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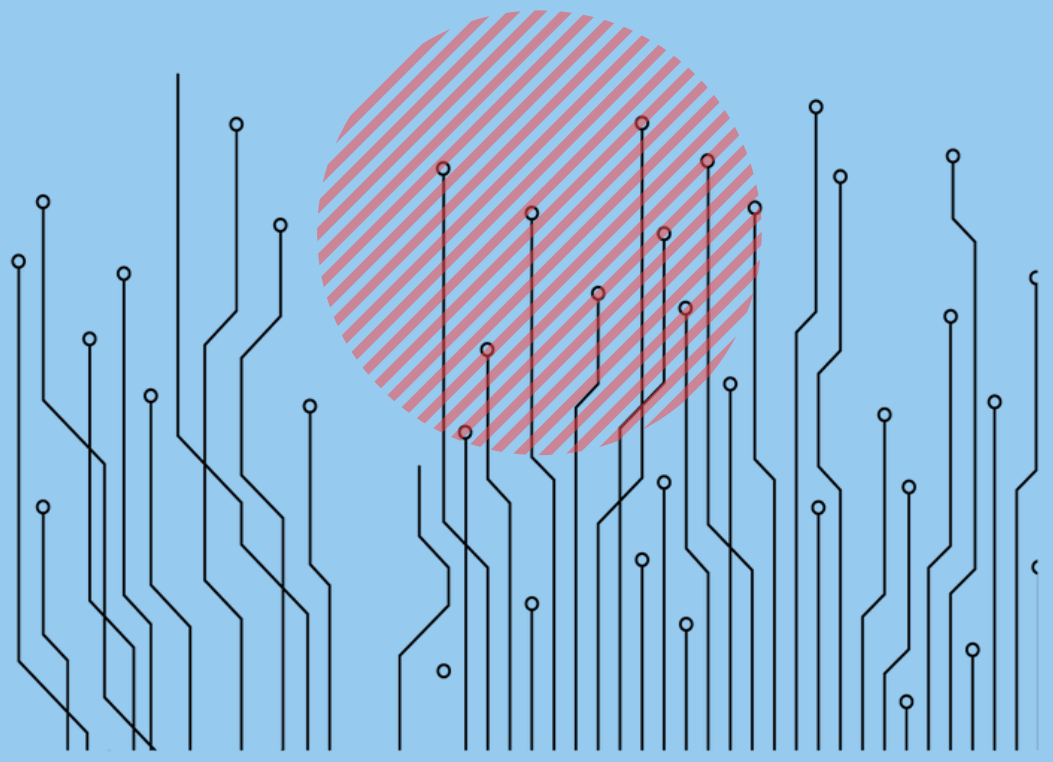
Cambridge International AS & A Level

PHYSICS

Paper 4

Topical Past Paper Questions
+ Answer Scheme

2016 - 2021



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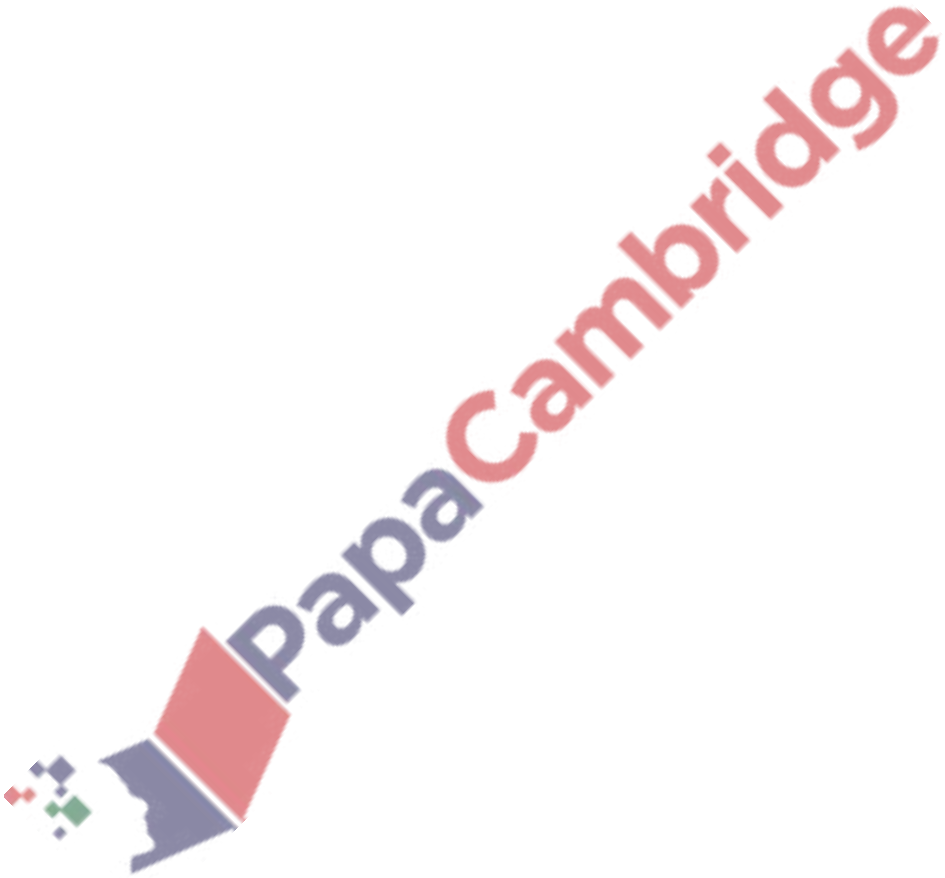
Chapter 11

Electronics



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218. 9702_s21_qp_42 Q: 7

(a) Two properties of an ideal operational amplifier (op-amp) are infinite input impedance and infinite bandwidth.

State what is meant by:

(i) *infinite input impedance*

.....

..... [1]

(ii) *infinite bandwidth*.

.....

..... [1]

(b) A student uses a negative temperature coefficient thermistor in the circuit of Fig. 7.1 to indicate changes in temperature.

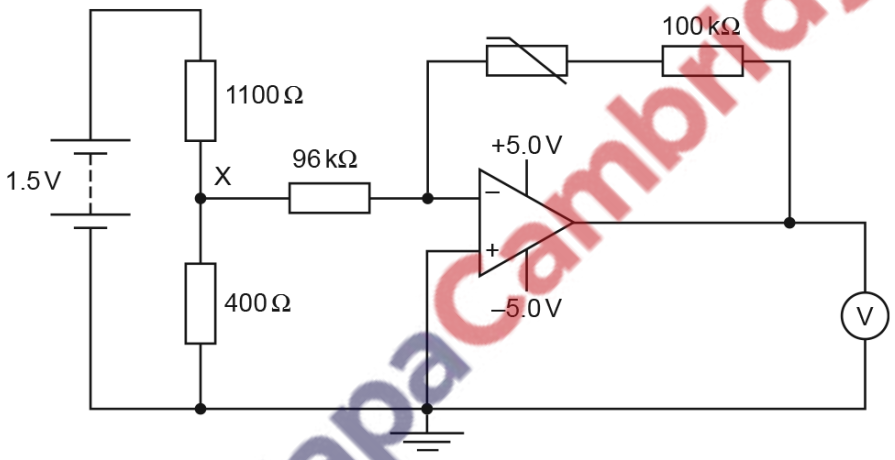

Fig. 7.1

(i) Show that the potential at point X is 0.40 V.

[1]

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(ii) The thermistor has a resistance of 360 kΩ at a particular temperature.

For this temperature of the thermistor, calculate the magnitude of the reading on the voltmeter.

voltmeter reading = ... V [3]

(iii) The temperature of the thermistor increases.

State and explain the effect of this change on the magnitude of the reading on the voltmeter.

.....

.....

..... [2]

(iv) Explain why the amplifier circuit will no longer indicate temperature changes when the magnitude of the gain of the circuit is greater than 12.5.

.....

..... [1]

[Total: 9]

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219. 9702_w21_qp_42 Q: 7

(a) An operational amplifier (op-amp) has two input terminals and one output terminal.

State what is meant by the *gain* of an op-amp.

.....

.....

..... [2]

(b) State **two** effects of negative feedback on the gain of an amplifier circuit that uses an op-amp.

1. .....

.....

2. .....

.....

[2]

(c) Fig. 7.1 shows an op-amp circuit that uses negative feedback.

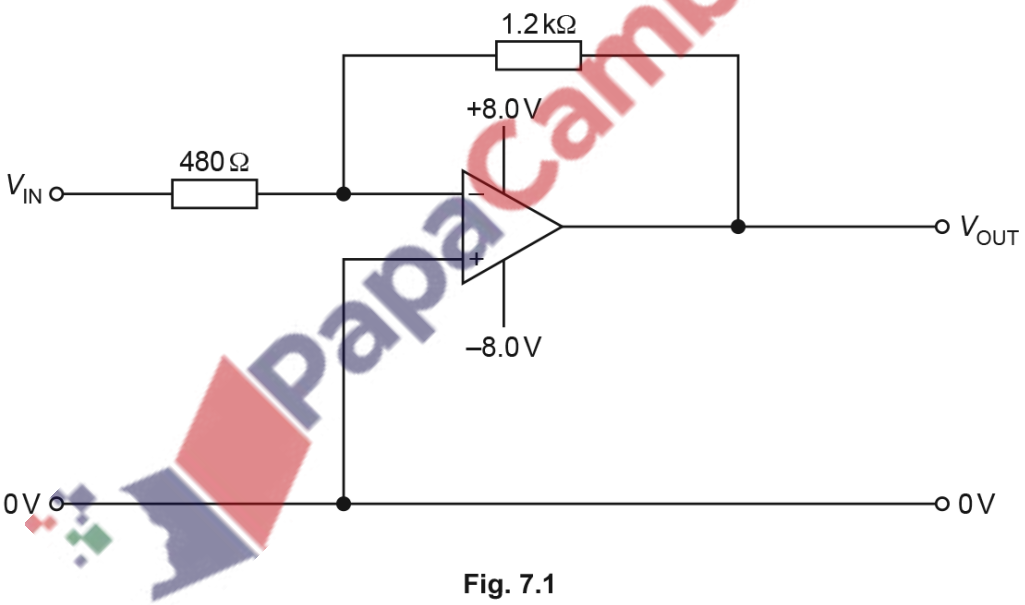

Fig. 7.1

(i) State the name of the type of circuit shown in Fig. 7.1.

..... [1]

(ii) On Fig. 7.1, label with the letter X a point in the circuit that is considered to be a virtual earth. [1]

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(iii) Calculate the gain of the circuit in Fig. 7.1.

gain = ... [2]

(iv) Determine the value of V_{IN} when V_{OUT} is +6.5 V.

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

(v) Determine the value of V_{OUT} when V_{IN} is –5.4 V.

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

[Total: 10]

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220. 9702_w21_qp_43 Q: 7

(a) State **two** properties of an ideal operational amplifier (op-amp).

1. .....

.....

2. .....

.....
[2]

(b) Fig. 7.1 shows a circuit that includes an ideal op-amp and two identical resistors R.

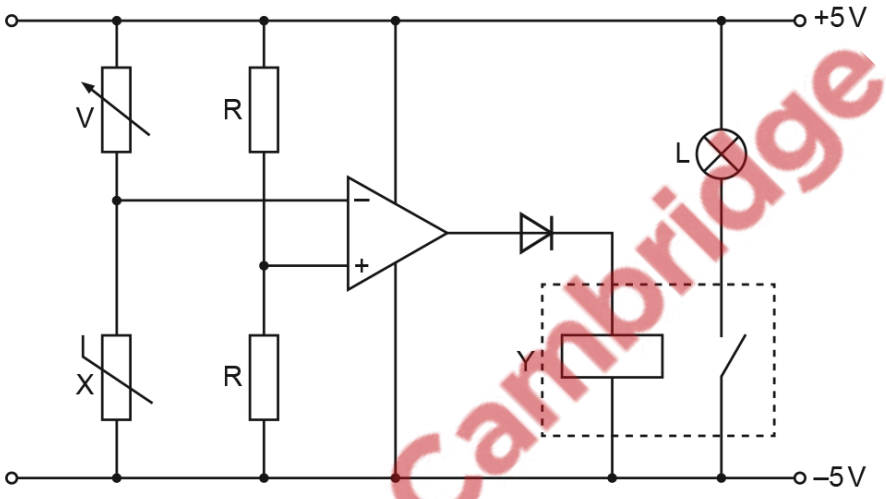

Fig. 7.1

State the names of components X and Y.

X: ..... Y: ..... [1]

(c) **(i)** Explain why the op-amp in Fig. 7.1 has only two possible output states.

.....

.....

.....

..... [2]

(ii) State the name of the type of op-amp circuit in which the op-amp behaves as in **(c)(i)**.

..... [1]

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(iii) Describe the environmental condition under which the lamp L in Fig. 7.1 will light.

.....

.....

..... [2]

(iv) Suggest the purpose of the variable resistor V in the circuit.

.....

..... [1]

[Total: 9]

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221. 9702_s20_qp_42 Q: 8

(a) An ideal operational amplifier (op-amp) is connected to a load resistor.
The op-amp is assumed to have infinite bandwidth and zero output resistance.

State:

(i) what is meant by *infinite bandwidth*

.....

..... [1]

(ii) the effect, if any, on the output voltage of increasing the load resistance.

.....

..... [1]

(b) A student designs the circuit shown in Fig. 8.1 in order to indicate changes in temperature of the thermistor T.

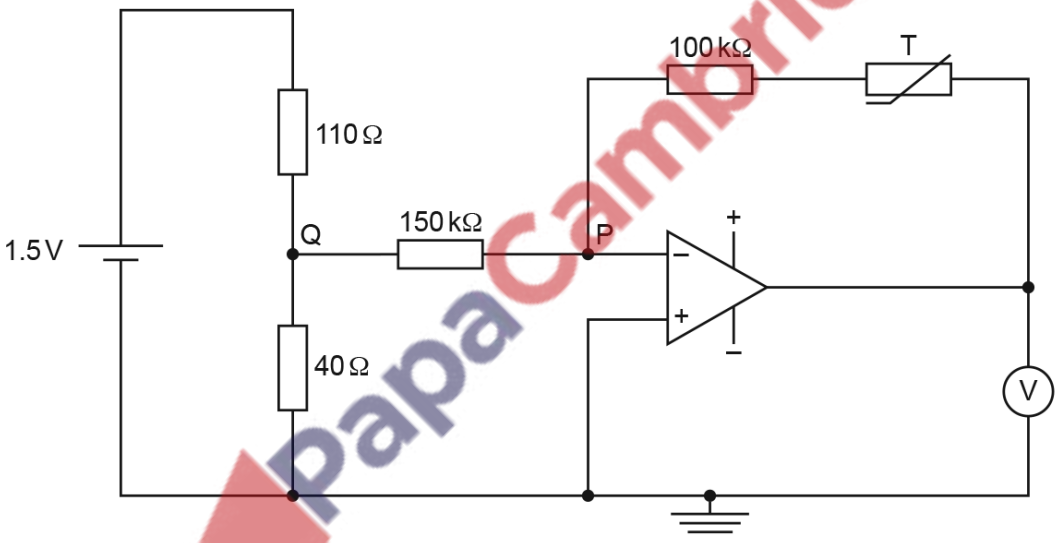

Fig. 8.1

(i) Explain why point P is known as a *virtual earth*.

.....

.....

.....

..... [3]

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(ii) Calculate the potential at point Q.

potential = ... V [2]

(iii) At a temperature of 13 °C, the resistance of the thermistor T is 230 kΩ.

Show that the potential difference measured with the voltmeter is 0.88 V.

[2]

(c) The resistance of the thermistor T in **(b)** decreases as its temperature rises.

Explain the effect of this change in temperature on the potential difference measured with the voltmeter.

.....

.....

..... [2]

[Total: 11]

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222. 9702_s20_qp_43 Q: 7

The output of a microphone is processed using a non-inverting amplifier. The amplifier incorporates an operational amplifier (op-amp).

(a) State, by reference to the input and output signals, the function of a non-inverting amplifier.

.....

.....

..... [2]

(b) The circuit for the microphone and amplifier is shown in Fig. 7.1.

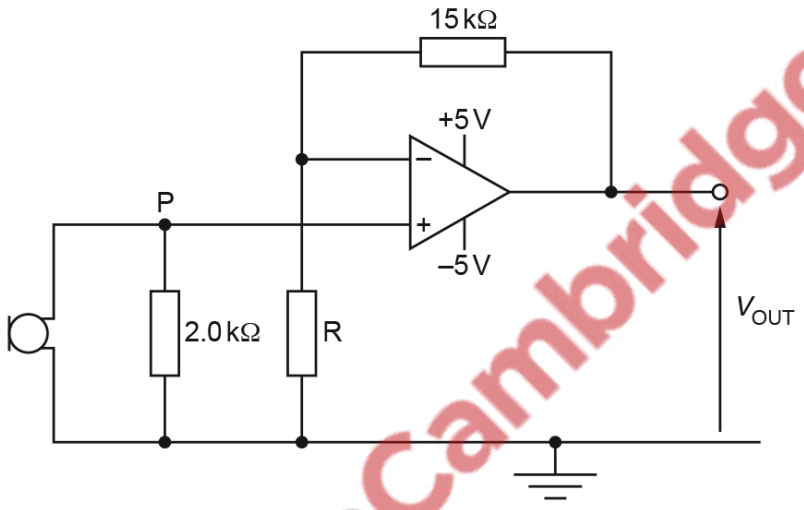

Fig. 7.1

The output potential difference V_{OUT} is 2.6 V when the potential at point P is 84 mV.

Determine:

(i) the gain of the amplifier circuit

gain = ... [1]

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(ii) the resistance of resistor R.

resistance = ... Ω [2]

(c) For the circuit of Fig. 7.1:

(i) suggest a suitable device to connect to the output such that the shape of the waveform of the sound received by the microphone may be examined

..... [1]

(ii) state and explain the effect on the output potential difference V_{OUT} of increasing the resistance of resistor R.

.....

.....

..... [2]

[Total: 8]

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223. 9702_m19_qp_42 Q: 7

(a) Two properties that an ideal operational amplifier (op-amp) would have are constant voltage gain and infinite slew rate.

State what is meant by:

(i) *gain* of an amplifier

.....

..... [1]

(ii) *infinite slew rate*.

.....

.....

..... [2]

(b) The partially completed circuit of a non-inverting amplifier, incorporating an ideal op-amp, is shown in Fig. 7.1.

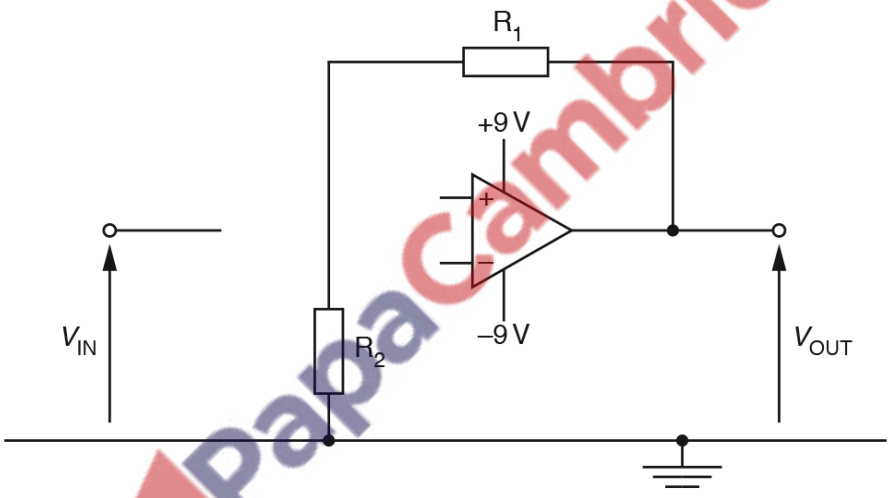

Fig. 7.1

(i) On Fig. 7.1, complete the circuit for the non-inverting amplifier. [2]

(ii) For the completed circuit of Fig. 7.1, the gain of the amplifier is 25. The resistance of resistor R_1 is 12 kΩ.

Calculate the resistance of resistor R_2.

resistance = ... Ω [2]

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(iii) Calculate, for the amplifier gain of 25, the range of values of V_{IN} for which the amplifier does not saturate.

range from ..... V to ..... V [2]

[Total: 9]

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224. 9702_s19_qp_42 Q: 9

Part of a circuit incorporating an operational amplifier (op-amp) is shown in Fig. 9.1.

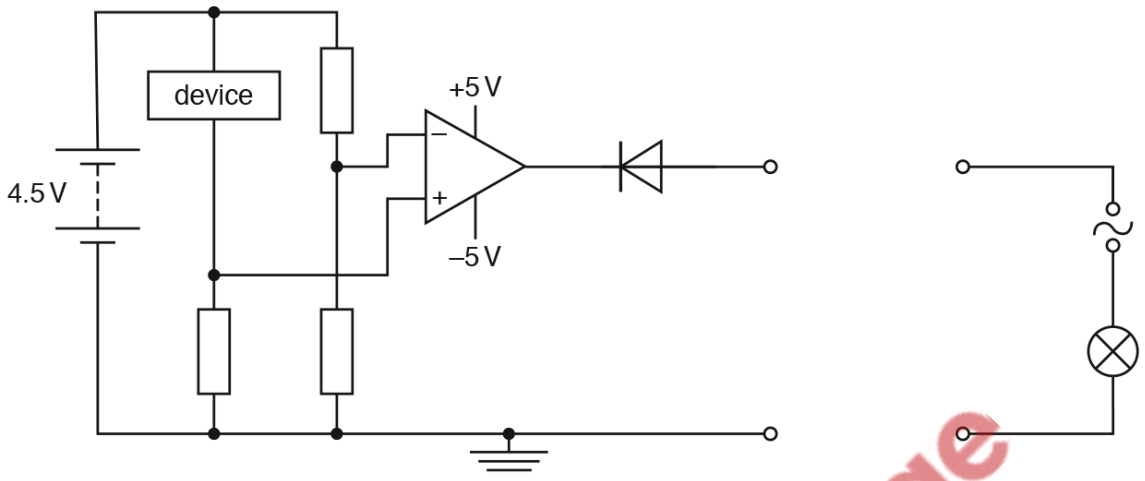

Fig. 9.1

(a) A relay is connected to the output of the op-amp circuit so that a lamp may be switched on or off.

(i) Complete Fig. 9.1 to show the relay connected into the circuit. [2]

(ii) State and explain whether the output of the op-amp is positive or negative for the lamp to be switched on.

.....

.....

.....[2]

(b) State the device in Fig. 9.1 that could be used so that the circuit indicates a change in:

(i) the bending of a rod

.....[1]

(ii) the level of daylight to switch on a street light.

.....[1]

[Total: 6]

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225. 9702_w18_qp_41 Q: 7

(a) An ideal operational amplifier (op-amp) has infinite bandwidth and infinite slew rate.

State what is meant by

(i) *infinite bandwidth*,

.....

.....

.....[2]

(ii) *infinite slew rate*.

.....

.....

.....[2]

(b) An incomplete circuit for a non-inverting amplifier incorporating an ideal operational amplifier is shown in Fig. 7.1.

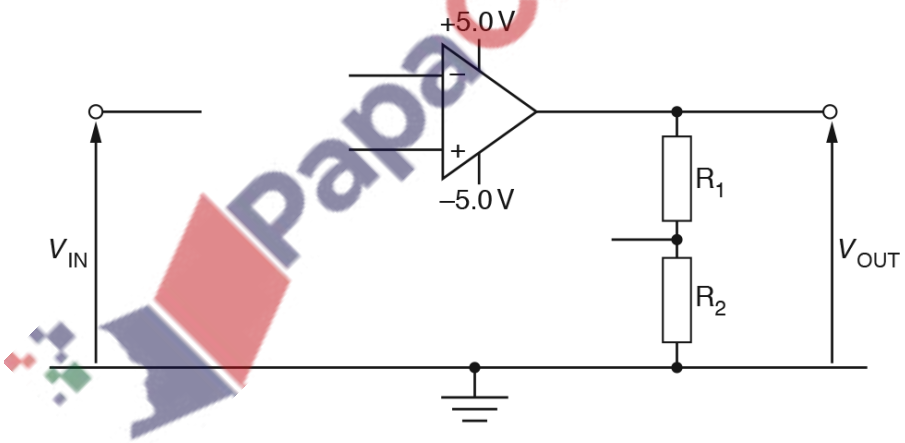

Fig. 7.1

On Fig. 7.1, draw lines to show the connections between the components to complete the circuit. [2]

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(c) The completed amplifier of Fig. 7.1 has a voltage gain of 10.

State the output voltage V_{OUT} for an input voltage V_{IN} of

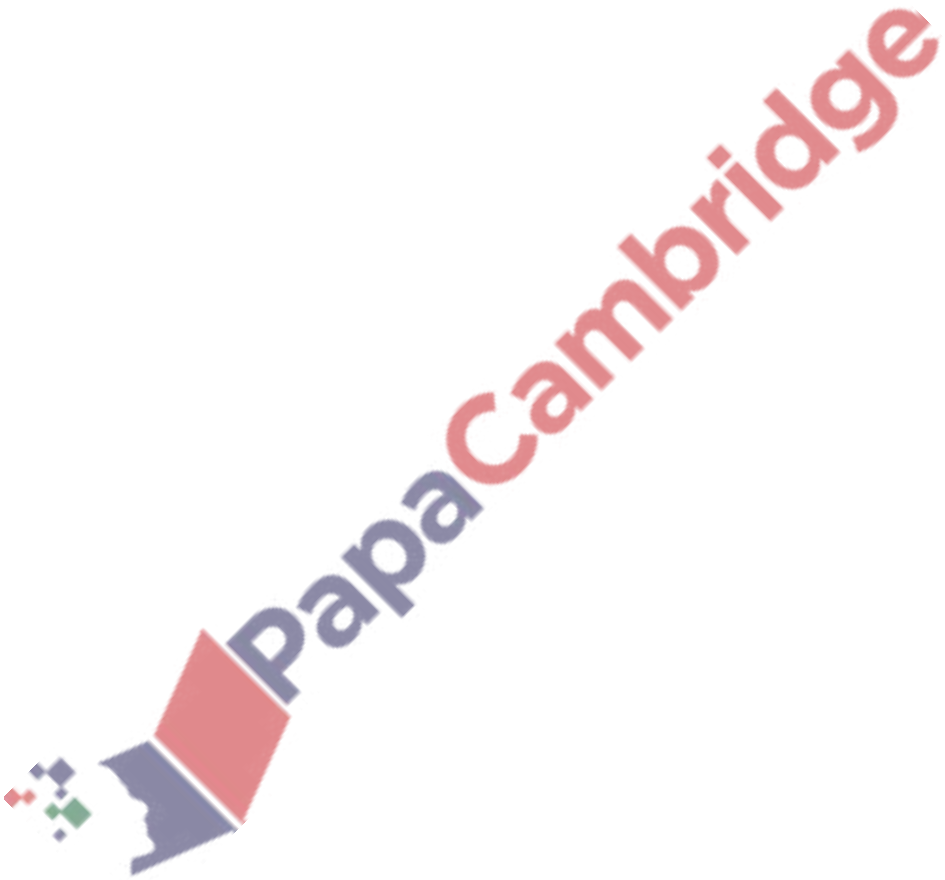
(i) –0.36 V,

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

(ii) 0.56 V.

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

[Total: 8]



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226. 9702_w18_qp_43 Q: 7

(a) An ideal operational amplifier (op-amp) has infinite bandwidth and infinite slew rate.

State what is meant by

(i) *infinite bandwidth*,

.....

.....

.....[2]

(ii) *infinite slew rate*.

.....

.....

.....[2]

(b) An incomplete circuit for a non-inverting amplifier incorporating an ideal operational amplifier is shown in Fig. 7.1.

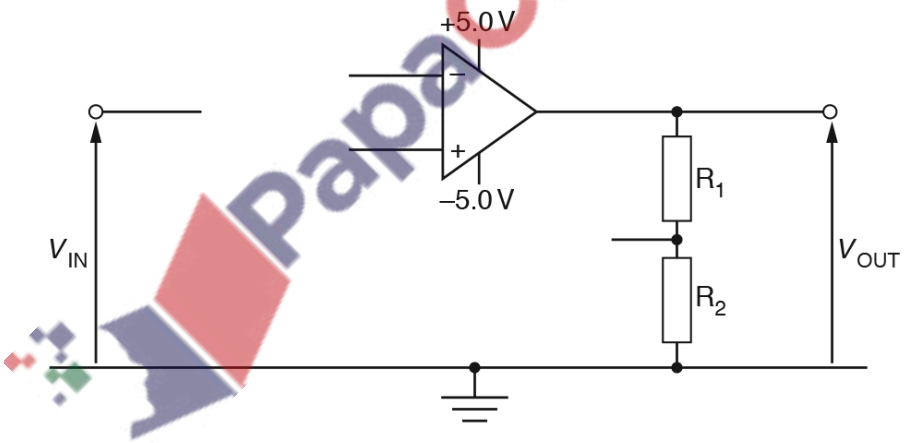

Fig. 7.1

On Fig. 7.1, draw lines to show the connections between the components to complete the circuit. [2]

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(c) The completed amplifier of Fig. 7.1 has a voltage gain of 10.

State the output voltage V_{OUT} for an input voltage V_{IN} of

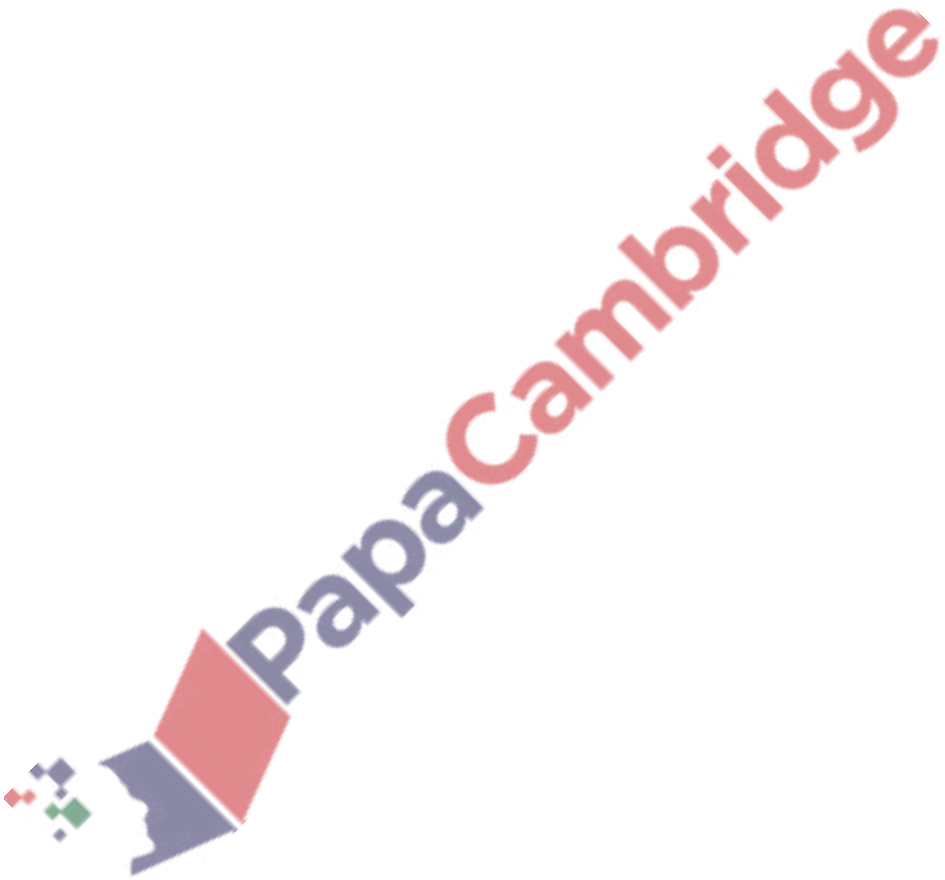
(i) –0.36 V,

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

(ii) 0.56 V.

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

[Total: 8]



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227. 9702_s17_qp_41 Q: 6

A comparator circuit is designed to switch on a mains lamp when the ambient light level reaches a set value.
An incomplete diagram of the circuit is shown in Fig. 6.1.

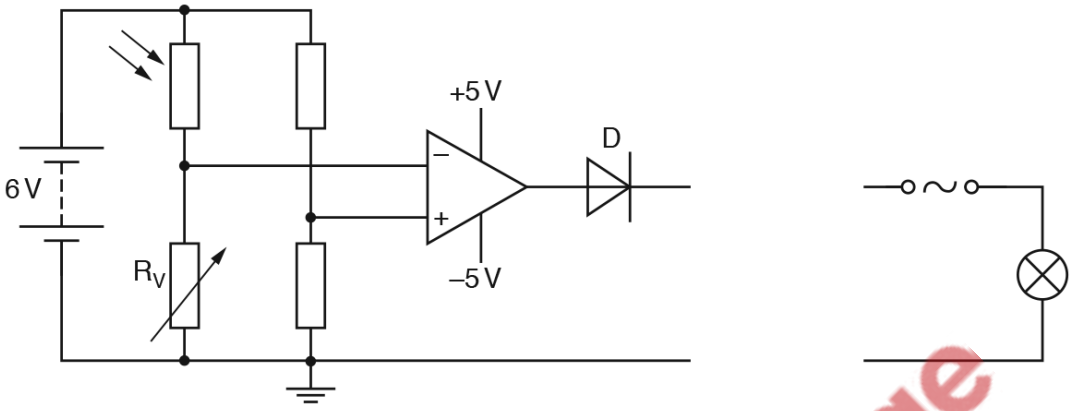

Fig. 6.1

(a) **(i)** A relay is required as part of the output device. This is not shown in Fig. 6.1. Explain why a relay is required.

.....

.....

.....[2]

(ii) On Fig. 6.1, draw the symbol for a relay connected in the circuit as part of the output device. [2]

(b) Describe the function of

(i) the variable resistor R_V,

.....

.....[1]

(ii) the diode D.

.....

.....[1]

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(c) State whether the lamp will switch on as the light level increases or as it decreases. Explain your answer.

.....

.....

.....

.....

.....[3]

[Total: 9]

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228. 9702_s17_qp_43 Q: 6

A comparator circuit is designed to switch on a mains lamp when the ambient light level reaches a set value.
An incomplete diagram of the circuit is shown in Fig. 6.1.

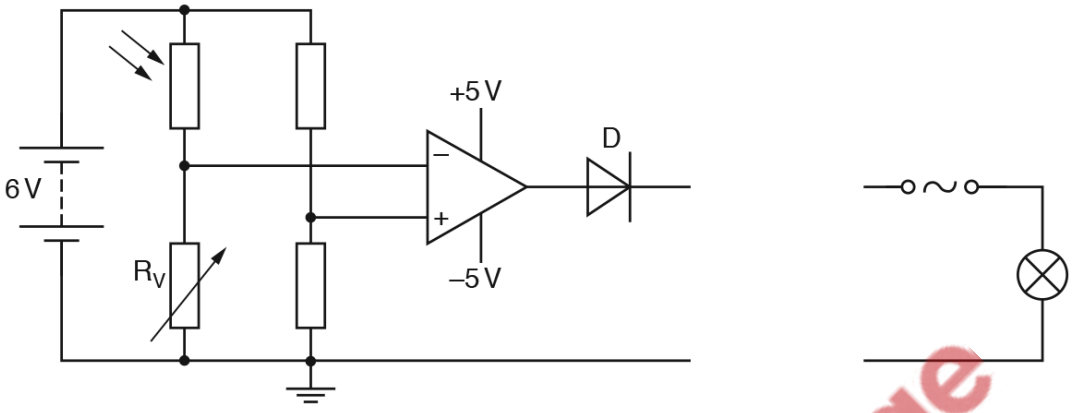

Fig. 6.1

(a) **(i)** A relay is required as part of the output device. This is not shown in Fig. 6.1. Explain why a relay is required.

.....

.....

.....[2]

(ii) On Fig. 6.1, draw the symbol for a relay connected in the circuit as part of the output device. [2]

(b) Describe the function of

(i) the variable resistor R_V,

.....

.....[1]

(ii) the diode D.

.....

.....[1]

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(c) State whether the lamp will switch on as the light level increases or as it decreases. Explain your answer.

.....

.....

.....

.....

.....[3]

[Total: 9]

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229. 9702_w17_qp_41 Q: 7

The circuit of an amplifier incorporating an ideal operational amplifier (op-amp) is shown in Fig. 7.1.

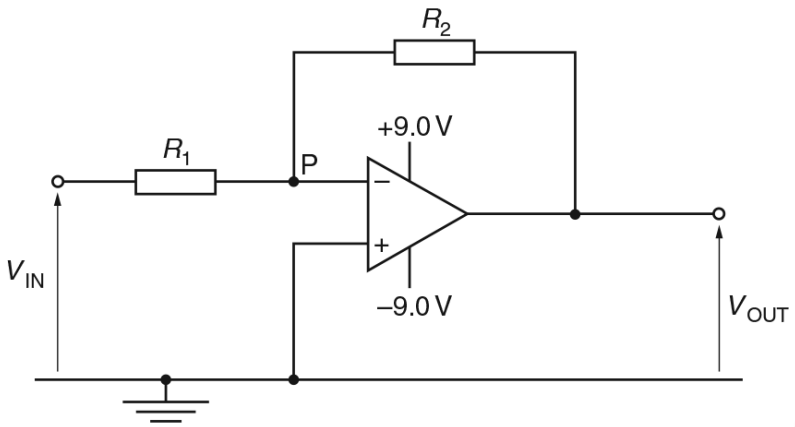

Fig. 7.1

(a) By reference to the properties of an ideal op-amp,

(i) explain why point P is referred to as a *virtual earth*,

.....

.....

.....

.....

..... [4]

(ii) derive an expression, in terms of the resistances R_1 and R_2, for the gain of the amplifier circuit.

[4]

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(b) In the circuit of Fig. 7.1, the ratio $\frac{R_2}{R_1}$ is 4.5.

The variation with time t of the input potential V_{IN} is shown in Fig. 7.2.

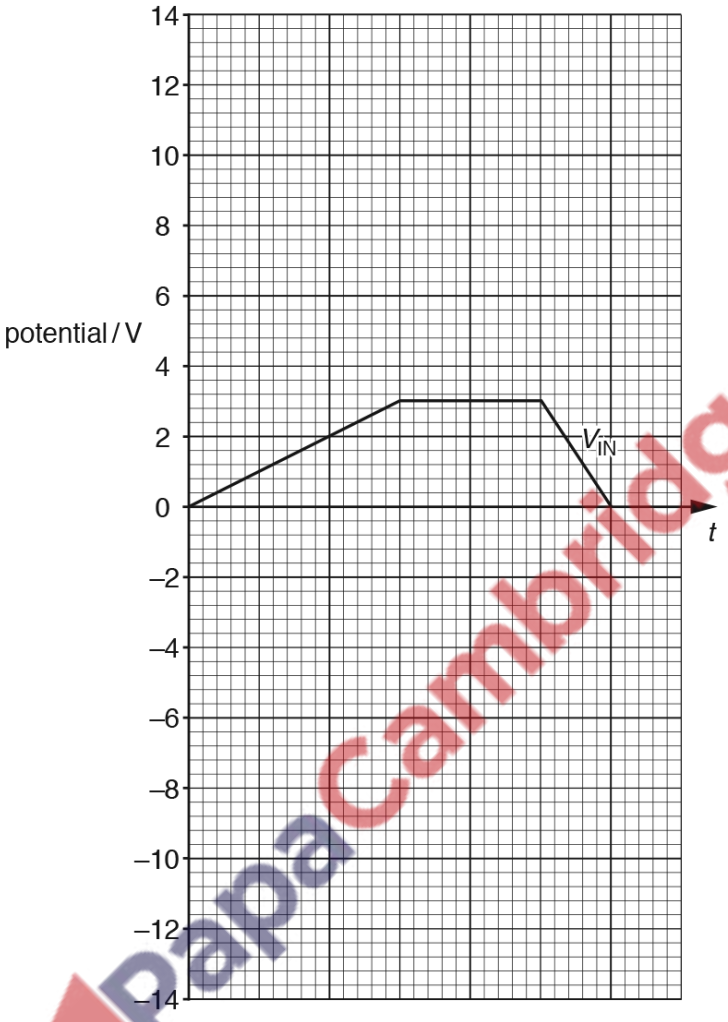

Fig. 7.2

On Fig. 7.2, show the variation with time t of the output potential V_{OUT}. [3]

[Total: 11]

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(a) Feedback is used frequently in amplifier circuits.

State

(i) what is meant by *feedback*,

.....

.....

.....[2]

(ii) two benefits of negative feedback in an amplifier circuit.

1. .....

.....

2. .....

.....

[2]

(b) An amplifier circuit incorporating an ideal operational amplifier (op-amp) is used to amplify the output of a microphone. The circuit is shown in Fig. 7.1.

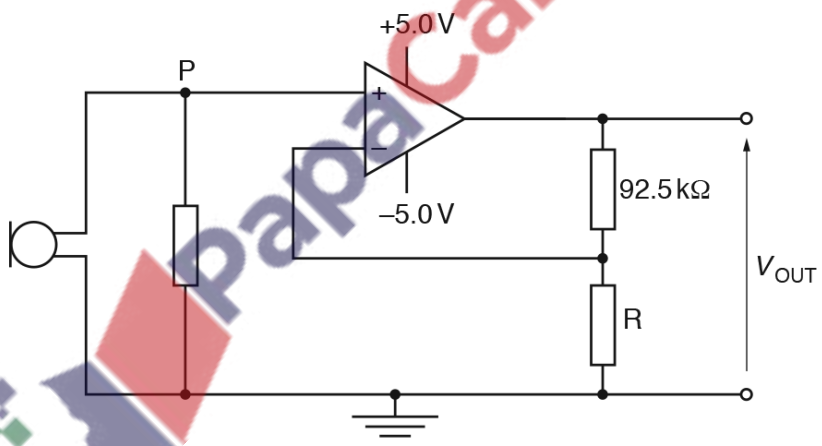

Fig. 7.1

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When the potential at point P is 48 mV, the output potential difference V_{OUT} is 3.6 V.

(i) Determine

1. the gain of the amplifier circuit,

gain = ... [2]

2. the resistance of resistor R.

resistance = ... Ω [2]

(ii) State and explain the effect on the amplifier output when the potential at P exceeds 68 mV.

.....

.....

.....[2]

[Total: 10]

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231. 9702_w17_qp_43 Q: 7

The circuit of an amplifier incorporating an ideal operational amplifier (op-amp) is shown in Fig. 7.1.

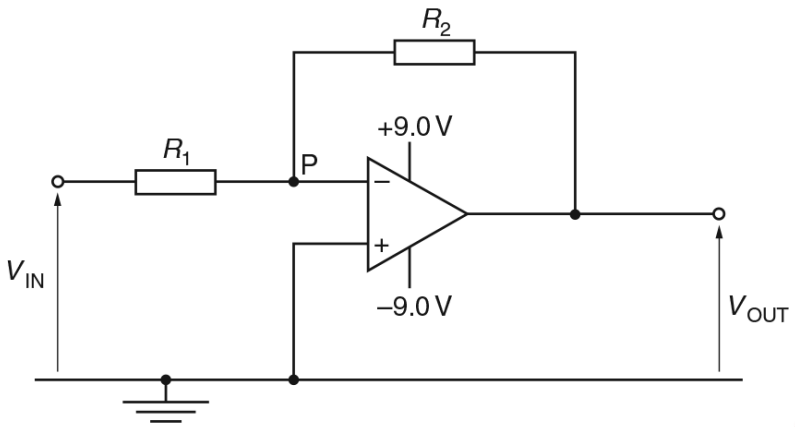

Fig. 7.1

(a) By reference to the properties of an ideal op-amp,

(i) explain why point P is referred to as a *virtual earth*,

.....

.....

.....

.....

..... [4]

(ii) derive an expression, in terms of the resistances R_1 and R_2, for the gain of the amplifier circuit.

[4]

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(b) In the circuit of Fig. 7.1, the ratio $\frac{R_2}{R_1}$ is 4.5.

The variation with time t of the input potential V_{IN} is shown in Fig. 7.2.

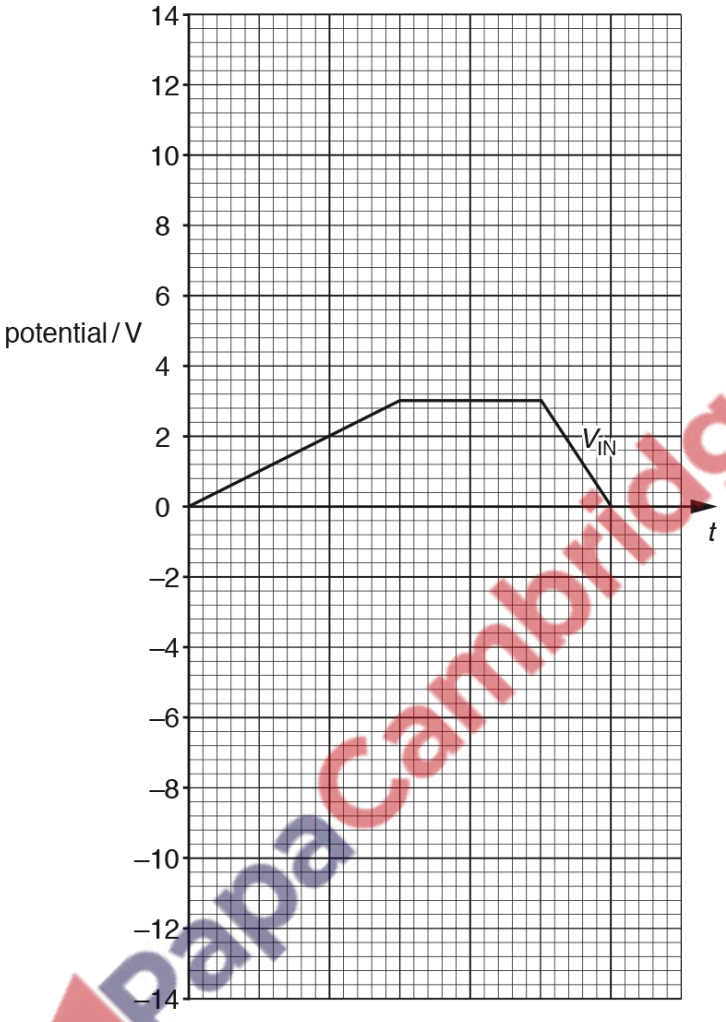

Fig. 7.2

On Fig. 7.2, show the variation with time t of the output potential V_{OUT}. [3]

[Total: 11]

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232. 9702_m16_qp_42 Q: 8

(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 diagram of an amplifier circuit incorporating an ideal operational amplifier is shown in Fig. 8.1.

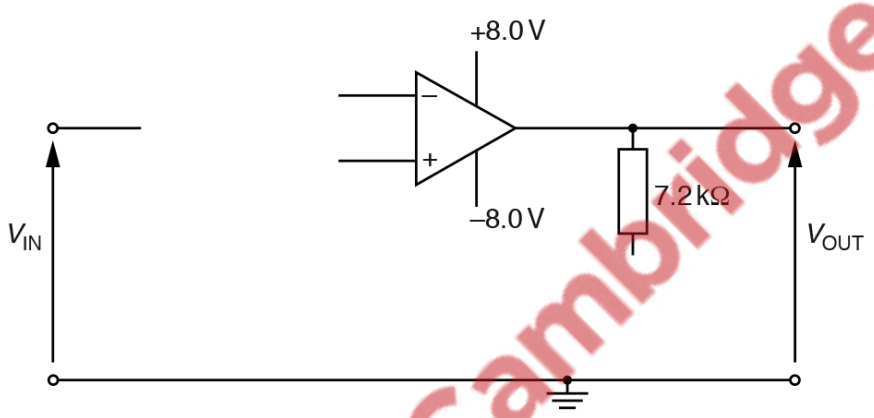

Fig. 8.1

The amplifier has a voltage gain of +5.0.

(i) Complete the circuit diagram of Fig. 8.1. [2]

(ii) Calculate the resistance of any additional resistor you have drawn on Fig. 8.1.

resistance = ... kΩ [2]

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(iii) Fig. 8.2 shows the variation with time of the input potential V_{IN}.

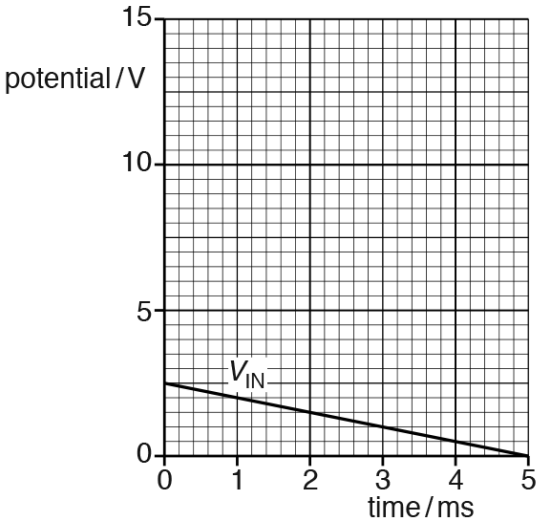

Fig. 8.2

On Fig. 8.2, draw the variation with time of the output potential V_{OUT}. [2]

[Total: 8]

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233. 9702_w16_qp_42 Q: 8

A circuit incorporating an ideal operational amplifier (op-amp) is shown in Fig. 8.1.

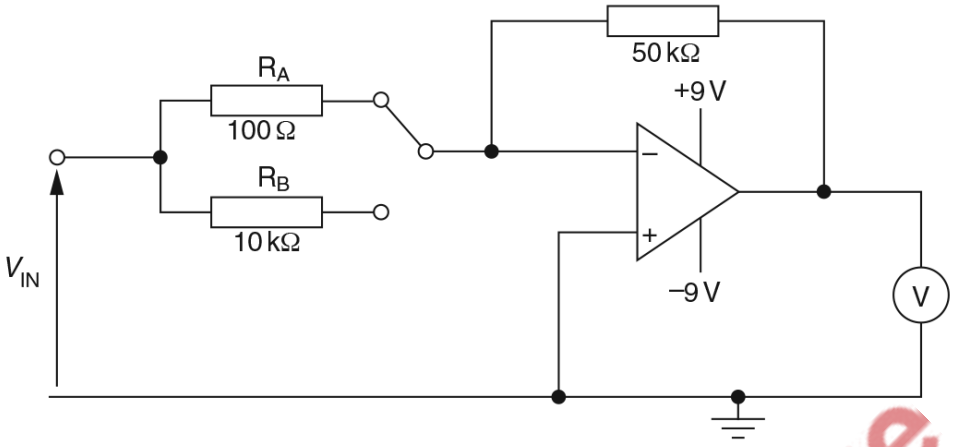

Fig. 8.1

The supply to the op-amp is +9 V/–9 V.
The output of the amplifier is measured using a voltmeter having a range 0 – 5.0 V.

A switch enables the inverting input to the op-amp to be connected to either resistor R_A or resistor R_B.

(a) A positive potential $+V_{IN}$ is applied to the input to the circuit.

On Fig. 8.1, mark with the letter P the positive connection of the voltmeter such that the voltmeter shows a positive reading. [1]

(b) Calculate the potential V_{IN} such that the voltmeter has a full-scale deflection when the inverting input to the op-amp is connected to

(i) resistor R_A of resistance 100 Ω,

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

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(ii) resistor R_B of resistance 10 kΩ.

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

(c) Suggest a use for this type of circuit.

.....

.....[1]

[Total: 5]

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234. 9702_m21_qp_42 Q: 7

(a) Fig. 7.1 shows the circuit diagram containing an operational amplifier (op-amp).

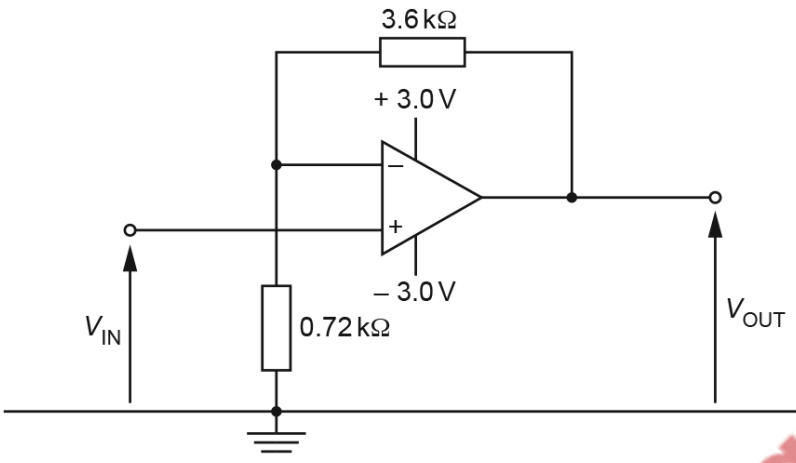

Fig. 7.1

(i) State the name of this type of amplifier.

..... [1]

(ii) Show that the gain of the amplifier is 6.0.

[1]

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(iii) At time $t = 0$ the input potential V_{IN} is zero. V_{IN} then gradually increases with time t as shown in Fig. 7.2.

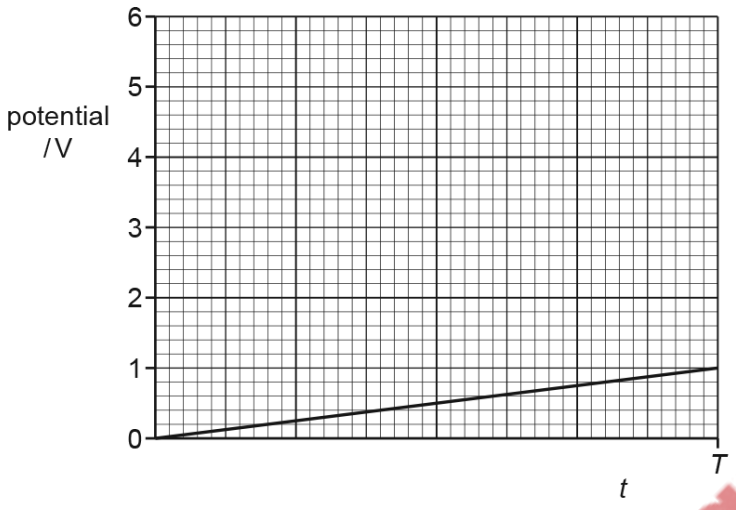

Fig. 7.2

On Fig. 7.2 sketch a line to show the variation with time t of the output potential V_{OUT} from time $t = 0$ to time $t = T$. [2]

(iv) State how the circuit of Fig. 7.1 may be changed so that the gain of the amplifier is dependent on light intensity.

.....

..... [1]

(b) An op-amp is to be used to switch on a high-voltage heater.

(i) State the name of the component used as the output device of the op-amp.

..... [1]

(ii) Complete Fig. 7.3 using the device named in **(i)** and a diode so that the heater may be switched on when the output of the op-amp is positive.

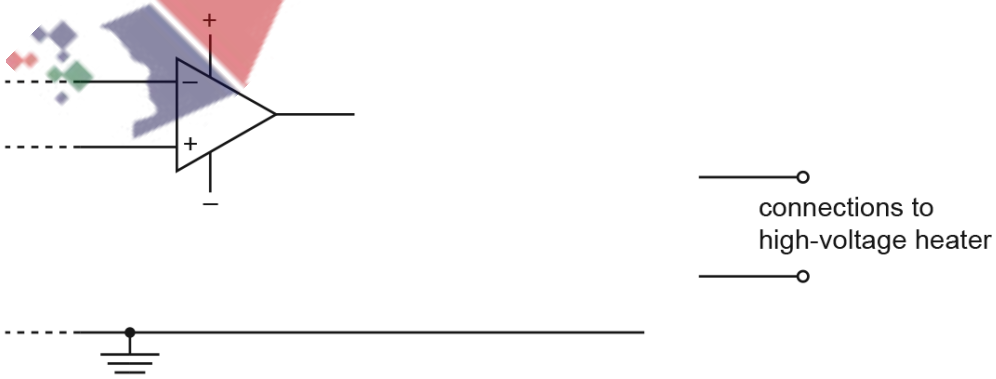

Fig. 7.3

[3]

[Total: 9]

235. 9702_s21_qp_41 Q: 8

The variation with temperature of the resistance of a thermistor is shown in Fig. 8.1.

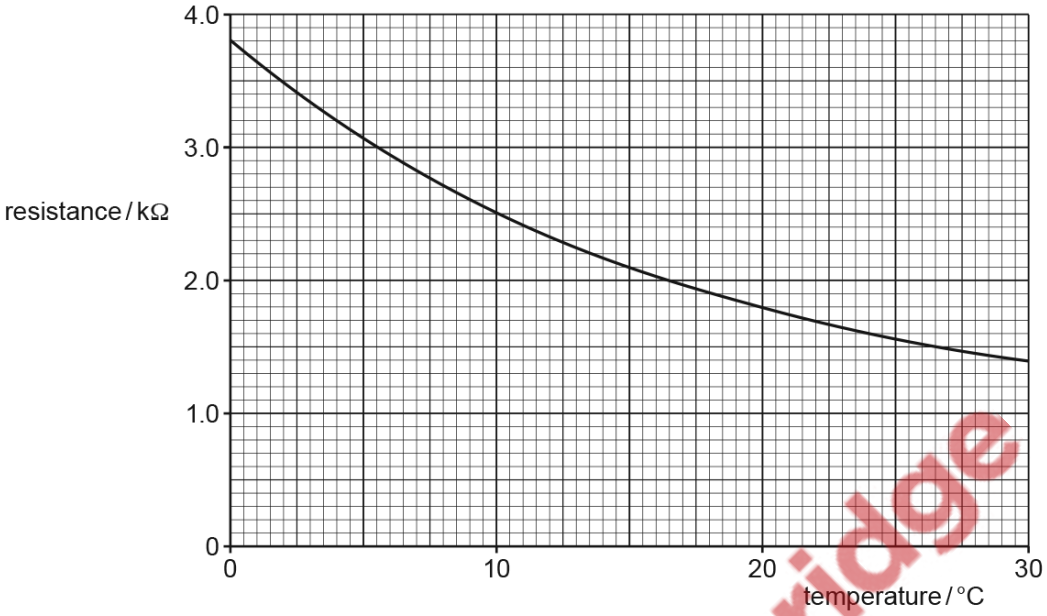

Fig. 8.1

A student includes the thermistor and an ideal operational amplifier (op-amp) in the circuit of Fig. 8.2.

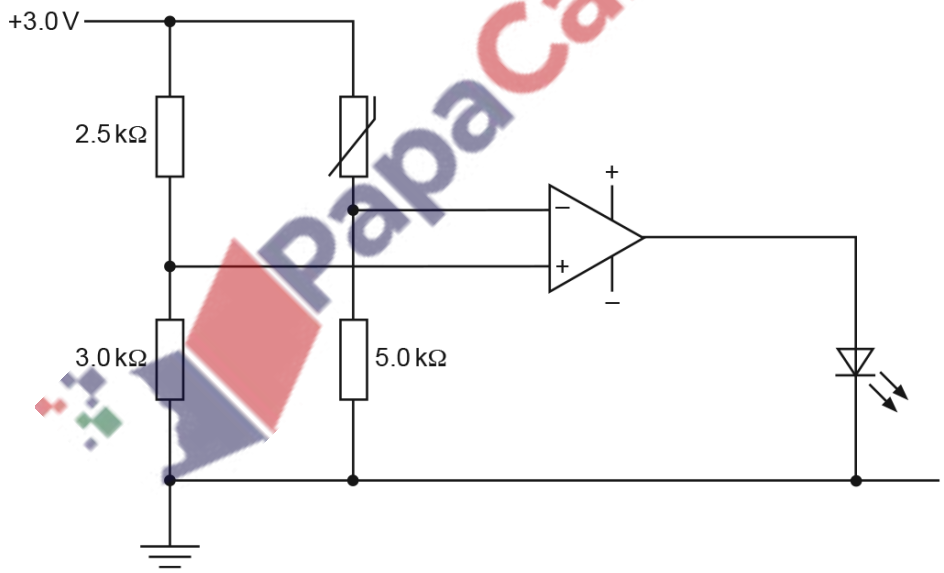

Fig. 8.2

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(a) Calculate the potential V^+ at the non-inverting input of the op-amp.

V^+ = ... V [2]

(b) At 10 °C, the resistance of the thermistor is 2.5 kΩ.

State and explain whether the light-emitting diode (LED) is emitting light.

.....

.....

..... [2]

(c) Explain why the student's circuit will not indicate any change in temperature above 0 °C.

.....

.....

..... [2]

(d) The resistor of resistance 5.0 kΩ is changed to a resistor of resistance R so that the LED switches on or off at a temperature of 20 °C.

Determine R in kΩ.

R = ... kΩ [3]

[Total: 9]

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236. 9702_s21_qp_43 Q: 8

The variation with temperature of the resistance of a thermistor is shown in Fig. 8.1.

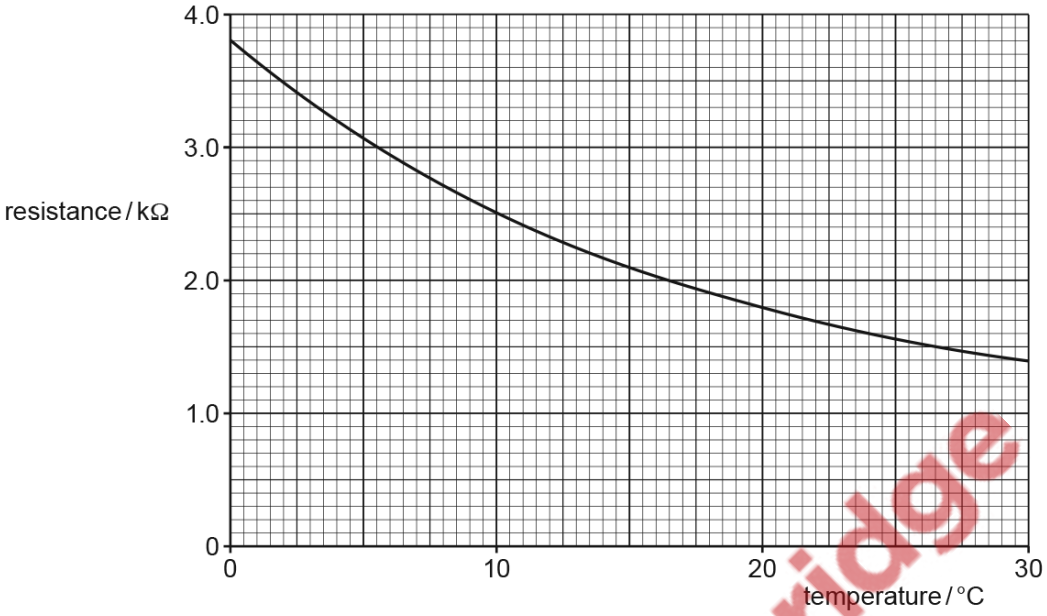

Fig. 8.1

A student includes the thermistor and an ideal operational amplifier (op-amp) in the circuit of Fig. 8.2.

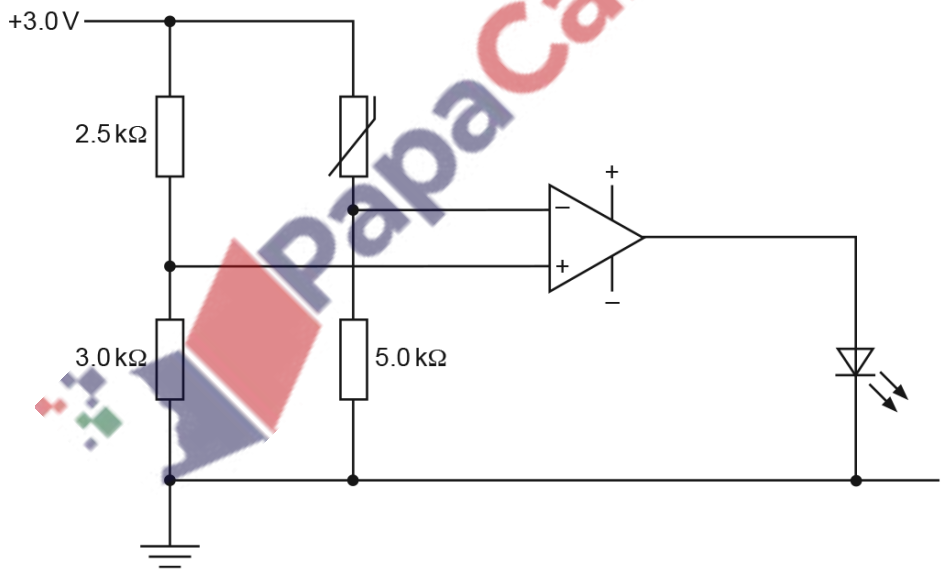

Fig. 8.2

PapaCambridge

(a) Calculate the potential V^+ at the non-inverting input of the op-amp.

V^+ = ... V [2]

(b) At 10 °C, the resistance of the thermistor is 2.5 kΩ.

State and explain whether the light-emitting diode (LED) is emitting light.

.....

.....

..... [2]

(c) Explain why the student's circuit will not indicate any change in temperature above 0 °C.

.....

.....

..... [2]

(d) The resistor of resistance 5.0 kΩ is changed to a resistor of resistance R so that the LED switches on or off at a temperature of 20 °C.

Determine R in kΩ.

R = ... kΩ [3]

[Total: 9]

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(a) State **two** properties of an ideal operational amplifier (op-amp).

1. .....

.....

2. .....

.....

[2]

(b) Fig. 7.1 shows a circuit that includes an ideal op-amp and two identical resistors R.

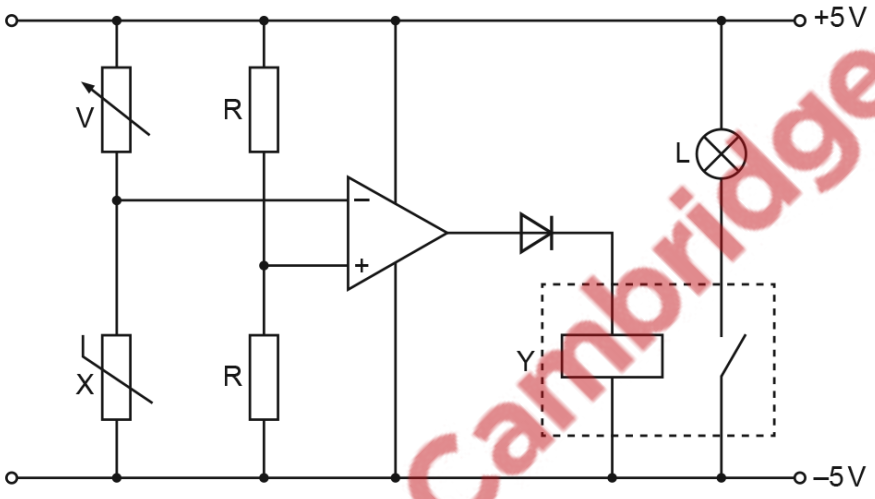

Fig. 7.1

State the names of components X and Y.

X: ..... Y: ..... [1]

(c) **(i)** Explain why the op-amp in Fig. 7.1 has only two possible output states.

.....

.....

.....

..... [2]

(ii) State the name of the type of op-amp circuit in which the op-amp behaves as in **(c)(i)**.

..... [1]

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(iii) Describe the environmental condition under which the lamp L in Fig. 7.1 will light.

.....

.....

..... [2]

(iv) Suggest the purpose of the variable resistor V in the circuit.

.....

..... [1]

[Total: 9]

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238. 9702_s20_qp_41 Q: 7

The output of a microphone is processed using a non-inverting amplifier. The amplifier incorporates an operational amplifier (op-amp).

(a) State, by reference to the input and output signals, the function of a non-inverting amplifier.

.....

.....

..... [2]

(b) The circuit for the microphone and amplifier is shown in Fig. 7.1.

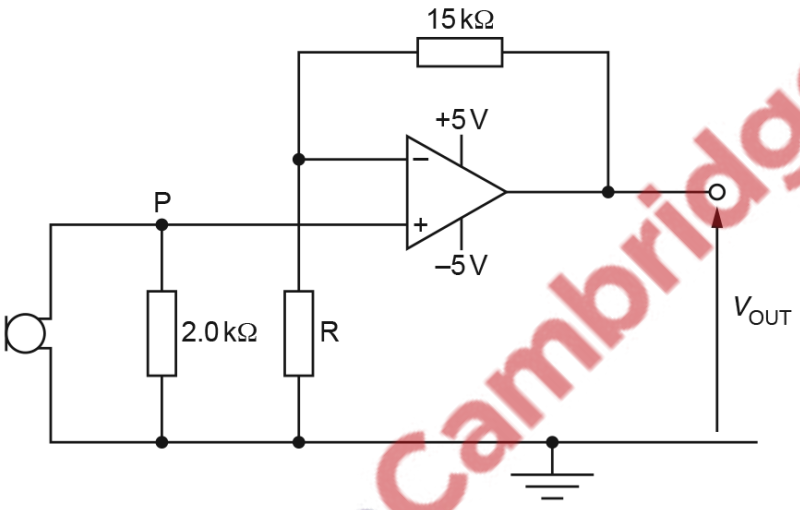

Fig. 7.1

The output potential difference V_{OUT} is 2.6 V when the potential at point P is 84 mV.

Determine:

(i) the gain of the amplifier circuit

gain = ... [1]

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(ii) the resistance of resistor R.

resistance = ... Ω [2]

(c) For the circuit of Fig. 7.1:

(i) suggest a suitable device to connect to the output such that the shape of the waveform of the sound received by the microphone may be examined

..... [1]

(ii) state and explain the effect on the output potential difference V_{OUT} of increasing the resistance of resistor R.

.....

.....

..... [2]

[Total: 8]

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239. 9702_s19_qp_41 Q: 7

The circuit for an inverting amplifier incorporating an ideal operational amplifier (op-amp) is shown in Fig. 7.1.

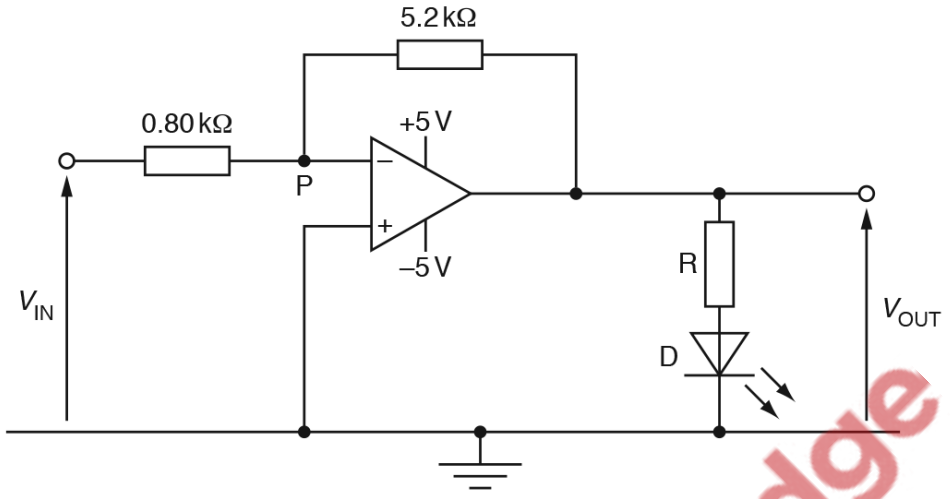

Fig. 7.1

(a) For the circuit of Fig. 7.1:

(i) explain why point P is known as a *virtual earth*

.....

.....

.....

..... [3]

(ii) calculate the gain of the amplifier.

gain = ... [2]

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(b) When the op-amp is saturated, the potential difference across the LED is 2.3 V.

Calculate the minimum resistance of resistor R so that the current in the LED is limited to 30 mA.

resistance = ... Ω [3]

[Total: 8]

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240. 9702_s19_qp_43 Q: 7

The circuit for an inverting amplifier incorporating an ideal operational amplifier (op-amp) is shown in Fig. 7.1.

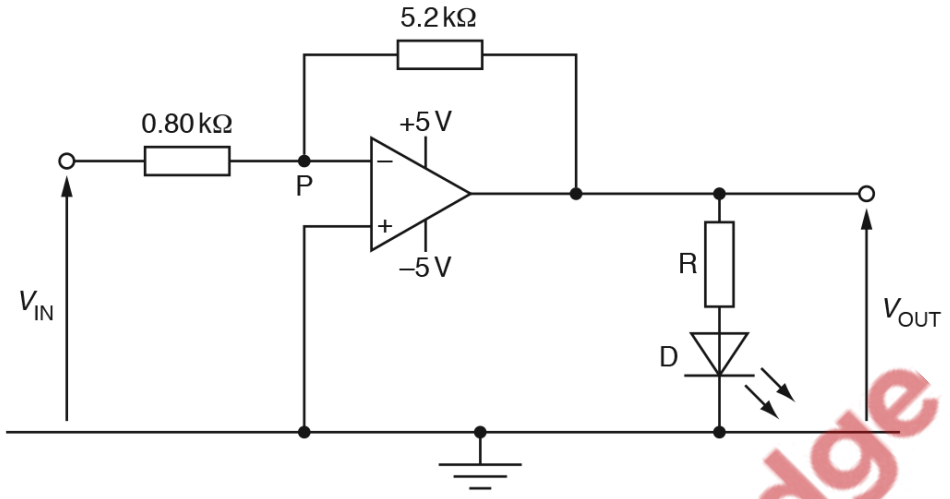

Fig. 7.1

(a) For the circuit of Fig. 7.1:

(i) explain why point P is known as a *virtual earth*

.....

.....

.....

..... [3]

(ii) calculate the gain of the amplifier.

gain = ... [2]

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(b) When the op-amp is saturated, the potential difference across the LED is 2.3 V.

Calculate the minimum resistance of resistor R so that the current in the LED is limited to 30 mA.

resistance = ... Ω [3]

[Total: 8]

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(a) An ideal operational amplifier (op-amp) has infinite bandwidth and zero output impedance.

State what is meant by:

(i) *infinite bandwidth*

.....

..... [1]

(ii) *zero output impedance*.

.....

..... [1]

(b) The circuit for a non-inverting amplifier incorporating an ideal op-amp is shown in Fig. 7.1.

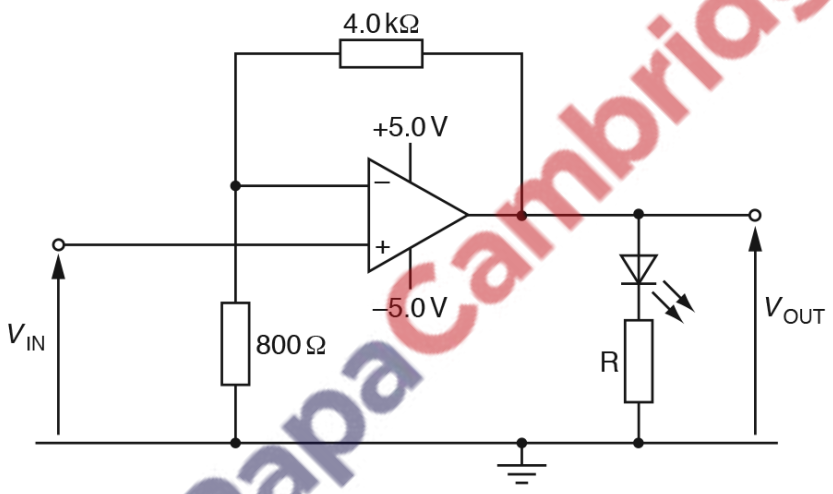

Fig. 7.1

The light-emitting diode (LED) emits light when the potential difference across it is at least 2.0 V.
The current in the LED must not be greater than 20 mA.

(i) Calculate the gain of the amplifier circuit.

gain = ... [2]

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(ii) Determine the value of V_{IN} for which the value of V_{OUT} is +2.0 V.

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

(iii) State the maximum value of the output potential V_{OUT}.

maximum potential = ... V [1]

(iv) When the op-amp is saturated, the potential difference across the LED is 2.2 V.

Calculate the minimum resistance of resistor R so that the current in the LED is limited to 20 mA.

resistance = ... Ω [2]

[Total: 8]

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(a) An ideal operational amplifier (op-amp) has infinite bandwidth and zero output impedance.

State what is meant by:

(i) *infinite bandwidth*

.....

..... [1]

(ii) *zero output impedance*.

.....

..... [1]

(b) The circuit for a non-inverting amplifier incorporating an ideal op-amp is shown in Fig. 7.1.

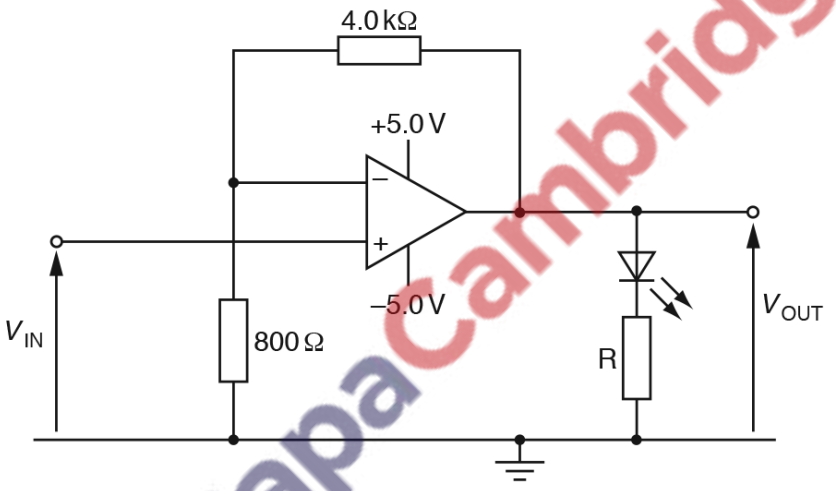

Fig. 7.1

The light-emitting diode (LED) emits light when the potential difference across it is at least 2.0 V.
The current in the LED must not be greater than 20 mA.

(i) Calculate the gain of the amplifier circuit.

gain = ... [2]

PapaCambridge

(ii) Determine the value of V_{IN} for which the value of V_{OUT} is +2.0 V.

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

(iii) State the maximum value of the output potential V_{OUT}.

maximum potential = ... V [1]

(iv) When the op-amp is saturated, the potential difference across the LED is 2.2 V.

Calculate the minimum resistance of resistor R so that the current in the LED is limited to 20 mA.

resistance = ... Ω [2]

[Total: 8]

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243. 9702_m18_qp_42 Q: 8

(a) Two properties of an ideal operational amplifier (op-amp) are infinite bandwidth and infinite slew rate.

Explain what is meant by

(i) infinite bandwidth,

.....

.....[1]

(ii) infinite slew rate.

.....

.....[1]

(b) An ideal op-amp is incorporated into the circuit of Fig. 8.1.

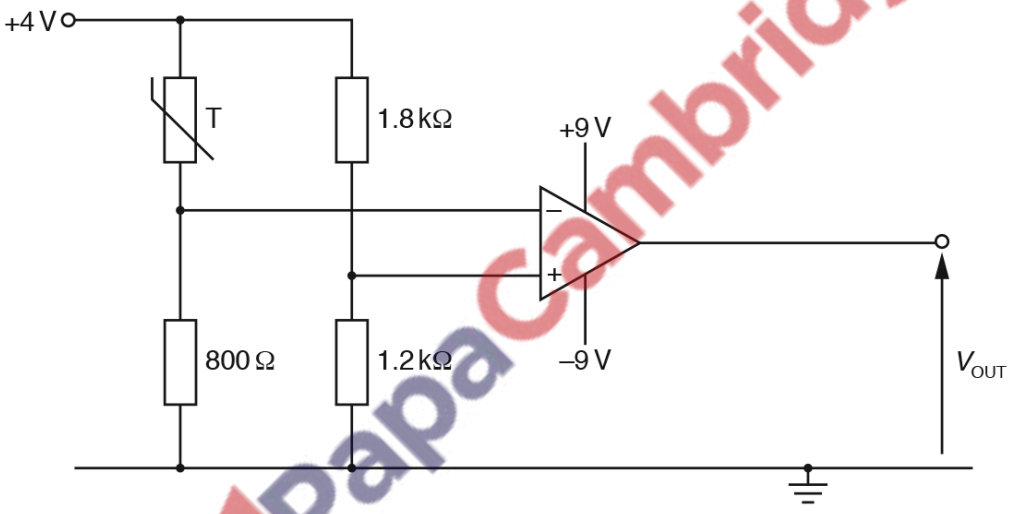

Fig. 8.1

(i) Determine the resistance R_T of the thermistor T at which the output potential difference V_{OUT} is zero.

R_T = ...Ω [1]

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(ii) The temperature of the thermistor is gradually increased so that its resistance decreases from $1.5R_T$ to $0.5R_T$.

On Fig. 8.2, draw a line to show the variation of the output potential difference V_{OUT} with the thermistor resistance.

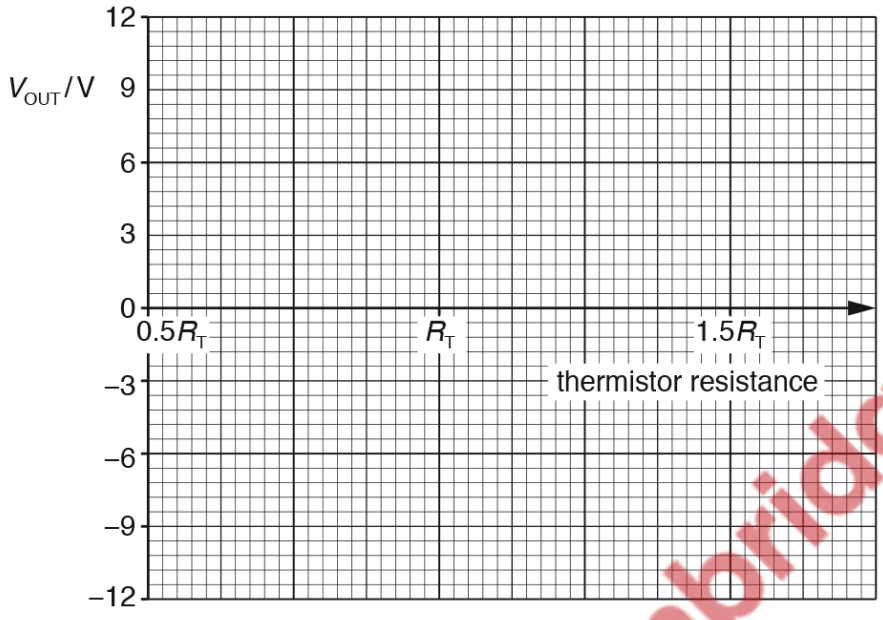

Fig. 8.2

[2]

(iii) On Fig. 8.1, draw the symbol for a light-emitting diode (LED), connected at the output of the circuit, such that it emits light when the resistance of the thermistor is less than R_T.

[2]

[Total: 7]

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244. 9702_s18_qp_41 Q: 8

(a) Negative feedback is often used in amplifiers incorporating an operational amplifier (op-amp).

State

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

.....

.....

.....[2]

(ii) two effects of negative feedback on the gain of an amplifier.

1. .....

.....

2. .....

.....

[2]

(b) An ideal op-amp is incorporated into the amplifier circuit shown in Fig. 8.1.

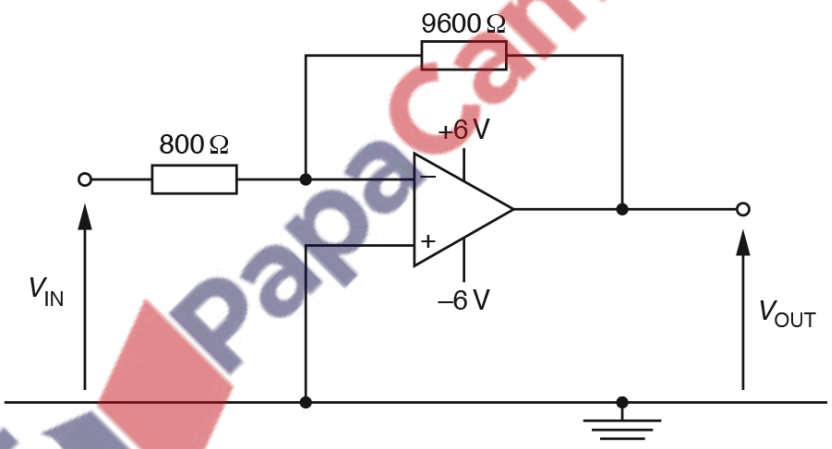

Fig. 8.1

(i) Calculate the gain *G* of the amplifier circuit.

G = ...[2]

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(ii) Determine the output potential difference V_{OUT} for input potential differences V_{IN} of

1. −0.10 V,

V_{OUT} = ... V

2. +1.3 V.

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

(iii) The gain of the amplifier shown in Fig. 8.1 is constant.

State one change that can be made to the circuit of Fig. 8.1 so that the amplifier circuit monitors light intensity levels, with the magnitude of the gain decreasing as light intensity increases.

.....

.....[1]

[Total: 9]

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245. 9702_s18_qp_42 Q: 7

(a) Negative feedback is often used in amplifiers.

State

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

.....

.....

.....[2]

(ii) two effects of negative feedback on the gain of an amplifier.

1. .....

.....

2. .....

.....

[2]

(b) An ideal operational amplifier (op-amp) is incorporated into the circuit shown in Fig. 7.1.

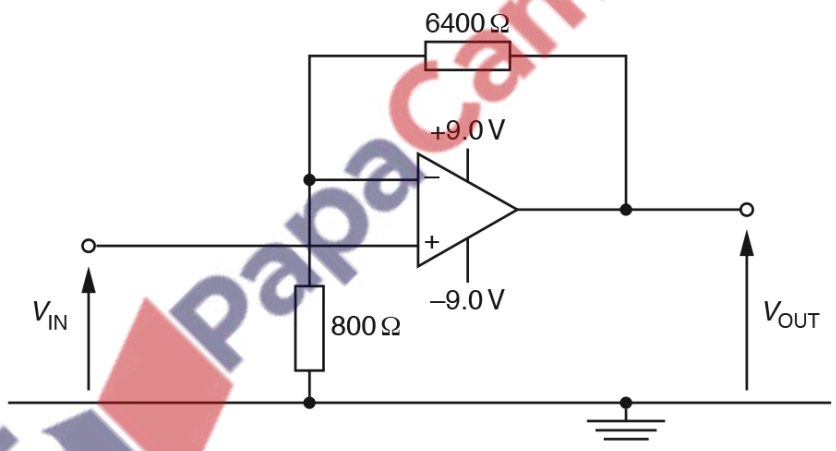

Fig. 7.1

(i) Calculate the gain *G* of the amplifier circuit.

G = ...[1]

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(ii) Determine the output potential difference V_{OUT} for an input potential difference V_{IN} of

1. +0.60 V,

V_{OUT} = ... V

2. –2.1 V.

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

(iii) The gain of the amplifier shown in Fig. 7.1 is constant.

State one change that may be made to the circuit of Fig. 7.1 so that the amplifier circuit monitors temperature with the gain decreasing as the temperature rises.

.....

.....[1]

[Total: 8]

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246. 9702_s18_qp_43 Q: 8

(a) Negative feedback is often used in amplifiers incorporating an operational amplifier (op-amp).

State

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

.....

.....

.....[2]

(ii) two effects of negative feedback on the gain of an amplifier.

1. .....

.....

2. .....

.....

[2]

(b) An ideal op-amp is incorporated into the amplifier circuit shown in Fig. 8.1.

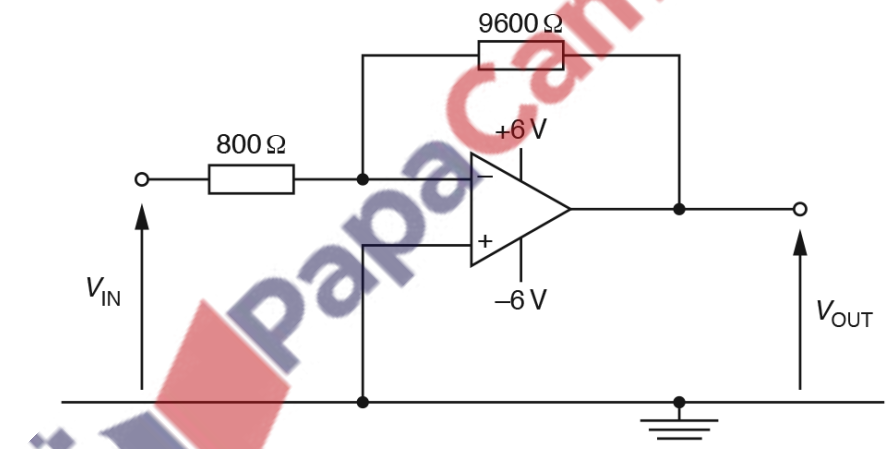

Fig. 8.1

(i) Calculate the gain *G* of the amplifier circuit.

G = ...[2]

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(ii) Determine the output potential difference V_{OUT} for input potential differences V_{IN} of

1. −0.10 V,

V_{OUT} = ... V

2. +1.3 V.

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

(iii) The gain of the amplifier shown in Fig. 8.1 is constant.

State one change that can be made to the circuit of Fig. 8.1 so that the amplifier circuit monitors light intensity levels, with the magnitude of the gain decreasing as light intensity increases.

.....

.....[1]

[Total: 9]

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247. 9702_w18_qp_42 Q: 7

A circuit incorporating an ideal operational amplifier (op-amp) is shown in Fig. 7.1.

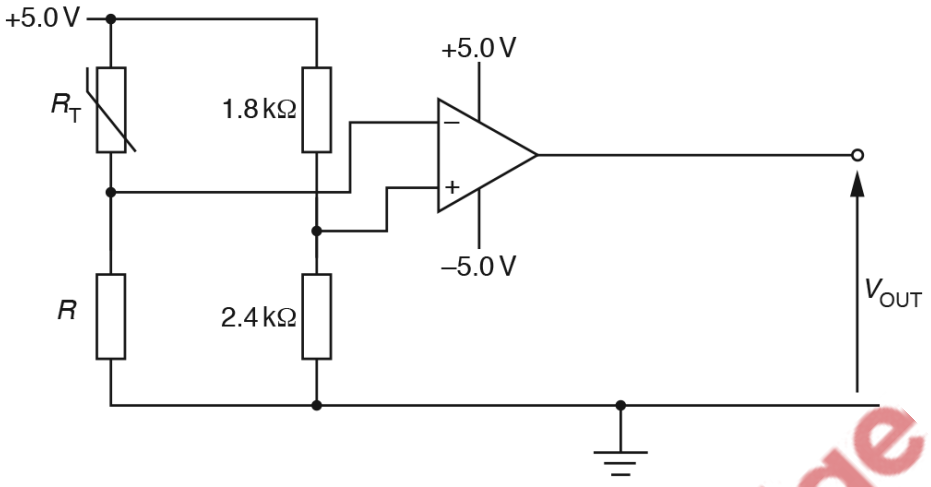

Fig. 7.1

The variation with temperature θ of the resistance R_T of the thermistor is shown in Fig. 7.2.

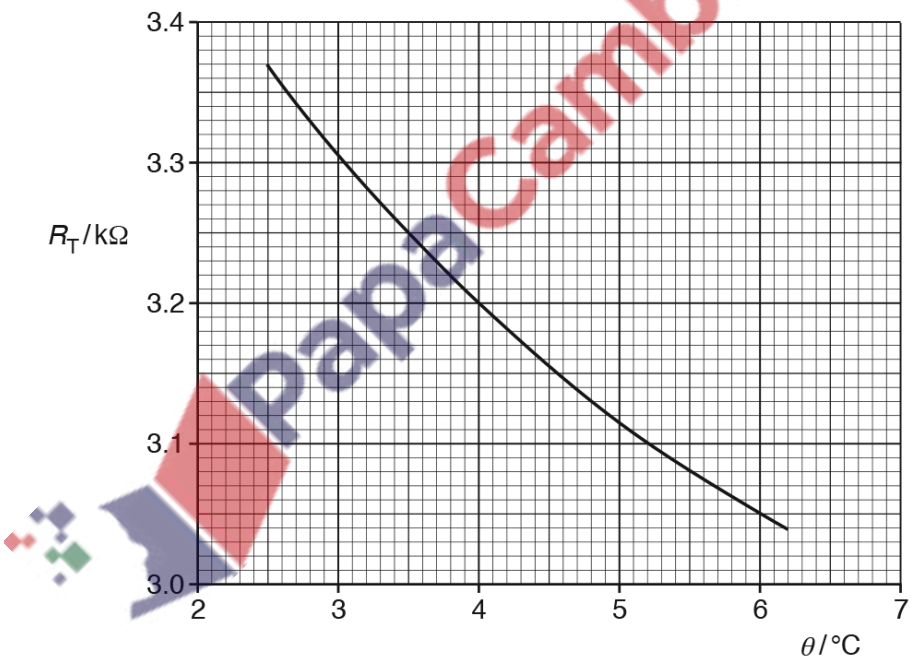

Fig. 7.2

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(a) The output potential V_{OUT} of the op-amp circuit changes sign when the temperature of the thermistor is 4.0 °C.
Calculate the resistance R.

R = ... kΩ [2]

(b) State and explain whether the output potential V_{OUT} is +5.0 V or –5.0 V for a thermistor temperature of 2.5 °C.

.....

.....

.....

.....[3]

(c) The output of the op-amp is to be displayed using two light-emitting diodes (LEDs) labelled G and B.
When the temperature of the thermistor is below 4.0 °C, only the LED labelled G emits light.
The LED labelled B emits light only when the temperature of the thermistor is above 4.0 °C.

On Fig. 7.1, draw and label the symbols for the two LEDs. [3]

[Total: 8]

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248. 9702_s17_qp_42 Q: 8

A student designs a circuit incorporating an operational amplifier (op-amp) as shown in Fig. 8.1.

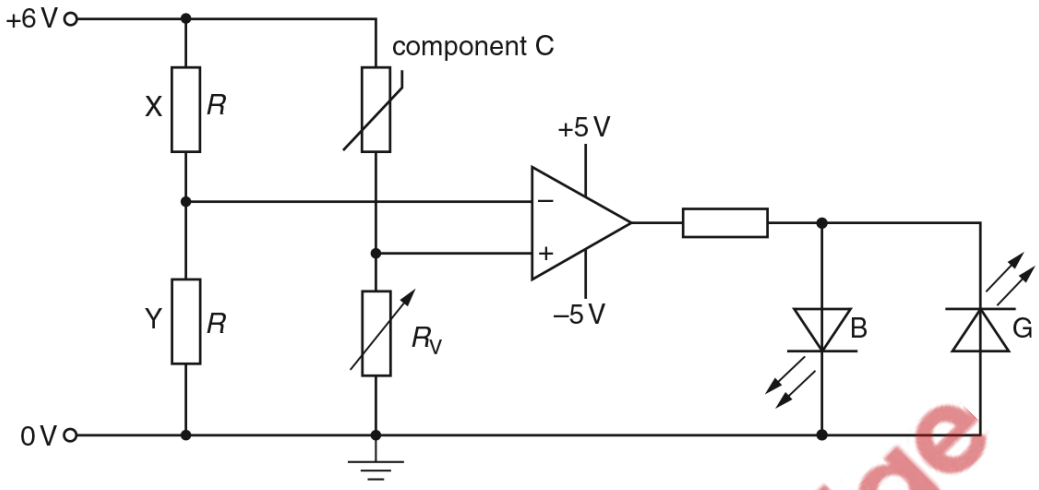

Fig. 8.1

(a) **(i)** On Fig. 8.1, draw a circle around the output device. [1]

(ii) State the purpose of this circuit.

.....

.....

.....[2]

(b) The resistors X and Y each have resistance *R*.
When conducting, the LED labelled B emits blue light and the LED labelled G emits green light.

(i) State whether blue light or green light is emitted when the resistance of component C is greater than the resistance R_V of the variable resistor. Explain your answer.

.....

.....

.....

.....

.....[3]

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(ii) State and explain what is observed as the resistance of component C is reduced.

.....

.....

.....

.....

.....[3]

(c) Suggest the function of the variable resistor.

.....

.....[1]

[Total: 10]

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249. 9702_w16_qp_41 Q: 6

(a) The slew rate of an ideal operational amplifier (op-amp) is said to be infinite.

Explain what is meant by *infinite slew rate*.

.....

.....

..... [2]

(b) The circuit of Fig. 6.1 is designed to indicate whether the temperature of the thermistor is above or below 24 °C.

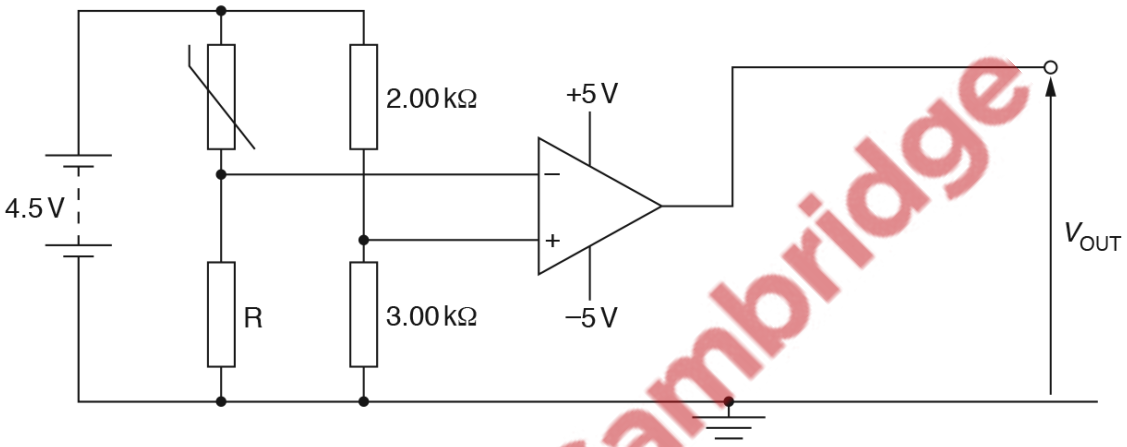

Fig. 6.1

The operational amplifier (op-amp) is assumed to be ideal.

At 24 °C, the resistance of the thermistor is 1.50 kΩ.

(i) Determine the resistance of resistor R such that the output V_{OUT} of the op-amp changes at 24 °C.

resistance = ... Ω [2]

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(ii) On Fig. 6.1,

1. draw two light-emitting diodes (LEDs) connected so as to indicate whether the output V_{OUT} of the op-amp is either +5 V or −5 V, [2]

2. label with the letter G the LED that will be emitting light when the temperature is below 24 °C. Explain your working.

.....

.....

..... [3]

[Total: 9]

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250. 9702_w16_qp_43 Q: 6

(a) The slew rate of an ideal operational amplifier (op-amp) is said to be infinite.

Explain what is meant by *infinite slew rate*.

.....

.....

..... [2]

(b) The circuit of Fig. 6.1 is designed to indicate whether the temperature of the thermistor is above or below 24 °C.

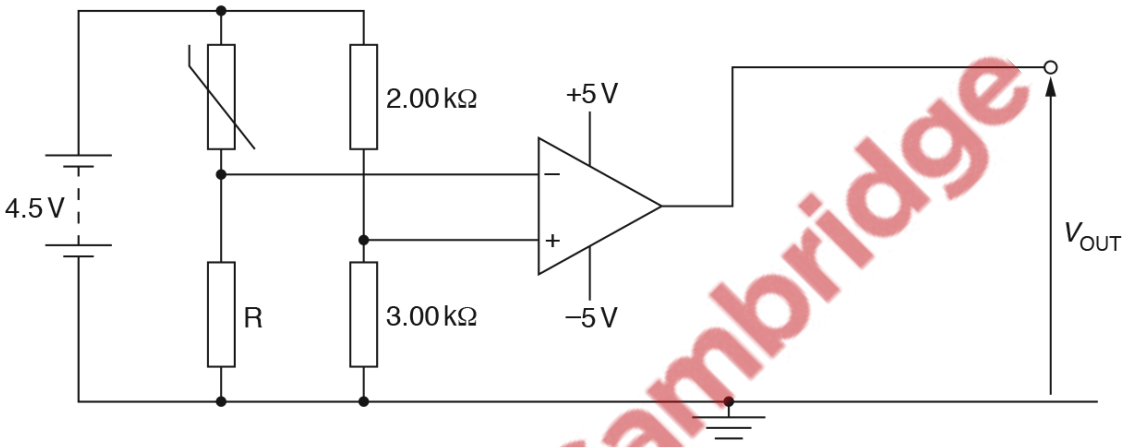

Fig. 6.1

The operational amplifier (op-amp) is assumed to be ideal.

At 24 °C, the resistance of the thermistor is 1.50 kΩ.

(i) Determine the resistance of resistor R such that the output V_{OUT} of the op-amp changes at 24 °C.

resistance = ... Ω [2]

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(ii) On Fig. 6.1,

1. draw two light-emitting diodes (LEDs) connected so as to indicate whether the output V_{OUT} of the op-amp is either +5 V or −5 V, [2]

2. label with the letter G the LED that will be emitting light when the temperature is below 24 °C. Explain your working.

.....

.....

..... [3]

[Total: 9]

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