Electronics

Question paper 4

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Electronics
Sub Topic	
Paper Type	Theory
Booklet	Question paper 4

Time Allowed: **63 minutes**

Score: **/52**

Percentage: **/100**

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

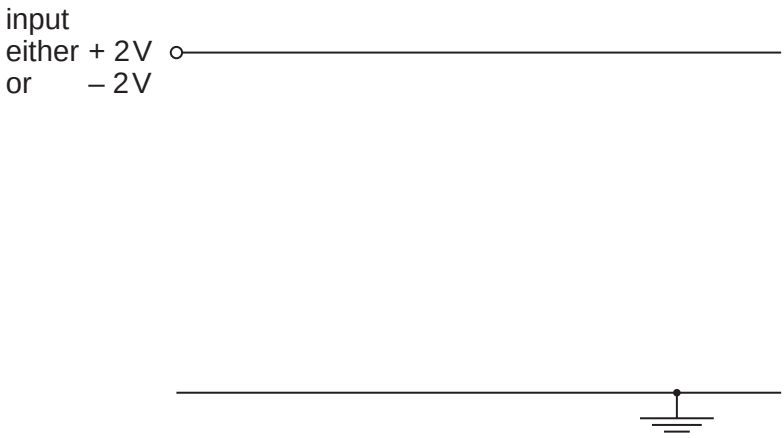
1 A block diagram for an electronic sensor is shown in Fig. 9.1.

Fig. 9.1

(a) Complete Fig. 9.1 by labelling the remaining boxes. [2]

(b) A device is to be built that will emit a red light when its input is at +2 V. When the input is at –2 V, the light emitted is to be green.

(i) On Fig. 9.2, draw a circuit diagram of the device.



[2]

Fig. 9.2

(ii) Explain briefly the action of this device.

.....

..... [1]

2 **(a)** Fig. 8.1 shows a circuit incorporating an ideal operational amplifier (op-amp).

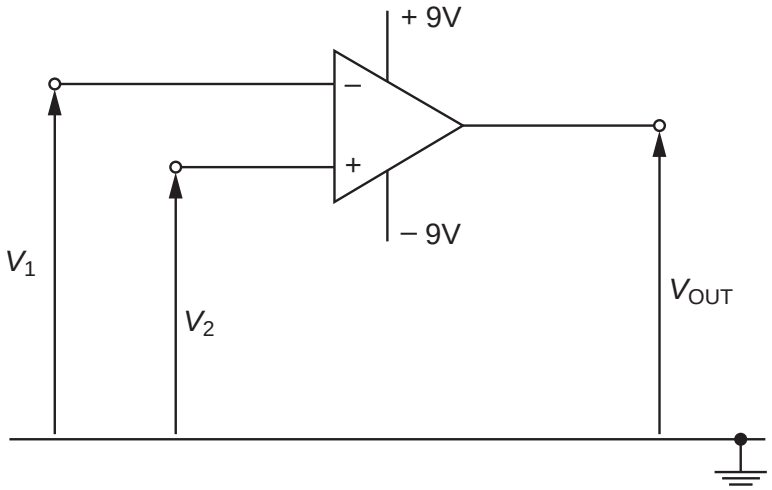


Fig. 8.1

The voltages applied to the inverting and the non-inverting inputs are V_1 and V_2 respectively.

State the value of the output voltage V_{OUT} when

(i) $V_1 > V_2$,

V_{OUT} = ... V

(ii) $V_1 < V_2$.

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

(b) The circuit of Fig. 8.2 is used to monitor the input voltage V_{IN}.

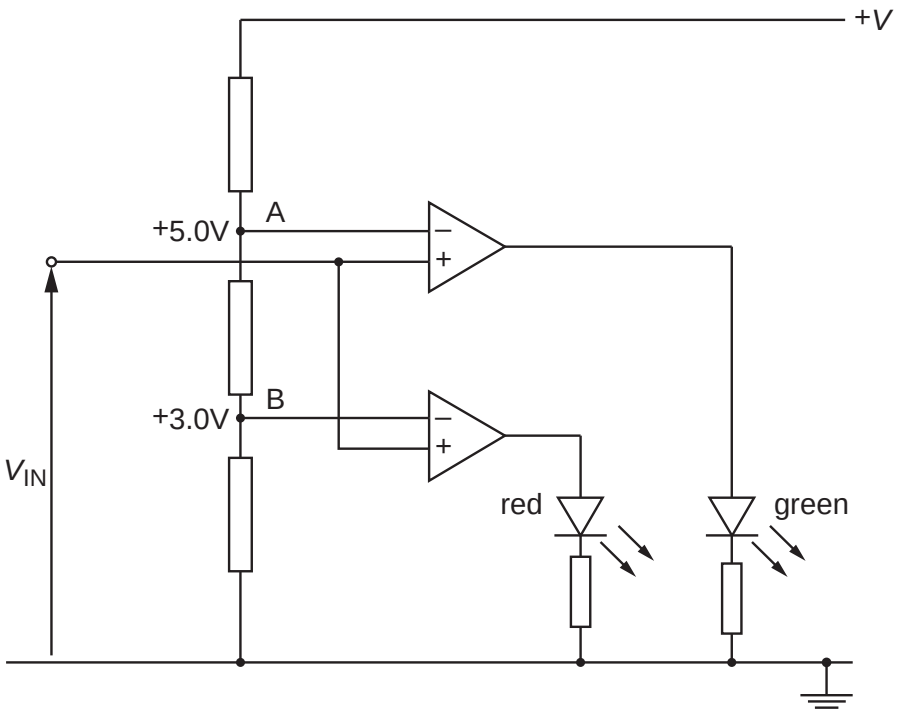


Fig. 8.2

At point A, a potential of 5.0V is maintained. At point B, a potential of 3.0V is maintained.

Complete Fig. 8.3 by indicating with a tick (✓) the light-emitting diodes (LEDs) that are conducting for the input voltages V_{IN} shown. Also, mark with a cross (✘) those LEDs that are not conducting.

V_{IN} / V	red LED	green LED
+2.0		
+4.0		
+6.0		

[3]

Fig. 8.3

(c) The input voltage V_{IN} in **(b)** is provided by a sensor circuit.

(i) Complete Fig. 8.4 to show a sensor circuit that will provide a voltage output that increases as the temperature of the sensor decreases. Show clearly the output connections from the circuit. [2]

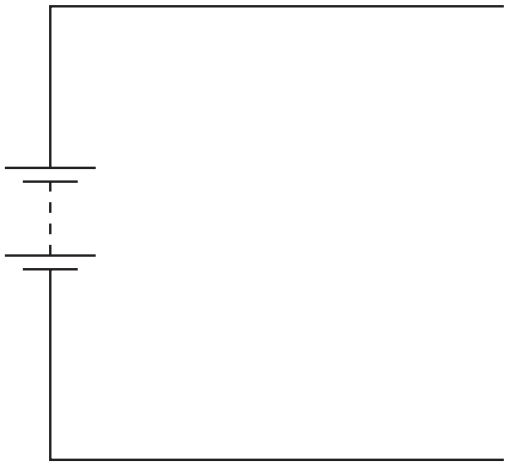


Fig. 8.4

(ii) Explain the operation of the sensor circuit.

.....

.....

.....

.....

.....

.....[3]

3 **(a)** State three characteristics of an ideal operational amplifier (op-amp).

1. .....

2. .....

3. ..... [3]

(b) An amplifier circuit for a microphone is shown in Fig. 8.1.

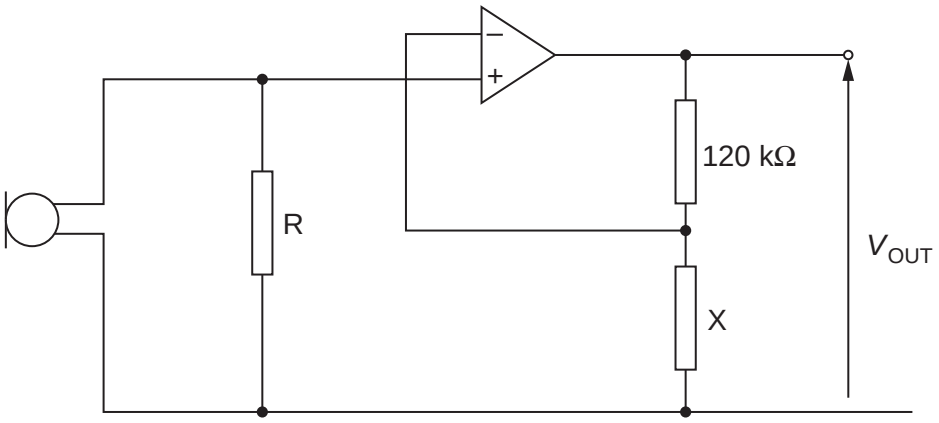


Fig. 8.1

(i) Name the type of feedback used with this op-amp.

..... [1]

(ii) The output potential difference V_{OUT} is 5.8V for a potential difference across the resistor R of 69 mV. Calculate

1. the gain of the amplifier circuit,

gain = ... [1]

2. the resistance of resistor X.

resistance = …… Ω [2]

(iii) State one effect on the amplifier output of reducing the resistance of resistor X.

.....

..... [1]

4 **(a)** The strain in a beam is to be monitored using a strain gauge.
The strain gauge is included in the potential divider circuit shown in Fig. 9.1.

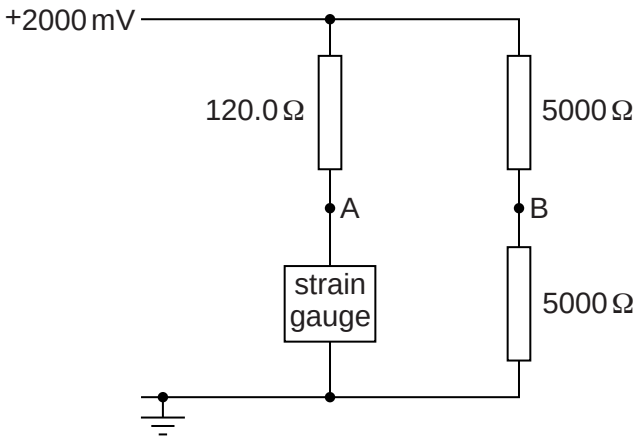


Fig. 9.1

The strain gauge has a resistance of 120.0 Ω when it is not strained. The resistance increases to 121.5 Ω when the strain is ε.

Calculate the potential difference between points A and B on Fig. 9.1 when the strain in the gauge is ε.

potential difference = ... mV [3]

(b) An inverting amplifier, incorporating an operational amplifier (op-amp), uses a high-resistance voltmeter to display the output. A partially completed circuit for the amplifier is shown in Fig. 9.2.

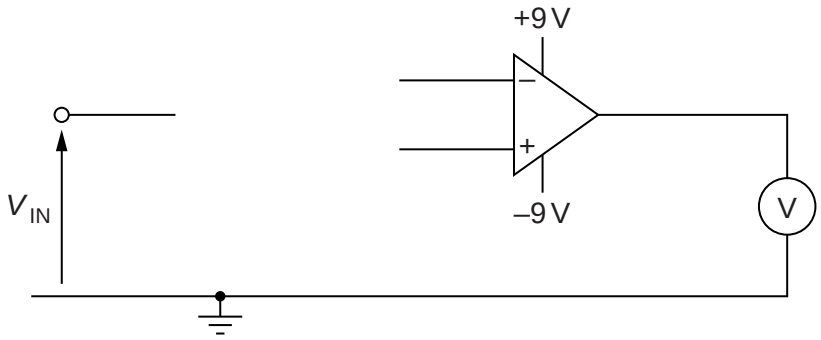


Fig. 9.2

The voltmeter is to indicate a full-scale deflection of +6.0V for an input potential V_{IN} of 0.15V.

(i) On Fig. 9.2,

1. complete the circuit for the inverting amplifier, [2]

2. mark, with the letter P, the positive terminal of the voltmeter. [1]

(ii) Suggest appropriate values for the resistors you have shown in Fig. 9.2.
Label the resistors in Fig. 9.2 with these values. [2]

5 **(a)** The resistance of a light-dependent resistor (LDR) is approximately 500 Ω in daylight.
Suggest an approximate value for the resistance of the LDR in darkness.

resistance = ... Ω [1]

(b) An electronic light-meter is used to warn when light intensity becomes low.
A light-dependent resistor is connected into the circuit of Fig. 9.1.

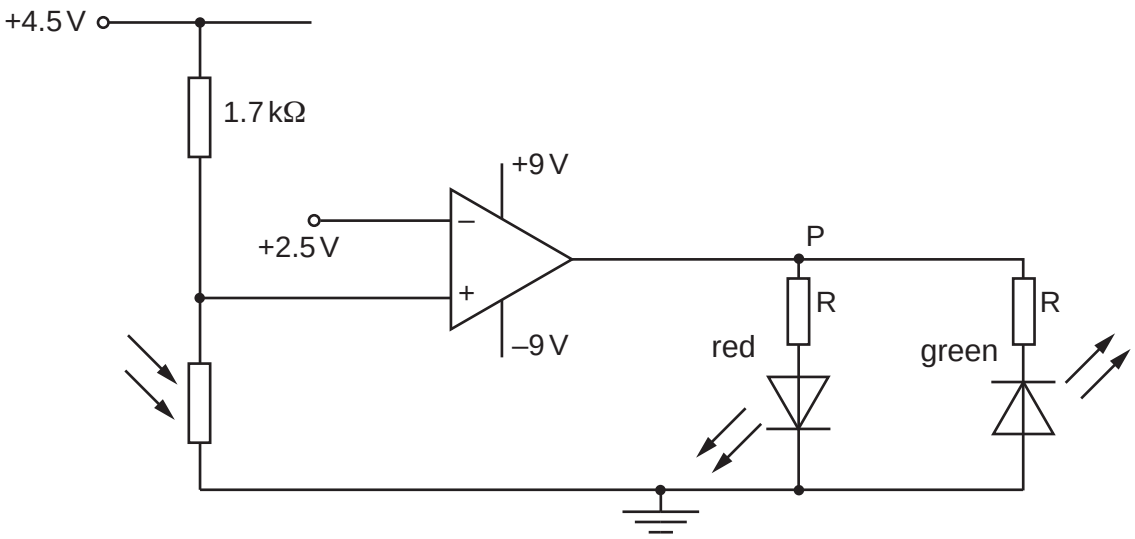


Fig. 9.1

The operational amplifier (op-amp) is ideal.
The resistors R are to ensure that the light-emitting diodes (LEDs) do not over-heat.

(i) On Fig. 9.1, mark the polarity of the point P for the red LED to be emitting light. [1]

(ii) The LDR is in daylight and has a resistance of 500 Ω.
State and explain which diode, red or green, will be emitting light.

.....

.....

.....

..... [3]

(iii) The intensity of the light decreases and the LDR is in darkness.
State and explain the effect on the LEDs of this change in intensity.

.....

.....

..... [2]

6 **(a)** Describe the structure of a metal wire strain gauge. You may draw a diagram if you wish.

.....

.....

.....

..... [3]

(b) A strain gauge S is connected into the circuit of Fig. 9.1.

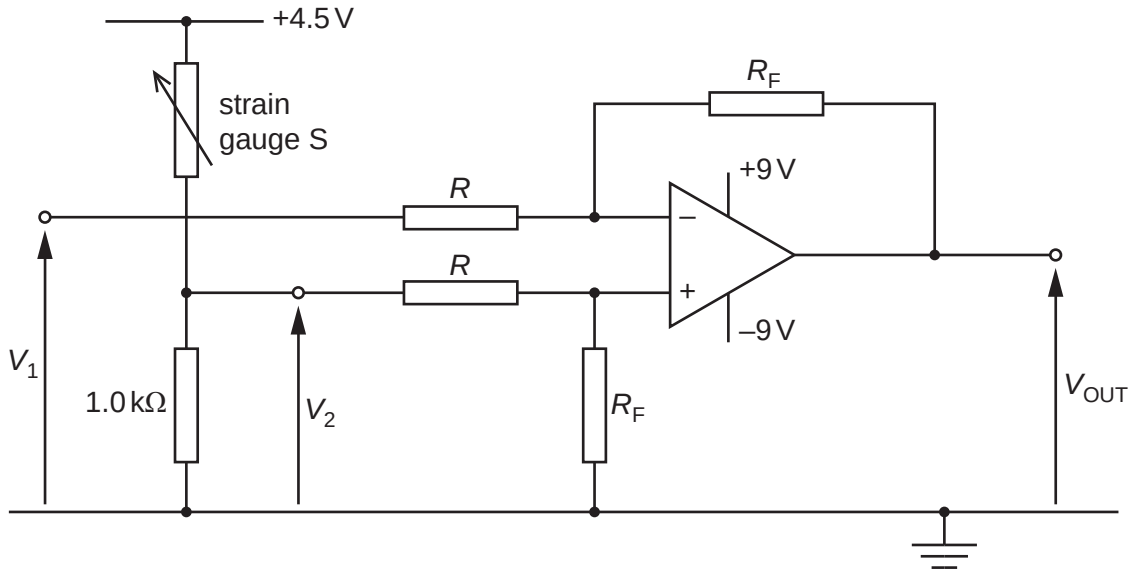


Fig. 9.1

The operational amplifier (op-amp) is ideal.
The output potential V_{OUT} of the circuit is given by the expression

$$V_{OUT} = \frac{R_F}{R} \times (V_2 - V_1).$$

(i) State the name given to the ratio $\frac{R_F}{R}$.

..... [1]

(ii) The strain gauge S has resistance 125 Ω when not under strain.
Calculate the magnitude of V_1 such that, when the strain gauge S is not strained, the output V_{OUT} is zero.

V_1 = ... V [3]

(iii) In a particular test, the resistance of S increases to 128 Ω. V_1 is unchanged.
The ratio $\frac{R_F}{R}$ is 12.
Calculate the magnitude of V_{OUT}.

V_{OUT} = ... V [2]

7 **(a)** State the name of an electrical sensing device that will respond to changes in

(i) length,

..... [1]

(ii) pressure.

..... [1]

(b) A relay is sometimes used as the output of a sensing circuit.

The output of a particular sensing circuit is either +2V or –2V.

On Fig. 10.1, draw symbols for a relay and any other necessary component so that the external circuit is switched on only when the output from the sensing circuit is +2V.

Fig. 10.1

[4]