A Level AQA Physics

29 Discrete semi-conductor devices – answers

OXFORD Revise

Question	Answers	Extra information	Mark	AO Spec reference
1.1	Gate, drain, and source all correctly labelled		1	3.13.1.1 AO1
1.2	Has very high input impedance/resistance No loading of logic gate output		1 1	3.13.1.1 AO1
1.3	MOSFET can easily become charged and switch on – the resistor prevents this/ keeps gate at 0 when no input		1	3.13.1.1 AO1
1.4	Diode An induced e.m.f. is created when a motor is switched on or off Without diode this would destroy MOSFET		1 1 1	3.13.1.1 AO1 AO2 × 2
2.1	2.2 V is min p.d. across gate and source to form a channel between drain and source/gate voltage when the transistor is just switched off		1	3.13.1.1 AO1
2.2	Resistance increases as light intensity decreases Potential difference across the LDR increases Until threshold voltage achieved/current flows between drain and source and LED switched on		1 1 1	3.5.1.5 3.13.1.1 AO2
2.3	p.d. across $R = 6 - 2.2 = 3.8\,\text{V}$ $\frac{R}{3.8} = \frac{100\,000}{2.2}$ $R = 100\,000 \times \frac{3.8}{2.2}$ $R = 170\,\text{k}\Omega$		1 1 1	3.5.1.5 3.13.1.1 AO2

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3.1	Max 4 marks from: • Behaviour in forward bias direction same/same threshold voltage and then low resistance • Diode has large breakdown voltage/zener diodes have low breakdown voltages • Diode breaks if breakdown voltage exceeded/voltage across zener/zener voltage remains constant even when current exceeded • Reverse current of zener remains constant/at least 5 mA until breakdown voltage applied	Must have similarities and differences for full marks	max 4	3.13.1.2 AO2
3.2	Correct symbol drawn Arrow pointing up		1 1	3.13.1.2 AO1
3.3	$P = VI$ $I = \frac{P}{V} = \frac{1.3}{4.3} = 0.30\text{ A}$		1	3.5.1.4 3.13.1.2 AO1
3.4	$V = 9 - 4.3 = 4.7\text{ V}$ $V = IR$ $R = \frac{4.7}{0.3} = 16\,\Omega$		1 1	3.5.1.1 3.13.1.2 AO2
4.1	In parallel with zener diode so pd = 4.7 V $I = \frac{V}{R} = \frac{4.7}{440} = 0.011\text{ A}$		1 1	3.13.1.2 3.5.1.1 AO2
4.2	p.d. = 10 – 4.7 = 5.3 V $I = \frac{V}{R} = \frac{5.3}{120} = 0.044\text{ A}$		1 1	3.13.1.2 3.5.1.1 AO2
4.3	$I_Z = 0.044 - 0.011 = 0.033\text{ A}$		1	3.13.1.2 3.5.1.4 AO1

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4.4	$P = IV = 0.033\,\text{A} \times 4.7 = 0.16\,\text{W} < 0.25\,\text{W}$ Use 250 mW zener diode		1 1	3.13.1.2 3.5.1.4 AO2
5.1	Reverse		1	3.13.1.3 AO1
5.2	Inverted parabola Peak at 850 nm Scale from 550 nm (min) to 1150 nm (max)	Ignore y-axis scale	1 1 1	3.13.1.3 AO1
5.3	Power = $I \times$ Area = $10 \times 1 \times 10^{-6}\,\text{m}^2$ Current = sensitivity $\times$ power = $0.62 \times 10 \times 1 \times 10^{-6}$ Current = 6.2×10^{-6} A		1 1 1	3.13.1.3 3.5.1.4 AO3
5.4	Max 4 marks from: • Photodiode in series with a resistor and a power supply • V_{out} across the resistor • When it is dark, the current is negligible and there is no pd across resistor. No V_{out} • When it is light, there is a current and hence a pd across the resistor – this is V_{out} • Resistor chosen to provide suitable pd to activate alarm	All marks can be awarded for suitably labelled diagram	max 4	3.13.1.3 AO3
6.1	Magnet placed on frame of set in line with hall effect sensor (allow vice versa) When the magnet is close to the sensor, voltage output is high/far from it, voltage output low Output fed to circuits for airbags/output amplified and input to circuits for airbags		1 1 1	3.13.1.4 AO1
6.2	3.5×10^{-4} T = 0.35 mT $V = 9 \times 0.35 = 3.2$ mV 0.014 T = 14 mT $V = 9 \times 14 = 126$ mV		1 1	3.13.1.4 AO2

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Question	Answers	Extra information	Mark	AO Spec reference
6.3	0.065 mT $V = 0.59$ mV Too small to affect reading as this was max strength 20% of smallest value so would affect accuracy of output		1 1	3.13.1.4 AO2
7.1	As the magnet passes the sensor, it registers a voltage output The number of voltage outputs can be counted Using circumference of wheel, the distance can be measured/number of counts multiplied by distance of wheel		1 1 1	3.13.1.4 AO3
7.2	Distance $= \pi \times D = \pi \times 0.05$ m Speed $= \frac{\text{distance}}{\text{time}} = \frac{\pi \times 0.05\text{ m}}{6.5 \times 10^{-3}} = 24\text{ m s}^{-1}$		1 1	3.13.1.4 AO2
7.3	Have more magnets on disc/have a smaller radius disc	Allow any sensible suggestion here	1	3.13.1.4 AO3
8.1	Reverse		1	3.13.1.3 AO1
8.2	Leakage current when there is no/zero light intensity		1	3.13.1.3 AO1
8.3	Current $= 0.6\text{ A W}^{-1} \times 0.2 \times 10^{-3}$ W Current $= 1.2 \times 10^{-4}$ A		1	3.13.1.3 3.5.1.4 AO2
8.4	p.d. across $R = IR = 1.2 \times 10^{-4}\text{ A} \times 5000\ \Omega = 0.6$ V $V_{out} = 9.0 - 0.6 = 8.4$ V		1 1	3.13.1.3 3.5.1.1, 3.5.1.4 AO2

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Skills box answers

Question	Answer
1	$I_{max} = \frac{P}{V} = \frac{500 \times 10^{-3}\,\text{W}}{5.1\,\text{V}} = 0.10\,\text{A}$
2	$P = IV = 10 \times 10^{-3}\,\text{A} \times 2.7\,\text{V} = 0.03\,\text{W}$
3	$R_{min} = \frac{(V_s - V_z)}{I_{max}} = \frac{(12 - 10)\,\text{V}}{100 \times 10^{-3}\,\text{A}} = 20\,\Omega$