Electronics

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Electronics
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **69 minutes**

Score: **/57**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1	**(a)**	**(i)** (potential =) $1.2/(1.2 + 4.2) \times 4.5 = +1.0\,V$	A	[1]
		(ii) (for $V_{IN} > 1.0\,V$) $V^+ > V^-$	B1	
		output (of op-amp) is +5 V or positive	M1	
		diode conducts giving +5 V across R or V_{out} is +5 V	A	
		(for $V_{IN} < 1.0\,V$) output of op-amp –5 V / negative so diode does not conduct, giving V_{out} = 0 or 0 V across R	A1	[4]
	(b)	**(** square wave with maximum value +5 V and minimum value 0	M1	
		vertical sides in correct positions and correct phase	A1	[2]
		(ii) re-shaping (digital) signals/regenerator (amplifier)	B1	[1]

2	**(a)**	e.g. zero output resistance / impedance infinite bandwidth infinite slew rate *1 mark each, max. 3*	B3	[3]
	(b)	**(i)** at 1.0 °C, thermistor resistance is 3.7 kΩ	B1	
		amplifier gain = $-R/740 = -3700/740$ *(negative sign essential)*	C1	
		$= -5.0$	C1	
		potential = $1.0/-5.0 = -0.20$ V	A1	[4]
		(ii) at 15 °C, R = 2.15 kΩ (*allow ±0.05 kΩ*)	C1	
		reading = $(2150/740) \times 0.2$		
		= 0.58 V (0.59 V → 0.57 V)	A1	[2]
	(c)	**(i)** 0.68 V	A1	[1]
		(ii) resistance (of thermistor) does not change linearly with temperature	B1	[1]

3 (a) *either* for transmission and reception of signal
or switching between transmitted and received signals M1
either so that one aerial may be used
or so that transmission and reception can occur in quick succession A1 [2]

(b) gives large signal for one (input) frequency M1
(and) rejects / very small signal for all other frequencies A1 [2]

4 **(a) (i)** thermistor / thermocouple [1]

(ii) quartz crystal / piezoelectric crystal *or* transducer / microphone [1]

(b) ($V_{OUT} = -5\,V$ A
inverting input is positive *or* V_- is positive *or* $V_- > V_+$ so V_{OUT} is negative B1
op-amp has very large / infinite gain and so saturates B1 [3]

(ii) sketch: V_{OUT} switches from (+) to (–) when V_{IN} is zero B1
V_{OUT} is +5 V or –5 V M
V_{OUT} is negative when V_{IN} is positive (*or v.v.*) A [3]

5 **(a) (i)** inverting amplifier B1 [1]

(ii) gain is very large/infinite B1
V^+ is earthed/zero B1
for amplifier not to saturate, P must be (almost) earth/zero B1 [3]

(b) ($R_A = 100\ k\Omega$ A1
$R_B = 10\ k\Omega$ A1
$V_{IN} = 1000$ mV A1 [3]

(ii) variable range meter B1 [1]

6 **(a)** compares the potentials/voltages at the (inverting and non-inverting) inputs B1

either output (potential) dependent on which input is the larger
or $V^+ > V^-$, then V_{OUT} is positive B1
states the other condition B1 [3]

(b) (i) ring drawn around both the LEDs (and series resistors) B1 [1]

(ii) $V^- = (1.5 \times 2.4)/(1.2 + 2.4) = 1.0\,V$ B [1]
(*allow* $1.5 \times 2.4/3.6 = 1.0\,V$)

(iii) **1.** V_{OUT} switches at $+1.0\,V$ B
maximum V_{OUT} is 5.0 V B
when curve is above $+1.0\,V$, V_{OUT} is negative (*or v.v.*) B [3]

2. at time t_1, diode R is emitting light, diode G is not emitting B1
at time t_2, diode R is not emitting, diode G is emitting B1 [2]
(*must be consistent with graph line. If no graph line then 0/2*)

7 **(a** e.g. zero output impedance/resistance
infinite input impedance/resistance
infinite (open loop) gain
infinite bandwidth
infinite slew rate
(*1 each, max. 3*) B3 [3]

(b) (i) gain = 1 + (10.8 / 1.2) C1
= 10 A1 [2]

(ii) graph: straight line from (0,0) towards V_{IN} = 1.0 V, V_{OUT} = 10 V B1
horizontal line at V_{OUT} = 9.0 V to V_{IN} = 2.0 V B1
correct +9.0 V → –9.0 V (and correct shape to V_{IN} = 0) B1 [3]