52 VOLTAGE, CURRENT, RESISTANCE, AND POWER

1. What is voltage, and what are its units?

2. What are some other possible terms for voltage?

3. Batteries create a potential difference.
   (A) The potential/voltage of a battery is also known as?
   (B) Its abbreviation is
   (C) Its units are

   (A)

   (B)

   (C)

4. Charge carriers
   (A) Which particles are the actual charge carriers in electricity?
   (B) Even though this is what really takes place, Physics theory is based on which particle?
   (C) Why doesn't it really matter which particle actually moves?

   (A)

   (B)

   (C)

5. Current: The amount of charge passing a point in a wire every second.

$$I = \frac{\Delta q}{\Delta t}$$

I	Current (amperes, amps, A, or C/s)
q	Charge (coulombs, C)
t	Time (seconds, s)

6. Conditions necessary for a current

7. 20 Coulombs of charge move past a point in a wire in 40 s.
   (A) Determine the current in the circuit.
   (B) Determine the number of electrons moving through that point each second.

   (A)

   (B)

8. Resistance: a value describing who difficult it is for charges to flow in a wire.

$$R = \frac{\rho \ell}{A}$$

R	Resistance (ohm's, Ω)
ρ	Resistivity (Ω•m)
ℓ	Length (meters, m)
A	Current (square meters, m^2)

9. Factors increasing resistance. List 4 ways to increase resistance.

10. Electrical devices having resistance.			
11. Unless told otherwise, assume the resistance of wires to be			
12. What is a resistor?			
13. Light Bulbs (A) What is a filament? (B) How does a light bulb work?	(A)		
	(B)		
14. Ohm's Law	$V = IR$ $\boxed{I = \frac{\Delta V}{R}}$	V	Potential, Voltage (volts, V)
		I	Current (amperes, amps, A, or C/s)
		R	Resistance (ohm's, Ω)
15. Power	$\boxed{P = I\Delta V}$ and $\boxed{P = \frac{\Delta E}{t}}$	P	Power (watts, W)
16. Common phrases substituted for the word power			
17. Combine the power equation $\boxed{P = IV}$ and Ohm's Law $\boxed{V = IR}$ to create two other equations for power			

Charges are pushed through electric circuits by the potential (voltage / pressure) of a power source, such as a battery. When circuit components, such as resistors, are connected to a battery their potential is equal to the potential created by the battery.

18. A 3 Ω resistor is connected to a battery producing 6 V. (A) Determine the current in the circuit. (B) Determine the power in the circuit.	(A)	(B)

53 KIRCHHOFF'S LAWS

19. Visualizing circuits
    (A) Batteries can be thought of as charge escalators. What do they do to potential in a circuit?
    (B) What must all the components do to potential so that energy is conserved?

(A)

(B)

20. How can you identify a
    (A) series circuit?
    (B) parallel circuit?

(A) Series

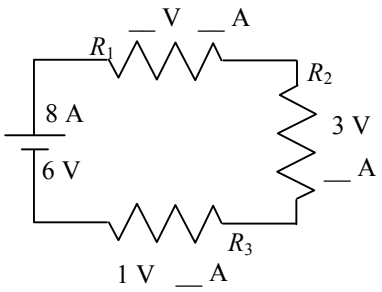
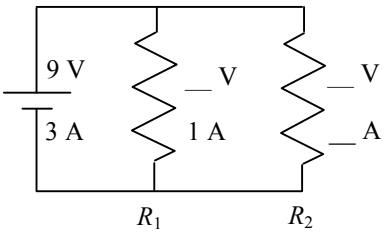
(B) Parallel

21. Kirchhoff's Rules
    (A) Loop Rule
    (B) Junction Rule

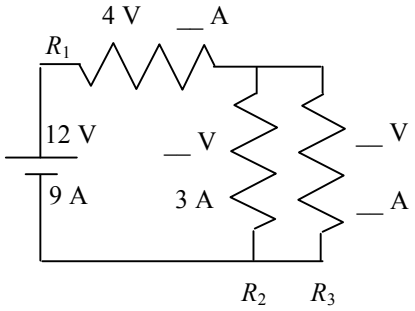
(A) Loop Rule

(B) Junction Rule

22. Analyzing potential and current in the two types of circuits.
    (A) Use loop rule to find the missing voltages in the two circuits at the right.
    (B) Use junction rule to find the missing currents in the two circuits at the right.
    (C) What overall patterns regarding current and potential are seen?

Series	Parallel
	
In series current…	In parallel current…
In series voltage…	In parallel voltage…

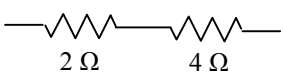
23. Apply the rules to solve for current and potential in the hybrid circuit shown.



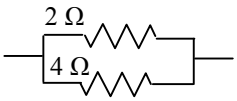
24. Circuit Rule Summary	Series	Parallel
Current		
Voltage		
Resistance	$\boxed{R_S = \sum_i R_i}$	$\boxed{\frac{1}{R_P} = \sum_i \frac{1}{R_i}}$

25. Equivalent resistance:

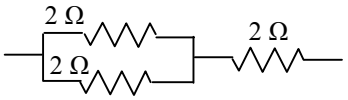
(A)



(B)



(C)

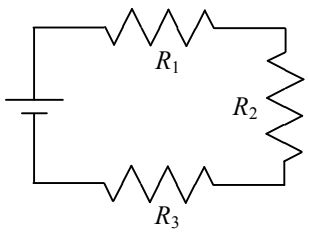


26. Loop Rule, Potential, and Conservation of Energy

27. Junction Rule, Current, and Conservation of Charge

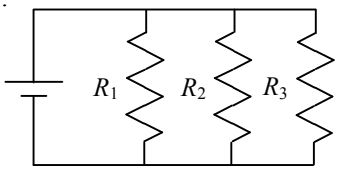
54 RESISTOR CIRCUITS

28.



	V	I	R	P
$\mathcal{E}$	12			
R_1			1	
R_2			2	
R_3			3	

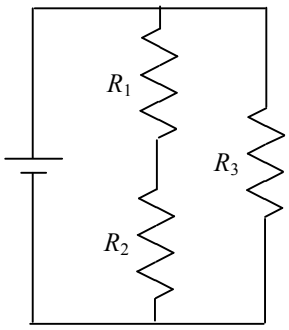
29.



	V	I	R	P
$\mathcal{E}$	12			
R_1			1	
R_2			2	
R_3			3	

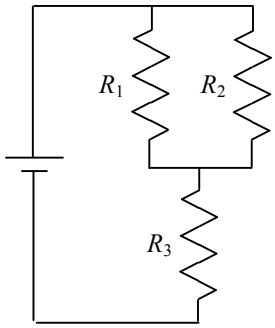
30. Compare the series and parallel circuits in the two problems above.	Series	Parallel
(A) Resistance: Which circuit has the highest resistance, and which has the lowest?		
(B) Current: Which circuit has the highest current, and which has the lowest?		
(C) Power: Which circuit uses the highest power, and which uses the lowest?		
(D) Brightness of light: If the resistors were light bulbs, which would be brightest?		

31.



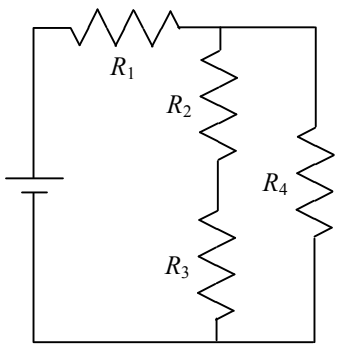
	V	I	R	P
ε	6			
R_1			2	
R_2			2	
R_3			2	

32.



	V	I	R	P
ε	6			
R_1			2	
R_2			2	
R_3			2	

33.



In the circuit shown above the emf of the battery is 12 V. The resistances of the resistors are: $R_1 = 2\ \Omega$, $R_2 = 3\ \Omega$, $R_3 = 3\ \Omega$, and $R_4 = 3\ \Omega$.

(A) Determine the total resistance.

(B) Determine the total current.

(C) Determine the power consumed by resistor 1.

(D) The resistors are acually light bulbs. Rank the brightness of the bulbs.

(E) Bulb 4 burns out.

(F) State if the remaining bulbs get brighter or dimmer.

Use this space for the table.

(A)

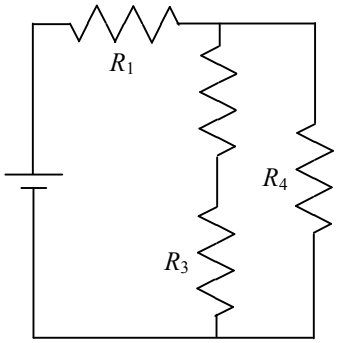
(B)

(C)

(D)

(E)

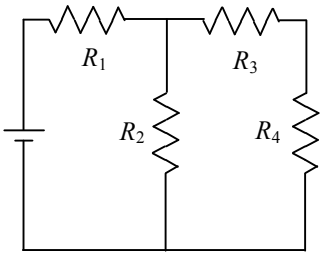
34.	Ammeter	Voltmeter
(A) What do they measure?		
(B) How are they positioned?		
(C) Why?		
(D) To be ideal, what does their resistance need to be?		



(E) Show the position of an ammeter and voltmeter to measure the current through and voltage drop across R_4.

35. Compare the circuits shown below.

36.



In the circuit shown above the emf of the battery is 12 V. The resistances of the resistors are: $R_1 = 3\ \Omega$, $R_2 = 6\ \Omega$, $R_3 = 2\ \Omega$, and $R_4 = 4\ \Omega$.

(A) Determine the total resistance.

(B) Determine the total current.

(C) Add an ammeter and voltmeter to the circuit diagram above in order to measure the current and voltage of resitor 1.

(D) Determine the power consumed by resistor 1.

(E) The resistors are acually light bulbs. Rank the brightness of the bulbs.

Use this space for the table.

(A)

(B)

(D)

(E)

37. Circuit design

38. Circuit design

55 REAL BATTERIES, HOME WIRING, AND LIGHT BULBS

39. Terminal voltage

$V = \mathcal{E} - Ir$

- V Potential (V)
- $\mathcal{E}$ emf (V)
- I Current (A)
- r Internal resistance (Ω)

40. Real batteries are made of conducting material and therefore have resistance. The resistance inside a battery is known as internal resistance. Draw the sketch of a real battery shown in class.

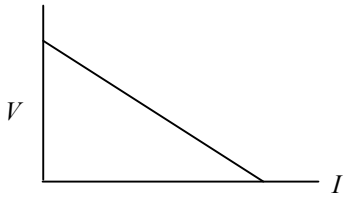
41. A battery has an emf of 6.0 V and an internal resistance of 0.10 Ω. Determine the terminal voltage if 2.0 A of current runs through the battery.

42. <u>Typically internal resistance is negligible in our problems.</u>

How does this change $V = \mathcal{E} - Ir$?

If internal resistance is negligible

43.



(A) Rearrange the equation $V = \mathcal{E} - Ir$ to match the axis of the graph above and the equation of a line, $y = mx + b$.

(B) The slope of the graph is…

(C) The y-intercept…

(A)

(B)

(C)

44. Household wiring

(A) How is your home wired?

(B) Why?

(C) In this type of circuit as you turn more electrical appliances, what happens to total resistance?

(D) What happens to total current and power?

(E) What happens to the temperature of the wires?

(F) How do you protect against fire?

(G) How is the device that protects the circuit wired into the circuit

(A)

(B)

(C)

(D)

(E)

(F)

(G)

45. Light bulbs are labeled with their wattage
    (A) Light bulbs are also labeled 120 V. Under what circumstances does a 60 W bulb use 60 W.
    (B) Wattage is not really fixed for a light. What quantity is fixed in light bulbs?

(A)

(B)

46. Complete the circuit tables below for a 120 W and 240 W bulb that are put into three different circuits.

A USA parallel 120 V circuit					Wired into a series circuit at 120 V					A European parallel 240 V circuit				
	V	*I*	*R*	*P*		*V*	*I*	*R*	*P*		*V*	*I*	*R*	*P*
$\mathcal{E}$	120				$\mathcal{E}$	120				$\mathcal{E}$	240			
L_1				120	L_1					L_1				
L_2				240	L_2					L_2				

Wattage in a US parallel circuit lets you calculate the resistance of each light. Resistance is actually the constant quantity.