.
B) For the first time, electrolysis made it possible to specify the chemical composition of water.
C) Thales observed that amber attracts silk after they have been rubbed together.
D) Pierre Maricourt distinguished between the north and south poles of magnets.
~~E) Maxwell described light and predicted the existence of invisible radiation.~~
E) Gilbert discovered that it was possible to electrify many materials.

Answer: C, D, E, B, A, F

F) Faraday discovered that magnets can be a source of electric current

3. Arrange in chronological order, from the earliest to the most recent, the following events taken from the history of electricity, magnetism and electromagnetism: (3 marks)

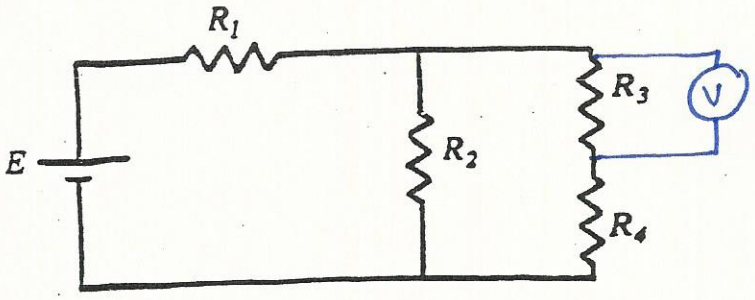
A) Volta developed the first battery.
B) Gilbert discovered that it was possible to electrify many materials.
C) It was first observed that magnetite attracts iron.
D) Marconi sent the first wireless transatlantic message
E) Faraday discovered that magnets can be a source of electric current.

Answer: _____

4. You wish to measure the voltage at the terminals of resistor R_3 in the circuit shown below. (6 marks)

a) What device should you use? (If you use a multimeter, what function should it be set to?) Voltmeter

b) On the diagram, illustrate how this device is connected.



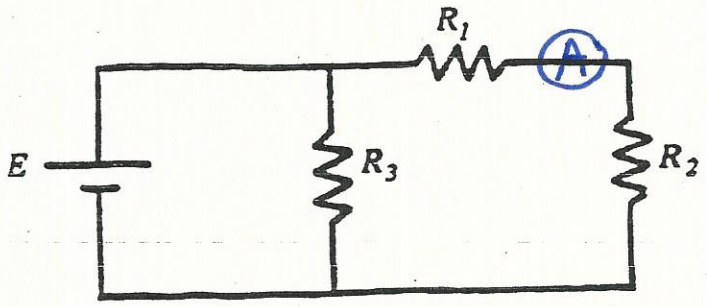
c) Is the measuring device connected in series or in parallel? Explain why it is connected in this manner.

The voltmeter is connected in parallel.
The electrons do not pass through it
in order to measure the potential difference.

4. You wish to measure the current flowing through resistor R_1 of the circuit shown below. (6 marks)

a) What device should you use? (If you use a multimeter, what function should it be set to?) Ammeter

b) On the diagram, illustrate how this device is connected.



c) Is the measuring device connected in series or in parallel? Explain why it is connected in this way. The ammeter is connected in series. The current must pass through it in order to be measured.

5. The batteries in a discman have already been used for some time. You want to use them to listen to a 45-minute CD. There are 0.0015 ampere-hours left in the batteries, and the discman operates on a current of 0.70 milliamperes.

Check whether you will have to change the batteries in order to listen to the CD. Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (3 marks)

5. You forgot to turn off your car's headlights. They were left on for five and a half hours on a 12 amperes current. The total charge of the battery is 90 ampere-hours. Given that start-up requires a current of 420 amperes for 3 seconds, indicate whether the car will be able to start again. (3 marks)

5. The batteries in a tape recorder have 0.018 ampere-hours left in them. The tape recorder operates on a 1.2 mA current. Will you be able to listen to a 230 minute recording before the batteries go dead?

(3 marks)

5. The total charge of a car battery is 90 ampere-hours. If you forget to turn off the headlights (overnight, which is for 8.5 hours), will the car start in the morning? The headlights operate on a 9.5 amperes current. Start-up requires a current of 380 amperes for 5 seconds. (3 marks)

6. A battery supplies energy to a light bulb in a simple circuit. A second light bulb is added, doubling the resistance in the circuit. After the change, is the current in the circuit increased or reduced? By how much? Explain your answer using the appropriate formula. (3 marks)

Answer: _____

Explain: _____

_____

_____

6. In a simple circuit, a 12-volt battery is replaced by an 8-volt battery. After the change, is the current in the circuit increased or reduced? By how much? Explain your answer using the appropriate formula. (3 marks)

Answer: _____

Explain: _____

_____

_____

7. A heating unit is plugged in using an extension cord half the size of the recommended cord. Is the resistance of the cord used greater or less than the resistance of the recommended cord?
Explain your answer using the appropriate formula. (3 marks)

7. A heating unit is plugged in using an extension cord twice the size of the recommended cord. Is the resistance of the cord used greater or less than the resistance of the recommended cord?
Explain your answer using the appropriate formula. (3 marks)

7. Industrial machines require a great deal of current. To obtain this, do the industrial circuit wires need to be larger than, smaller than, or the same size as those in residential circuits?
Explain your answer using the appropriate formula. (3 marks)

8. How much power is dissipated by a toaster oven plugged into a 120-volt outlet if the oven runs on a 22 ampere current? (3 marks)
Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations.

$P = VI$

$P = (120V)(22A)$

$= 2640\ W$

8. How much power is dissipated by a space heater plugged into a 120-volt outlet if the heater runs on a 19.5 ampere current? (3 marks)
Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations.

$P = VI$

$= (120\ V)(19.5\ A)$

$= 2340\ W$

8. Calculate the energy consumed by a 950-watt clothes dryer used over a period of six and a half hours. Give your answer in kilowatt-hours. Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (3 marks)

8. Calculate the energy consumed by a 60-watt light bulb left on for a period of 24 hours. Give your answer in kilowatt-hours. Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (3 marks)

8. How much power is dissipated by an electric dryer that is plugged into a 240-V outlet if the dryer runs on a 60 amperes current? Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (3 marks)

$P = VI$

$= (240V)(60A)$

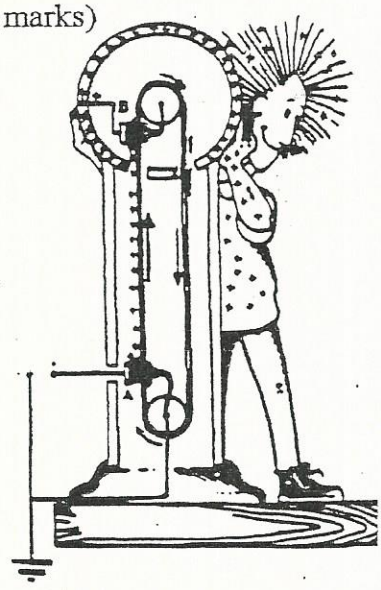
$= 14\ 400\ W$

8. Calculate the energy consumed by a 300-watt air conditioner used over a period of six and a half hours. Give your answer in kilowatt-hours. Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (3 marks)

9. After using a plastic comb, you notice that your hair is attracted to the comb. Explain why there is static electricity and why your hair is attracted to the comb. (3 marks)

When hair is combed, electrons transfer into the comb. Thus, the comb takes on a negative charge and the hair is left with a positive charge. Opposite charges attract.

9. A visitor to the science museum steps up to a machine that makes her hair stand on end (Van De Graaff). Explain why her hair stands on end when she touches the metal ball on the machine. (3 marks)

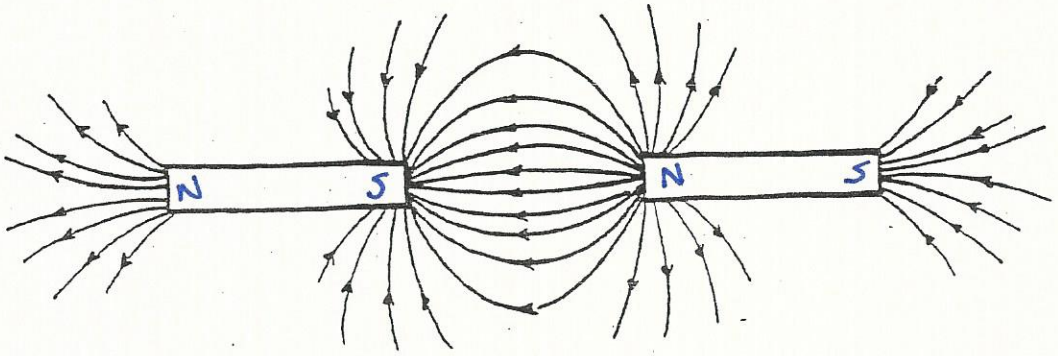


10. A force is exerted between two electric charges. What happens to the force if the distance separating the two charges is doubled? Is the force increased or reduced? By how much? Support your answer using the appropriate formula. (3 marks)

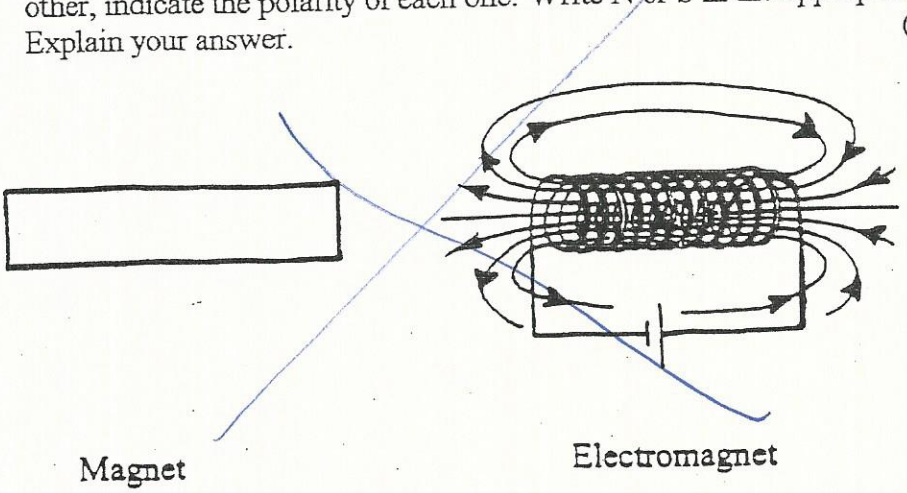
10. A force is exerted between two electric charges. What happens to the force if the distance separating the two charges is reduced by half? Is the force increased or reduced? By how much? Support your answer using the appropriate formula. (3 marks)

11. Complete the diagram below and indicate the magnetic polarities. Write N or S in the appropriate places. Explain your answer. (3 marks)

→ Lines of force run from N→S outside a magnet.



11. Given that the magnet and electromagnet in the following diagram attract each other, indicate the polarity of each one. Write N or S in the appropriate places. Explain your answer. (3 marks)



Magnet

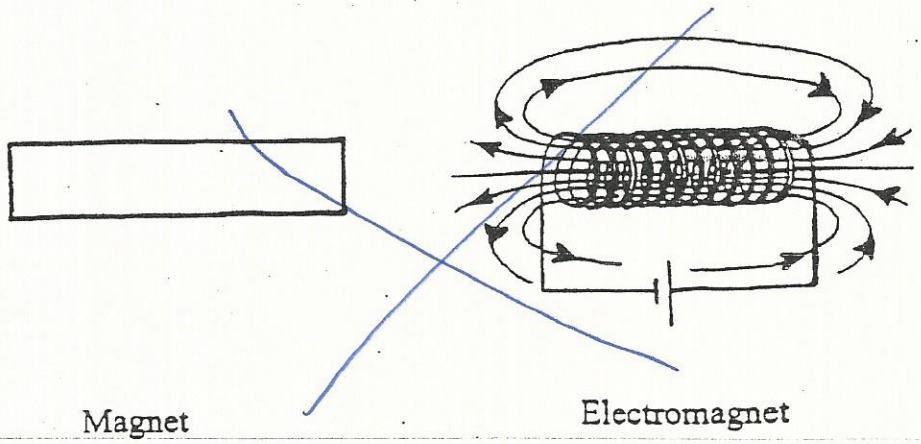
Electromagnet

Explain your answer:

_____

_____

11. Given that the magnet and electromagnet in the following diagram repel each other, indicate the polarity of each one. Write N or S in the appropriate places. Explain your answer. (3 marks)



Magnet Electromagnet

12. The following statements pertain to the characteristics and the functions of the components of an electric circuit comprising a power source, a resistor, a switch, and conductor wires. Indicate whether each statement is true or false. (3 marks)

a) The voltage across the terminals of a battery represents the increase of energy undergone by the charges passing through it.
b) The voltage across the terminals of a resistor expresses the decrease in energy acquired by the charges flowing through it.
c) When the switch is closed, the electrons take less than a second to travel from the power source to the resistor.
d) The energy of the charges varies only slightly when they pass through a conductor wire.
e) Convention dictates that electric current flows through a circuit from the negative terminal of the source to the positive terminal.
f) Electric current can flow through a circuit only when the switch is closed.
g) The electrons travel more quickly in the conductor than in the resistor.
h) The voltage between two points on the same conductor wire is practically nil.
i) Opening the switch cuts the power supply to the whole circuit.

13. The emergency lighting in one wing of a hospital is powered by a 12-V battery. When the time comes to replace the battery, two 12-V batteries are installed. (3 marks)

a) Should the batteries be connected in series or in parallel?

The batteries should be connected in parallel.

b) What is the advantage of using two batteries instead of one?

The batteries will last twice as long.

13. Is it better to buy Christmas lights that are arranged in series or in parallel? Explain. (3 marks)

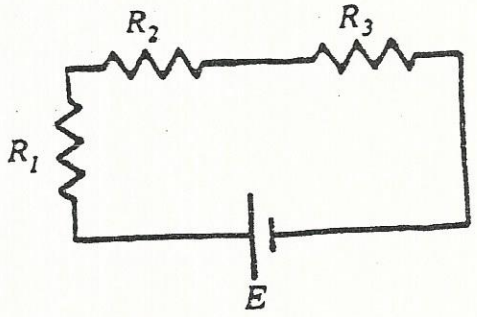
Parallel; that way when one goes out they don't all go out.

13. A child's toy operates on a power supply of 4.5 volts. Three 1.5 volt batteries are required. Should the batteries be connected in series or in parallel? Explain. (3 marks)

Series. When batteries are connected in series the emf is the sum of the individual batteries. $\mathcal{E} = 1.5V + 1.5V + 1.5V = 4.5V$

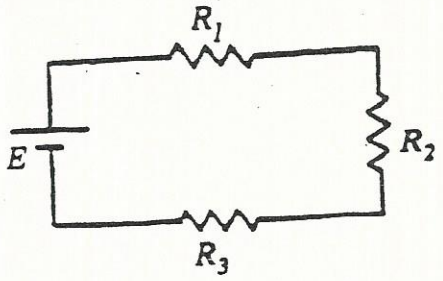
14. In the circuit diagram below, determine the value of V, the electromotive force. Your answer must include the formula or formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (4 marks)

$I = 3$ A
$R_1 = 7\ \Omega$
$R_2 = 8\ \Omega$
$R_3 = 5\ \Omega$
$V = ?$



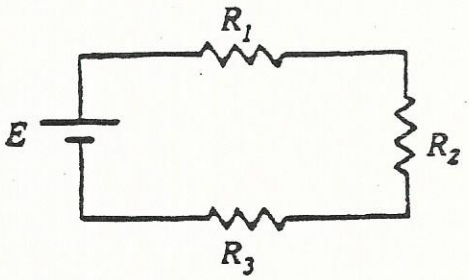
14. In the circuit diagram below, determine the value of I, the current supplied by the source. Your answer must include the formulas used and all of the calculations including a clear indication of the units of measure throughout the calculations. (4 marks)

$R_1 = 7\ \Omega$
$R_2 = 6\ \Omega$
$R_3 = 5\ \Omega$
$\varepsilon = 30\ V$
$I = ?$



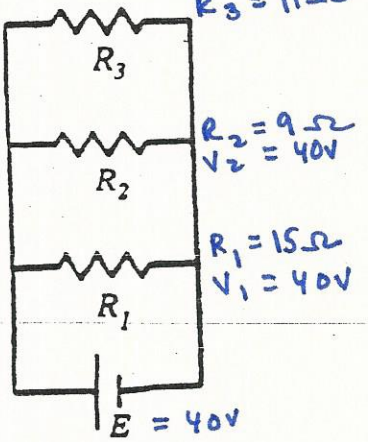
14. Determine the value of R_2 in the following diagram. Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (4 marks)

$R_1 = 7\ \Omega$
$R_2 = ?$
$R_3 = 1\ \Omega$
$\varepsilon = 60\ V$
$I = 4.5\ A$



15. In the following diagram, determine the value of I_3, the current flowing through R_3. Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (4 marks)

$R_1 = 15\ \Omega$
$R_2 = 9\ \Omega$
$R_3 = 11\ \Omega$
$\varepsilon = 40$ V
$I_t = 10.74$ A
$I_3 = ?$



$V_3 = 40V$, $R_3 = 11\Omega$

$R_2 = 9\Omega$, $V_2 = 40V$

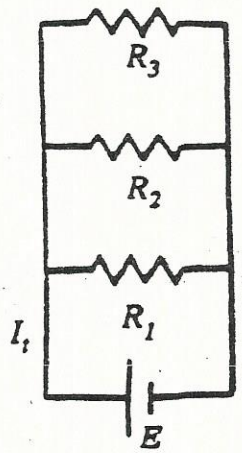
$R_1 = 15\Omega$, $V_1 = 40V$

$$I_3 = \frac{V_3}{R_3}$$

$$I_3 = \frac{40\text{ V}}{11\ \Omega} = 3.64\text{ A}$$

15. In the circuit diagram given below, determine the value of I_t, the current supplied by the source. Your answer must include the formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (4 marks)

$R_1 = 7\ \Omega$
$R_2 = 8\ \Omega$
$R_3 = 12\ \Omega$
$\varepsilon = 35$ V
$I_t = ?$



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq}} = \frac{1}{7} + \frac{1}{8} + \frac{1}{12}$$

$$\frac{1}{R_{eq}} = 0.1429 + 0.125 + 0.0833$$

$$\frac{1}{R_{eq}} = 0.3512$$

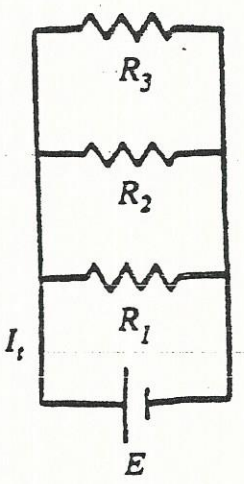
$$R_{eq} = \frac{1}{0.3512} = 2.85\ \Omega$$

$$I_T = \frac{\varepsilon}{R_{eq}} = \frac{35\text{ V}}{2.85\ \Omega} = 12.28\text{ A}$$

$\mathcal{E} = ?$

15. In the circuit diagram given below, determine the value of V, the electromotive force. Your answer must include the formula or formulas used and all of the calculations, including a clear indication of the units of measure throughout the calculations. (4 marks)

$R_1 = 4\ \Omega$
$R_2 = 5\ \Omega$
$R_3 = 2\ \Omega$
$I_t = 20$ A
$V = ?$



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{5} + \frac{1}{2}$$

$$\frac{1}{R_{eq}} = \frac{1\cdot 5}{4\cdot 5} + \frac{1\cdot 4}{5\cdot 4} + \frac{1\cdot 10}{2\cdot 10}$$

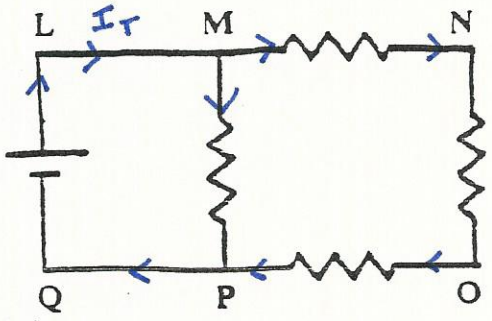
$$\frac{1}{R_{eq}} = \frac{5}{20} + \frac{4}{20} + \frac{10}{20}$$

$$\frac{1}{R_{eq}} = \frac{19}{20} \quad \therefore \quad R_{eq} = \frac{20}{19}$$

$$\mathcal{E} = I_T R_{eq} = (20\text{A})\left(\frac{20}{19}\ \Omega\right) = 21\tfrac{1}{19}\ \text{V}$$

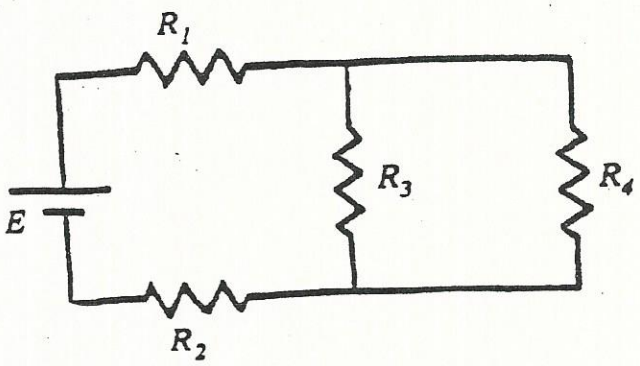
or 21.05 V

16. In which segment(s) of the following circuit is the current equal to the current in segment NO? (4 marks)



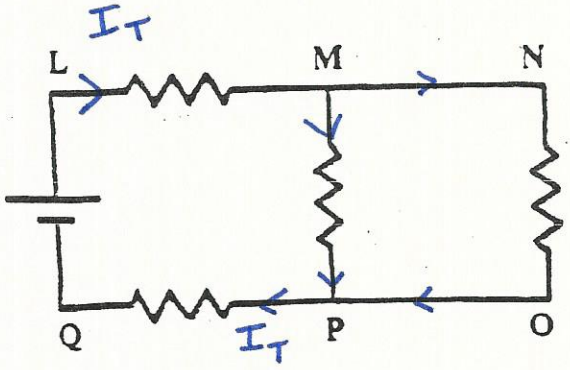
a) LM
b) MP
c) MN
d) OP
e) PQ

16. In the circuit below, which resistors have the same voltage? (4 marks)



$R_3 + R_4$ have same voltage since they're in parallel.

16. In which segment(s) of the following circuit is the current equal to that of segment PQ? (4 marks)



a) MN
b) MP
c) NO
d) OP
e) LM

17. Why should rechargeable batteries be used instead of ordinary (carbon-zinc) batteries as a way of protecting the environment? (3 marks)

With rechargeable batteries there's less waste in landfills.

17. Why is it better to use alkaline batteries instead of rechargeable batteries in a camera flash? (3 marks)

Alkaline batteries last longer between uses.

18. A heating element of an electric stove comprises two serial resistors. Depending on the setting selected, one or two resistors are used. The following data pertain to positions 1 and 3: (3 marks)

- position 1 (low) : 120V – 120W – 120 Ω
- position 3 (med) : 240V – 480W – 120 Ω

The above data show that the power produced by an element, in other words, the heat obtained, does not depend only on the resistance of the element.

Using the appropriate equations, explain why more heat is obtained from position 3, even though the resistance is the same.

18. The power output of an electric generating station is measured at 20 kilovolts. This is increased to 735 kilovolts to bring power to the users of the electric system. (3 marks)

a) What is the advantage of delivering electricity over high-voltage lines?

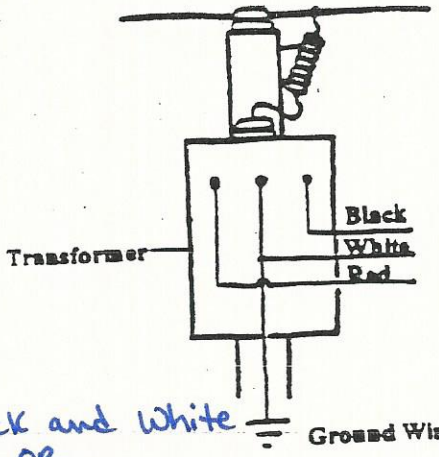
Less power lost due to the Joule Effect.

b) Explain this using the appropriate formula.

$P = VI$ ↑ power carried in line — By ↑ V, the I ↓

$P = I^2R$ ↑ power lost to Joule Effect — By ↓ I, ↓↓ Power lost due to Joule Effect.

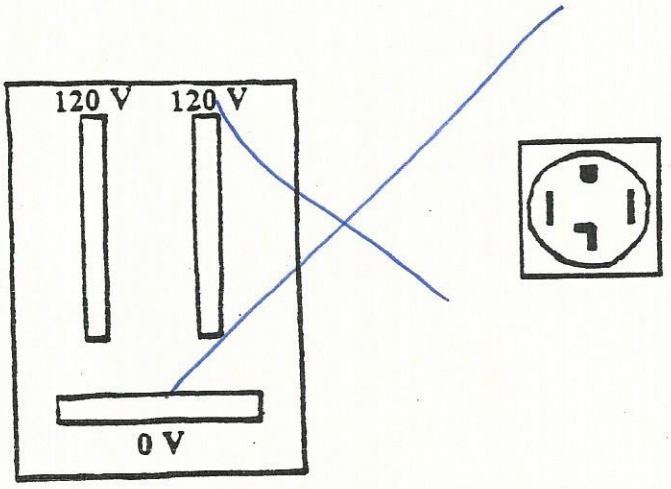
19. Refer to the diagram below. Explain all the possible connections that can be used to obtain: (3 marks)



a) 120 volts : Black and White OR Red and White

b) 240 volts : Black, Red, and White

19. Complete the connection diagram for the distribution panel with one outlet for a clothes dryer. (3 marks)

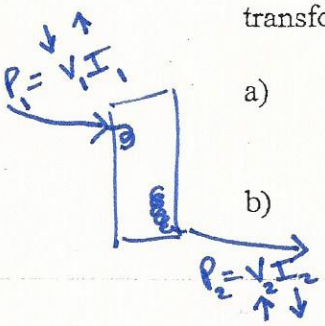


20. In more modern houses, the double outlets above the kitchen counter have two independent circuits. Give the main reason for this set-up. (3 marks)

20. A branch circuit is used to provide power to a living room comprising three outlets and a ceiling lamp. How do you explain the fact that a television plugged into one of the outlets continues to function even if the bulb in the ceiling lamp is burnt out? (3 marks)

The outlets + lamp must all be connected in parallel.

21. The power output of a generating station is measured at 30 kilovolts. A transformer is used to increase this to 500 kilovolts. (3 marks)



a) Is the transformer in question a voltage booster or a voltage reducer?

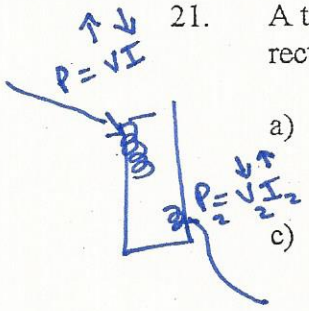
b) Is the current at the input of the transformer greater than, less than or equal to the current at the output?

Greater

c) Is the number of turns in the primary coil greater than, less than or equal to the number of turns in the secondary coil?

Less than

21. A toy operates on a 6-volt current. An adaptor consisting of a transformer and a rectifier is used when connecting it to the Hydro-Québec network. (3 marks)



a) Is the transformer in question a voltage booster or a voltage reducer?

c) Is the current at the input of the transformer greater than, less than or equal to the current at the output?

Less than

d) Is the number of turns in the primary coil greater than, less than or equal to the number of turns in the secondary coil?

Greater than

22. If you accidentally touch an electric wire, the shock always feels stronger if your hands are wet. Explain why. (3 marks)

22. Some electric appliances are equipped with three-pronged plugs, but they can also function with two-pronged plugs. However, for safety reasons, it is forbidden to cut off or bend the third prong.

(3 marks)

a) What types of appliances are equipped with three-pronged plugs?

Appliances with metal casings must have a 3-prong plug.

b) What is the role of the third prong?

The third prong is a ground. It channels excess charge into the ground so you can't get a shock.

23. The following statements pertain to electric motors and generators. (3 marks)

a) The stator is the mobile component of an electric motor.

b) A generator converts electrical energy into mechanical rotational energy.

c) In an electric motor, the mechanical rotation of a conductor coil in a magnetic field produces an electromotive force in the coil.

d) The power of a generator can be increased by increasing the number of turns of the electromagnet.

e) The rotor is the stationary part of a generator.

f) An electric motor converts electrical energy into rotational mechanical energy.

g) The power of an electric motor can be increased by reducing the voltage of the power supply.

Which of the above statements are false? A, B, C, e, g

Rewrite the false statements to make them true.

a) The stator is the stationary component of an electric motor

b) A generator converts mechanical rotational energy into electrical energy.

c) In an electric generator, the mechanical rotation of a conductor coil in a magnetic field produces an emf in the coil.

e) The stator is the stationary part of a generator.

g) The power of an electric motor can be increased by increasing the voltage of the power supply.

24. Explain briefly how an electromagnet works (3 marks)

24. Plastic wrap is often used in kitchens to keep food fresh in the refrigerator. (3 marks)

a) Explain how plastic wrap adheres to glass and plastic bowls.

Plastic wrap is charged in the factory so there are positive and negative pockets throughout. Since opposite charges attract, the plastic wrap sticks to itself.

~~b) Explain why plastic wrap does not adhere to metal containers.~~