Name:

Physics 11
M. Lam

Brightness Simulation

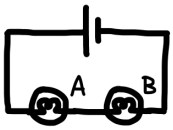
Block:

Objective
Investigate the brightness of identical lightbulbs in different circuits

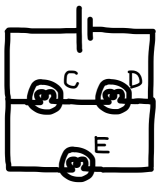
Website: https://phet.colorado.edu
Simulations > Physics > Electricity, Magnets & Circuits > Circuit Construction Kit: DC

Each of the circuits below is constructed with identical ideal batteries and identical lightbulbs.

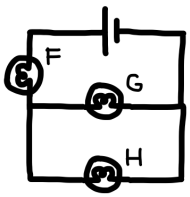
Circuit I



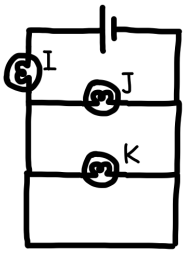
Circuit II



Circuit III



Circuit IV



1. For each circuit, predict the ordering of the bulbs from dimmest to brightest. Indicate bulbs of equal brightness with an equals sign.
    a) Circuit I

    b) Circuit II

    c) Circuit III

    d) Circuit IV

2. Construct each circuit. Were your predictions correct?

3. Provide an explanation for your findings.
    a) Circuit I
    $R_A = R_B$ and $V_A = V_B$
    so $P_A = P_B$

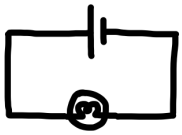
    b) Circuit II
    $R_C = R_D = R_E$ and $V_C = V_D = 1/2\ V_E$
    so $P_E > P_C = P_D$

c) Circuit III
$R_F = R_G = R_H$ and $I_G = I_H = 1/2\ I_F$
so $P_F > P_G = P_H$

d) Circuit IV
$I_I \neq 0$ and $I_J = I_K = 0$
so $P_I > P_J = P_K$

4. Rank all the bulbs (A-K) from dimmest to brightest. Indicate bulbs of equal brightness with an equals sign.
$P_J = P_K < P_G = P_H < P_A = P_B = P_C = P_D < P_F < P_E = P_I$

5. If the following bulb, identical to all the others, has a brightness of P, determine the brightness of all the bulbs (A-K) in terms of P. Show your work.



$P = V_T^2/R$ (express P in terms of V_T and R which are the same for all circuits)

$V_A = V_B = 1/2\ V_T$
$\mathbf{P_A = P_B = 1/4\ P}$

$V_C = V_D = 1/2\ V_T$ and $V_E = V_T$
$\mathbf{P_C = P_D = 1/4\ P}$ and $\mathbf{P_E = P}$

$R_{eq} = 1/2\ R$
$R_T = 3/2\ R$
$I_T = 2/3\ V_T/R$
$I_F = 2/3\ V_T/R$ and $I_G = I_H = 1/3\ V_T/R$
$V_F = 2/3\ V_T$ and $V_G = V_H = 1/3\ V_T$
$\mathbf{P_F = 4/9\ P}$ and $\mathbf{P_G = P_H = 1/9\ P}$

$V_I = V_T$ and $I_J = I_K = 0$
$\mathbf{P_I = P}$ and $\mathbf{P_J = P_K = 0}$