Mark schemes

Q1.

(a) V_R = 5 V chosen and idea that the photocurrent increases linearly/ most throughout the light intensity change ✓

$(2 \times 10^{-5} - 5 \times 10^{-6})$ A OR $(20 \times 10^{-6} - 5 \times 10^{-6})$ A

Change in photocurrent = 15×10^{-6} A ✓

MP1 for reason of choice

MP2 for answer

*If no other mark awarded, allow **1 MAX** for identification of V_R = 1V and answer in range 5 to 6 $\times 10^{-6}$ A.*

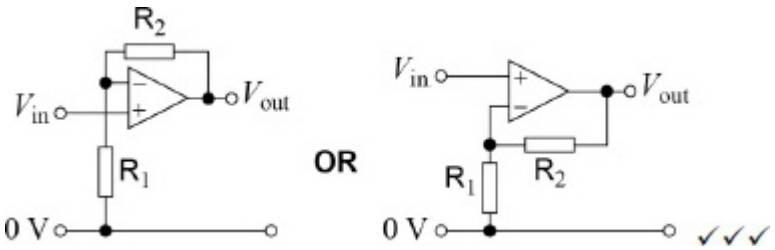
2

(b) Atomic particles need to interact with scintillation material to produce light ✓

Photodiode is used in photoconductive mode / with reverse bias ✓

2

(c)



✓✓✓

1st mark for correct configuration

2nd mark for only two resistors seen, in the ratio 9 : 1 for R_2:R_1

3rd mark:

- *output labelled*
- *resistor values within suggested range*

3

[7]

Q2.

The mark scheme gives some guidance as to what statements are expected to be seen in a 1- or 2-mark (L1), 3- or 4-mark (L2) and 5- or 6-mark (L3) answer. Guidance provided in section 3.10 of the 'Mark Scheme Instructions' document should be used to assist in marking this question.

Mark	Criteria
L3 6 marks	All three areas covered with at least two aspects covered in some detail. 6 marks can be awarded even if there is an error and/or parts of one aspect missing.
L3 5 marks	A fair attempt to analyse all three areas. If there are several errors or missing parts, then 5 marks should be awarded.
L2 4 marks	Two areas successfully discussed, or one discussed and two others covered partially. Whilst there will be gaps, there should only be an occasional error.
L2 3 marks	One area discussed and one discussed partially, or all three covered partially. There are likely to be several errors and omissions in the discussion.
L1 2 marks	Only one area discussed or makes a partial attempt at two areas.
L1 1 marks	None of the three areas covered without significant error. Response is likely to show weakness in technical detail.
L1 0 marks	No relevant analysis.

The following information is likely to appear in the answer statements.

Component A - Zener diode

Role in circuit
- Used to provide a reference voltage for component B.
- Reference voltage set at a value below the noise level / to exclude the noise on the signal.

Useful characteristic properties
- Used in reverse bias mode.
- Produces a fixed reverse breakdown voltage.

Component B - operational amplifier

Role in circuit
- Used as a comparator.
- Output will saturate high when the input signal is larger than the reference voltage (V+ > V-).
- Output will drop to zero volts when the signal voltage is below the level of the reference voltage (V+ < V-).

Useful characteristic properties
- Very high open loop gain which provides saturation for very small voltage difference at the inputs.
- Very high input resistance - negligible load on input signals.
- Produces a clean switching pulse at the output when signal voltage transits the reference voltage.

Component C - MOSFET

Role in circuit
- Acts as a voltage-controlled switch.

Useful characteristic properties
- The MOSFET is a voltage-controlled device.
- Has a very high input resistance to interface with comparator (draws negligible current from the comparator).
- Low drain-source resistance when ON leads to very little power dissipated in the MOSFET.
- Can be considered as a current amplifier

[6]