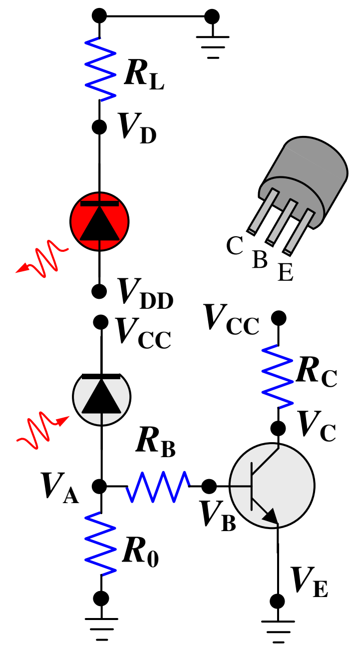
Name: ______________________________
Partner: ______________________________



Purpose: Build and examine the properties of a transistor-amplified analog light detector. We'll shine an LED directly into a photodiode to see how bright it is. The direction shown for the photo-diode is correct; current normally runs through it backwards. Note that the flat edge of the plastic cylinder of the photodiode is connected to V_{CC}.

The output of this circuit is "V_C". It is our intention for this analog output to range from 5V to 0V as the light changes from "dark" to "bright". However, "bright" and "dark" are relative. This circuit is more sensitive to inputs that I would call "bright". If you want V_C to more accurately distinguish between inputs that are "dark", you would use a larger R_C.

You may use a multimeter to measure voltage, resistance, and two nominal diode voltages (but not current). Whenever $V < 1$V, then change the setting of the multimeter to "mV". Also, note that measurement V_{AB} is not made with respect to ground!

The transistor might be in one of three states: "off", "on", or "saturated". When there is current into the base of the transistor, it is "on" or "saturated", and we expect that V_{BE} will be a constant of about 0.65 V. So, if you measure V_{BE} and it is significantly less that that, the transistor is "off". On the other hand, the transistor is "saturated" when it can't provide enough $I_C = \beta I_B$. When this happens, V_{CE} will be less than about 0.25 V.

Component Values		
Property	**Nominal Value**	**Actual Value**
V_{CC}	5 V	V
R_B	10 kΩ	kΩ
R_C	150 Ω	Ω
R_0	1.8 MΩ	MΩ
$V_{BE\ init}$	0.65 V	V
R_L	100 Ω	Ω
$V_{Diode\ init}$	1.65 V	V

To vary the brightness, we will adjust V_{DD}. To limit environmental effects, use the black plastic LED/photodiode holder. This will generate our primary independent variable, which is the power through the LED. To protect the LED, do not allow V_{DD} to exceed 5V!

V_{DD}	V_D	V_{AB}	V_{BE}	V_{CE}	I_{LED} (mA)	ΔV_{LED}	P_{LED} (mW)	I_B (mA)	I_C (mA)	State	β
0.0 V											
2.0 V											
2.5 V											
3.0 V											
3.5 V											
4.0 V											
4.5 V											
5.0 V											

Instructions for Measurement and Analysis

You measure the first four columns directly, and compute the last seven. For state, write "on", "off", or "sat". Compute β even when it doesn't make sense to do so. Before doing the lab, directly examine the output of the LED by eye while varying V_{DD} from 0 to 5V. This will give you a feeling for what "bright" and "dark" mean in the context of this experiment. Do not exceed 5 V! Do not aim the LED directly into your eye; it can be painfully bright!

Post-Analysis Questions:

1. What seems to be the most likely value for β? Explain your choice.

2. Discuss any cases where it was not perfectly clear whether the state was "on", "off", or "sat". "Discussing" is not the same as "listing".

3. What would be the impact of choosing a different value of either R_B or R_0? Your answer should only address how the changes would affect the primary output (V_C).

4. Since you figured out in the previous question that the value for R_B does not have a significant impact on V_C, and that generally smaller is better, what negative consequences might arise if we simply replaced R_B with a wire?

5. You may have noticed in the table that the input range for V_{DD} is not exactly linear. Why did we skip V_{DD} = 0.5, 1.0, and 1.5?