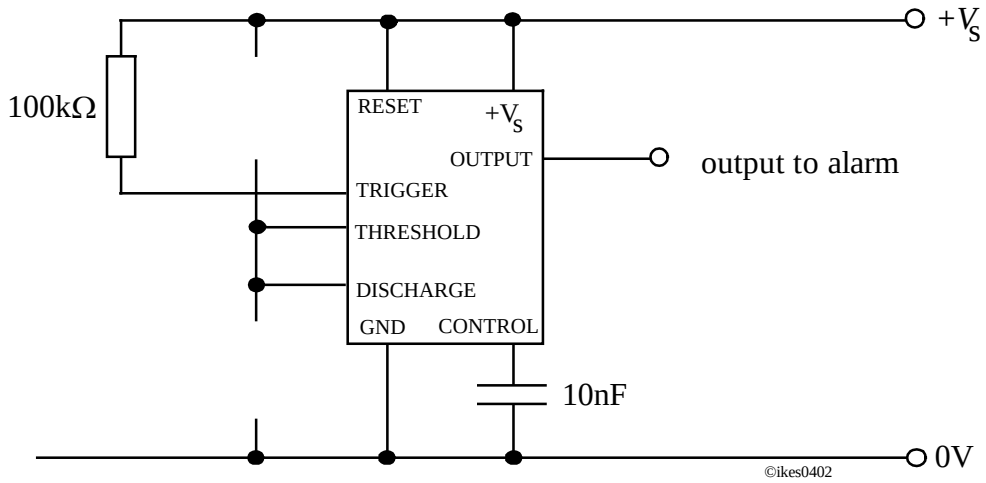
555 timer revision.

1). In order to cook eggs so that they are neither too soft or too hard, a timer is required that will sound an alarm after a period of three minutes. The timer is based on a 555 timer monostable circuit which is partly drawn in the diagram below.



(a) Add to the circuit diagram a resistor and a capacitor to complete the circuit diagram for the monostable circuit.

(2)

(b) Mark onto the circuit diagram where a push switch should be connected to set the monostable circuit timing.

(1)

(c) Describe, in detail, how a 555 timer monostable circuit operates.

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(5)

(d) The period of the monostable is to be three minutes.

(i) How many seconds are there in three minutes?

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(1)

(ii) The timing capacitor used has a value of 100μF. Calculate the value of the timing resistor needed.

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(2)

(iii) Explain which value resistor would you use from the E24 series?

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(1)

(iv) State the coloured bands of this resistor, assuming it had a 5% tolerance.

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(3)

(e) (i) Mark onto the circuit diagram where you would connect a buzzer so that it sounded when the timing period had elapsed.

(1)

(ii) Explain why you have connected the buzzer in that way.

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(1)

(f) Mark onto the circuit diagram where you would connect an ON/OFF switch.

(1)

(g) When the circuit was tested it was found to have a timing error of 25%. Explain which component is likely to be responsible for this error

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(2)

(h) Explain how you would expect the timing period to alter when the voltage of the battery powering the circuit starts to fall.

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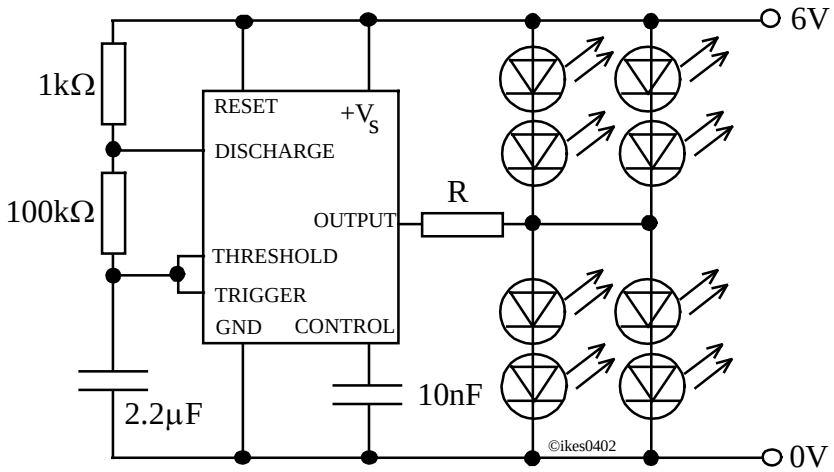
(1)

2). The rear lamp for a bicycle consists of two sets of flashing red LEDs operated by a 555 timer astable circuit. The circuit diagram is shown below.



(a) Explain how a 555 timer astable circuit functions.

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(6)

(b) (i) Calculate the time that the output of the 555 timer is at 6V.

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(2)

(ii) Calculate the time that the output of the 555 timer is at 0V.

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(2)

(iii) Calculate the overall period of the 555 timer astable

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(1)

(iv) Calculate the frequency of the 555 timer astable.

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(1)

(c) Each LED has a forward voltage of 1.9V and a maximum current of 50mA.

(i) Explain why although the LEDs are connected directly across the battery they do not short circuit it.

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(2)

(ii) Calculate the minimum value of resistor R.

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(2)

(iii) Calculate the power that will be dissipated within this resistor

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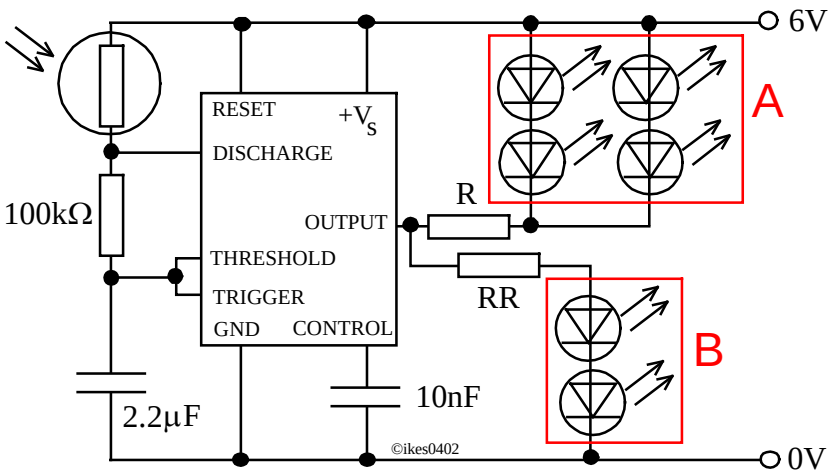
(2)

(d) Since the bicycle is often rode along country lanes where there are not many cars, the cyclist decides to modify the circuit to conserve battery power. The modified circuit diagram is shown below.



(i) Explain two ways in which this circuit uses less power than the original circuit.

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(1)

(ii) Explain what will happen to the circuit when light from a car headlamp is incident on the LDR.

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(1)

(e) Calculate a value for the resistor RR

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(2)

(f) Using the graph of the characteristic of the LDR, state the resistance of the LDR at the following light levels:

(i) 10 lux .....

(ii) 70 lux .....

(iii) 200 lux .....

(iv) 1000 lux .....

(v) 4000 lux .....

(5)

(g) When the light incident upon the LDR has a value of 1lux, calculate:

(i) the time that the block of LEDs labelled A are alight for.

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(2)

(ii) the time that the block of LEDs labelled B are alight for.

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(2)

(iii) the frequency of the astable.

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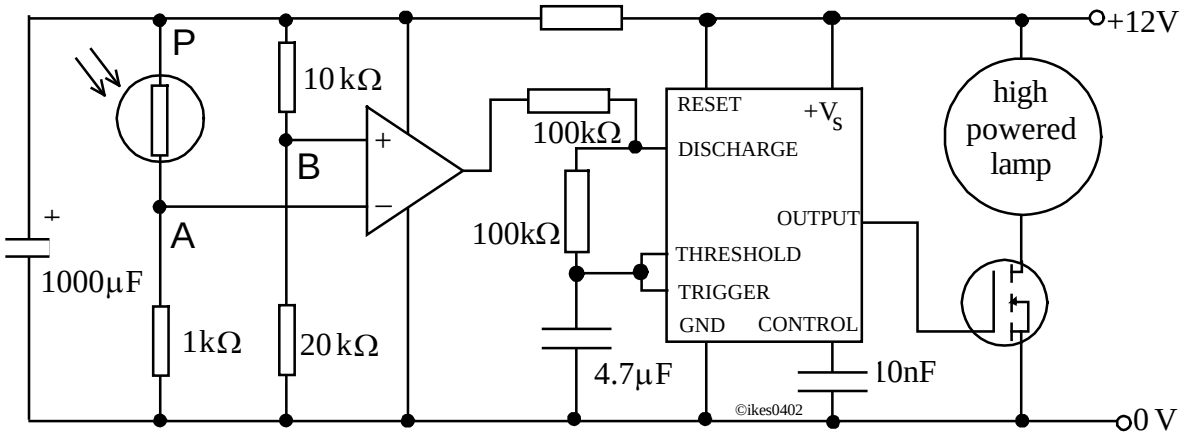
(2)

3). A navigational buoy flashes a high powered lamp whenever the light level falls below a certain value. The circuit diagram is shown below.



(a) Mark onto the circuit diagram above the following sub-systems:

(i) the astable sub-system,
(ii) an input sub-system,
(iii) a voltage divider sub system,
(iv) an output sub-system
(v) a comparator sub-system.

(5)

(b) (i) Explain how the astable sub-system operates.

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(6)

(iii) When working, calculate the time that the output of the astable is high.

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(2)

(iv) When working, calculate the time that the output of the astable is low

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(2)

(v) Calculate the period of the astable

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(2)

(c) Using the graph of the characteristic of the LDR, state the resistance of the LDR at the following light levels:

(i) 10 lux .....

(ii) 70 lux .....

(iii) 200 lux .....

(iv) 1000 lux .....

(v) 4000 lux .....

(5)

(d) (i) Calculate the voltage at point B.

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(2)

(ii) State, with a reason, the voltage at point A that will make the output of the op-amp change state.

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(2)

(iii) State, with a reason, the resistance of the LDR that will make the output of the op-amp change state.

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(2)

(iv) State, with a reason, the light level that will make the output of the op-amp change state.

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(2)

(v) State and explain two reasons why an op-amp makes such an effective comparator.

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(2)

(e) (i) State, with a reason, whether the high powered lamp will flash when the light level is 2000lux.

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(2)

(ii) State and explain *three* reasons why a MOSFET makes an ideal output buffer.

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(3)

(iii) Explain why the lamp cannot be connected directly to the output of the op-amp

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(1)