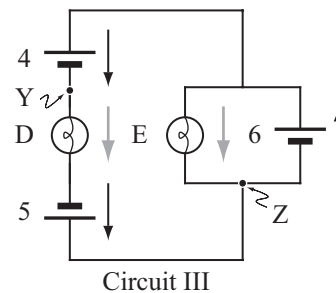
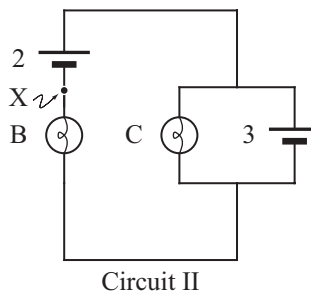
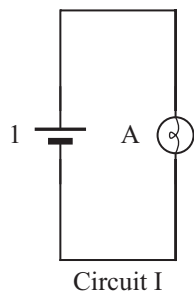


Name _____
last first

Student ID _____

Score _____

IV. [20 pts total] In the circuits shown at right, all bulbs are identical, and all batteries are identical and ideal.



- A. [3 pts] Rank the batteries according to *absolute value of the potential difference across each battery*, from largest to smallest. Explain.

Because all batteries are assumed ideal and identical, the absolute value of the potential differences across all batteries are the same.

- B. [5 pts] Is the brightness of bulb B *greater than*, **less than**, or *equal to* the brightness of bulb A? Explain. If either bulb does not light, state so explicitly.

*Consider the (clockwise) loop starting at point X, containing battery 2, battery 3, and bulb B. Battery 2 provides a potential gain and battery 3 provides a potential drop of the same magnitude. For the sum of the potential differences around the loop to be zero, the potential difference across bulb B must be zero. This means **bulb B does not light**, whereas bulb A does because battery 1 sets a non-zero potential difference across it. Therefore the brightness of bulb B is **less than** that of bulb A.*

- C. [5 pts] Is the brightness of bulb D *greater than*, *less than*, or **equal to** the brightness of bulb A? Explain. If bulb D does not light, state so explicitly.

*As above, battery 1 sets a potential difference across bulb A equal to that of one battery. Consider the (clockwise) loop starting at point Y, containing batteries 4, 6, and 5, and bulb D. Battery 4 provides a potential gain, while batteries 5 and 6 each provide a potential drop of the same magnitude. Thus from the bottom of bulb D to the top, there must be a gain in potential equal to that of one battery to make the sum of the potential differences zero. Since brightness is an indicator of potential difference across a bulb, the ranking by the brightness is the same as by potential difference. Thus the brightness of bulb D is **equal to** that of bulb A.*

- D. [4 pts] On the diagram for *circuit III* above, indicate the direction of the current through each of the batteries. Explain.

Current flows through a bulb from high potential to low. In the answer to part B, it was determined that the top of bulb D is at a higher potential than the bottom, so the current must flow down through bulb D. Series elements have the same current flowing through them, so the current through batteries 4 and 5 are also down. Battery 6 sets the top of bulb E at a higher potential than the bottom, so the current through bulb E is also down. Considering the junction at point Z, the current flows into the junction from battery 5 and bulb E, meaning the current through battery 6 is up.

- E. [3 pts] Is the current through battery 6 **greater than**, *less than*, or *equal to* the current through battery 5? Explain.

*Applying the results from part D to the junction at point Z, the current through battery 5 equals the current through battery 5 plus that through bulb E. Thus, the current through battery 6 is **greater than** the current through battery 5.*