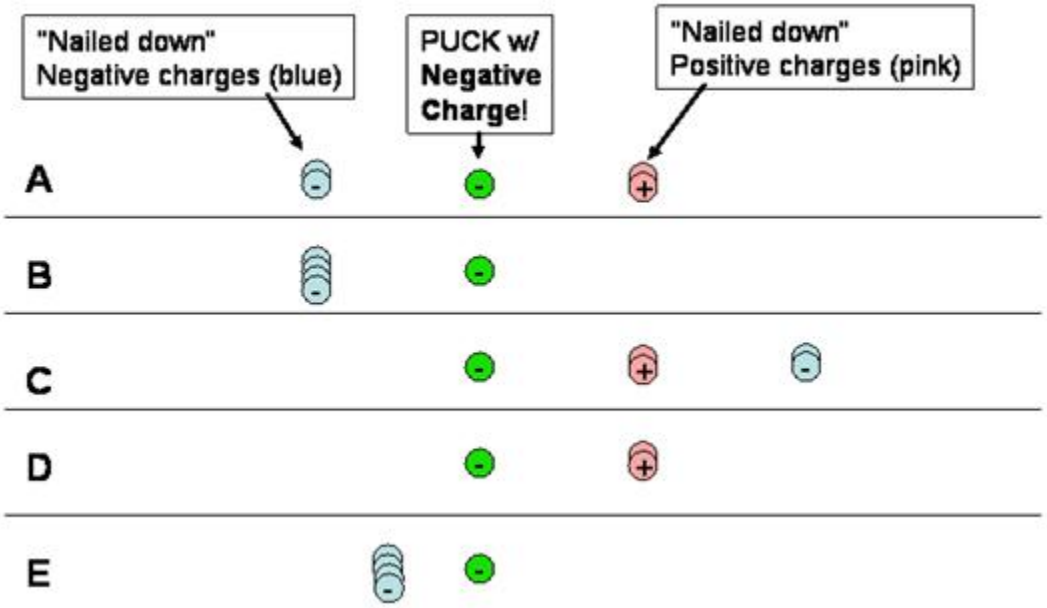
Physics 1010 Homework 9 (21+ points)

Due Mon 11/12 at midnight

1.) (2pts) **HW 8 Correction.** Each week you should review both your answers and the answer key for the previous week's homework. Often (including this week) you will get to submit one homework correction. Select one problem for which you had the wrong answer. In the text box below, 1) identify the question number you are correcting, 2) state (copy) your original wrong answer, 3) explain where your original reasoning was incorrect, the correct reasoning for the problem, and how it leads to the right answer. If you got all the answers correct!!! bling bling... state which was your favorite / most useful homework problem, and why.

Questions 2-5: Consider the following 5 arrangements of charges. It may help to use the Electric Field Hockey Simulation (http://phet.colorado.edu/en/simulation/electric-hockey) to consider these arrangements, **but notice that here the puck has a negative charge (!) You can CHANGE the charge on the puck in the simulation by checking the box at the bottom**. When thinking about these arrangements, you should be sure you understand how Coulomb's Law works to tell you how the force the puck feels under each of the circumstances will differ.



Consider the following statements about these configurations.

2.) (0.5pt) True / False: All of the pucks feel a force to the right.

3.) (0.5pt) True / False: The puck in C feels a greater force to the right than the puck in D.

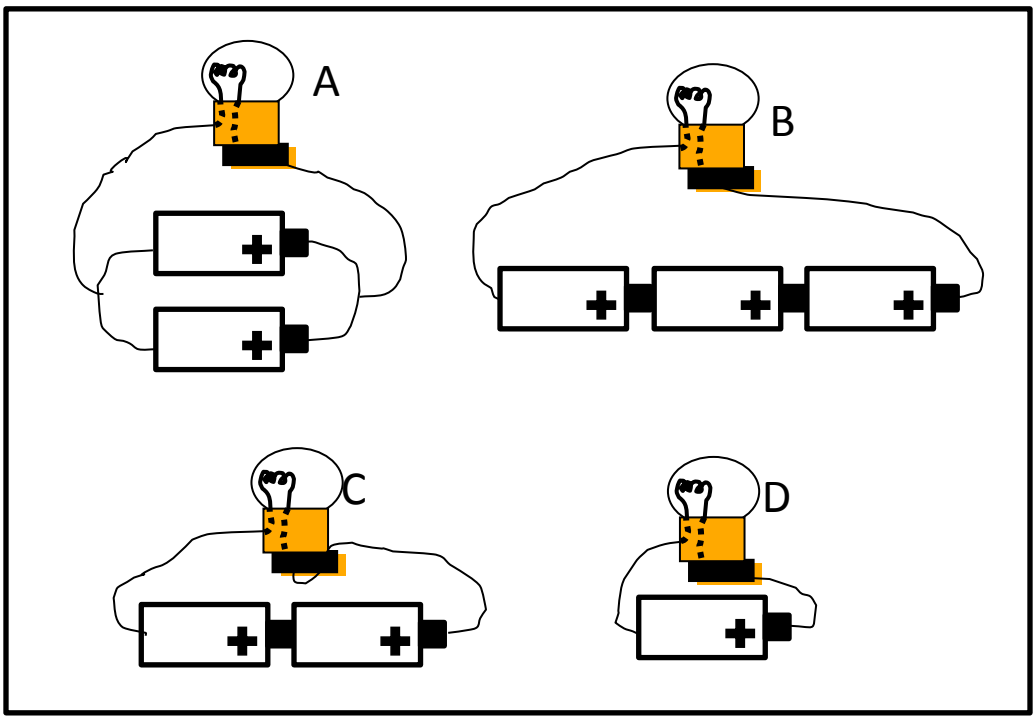
4.) (0.5pt) True / False: The puck in E feels a force to the right that is four times greater than that felt by the puck in B.

5.) (0.5pt) True / False: The net force on the puck in A is zero.

For this homework there are a number of simulations that will be valuable in helping you think about circuits, power, electron flow, current, and voltage. The simulations include:
#1: The Circuit Construction Kit (CCK) (http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc) which allows you to build any circuit, change the battery voltage, change the resistance values, measure voltage differences across any part of the circuit, or measure the current flowing through any part of the circuit. USE this simulation to check your reasoning and answers to many of the homework questions.
#2: The Battery-Resistor Circuit Simulation (http://phet.colorado.edu/en/simulation/battery-resistor-circuit) which shows what the electrons are doing inside a filament to heat up the filament.

Questions 6-26 refer to the figure below.

You are looking to purchase a new bike light and are considering the various models available. You are concerned about properties such as brightness and how long the rechargeable batteries will last. Below are some configurations for different lights. All the batteries are 6V batteries and all the bulbs are identical (have the same resistance). You can assume that the resistance of the connecting wires is zero.



6.) (0.5pt) The light bulb will turn on in which of the cases – select **ALL** that apply:
a) A
b) B
c) C
d) D

7.) (1pt) Which circuit(s) produces the brightest bulb(s) – select **ALL** that apply:

a) A
b) B
c) C
d) D

8.) (0.5pt) In which circuit will the bulb stay at a constant brightness for longest – select ALL that apply:

a) A
b) B
c) C
d) D

9.) (1pt) Which bulbs are the same brightness – select ALL that apply:

a) A
b) B
c) C
d) D

The voltage difference across the light bulb is an important factor in determining the brightness of the bulb. In case D, the voltage difference is 6 V since the light bulb is simply connected across one battery. (Again, ignore resistance of the wires.)

What is the voltage difference across the light bulb in the other cases?

10.) (0.5pt) Case C?

a) 0V
b) 6V
c) 12V
d) 18V
e) Can't be determined from information given

11.) (0.5pt) Case B?

a) 0V
b) 6V
c) 12V
d) 18V
e) Can't be determined from information given

12.) (0.5pt) Case A?

a) 0V
b) 6V
c) 12V
d) 18V
e) Can't be determined from information given

13.) (0.5pt) Consider circuit C. If the bulb has a resistance of 15 Ohms, what is the current flowing in the circuit?

a) 0.5 A
b) 0 A
c) 0.8 A
d) 15 A
e) 1.25 A

14.) (0.5pt) How much electrical power is being used in the bulb in circuit C?

a) 9.6 W
b) 0.8 W
c) 180 W
d) 0 W
e) 12 W

15.) (0.5pt) How much electrical power is being produced by the batteries in circuit C? (The power produced by both batteries total, not the power produced by each individually.)

a) 12 W
b) 0W
c) 0.8 W
d) 180 W
e) 9.6 W

16.) (1pt) Roughly how many watts of visible light is the bulb in circuit C producing? Explain your answer. [HINT: does all the power go into visible light (remember from last week)?!?!?]

17.) (0.5pt) We replace the bulb in circuit C with a different bulb. We notice that the current is now 0.5A. What is the resistance of this bulb?

a) 6 Ohms
b) 12 Ohms
c) 18 Ohms
d) 0.5 Ohms
e) 24 Ohms

18.) (0.5pt) How does the brightness of the new bulb in Question 17 compare to the brightness of the original bulb in circuit C?

a) Brighter
b) Less bright
c) Same brightness
d) Can't tell without more information

19.) (0.5pt) In which direction will electrons flow in circuit C?

a) Clockwise
b) Counterclockwise

20.) (0.5pt) In which direction will electrons flow in circuit A?

a) Clockwise
b) Counterclockwise
c) Can't determine because different directions in different parts of the circuit

21.) (1pt) Battery capacity is measured in Amp-hours. It describes how long a battery can maintain a current of so many Amps, while maintaining a constant voltage. For example: a 4 amp-hour battery can output a current of 1 amp for 4 hours, or 2 amps for 2 hours, or 4 amps for 1 hour etc. before the voltage begins to drop and the battery runs flat.

Consider circuit D. If the battery has a capacity of 3 amp-hours, how long will this bulb remain at a constant brightness? Show all your work. (The resistance of the bulb is 15 Ohms.)

22.) (0.5pt) What is the power output of the battery while the bulb is at constant brightness in circuit D?

a) 0.4 W
b) 2.4 W
c) 90 W
d) 0.16 W
e) 4.8 W

23.) (0.5pt) What is the total energy output of the battery in circuit D, if you start with a fresh battery and let the circuit run until the voltage begins to drop?

a) 1080 J
b) 18 J
c) 64800 J
d) 0.005 J
e) 1152 J

The more energy per second that goes into heating the filament, the hotter the filament and the brighter the light. Power is our measure for the energy per second. Let's take a look at the differences that affect the amount of power that goes into heating the filament in Case D and Case B.

24.) (0.5pt) The number of electrons per second flowing through the bulb in Case B is …… the number flowing through the bulb in Case D.

a) one ninth of
b) one third of
c) the same as
d) three times

25.) (0.5pt) The amount of electric potential energy that each electron releases as it makes its way through the wire and the bulb back to the other end of the battery in Case B is …… the amount of energy that an electron releases in Case D.

a) one ninth of
b) one third of
c) the same as
d) three times
e) nine times

26.) (0.5pt) The amount of power (energy per second) that goes into heating the filament in Case B is …… the amount of power in Case D.

a) one ninth of
b) one third of
c) the same as
d) three times
e) nine times

In questions 27-32 we considered how the configuration of batteries affects flashlights. In this problem, we will use the Battery-Resistor Circuit Simulation (which you can access online at http://www.colorado.edu/physics/phys1010/) to help us better understand what conditions make the filament brighter.

27.) (2pts) What is going on inside the filament to make it hot? Include all the energy exchanges that occur in the battery and circuit.

Consider circuit D in the diagram of Question 6. You replace the 15 ohm bulb with a bulb that has a resistance of 30 ohms. Questions 28-32 compare this new bulb circuit with the old one.

28.) (0.5pt) The temperature of the filament will:
a) Decrease
b) Increase
c) Stay the same

29.) (0.5pt) The brightness of the bulb will:
a) Decrease
b) Increase
c) Stay the same

30.) (0.5pt) The current through the bulb will:
a) Decrease
b) Increase
c) Stay the same

31.) (0.5pt) The amount of electrostatic potential energy that each electron releases as it travels through the circuit will:
a) Decrease
b) Increase
c) Stay the same

32.) (0.5pt) The power that goes into heating the light bulb and producing light will be …… the power that went into heating the bulb when the resistance was 15 ohms.
a) one quarter of
b) one half of
c) the same as
d) two times
e) four times

BONUS: Home experiment with a flashlight (regular, <u>not</u> LED) or with the CCK simulation in a pinch:
- try to flip the battery order in your flashlight
- you might not be able to complete the circuit, so be clever and use a paper clip if needed…
    - Does it matter which order they are in if they are all facing the same direction?
    - What if you flip the direction – does the order matter now?
    - What if you flip some of the batteries in direction and not others?
    - Can you distinguish between not lighting and being dim?