Electronics

Question paper 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Electronics
Sub Topic	
Paper Type	Theory
Booklet	Question paper 3

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) State three properties of an ideal operational amplifier (op-amp).

1. .....

2. .....

3. .....

[3]

(b) A circuit incorporating an ideal op-amp is to be used to indicate whether a door is open or closed.
Resistors, each of resistance *R*, are connected to the inputs of the op-amp, as shown in Fig. 10.1.

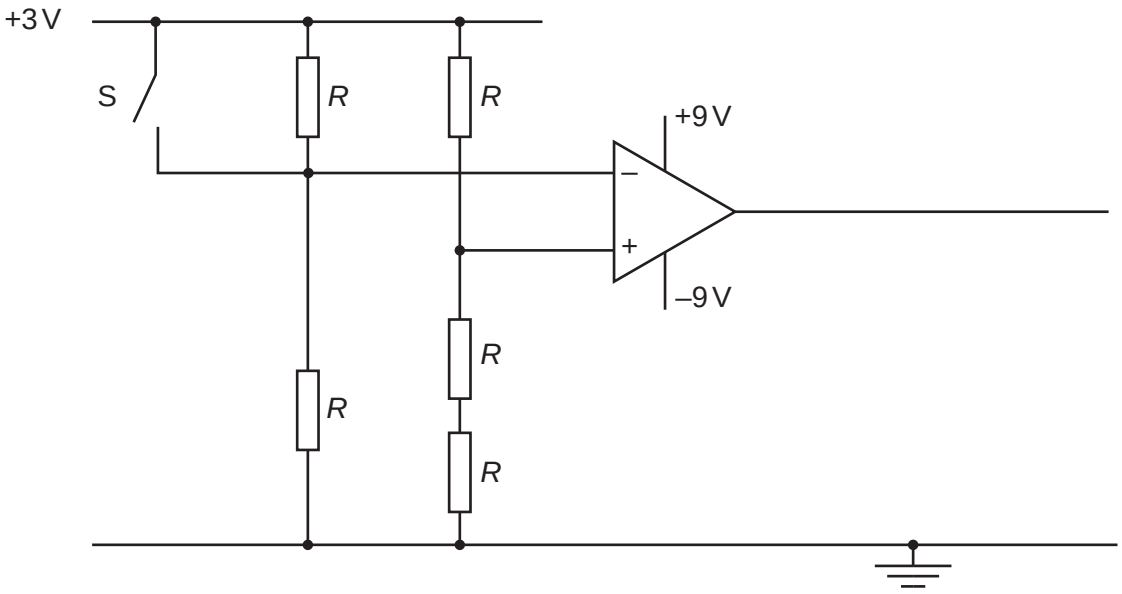

Fig. 10.1

The switch S is attached to the door so that, when the door is open, the switch is open. The switch closes when the door is closed.

(i) Explain why the polarity of the output of the op-amp changes when the switch closes.

.....

.....

.....

..... [3]

(ii) A red light-emitting diode (LED) is to be used to indicate when the door is open. A green LED is to indicate when the door is closed.

On Fig. 10.1,

1. draw symbols for the LEDs to show how they are connected to the output of the op-amp, [1]

2. identify the green LED with the letter G. [1]

2 The circuit diagram of Fig. 9.1 is an amplifier circuit incorporating an operational amplifier (op-amp).

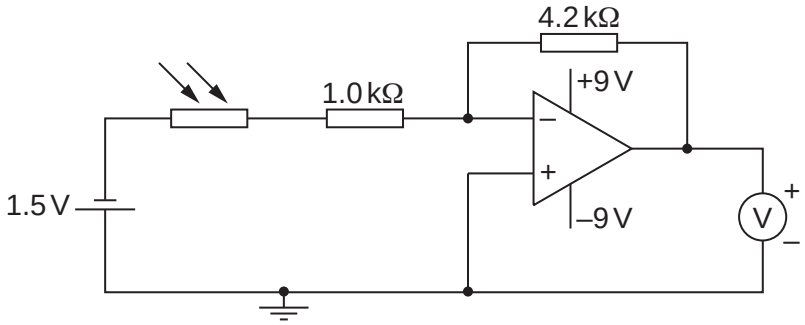

Fig. 9.1

(a) **(i)** On Fig. 9.1, mark, with the letter X, the virtual earth. [1]

(ii) Explain what is meant by a *virtual earth*.

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.....

..... [3]

(b) In bright sunlight, the light-dependent resistor (LDR) has resistance 200 Ω.

(i) Calculate, for the LDR in bright sunlight, the voltmeter reading.

reading = ... V [3]

(ii) The sunlight incident on the LDR becomes less bright.
State and explain the effect on the voltmeter reading of this decrease in brightness.

.....

.....

.....

.....[3]

3 **(a)** Negative feedback may be used in amplifier circuits. State

(i) what is meant by *negative feedback*,

.....

.....

..... [2]

(ii) two effects of negative feedback on an amplifier incorporating an operational amplifier (op-amp).

1. .....

.....

2. .....

..... [2]

(b) Fig. 9.1 is a circuit for an amplifier that is used with a microphone.

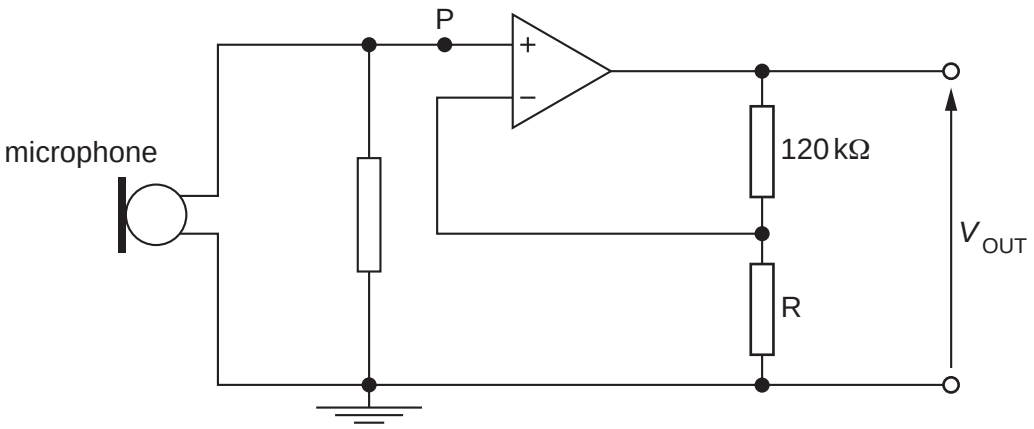

Fig. 9.1

The output potential difference V_{OUT} is 4.4 V when the potential at point P is 62 mV.

Determine

(i) the gain of the amplifier,

gain = ... [1]

(ii) the resistance of the resistor R.

resistance = ... Ω [2]

(c) The maximum potential produced by the microphone at point P on Fig. 9.1 is 95 mV.
The power supply for the operational amplifier may be either +/– 5 V or +/– 9 V.

State which power supply should be used. Justify your answer quantitatively.

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.....

..... [3]

4 The circuit of Fig. 10.1 may be used to indicate temperature change.

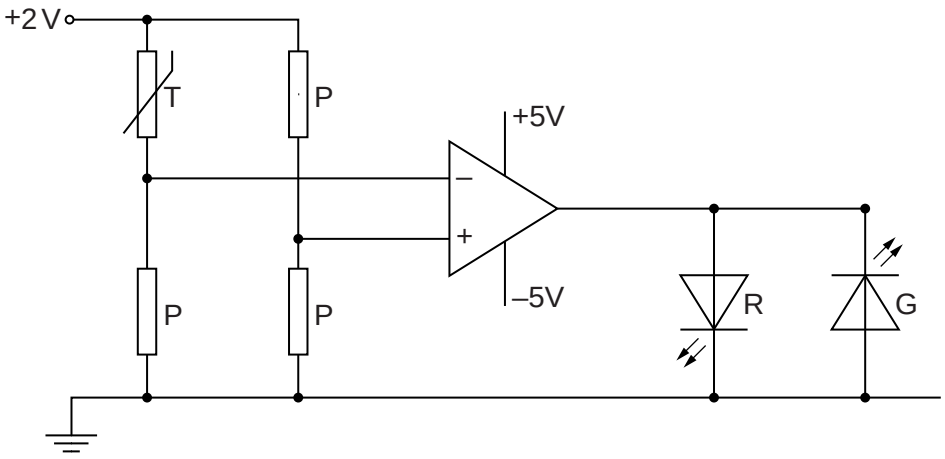

Fig. 10.1

The resistance of the thermistor T at 16 °C is 2100 Ω and at 18 °C, the resistance is 1900 Ω. Each resistor P has a resistance of 2000 Ω.

Determine the change in the states of the light-emitting diodes R and G as the temperature of the thermistor changes from 16 °C to 18 °C.

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..... [4]

5 An amplifier incorporating an operational amplifier (op-amp) has three inputs A, B and C, as shown in Fig. 9.1.

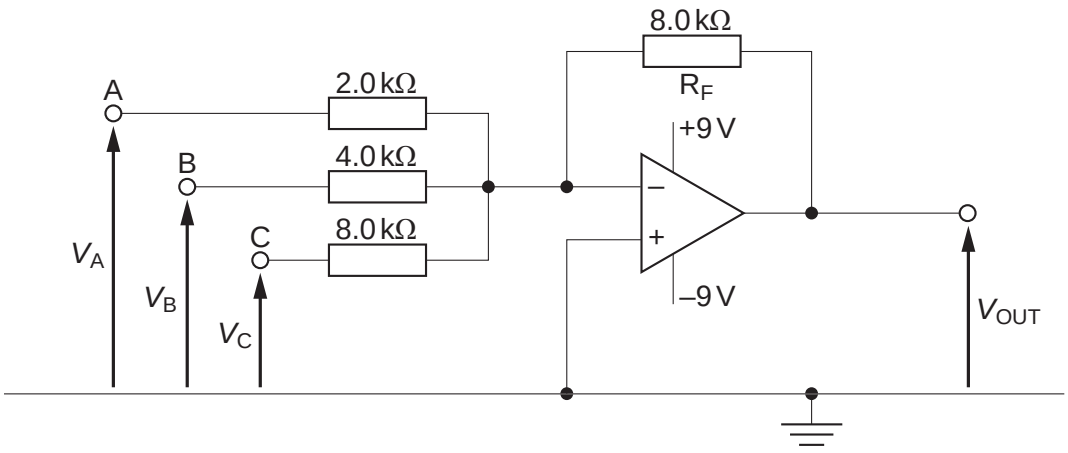

Fig. 9.1

Negative feedback is provided by the resistor R_F of resistance 8.0 kΩ.

For each of the inputs A, B and C, the amplifier may be considered as a single input amplifier. That is, each input is independent of the other two.

When the amplifier is not saturated, the output potential V_{OUT} is given by the expression

$$V_{OUT} = -(4V_A + GV_B + V_C),$$

where V_A, V_B and V_C are the input potentials of the inputs A, B and C respectively and G is a constant.

(a) State two effects of negative feedback on an amplifier.

1. .....

.....

2. .....

.....

[2]

(b) In the expression for the output potential V_{OUT}, the constant G is the gain associated with input B. Show that the numerical value of G is 2.

[1]

(c) The input potentials V_A, V_B and V_C are either zero or 1.0V.

The magnitudes of some output potentials for different combinations of V_A, V_B and V_C are shown in Fig. 9.2.

V_A/V	V_B/V	V_C/V	V_{OUT}/V
0	0	1	1
0	1	0	……
1	0	0	4
1	0	1	5
1	1	0	……
1	1	1	……

Fig. 9.2

(i) Complete Fig. 9.2 for the three remaining values of V_{OUT}. [1]

(ii) Suggest a use for this circuit.

..... [1]

6 **(a)** By reference to an amplifier, explain what is meant by *negative feedback*.

.....

.....

..... [2]

(b) An amplifier circuit incorporating an ideal operational amplifier (op-amp) is shown in Fig. 10.1.

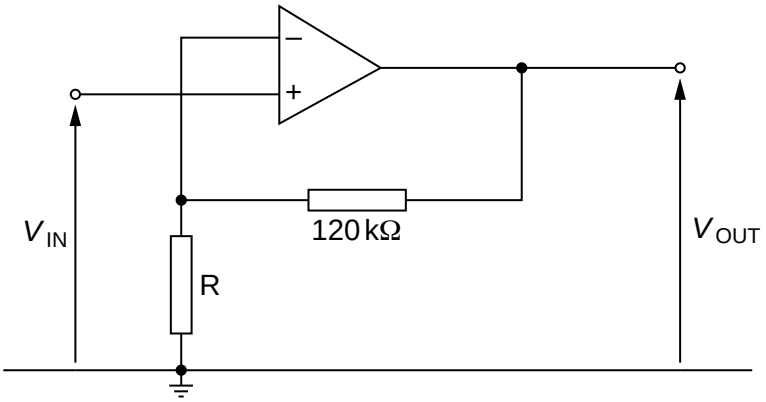

Fig. 10.1

The supply for the op-amp is ±9.0V.
The amplifier circuit is to have a gain of 25.

Calculate the resistance of resistor R.

resistance = ... Ω [2]

(c) State the value of the output voltage V_{OUT} of the amplifier in **(b)** for input voltages V_{IN} of

(i) −0.08V,

V_{OUT} = ... V [1]

(ii) +0.4V.

V_{OUT} = ... V [1]

7 **(a)** The circuit for an amplifier incorporating an ideal operational amplifier (op-amp) is shown in Fig. 10.1.

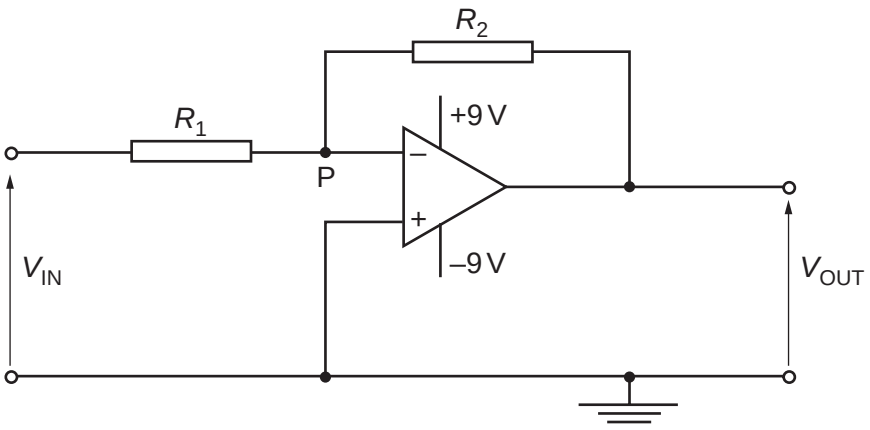

Fig. 10.1

(i) State

1. the name of this type of amplifier circuit,

.....[1]

2. why the point P is referred to as a *virtual earth*.

.....

.....

.....

.....[3]

(ii) Show that the gain G of this amplifier circuit is given by the expression

$$G = -\frac{R_2}{R_1}.$$

Explain your working.

[4]

(b) The circuit of Fig. 10.1 is modified by connecting a light-dependent resistor (LDR) as shown in Fig. 10.2.

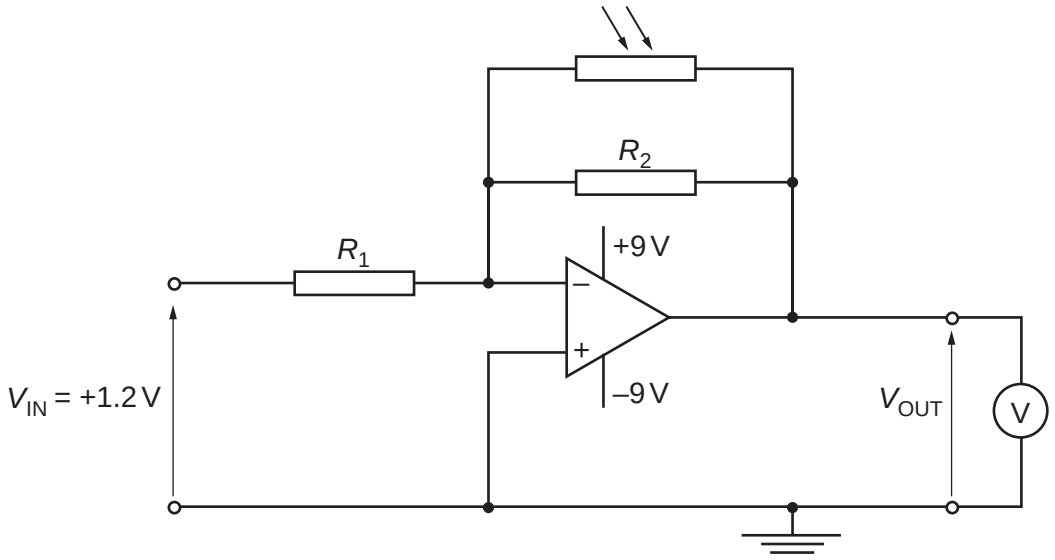

Fig. 10.2

The resistances R_1 and R_2 are 5.0 kΩ and 50 kΩ respectively.
The input voltage V_{IN} is +1.2V. A high-resistance voltmeter measures the output V_{OUT}.
The circuit is used to monitor low light intensities.

(i) Determine the voltmeter reading for light intensities such that the LDR has a resistance of

1. 100 kΩ,

reading = ... V [3]

2. 10 kΩ.

reading = ... V [2]

(ii) The light incident on the LDR is provided by a single lamp. Use your answers in **(i)** to describe and explain qualitatively the variation of the voltmeter reading as the lamp is moved away from the LDR.

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..... [3]