STE Pretest 3.2

1. The force, F, between two objects with charge q_1 and q_2, is given by:

$F = \frac{k q_1 q_2}{r^2}$, where r = distance between the two charges in meters

k = Coulomb's constant = 9 X 10^9 Nm^2/C^2.

Charges of 3 X 10^{-8} C and 5 X 10^{-8} C are 200 cm apart.

How much force repels these like-charges?

Careful 200 cm = 2 m

F = 9 X 10^9 Nm^2/C^2 (5 X 10^{-8} C) (3 X 10^{-8} C) / $2^2 m^2$ = 3.4 X 10^{-6} N

2. Two spheres are attracted to each other while separated by a distance of 0.020 m. If we want the force of attraction to increase by a factor of 5, what distance in metres should separate the spheres?

Express the two forces as a ratio; k and charges cancel:
$5/1 = (1/x^2) / (1/0.020^2)$
Cross multiply:
$1/x^2 = 5/0.020^2$
Cross multiply again:
$5x^2 = .0004$
x = 0.0089 m apart

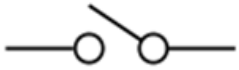
3. Draw a circuit in which two 10 Ω resistors create an equivalent resistance of 5 Ω .

(2 marks)

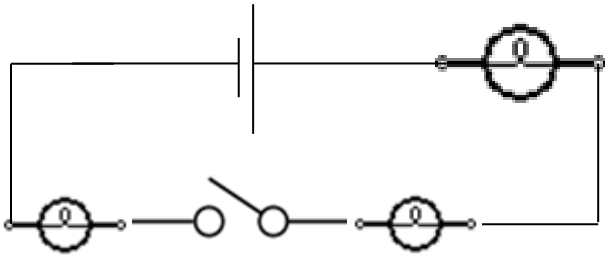
Connect them in parallel $(10^{-1}+10^{-1})^{-1} = 5\ \Omega$

4. Draw three light bulbs in a series circuit. Show that if one bulb is off, the rest will not receive current.

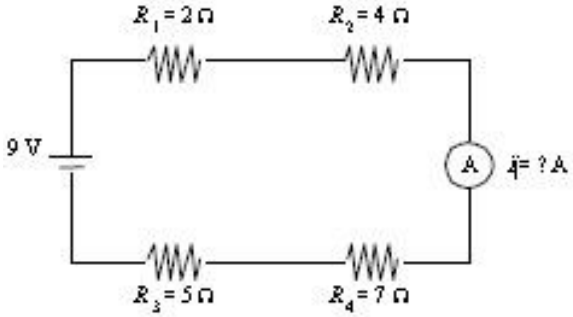
Symbol for switch in off position :



Symbol for light bulb:

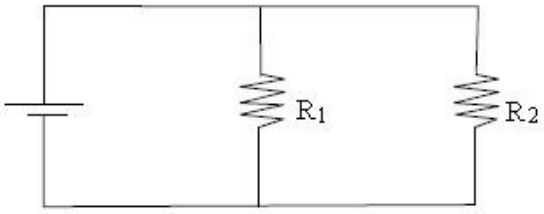


5. The circuit in the diagram at the right consists of 4 resistors whose values are 2 Ω, 4 Ω, 5 Ω and 7 Ω respectively.
What is the reading of the ammeter if the cell's voltage is 9V?



$V_T = IR_T$
$9 = I\,(2 + 4 + 5 + 7)$
$I = 0.5$ A

6. The following electric circuit consists of two resistors R_1 and R_2 and a power source. Using an ammeter, you measured the current intensity (I) through each resistor. Here are the results :



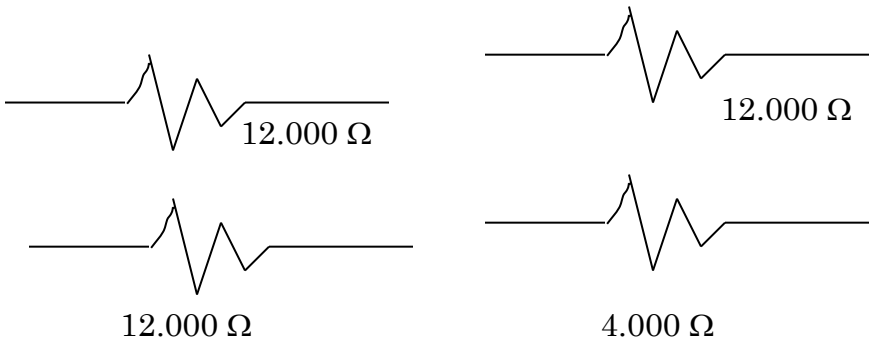
a) Given this information, what is the current provided by the power source I_s? (Find the total current)

b) Are the resistors identical?
How do you know?Show all your work.

$I_T = 0.75 + 0.75 = 1.5$ A
They each draw the same current and since they are in parallel, their voltages are also the same.

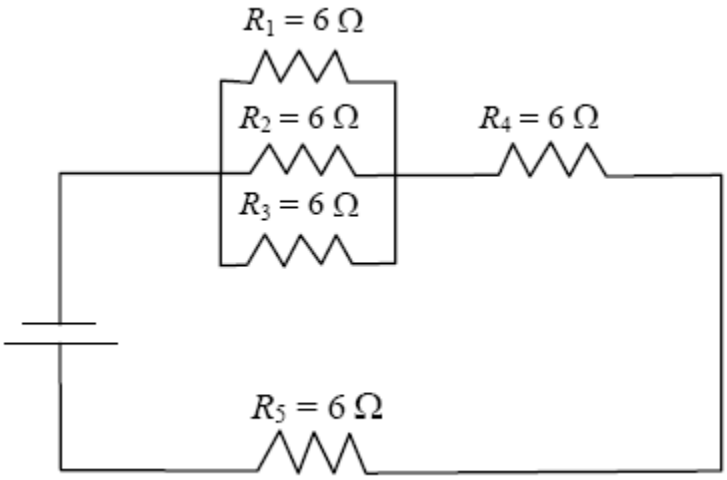
Resistor	Intensity (A)
R_1	0.75
R_2	0.75

7. Design a circuit so that its total resistance is exactly 8 Ω. You are given the following resistors and you have to use all four of them: (3 marks)



Place the three 12 Ω in parallel with each other. Then place that in series with the 4 Ω

8. Find the **total resistance** and then the **voltage of the power source** if 1A flows through each of the resistors in parallel. (3 marks)



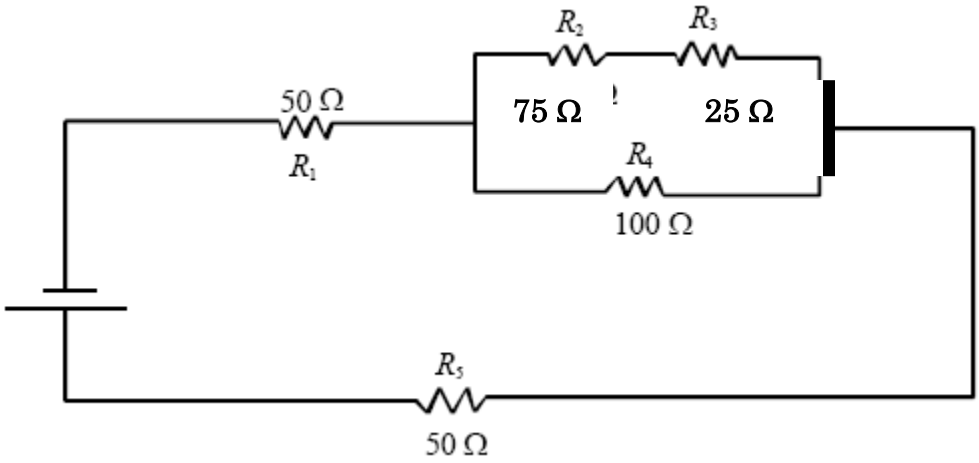
In parallel, Req = $[6^{-1}+6^{-1}+6^{-1}] = 2\ \Omega$

But it is in series with the rest, so the total resistance $=2\ \Omega + 6\Omega + 6\ \Omega = 14\ \Omega$

The total current is 1A + 1A + 1A = 3A

Vt = IR = 3(14) = 42 V

9.



If the voltage of the power source is 150 V, what is the potential difference across R_3? (3 marks)

R parallel = $[100^{-1} + (75+25)^{-1}]^{-1} = 50\ \Omega$
R total = $50\ \Omega + 50\ \Omega + 50\ \Omega = 150\ \Omega$

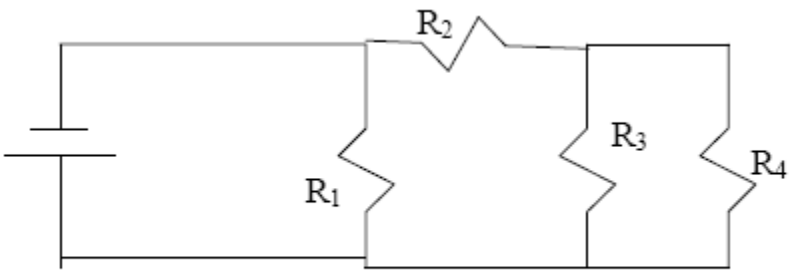
$I_T = V / R = 150 / 150 = 1$ A

But only half the current flows through R_3 because in parallel and with equal resistances(75 + 25 = 100) the current will divide equally.

$I_3 = 1\ A / 2 = 0.5$ A

$V_3 = I_3R_3 = 0.5\ (25) = 12.5$ V

10. If all four resistors are identical, what is the ammeter reading across R_3? Total current = 10.0 A



(3 marks)

R_2 will receive x amps
R_1 will receive the rest: 10 - x amps
Since R_3 and R_4 are parallel and identical they experience 0.5 R_1 of resistance

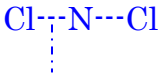
The voltage of R_1 is parallel and equal to the combined voltage of R_2, R_3 and R_4, so:

$I_1R_1 = I_2R_2 + I_2R_p$ and recall that $R_1 = R_2$ and that $Rp = 0.5\ R_1$
$(10 - x)R_1 = x\ R_1 + x(0.5\ R_1)$
Cancel R_1
$10 - x = x + 0.5\ x$
$10 = x + x + 0.5\ x$
$10 = 2.5\ x$
$x = 10 / 2.5 = 4\ A = I_2$
so R_3 will receive 4A / 2 = 2A

FLASHBACK

11. a) Use a dot structure to show what happens when chlorine reacts with nitrogen. Give a formula for the resulting compound.

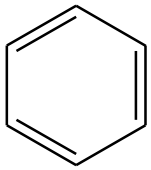
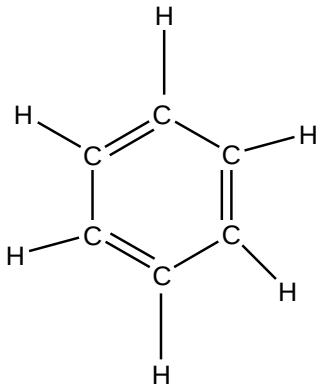
N makes 3 bonds (it has 5 valence electrons but its valence shell has room for 8)
Cl makes 1 bond (it has 7 valence electrons but its valence shell has room for 8)

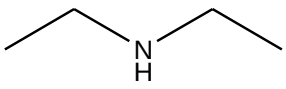


NCl_3

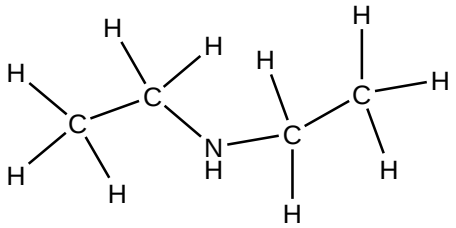
Extra

b) Use the following molecular formulas and structures as a guideline to place the atoms in their proper spots in the structural formulas (A structural formula is like a Lewis dot structure, but only the bonds are shown).

EXAMPLE	ANSWER
C_6H_6 	You know that each carbon makes 4 bonds and that there are six corners for six carbons. Hydrogens can only make 1 bond each 

c) $C_4H_{11}N$ 

Answer



12. Find the **number of moles f**or each of these ions or molecules involved in the nitrogen cycle.

a) 30 g of NO_3^-

30 g (mole/62 g) = 0.48 moles

b) 6.02 X 10^{22} ions of NO_2^- = 0.10 moles

c) The amount of N_2 that will react with 30 g of H_2 according to:

$N_2 + 3\ H_2 \rightarrow 2\ NH_3$

30 g H_2(mole/2 g)= 15 moles H_2

15 moles H_2 (1N_2 / 3 H_2) = 5 moles N_2