## Electronics

## Mark Scheme 2

| Level | International A Level |
| :--- | :--- |
| Subject | Physics |
| Exam Board | CIE |
| Topic | Electronics |
| Sub Topic |  |
| Paper Type | Theory |
| Booklet | Mark Scheme 2 |


| Time Allowed: | 71 minutes |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Score: | /59 |  |  |  |  |
| Percentage: | /100 |  |  |  |  |
| A* A | B | C | D | E | U |
| >85\% '77.5\% | 70\% | 62.5\% | 57.5\% | 45\% | <45\% |

1 (a e.g. zero output impedance/resistanceinfinite input impedance/resistanceinfinite (open loop) gain
infinite bandwidth
infinite slew rate
1 each, max. 3B3
(b) (i) graph: square wave ..... M1
correct cross-over points where $V_{2}=V_{1}$ ..... A1
amplitude 5 V ..... A
correct polarity (positive at $t=0$ ) ..... A
(ii) correct symbol for LED ..... M1
diodes connected correctly between $V_{\text {out }}$ and earth ..... A1
correct polarity consistent with graph in (i) ..... A1
( $R$ points 'down' if (i) correct)

    ( \(R\) points 'down' if (i) correct)
    2 (a light-emitting diode (allow LED)(b) gives a high or a low output $/+5 \mathrm{~V}$ or -5 V outputM1dependent on which of the inputs is at a higher potentialA1
B(c) ( provides a reference/constant potentialB1(ii) determines temperature of 'switch-over'B1 [1]
(d) ( relayA1 [1]
(ii) relay connected correctly for op-amp output and high-voltage circuit ..... B1 diode with correct polarity in output from op-amp ..... B1

3 (a) light-dependent resistor (allow LDR) B1
(b) ( two resistors in series between +5 V line and earth M1
midpoint connected to inverting input of op-amp A1
(ii) relay coil between diode and earth M1
switch between lamp and earth A1
(c) switch on/off mains supply using a low voltage/current output

B1
(ii) relay will switch on for one polarity of output (voltage) switches on when output (voltage) is negative

C1
A1

4 (a e.g. infinite input impedance/resistance
infinite (open loop) gain
infinite bandwidth
infinite slew rate
(any four, one mark each)
(b) graph: square wave M1
(b) $180^{\circ}$ phase change A1 amplitude 5.0 V A
(c) correct symbol for LED M1
diodes connected correctly between $\mathrm{V}_{\text {OUt }}$ and earth A1 diodes identified correctly A1
(special case: if diode symbol, not LED symbol, allow $2^{\text {nd }}$ and $3^{\text {rd }}$ marks to be scored)
At
(a) e.g. reduced gain
increased stability
greater bandwidth or less distortion
(allow any two sensible suggestions, 1 each, max 2)
$\begin{array}{ll}\text { (b) (i) } V^{-} \text {connected to midpoint between resistors } & \text { B1 } \\ V_{\text {OUT }} \text { clear and input to } \mathrm{V}^{+} \text {clear } & \text { B1 }\end{array}$
(ii) gain $=1+R_{\mathrm{F}} / R$
$15=1+12000 / R$
C1
$R=860 \Omega$
(c) graph: straight line from $(0,0)$ to $(0.6,9.0)$
straight line from $(0.6,9.0)$ to $(1.0,9.0)$
B1
(d) either relay can be used to switch a large current/voltage

M1
output current of op-amp is a few $\mathrm{mA} /$ very small
or relay can be used as a remote switch for inhospitable region/avoids using long heavy cables

6 (a) to compare two potentials / voltages output depends upon which is greater
(b) (i) resistance of thermistor $=2.5 \mathrm{k} \Omega$
resistance of $X=2.5 \mathrm{k} \Omega$ A1
(ii) at $5^{\circ} \mathrm{C} /$ at $<10^{\circ} \mathrm{C}, V^{-}>V^{+} \quad \mathrm{M} 1$
so $V_{\text {Out }}$ is -9 V A1
at $20^{\circ} \mathrm{C} /$ at $>10^{\circ} \mathrm{C}, V^{-}<V^{+}$and $V_{\text {OUt }}$ is +9 V B1
$V_{\text {out }}$ switches between negative and positive at $10^{\circ} \mathrm{C}$ B1
(allow similar scheme if $20^{\circ} \mathrm{C}$ treated first)
(a) (i) non-inverting (amplifier) B1
(ii) $(G=) 1+R_{2} / R_{1}$

B1
(b) ( gain $=1+100 / 820$
output $=17 \mathrm{mV}$
(ii) 9 V
( $R_{2} / R_{1}$ scores 0 in (a)(ii) but possible 1 mark in each of (b)(i) and (b)(ii)
( $1+R_{1} / R_{2}$ ) scores 0 in (a)(ii), no mark in (b)(i), possible 1 mark in (b)(ii)
( $1-R_{2} / R_{1}$ ) or $R_{1} / R_{2}$ scores 0 in (a)(ii), (b)(i) and (b)(ii))

