1. Nov/2021/Paper_41/No.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.

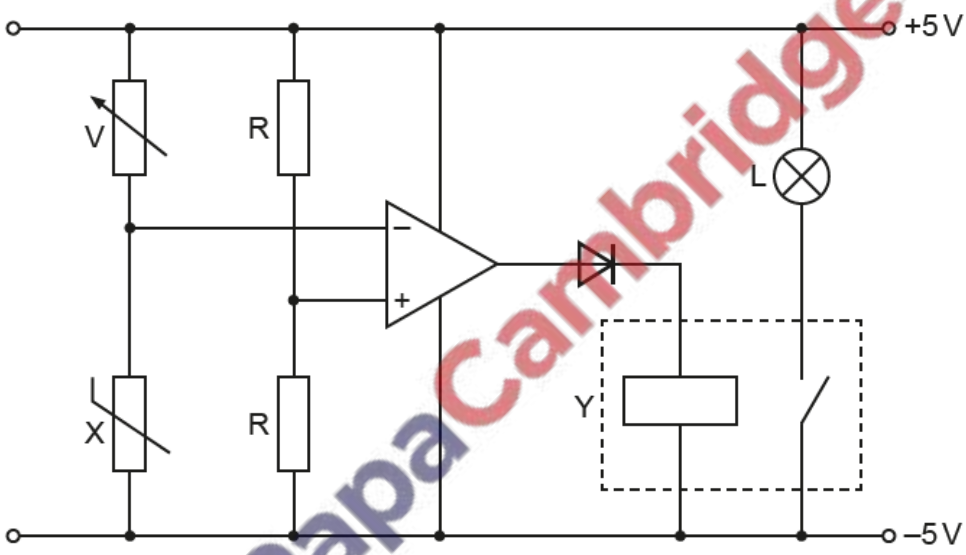

Fig. 7.1

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]

(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]

2. Nov/2021/Paper_42/No.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.

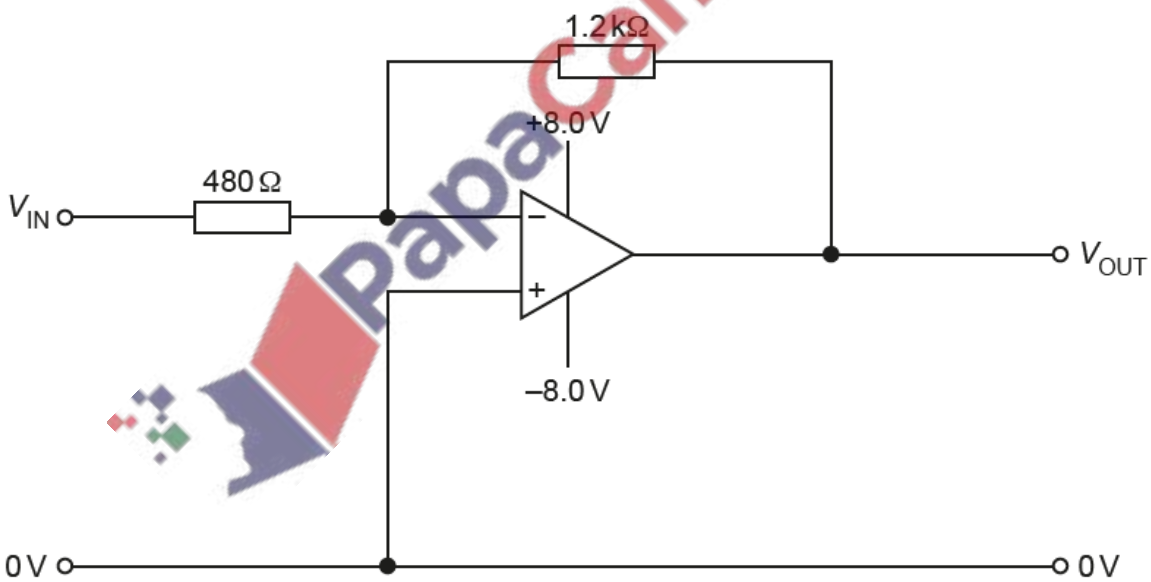

Fig. 7.1

(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]

(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]

3. June/2021/Paper_41/No.8

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

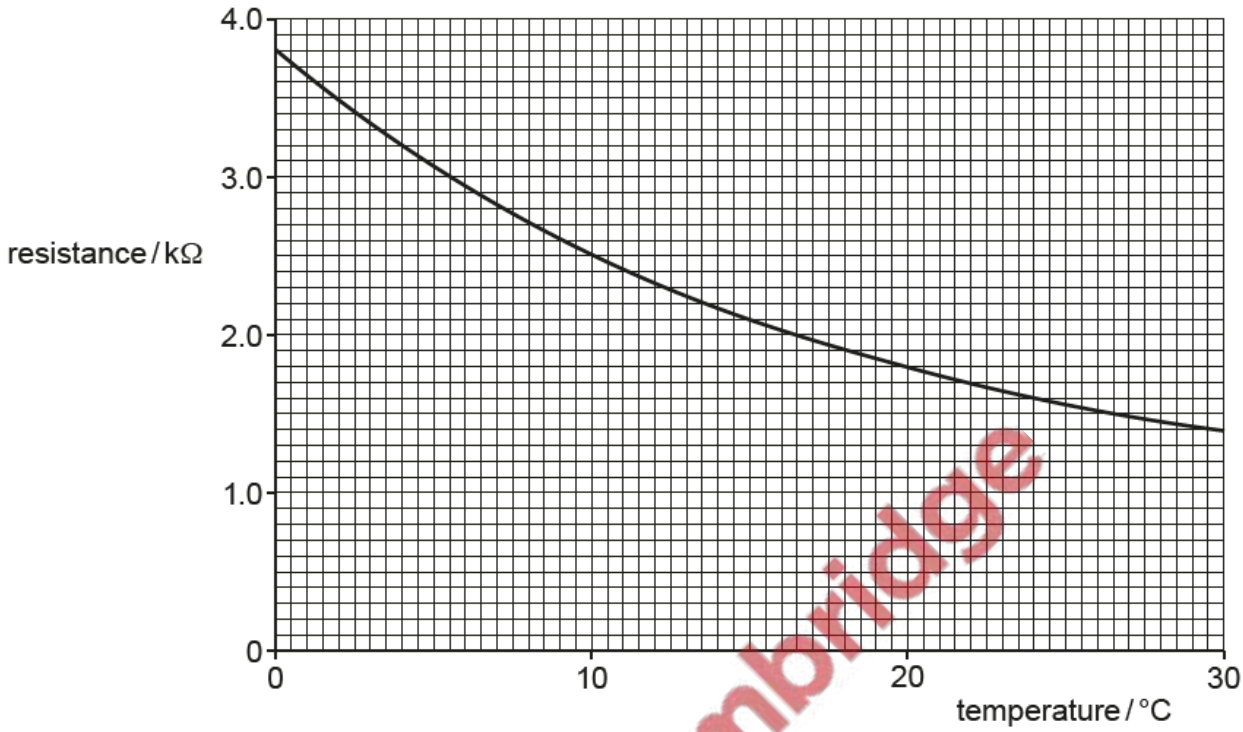

Fig. 8.1

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

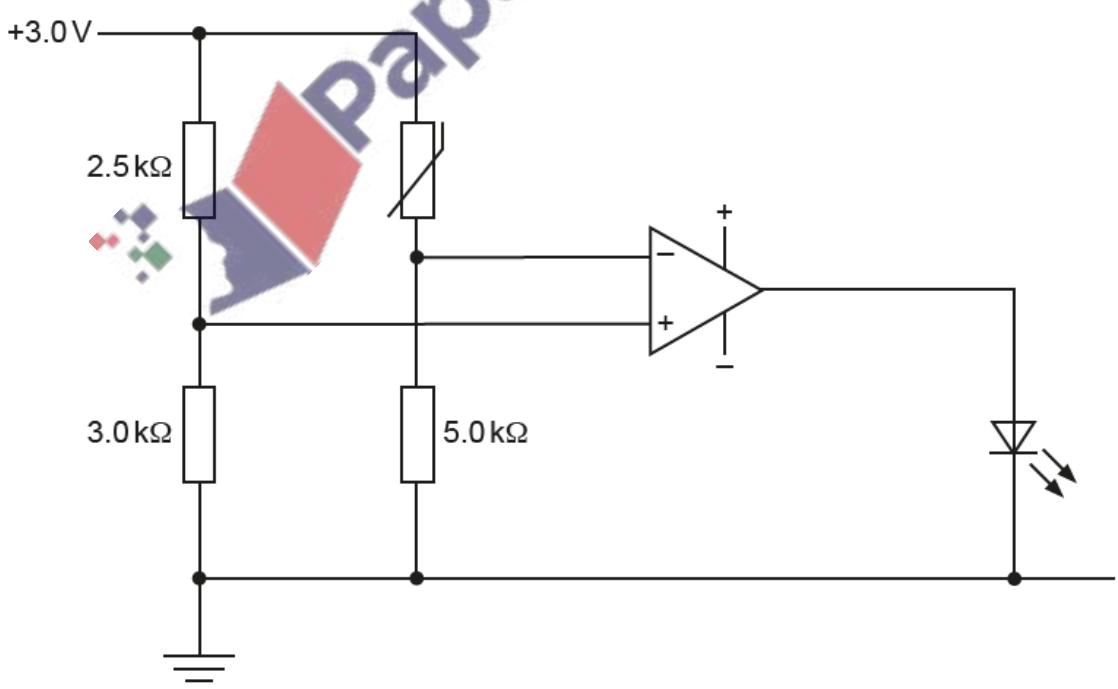

Fig. 8.2

(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]

4. **(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.

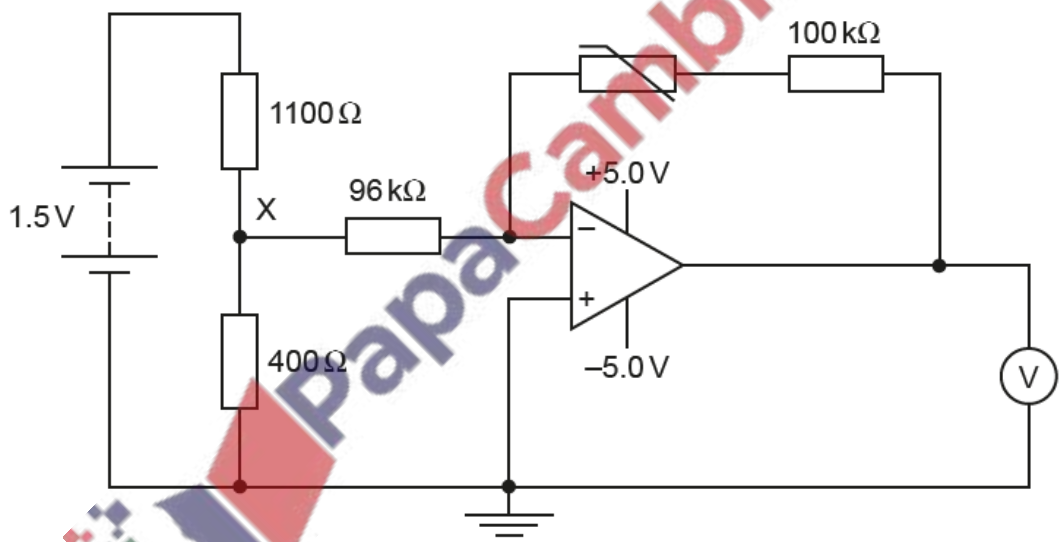

Fig. 7.1

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

[1]

(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]

5. March/2021/Paper_42/No.7

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

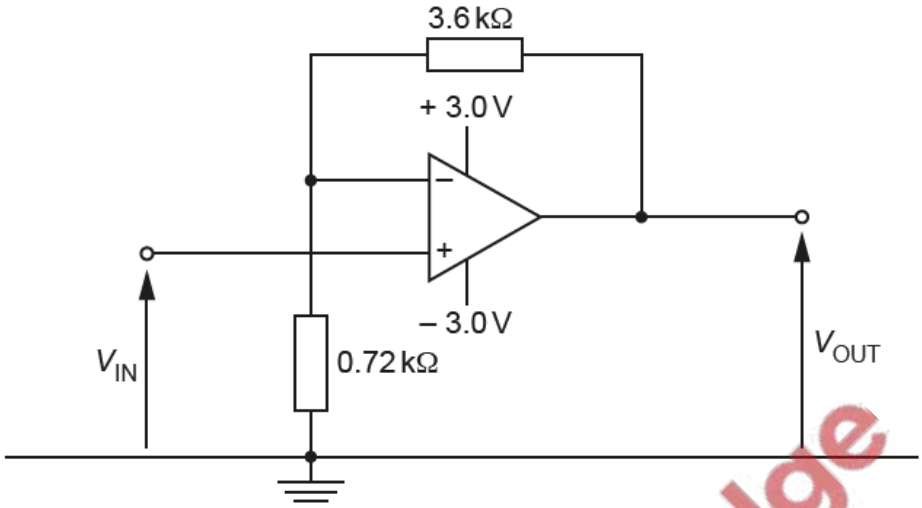

Fig. 7.1

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

..... [1]

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

[1]

(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.

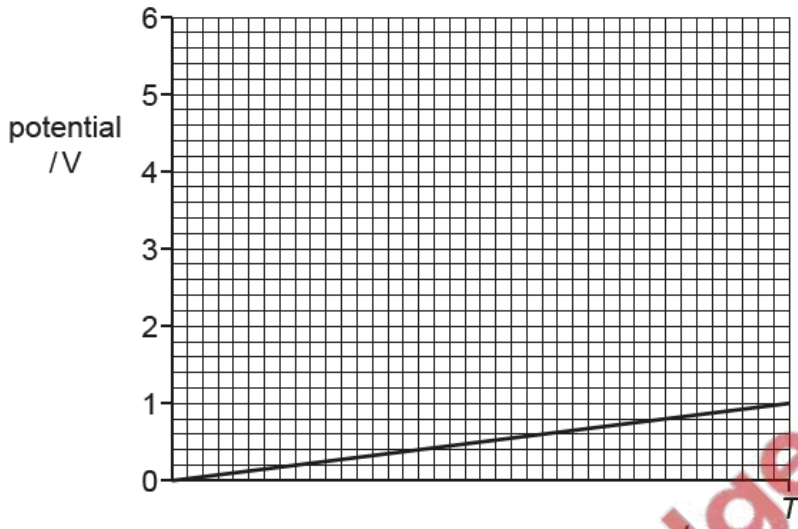

Fig. 7.2

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.

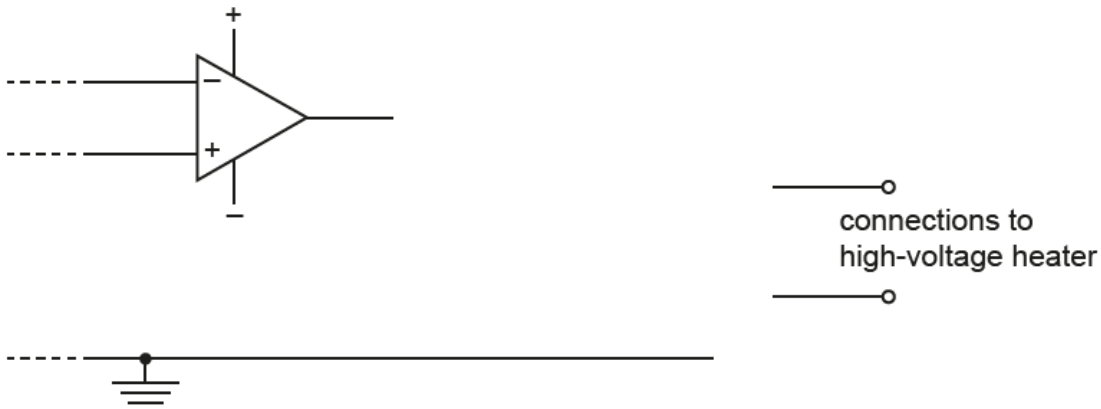

Fig. 7.3

[3]

[Total: 9]