Electronics

Question paper 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Electronics
Sub Topic	
Paper Type	Theory
Booklet	Question paper 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 An operational amplifier (op-amp) may be used as part of the processing unit in an electronic sensor.

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

1. .....

2. .....

3. .....

[3]

(b) A comparator circuit incorporating an ideal op-amp is shown in Fig. 9.1.

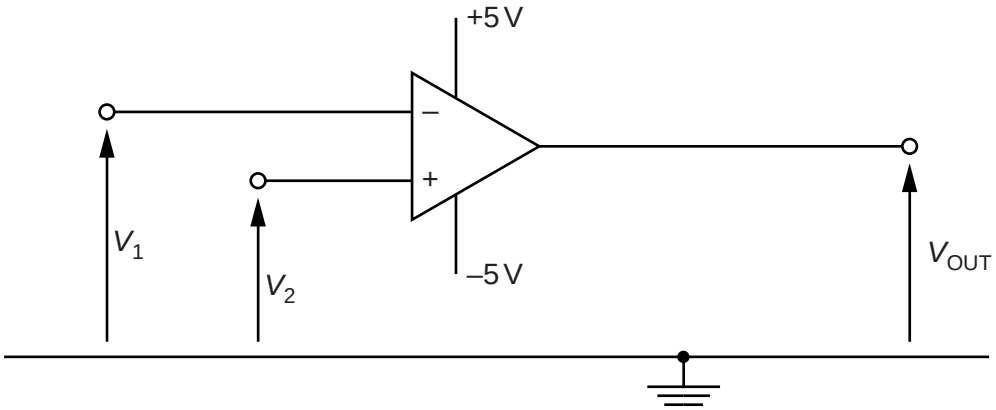

Fig. 9.1

(i) In one application of the comparator, V_2 is kept constant at +1.5 V.
The variation with time t of the potential V_1 is shown in Fig. 9.2. The potential V_2 is also shown.

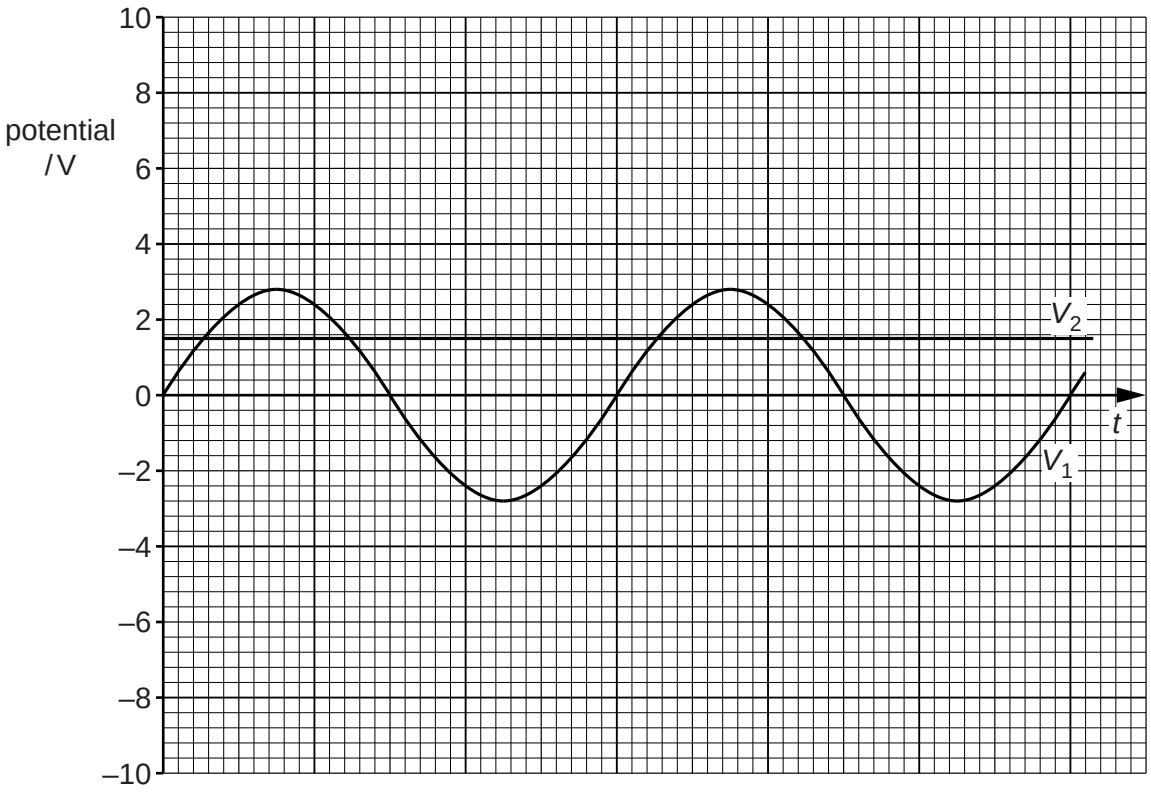

Fig. 9.2

On Fig. 9.2, show the variation with time t of the output potential V_{OUT}. [4]

(ii) Two light-emitting diodes (LEDs) R and G are connected to the output of the op-amp in Fig. 9.1 such that R emits light for a longer time than G.

On Fig. 9.1, draw the symbols for the two diodes connected to the output of the op-amp and label the diodes R and G. [3]

2 A student designs an electronic sensor to monitor whether the temperature in a refrigerator is above or below a particular value. The circuit is shown in Fig. 9.1.

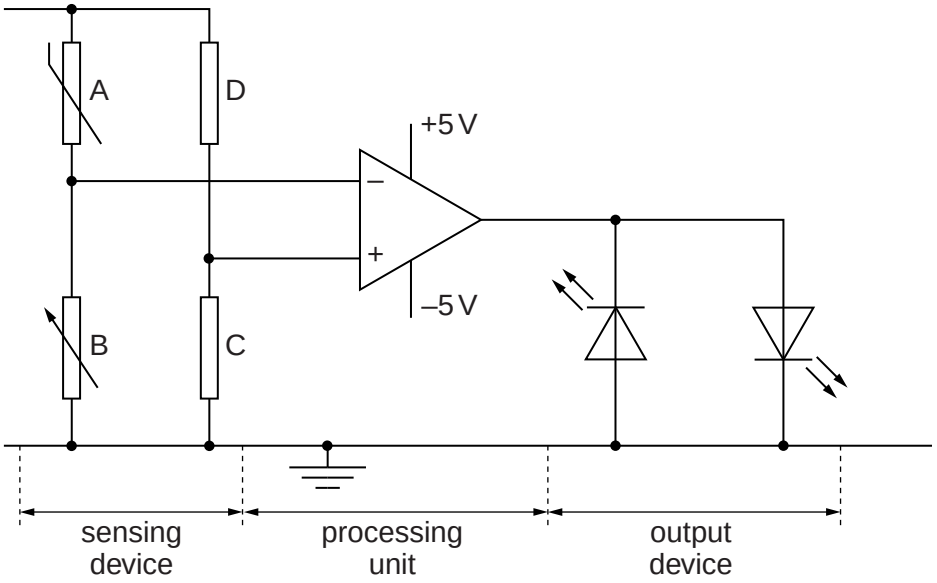

Fig. 9.1

(a) Name the components used in the output device.

.....[1]

(b) An operational amplifier (op-amp) is used as the processing unit. Describe the function of this processing unit.

.....

.....

.....[2]

(c) State the function of

(i) the resistors C and D,

.....

.....[1]

(ii) the resistor B.

.....

.....[1]

(d) The output device of the circuit in Fig. 9.1 is changed so that the new output device may be used to switch on a high-voltage circuit.

(i) State the component that is used in the new output device.

.....

..... [1]

(ii) Draw on Fig. 9.2 to show how the component in **(i)**, together with a diode, are connected so that the high voltage may be switched on when the output of the op-amp is negative.

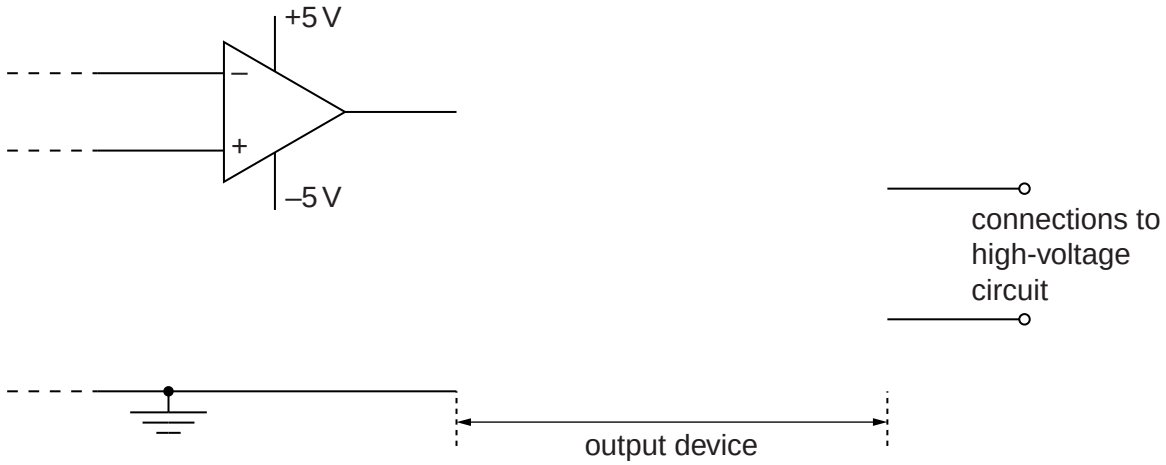

Fig. 9.2

[2]

3 A student designs an electronic sensor that is to be used to switch on a lamp when the light intensity is low. Part of the circuit is shown in Fig. 10.1.

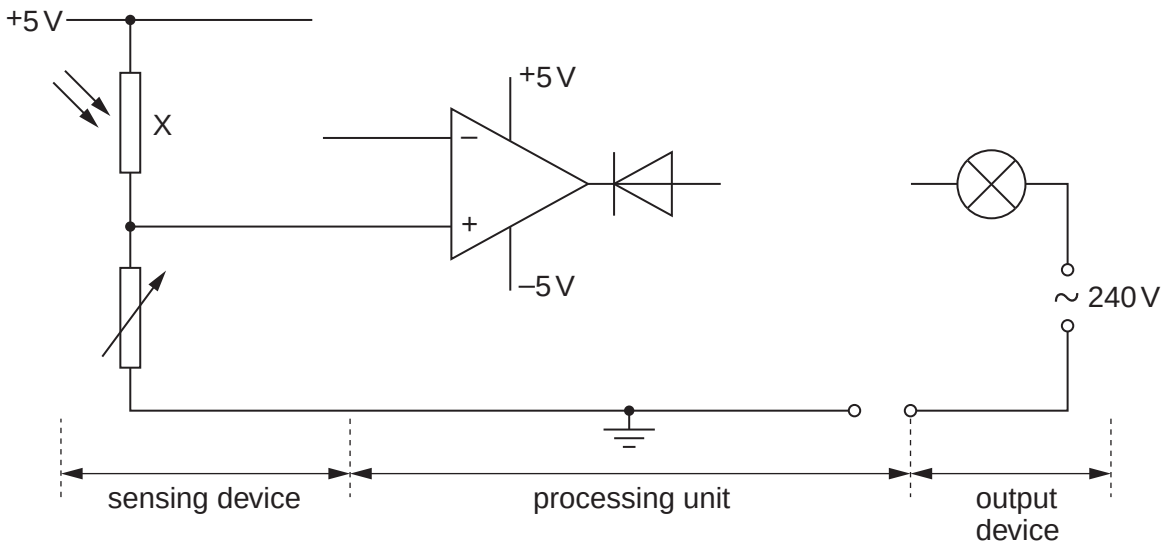

Fig. 10.1

(a) State the name of the component labelled X on Fig. 10.1.

..... [1]

(b) On Fig. 10.1, draw the symbols for

(i) two resistors to complete the circuit for the sensing device, [2]

(ii) a relay to complete the circuit for the processing unit. [2]

(c) **(i)** State the purpose of the relay.

.....

..... [1]

(ii) Suggest why the diode is connected to the output of the operational amplifier (op-amp) in the direction shown.

.....

.....

..... [2]

4 An operational amplifier (op-amp) may be used as part of the processing unit in an electronic sensor.

(a) State four properties of an ideal operational amplifier.

1. .....

2. .....

3. .....

4. .....

[4]

(b) A comparator circuit incorporating an ideal op-amp is shown in Fig. 9.1.

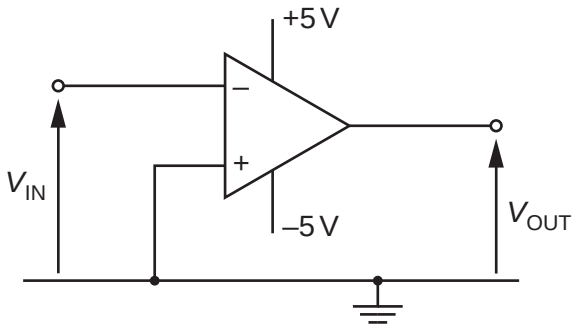

Fig. 9.1

The variation with time *t* of the input potential V_{IN} is shown in Fig. 9.2.

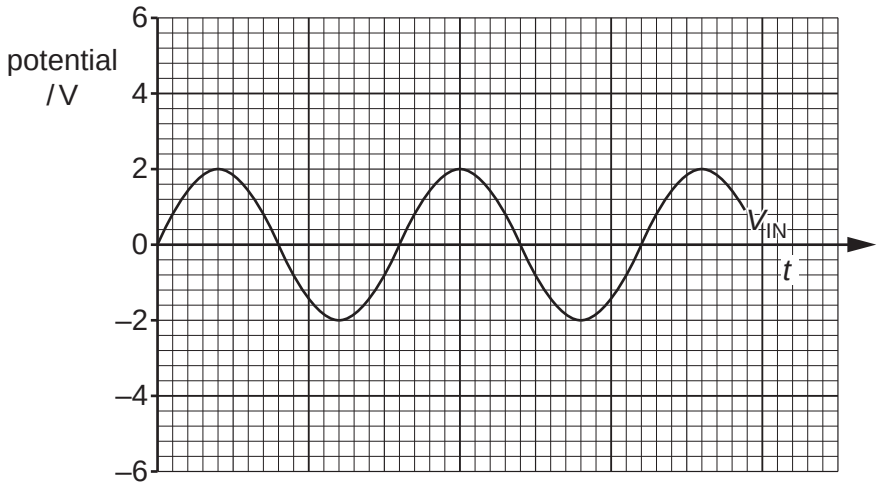

Fig. 9.2

On the axes of Fig. 9.2, draw a graph to show the variation with time *t* of the output potential V_{OUT}. [3]

(c) The output potential V_{OUT} is to be displayed using two light-emitting diodes (LEDs). A diode emitting red light is to indicate when V_{OUT} is positive and a diode emitting green light is to be used to indicate when V_{OUT} is negative.

Complete Fig. 9.3 to show the connections of the two LEDs to the output of the op-amp. Label each LED with the colour of light that it emits.

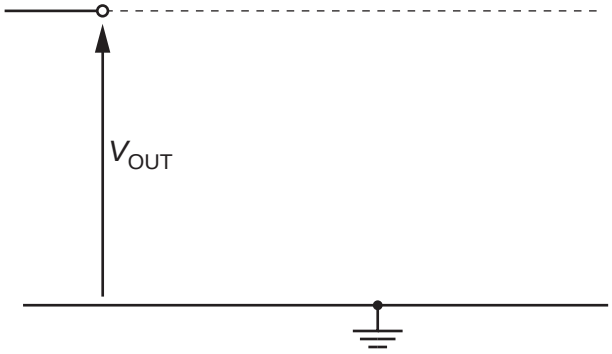

Fig. 9.3

[3]

5 **(a)** State two effects of negative feedback on the gain of an amplifier incorporating an operational amplifier (op-amp).

1. .....

.....

2. .....

.....

[2]

(b) An incomplete circuit diagram of a non-inverting amplifier using an ideal op-amp is shown in Fig. 9.1.

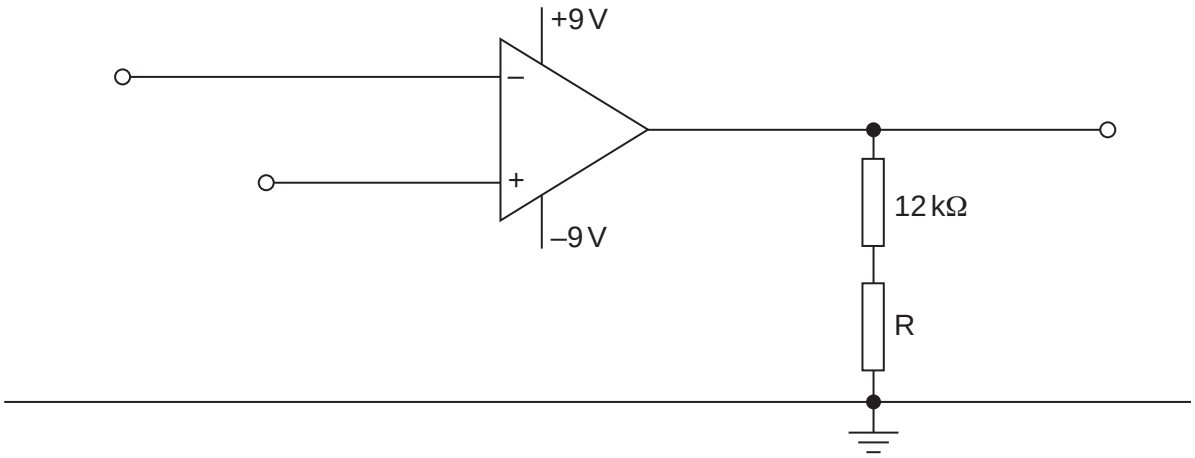

Fig. 9.1

(i) Complete the circuit diagram of Fig. 9.1. Label the input and the output. [2]

(ii) Calculate the resistance of resistor R so that the non-inverting amplifier has a voltage gain of 15.

resistance = ... Ω [2]

(c) On Fig. 9.2, draw a graph to show the variation with input potential V_{IN} of the output potential V_{OUT}.
You should consider input potentials in the range 0 to +1.0V.

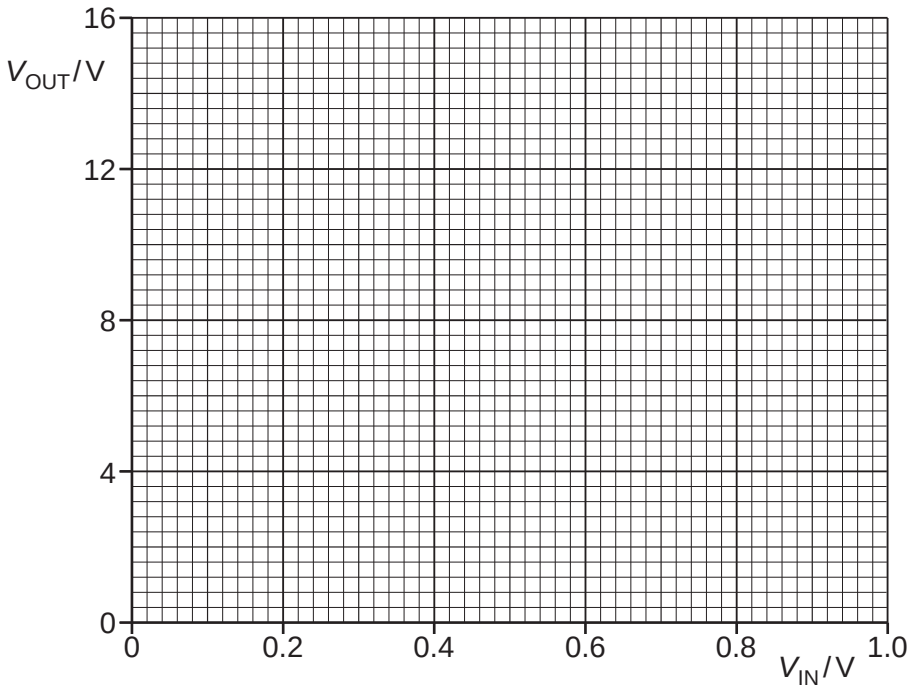

Fig. 9.2

[2]

(d) The output of the amplifier circuit of Fig. 9.1 may be connected to a relay.
State and explain one purpose of a relay.

.....

.....

..... [2]

6 **(a)** An operational amplifier (op-amp) may be used as a comparator.
State the function of a comparator.

.....

.....

..... [2]

(b) The variation with temperature θ of the resistance R of a thermistor is shown in Fig. 9.1.

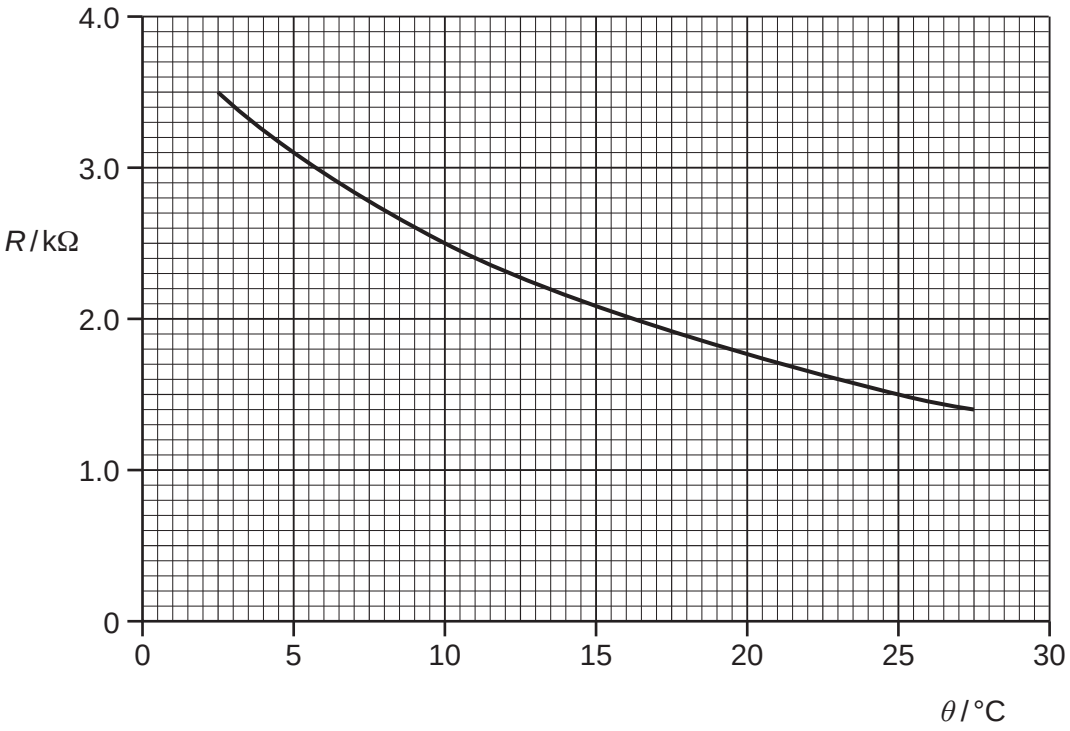

Fig. 9.1

The thermistor is connected into the circuit of Fig. 9.2.

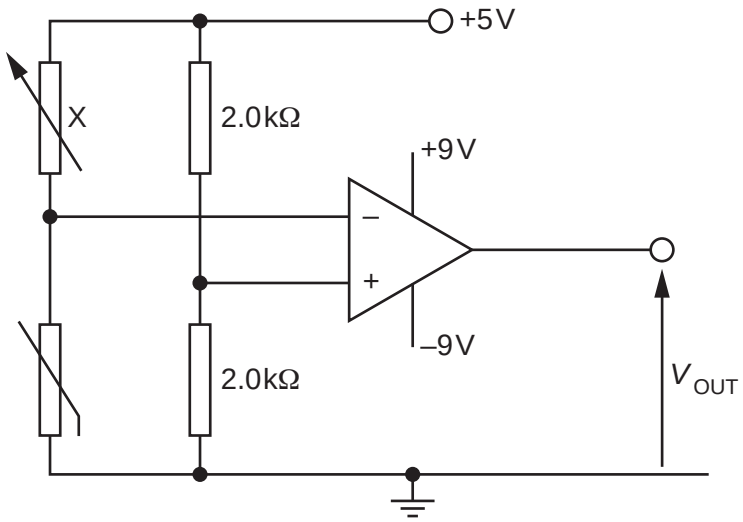

Fig. 9.2

The op-amp may be considered to be ideal.

(i) The temperature of the thermistor is 10 °C.
Determine the resistance of the variable resistor X such that the output potential V_{OUT} is zero.

resistance = ... Ω [2]

(ii) The resistance of the resistor X is now held constant at the value calculated in **(i)**.
Describe the change in the output potential V_{OUT} as the temperature of the thermistor is changed from 5 °C to 20 °C.

.....

.....

.....

.....

..... [4]

7 An amplifier circuit incorporating an operational amplifier (op-amp) is shown in Fig. 9.1.

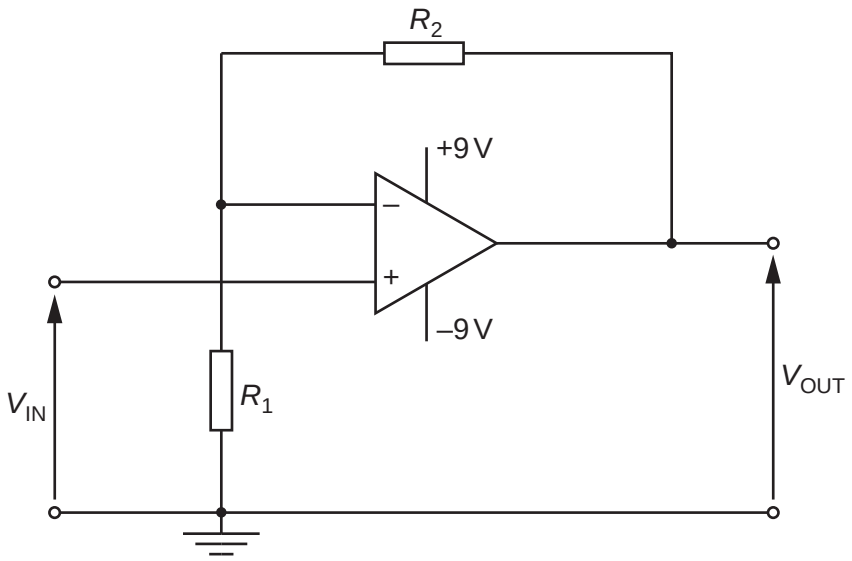

Fig. 9.1

(a) State

(i) the name of this type of amplifier circuit,

.....[1]

(ii) the gain G in terms of resistances R_1 and R_2.

.....[1]

(b) The value of R_1 is 820 Ω. The resistor of resistance R_2 is replaced with a light-dependent resistor (LDR).
The input potential difference V_{IN} is 15 mV.
Calculate the output potential difference V_{OUT} for the LDR having a resistance of

(i) 100 Ω (the LDR is in sunlight),

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

(ii) 1.0 MΩ (the LDR is in darkness).

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