2014 Science Olympiad Clinic

Region 7

Jan 9, 2014

Shock Value

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Event Description

- Tests knowledge of:
  - Div C: DC Electrical Circuits
- 25 to 50% of score from practical portion (hands-on tasks)
- 50 to 75% of score from theoretical portion (written questions)
- Students bring:
  - Any calculators (external probes / sensors prohibited)
  - Reference material in 3-ring binder any size
  - **Basic multimeters (optional- but recommended)**
- 2 students per team allowed
- Points awarded for correct answers or techniques

What to Include in your Binder – Div B

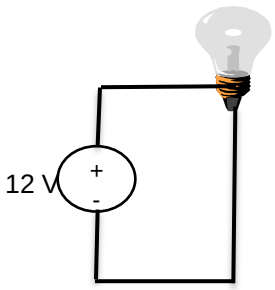
- "1 Page" Cheat Sheet – Quick reference
- Units and constants
  - M, m, k, p, n, …
  - resistivity
- Detailed sections
  - Basic DC
  - Battery
  - Types of components
  - Magnetics
  - Basic Circuits
  - History
  - ….
- Definitions

Div. B Topics

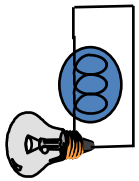
- Basic electrical DC circuit theory
  - Concepts of voltage
  - Current flow and current flow direction
  - Electrical pathways
  - Electrical units
  - Ohms law
  - Schematics
  - History

Possible types of problems

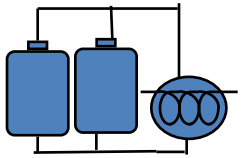
Does Current Flow?



Yes



No



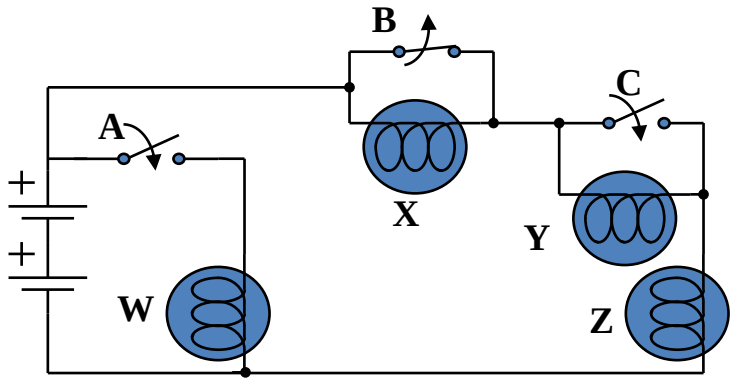
No

(i) When atoms lose or gain electrons, charged particles form called _____

(ii) Electrons can move from one atom to atom and from object to object creating a _____

(iii) A _____flow can be caused by electrons moving in a solid or ions moving in a liquid.

Basic Schematics



If you activate only switch B, which bulbs will be lit?

A – W, X,Y and Z are lit
B – X, Y and Z are lit
C - Y and Z are lit
D - Only Z are lit
E - None of the above

If you activate only switch A and switch B, which bulbs will be lit?

A – W, X,Y and Z Will Light
B – X, Y and Z will light
C - Y and Z will light
D - Only W will light
E - None of the above

History

- Named SI Units only
  - Ohm
  - Volt
  - Ampere
  - Henry
  - Coulomb
  - …. (this is not a complete list)
- Who, When, Why, What style of questions
- Related Laws

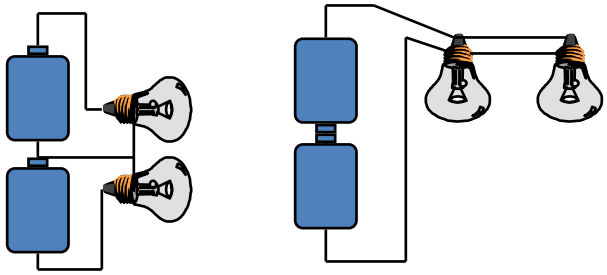
Name[3][4]	Life	Nationality	Quantity[5]	SI unit[Note 2]
André-Marie Ampère[6]	1775–1836	French	Electric current [7]	(Base unit)
William Thomson, 1st Baron Kelvin[8]	1824–1907	British (Scottish)	Thermodynamic temperature[9]	(Base unit)
Blaise Pascal[10]	1623–1662	French	Pressure[11]	pascal (Pa)
Isaac Newton[12]	1643–1727	British (English)	Force[13]	newton (N)
Anders Celsius[14]	1701–1744	Swedish	Temperature[15]	degree Celsius (°C)
Charles-Augustin de Coulomb[16]	1736–1806	French	Electric charge[17]	coulomb (C)
James Watt[18]	1736–1819	British (Scottish)	Power[19]	watt (W)
Alessandro Volta [20]	1745–1827	Italian	Electric potential[21]	volt (V)
Georg Simon Ohm[22]	1789–1855	German	Electrical resistance[23]	ohm (Ω)
Michael Faraday[24]	1791–1867	British (English)	Capacitance[25]	farad (F)
Joseph Henry[26]	1797–1878	American	Inductance[27]	henry (H)
Wilhelm Eduard Weber[28]	1804–1891	German	Magnetic flux[29]	weber (Wb)
Ernst Werner von Siemens [30]	1816–1892	German	Conductance[31]	siemens (S)
James Prescott Joule[32]	1818–1889	British (English)	Energy[33]	joule (J)
Antoine Henri Becquerel[34]	1852–1908	French	Radioactivity[35]	becquerel (Bq)
Nikola Tesla [36]	1856–1943	Serbian[Note 3]-American	Magnetic flux density[37]	tesla (T)
Heinrich Rudolf Hertz[38]	1857–1894	German	Frequency[39]	hertz (Hz)
Rolf Maximilian Sievert[40]	1896–1966	Swedish	Dose equivalent of radiation[41]	sievert (Sv)
Louis Harold Gray [42]	1905–1965	British (English)	Absorbed dose of radiation[43]	gray (Gy)
John Napier[44]	1550–1617	British (Scottish)	Magnitude (natural logarithmic) [45]	neper (Np)
Alexander Graham Bell[46]	1847–1922	British (Scottish)-American	Magnitude (common logarithmic)[47]	bel (B)
Hans Christian Ørsted	1777-1851	Danish	Magnetic field	oersted (Oe)
Johann Carl Friedrich Gauss	1777-1855	German	Magnetic flux density	gauss (G)
James Clerk Maxwell	1831-1879	British (Scottish)	Magnetic flux	maxwell (Mx)

Div. B Topics

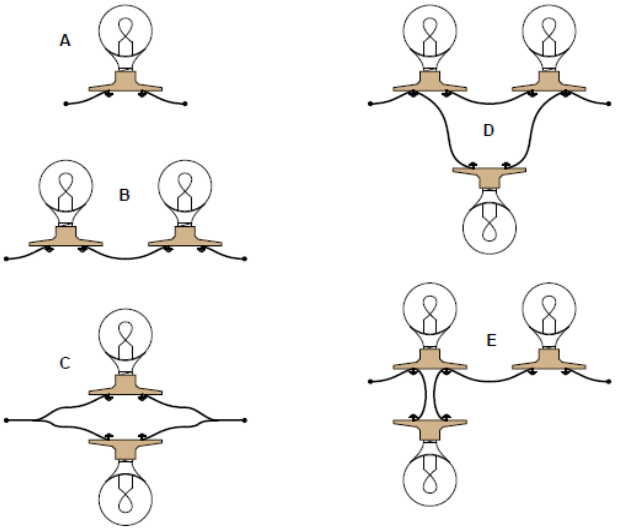
- Basic electrical device concepts
  - Battery polarity
  - Parallel versus series
  - Light bulb
  - Motor
  - Dry cell versus wet cell

Possible Types of Problems

- Battery polarity

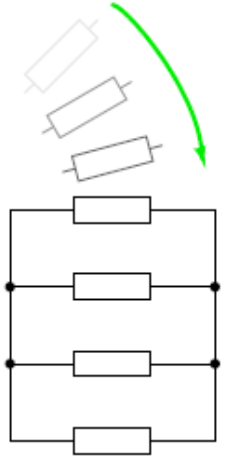


- Parallel versus series



Describe what ill happen to the total resistance and conductance when you add additional resistors in parallel

Adding successive resistors in parallel



Batteries Division B Only

- Types of batteries – Wet / Dry; Storage / Primary
- Parts of a battery – electrolyte, anode, cathode
- Terminology relating to batteries
- Construction of a battery
- Materials for batteries – lead acid, zinc air

Possible Types of Problems

Label the parts of a battery

Identify the type of battery

Multiple choice style questions

1. In a battery the positive terminal is called the:

a) anode

b) cathode

c) electrolyte

d) wire

2. What causes electrons to flow through the wire is:

a) a gravitational potential forces electrons through the wire

b) acids push the electrons through the wire

c) a potential difference between anode and cathode pushes electrons through the wire

d) electrons do not flow through the wire but through the electrolyte

3. Which statement is true about a lemon battery?

a) The energy for the battery does not come from the lemon, but rather the chemical change in zinc (or other metal)

b) The battery is made with two metallic electrodes of different metals such as a copper penny or wire and a galvanized nail.

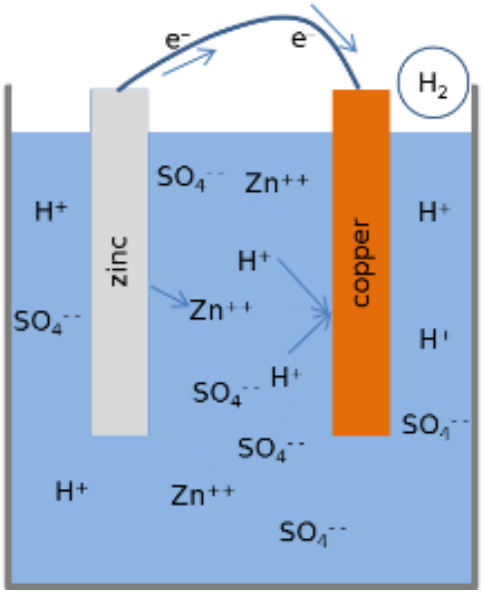
c) In a lemon battery, both oxidation (loss of electrons) and reduction (gain of electrons) occur.

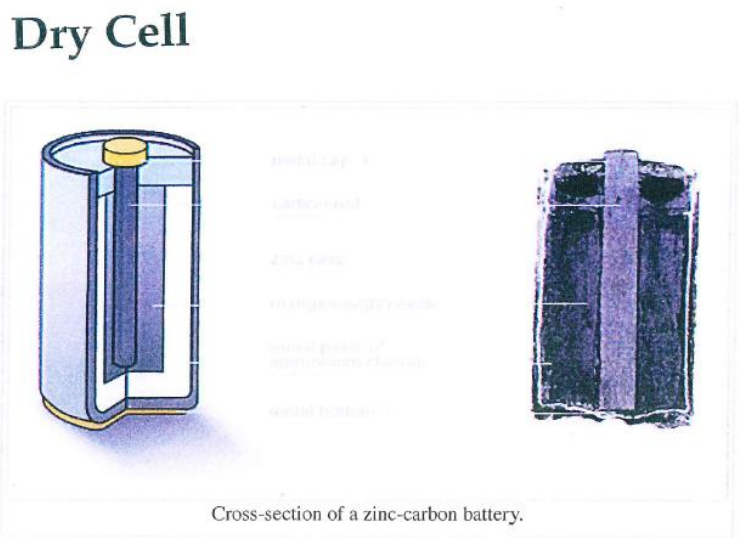
d) All of the above are correct

Batteries Division B Only

- **Wet cell**
- A *wet cell* battery has a liquid electrolyte. The wet cell battery may be required to be placed in a certain orientation to prevent the liquid form leaking out
- **Dry cell**
- A *dry cell* has the electrolyte immobilized as a paste, with only enough moisture in it to allow current to flow. Unlike a wet cell, a dry cell can operate in any orientation without spilling as it contains no free liquid, making it suitable for portable equipment

$Zn \rightarrow Zn2+ + 2e-$. $2H++ 2e- \rightarrow H2$

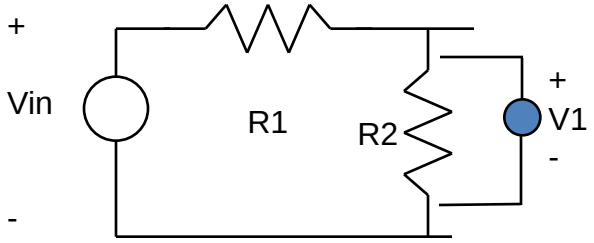




Div. B Topics

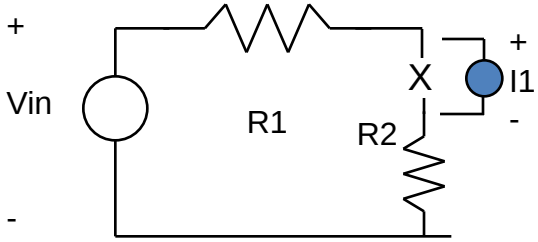
- Basic electrical circuit construction/analysis
  - Using meters
  - Switches
  - Batteries

Using Meters



Measure Voltage

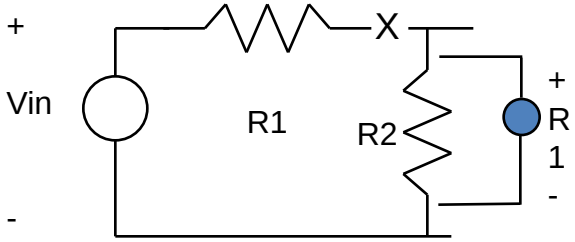
Voltage is measured across a component. Otherwise known as a voltage drop across the component. The meter is connected in parallel with the component to be measured.



Measure Current

Current is measured as a flow through a component. In order to measure current through a component, you will have to disconnect the circuit and hook the meter in series with the component to measure the current through.

Watch for Short Circuit



Measure Resistance

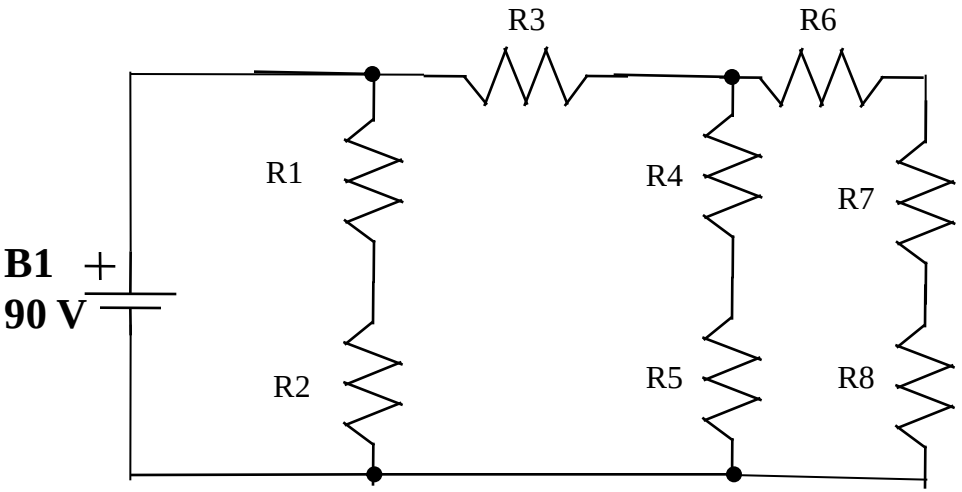
Resistance is measured across a component. The meter is connected in parallel with the component to be measured. In order to accurately measure the resistance, you should disconnect other components to prevent them from interfering with your reading.

Possible Types of Problems

- Draw and build the circuit that matches the following description:
  - 3 Batteries in series
  - Connected 3 parallel bulbs in parallel the batteries
  - Connect Switch 1 so that controls only Bulb #1
  - Connect Switch 2 so that it controls Bulb #1 and Bulb #2

- Draw the following circuits. Partial credit will be given.
  1) A series circuit consisting of a battery, switch and a light bulb.

  2) A circuit made from 6 light bulbs, 2 switches and 4 batteries. The batteries are connected to provide the most voltage to the circuit. 2 light bulbs are in series and controlled by a switch. 3 bulbs are in parallel and controlled by the other switch. The last bulb is connected such that it is always on.



Complete the below table

Resistor Number	Resistance	Voltage	Current	Power
R1	25 Ohms	**25 V**	1 Amp	**25W**
R2	**65 Ohms**	**65 V**	**1 A**	**65W**
R3	**30 Ohms**	**30 V**	1 Amp	**30W**
R4	30 Ohms	15 Volts	**0.5 A**	**7.5 W**
R5	**90 Ohms**	**45 V**	**0.5 A**	**22.5 W**
R6	**40 Ohms**	**20 V**	0.5 Amps	10 Watts
R7	40 Ohms	**20 V**	**0.5 A**	**10 W**
R8	40 Ohms	**20 V**	**0.5 A**	**10 W**
B1	XXXXXXXXX	90 Volts	**2 A**	**180W**

Start Here

R3 current splits

Start Here

Same Current in a series circuit

(1 Points per Blank)

Div. B Topics

- Basic magnetism concepts
  - Magnetic poles earth's magnetic field;
  - Magnetic vs non magnetic materials,
  - Magnetic shapes

- Basic magnetic applications
  - Use of compass
  - Operation of an electromagnet
  - Use of magnets in motors

Circle the best answer for the following questions.

Which of the following elements is a magnetic material?
1. aluminum
2. copper
3. tin
4. nickel

In a stereo system, the energy conversion of the speakers is
1. electrical energy to mechanical energy.
2. electrical energy to magnetic energy.
3. electrical energy to thermal energy.
4. electrical energy to potential energy.

Which of the following best describes an electromagnet?
1. insensitive to electrical currents
2. permanent magnet
3. temporary magnet
4. unchanging magnetic properties

North poles of magnets always attract _____ .
1. other north poles
2. negative charges
3. south poles
4. positive charges

A compass needle is
a. a fixed magnet.
b. a fixed nonmagnetic piece of metal.
c. a magnet that is free to rotate.
d. a nonmagnetic piece of metal that is free to rotate.

The interaction between two magnets is called _____ .
1. a magnetic field
2. polarity
3. current
4. magnetic force

What effect does increasing the current flowing in the wire have on an electromagnet?
1. It increases the strength of the magnetic field.
2. It causes it to become a permanent magnet.
3. It has no effect on the electromagnet.
4. It decreases the strength of the magnetic field.

Which of the following is found in all magnets?
1. a geographic pole
2. a transformer
3. an electrical field
4. a north pole and a south pole

When a bar magnet is broken into two pieces, each piece has a north and south pole because _____.
1. the magnetic fields reversed
2. every magnet is made of many aligned smaller magnets
3. bar magnets are permanent magnets
4. the magnetic poles have been isolated

The region around a magnet in which magnetic forces can act is called the
a. magnetic field.
b. domain.
c. pole.
d. solenoid.

2 Points/question

Possible Types of Problems

Make a drawing of the stack of magnets.

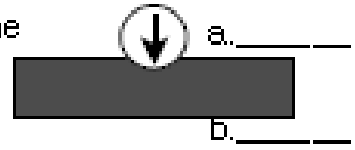
Use a compass to label the north and south pole for each of the magnets

Draw the magnetic field lines for each magnet.

- Draw at least 4 field lines per magnet
- Draw an arrow on the field lines to show the direction of the field line

13. Four compasses are placed around a bar magnetic. If the compasses have arrows that all point toward the geographic north what would be the directions of these compasses illustrated below?

14. You are given a washer magnet and a compass is placed near the magnet as shown below. Label the poles of the magnet.



Suggested References

- Websites:
  - Soinc.org Shock Value / Circuit Lab Event pages
  - Scioly.org student forums / wiki / test exchange
  - Wikipedia (Electrical Circuit, Magnetism, etc.)
  - Ibiblio (Lessons in Electric Circuits, Volumes I,V and VI)
  - Youtube (Intro to electricity, Principles of Electricity)
  - http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc
  - http://www.khanacademy.org/#Physics
- Books:
  - Science / Physics textbooks – most have chapters on this material
  - Electric Circuits, James W. Nilsson

Hands On / Fun Stuff

- Kits and parts
  - www.Sparkfun.com electronics kits, books
  - http://www.elenco.com/ electronics kits
  - http://www.kelvin.com/ Parts and kits – many subjects

- YouTube 2000 V demonstration
  - http://www.youtube.com/watch?v=8hwLHdBTQ7s&feature=youtube_gdata_player