

Sensing Devices

Question paper 2

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Current of Electricity
Sub Topic	Sensing Devices
Paper Type	Theory
Booklet	Question paper 2

Time Allowed: 70 minutes

Score: /58

Percentage: /100

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

1 (a) Define *potential difference* (p.d.).

.....[1]

(b) A battery of electromotive force 20V and zero internal resistance is connected in series with two resistors R_1 and R_2 , as shown in Fig. 6.1.

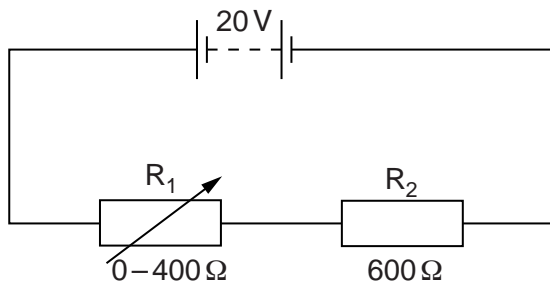


Fig. 6.1

The resistance of R_2 is 600 Ω . The resistance of R_1 is varied from 0 to 400 Ω .

Calculate

(i) the maximum p.d. across R_2 ,

maximum p.d. = V [1]

(ii) the minimum p.d. across R_2 .

minimum p.d. = V [2]

(c) A light-dependent resistor (LDR) is connected in parallel with R_2 , as shown in Fig. 6.2.

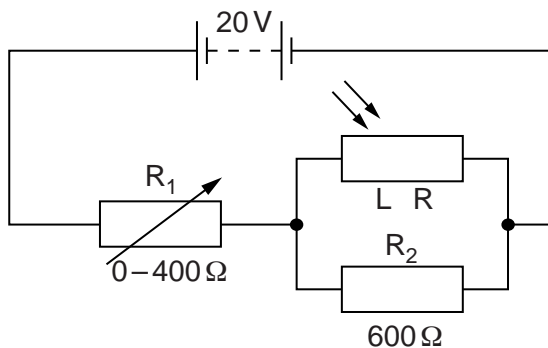


Fig. 6.2

When the light intensity is varied, the resistance of the LDR changes from $5.0\text{ k}\Omega$ to $1.2\text{ k}\Omega$.

(i) For the **maximum** light intensity, calculate the total resistance of R_2 and the LDR.

total resistance = Ω [2]

(ii) The resistance of R_1 is varied from 0 to 400Ω in the circuits of Fig. 6.1 and Fig. 6.2. State and explain the difference, if any, between the minimum p.d. across R_2 in each circuit. Numerical values are not required.

.....

 [2]

- 2 A battery of electromotive force 12V and negligible internal resistance is connected to two resistors and a light-dependent resistor (LDR), as shown in Fig. 4.1.

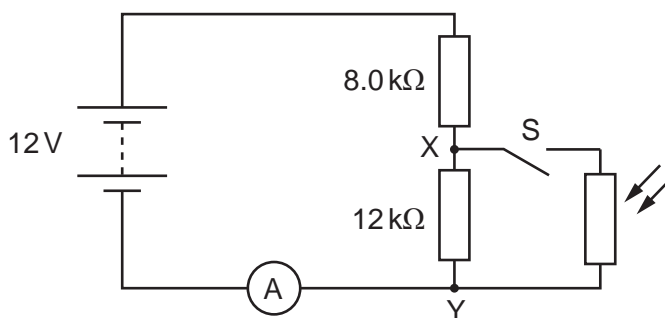


Fig. 4.1

An ammeter is connected in series with the battery. The LDR and switch S are connected across the points XY.

- (a) The switch S is open. Calculate the potential difference (p.d.) across XY.

p. d. = V [3]

- (b) The switch S is closed. The resistance of the LDR is 4.0 kΩ. Calculate the current in the ammeter.

current = A [3]

(c) The switch S remains closed. The intensity of the light on the LDR is increased. State and explain the change to

(i) the ammeter reading,

.....
.....
..... [2]

(ii) the p.d. across XY.

.....
.....
..... [2]

- 3 A battery of e.m.f. 4.50 V and negligible internal resistance is connected in series with a fixed resistor of resistance $1200\ \Omega$ and a thermistor, as shown in Fig. 7.1.

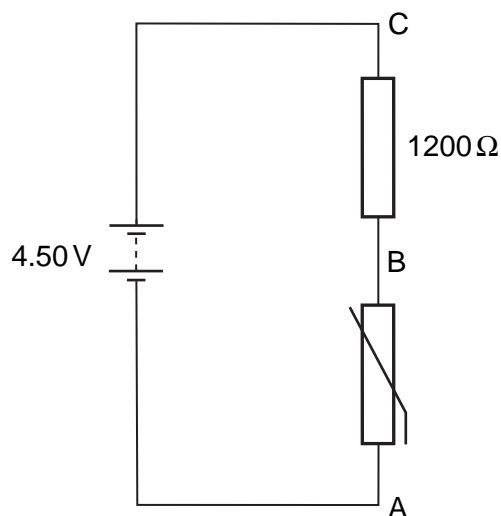


Fig. 7.1

- (a) At room temperature, the thermistor has a resistance of $1800\ \Omega$. Deduce that the potential difference across the thermistor (across AB) is 2.70 V.

[2]

- (b) A uniform resistance wire PQ of length 1.00 m is now connected in parallel with the resistor and the thermistor, as shown in Fig. 7.2.

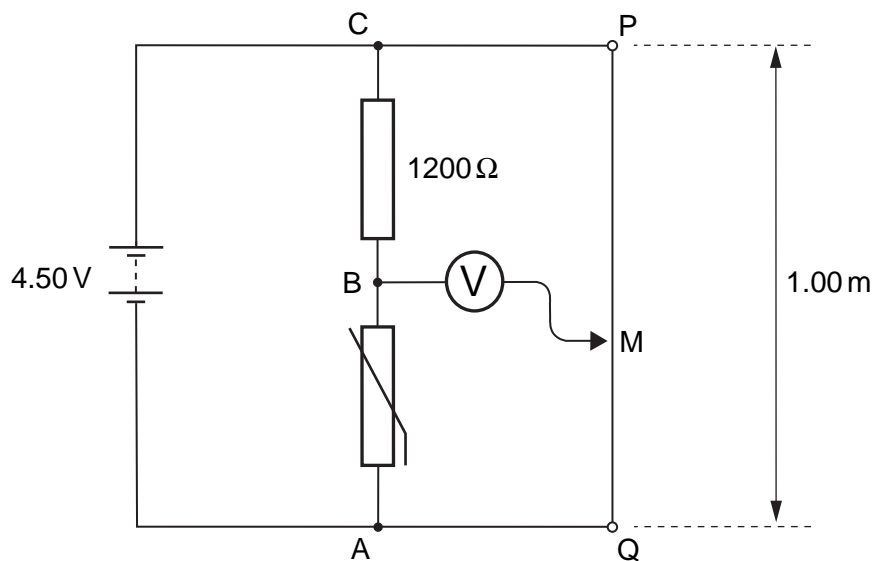


Fig. 7.2

A sensitive voltmeter is connected between point B and a moveable contact M on the wire.

- (i) Explain why, for constant current in the wire, the potential difference between any two points on the wire is proportional to the distance between the points.

.....
.....
.....[2]

- (ii) The contact M is moved along PQ until the voltmeter shows zero reading.

- 1. State the potential difference between the contact at M and the point Q.

potential difference = V [1]

- 2. Calculate the length of wire between M and Q.

length = cm [2]

- (iii) The thermistor is warmed slightly. State and explain the effect on the length of wire between M and Q for the voltmeter to remain at zero deflection.

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.....[2]

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

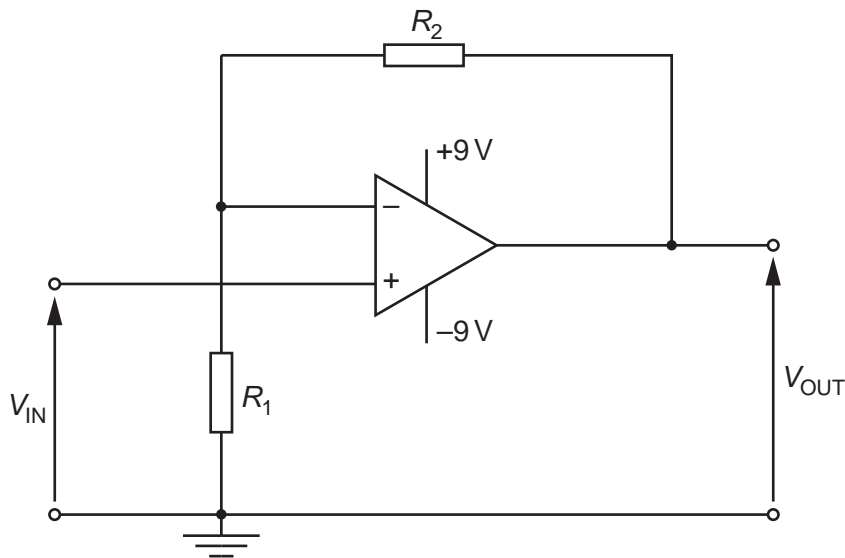


Fig. 9.1

(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 $820\ \Omega$. 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) $100\ \Omega$ (the LDR is in sunlight),

$$V_{OUT} = \dots\dots\dots\text{ V [2]}$$

(ii) $1.0\text{ M}\Omega$ (the LDR is in darkness).

$$V_{OUT} = \dots\dots\dots\text{ V [1]}$$

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

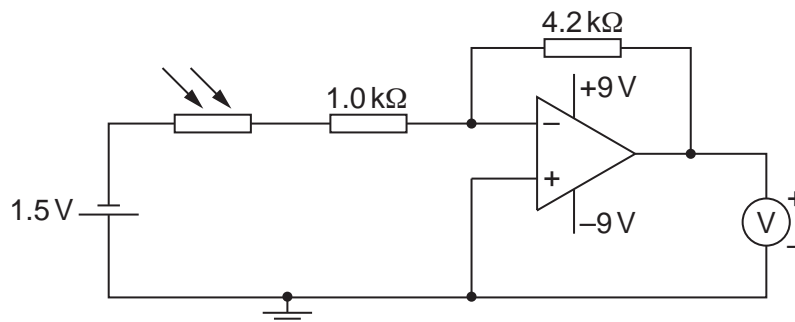


Fig. 9.1

- (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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.....

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..... [3]

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

- (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.

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.....[3]

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

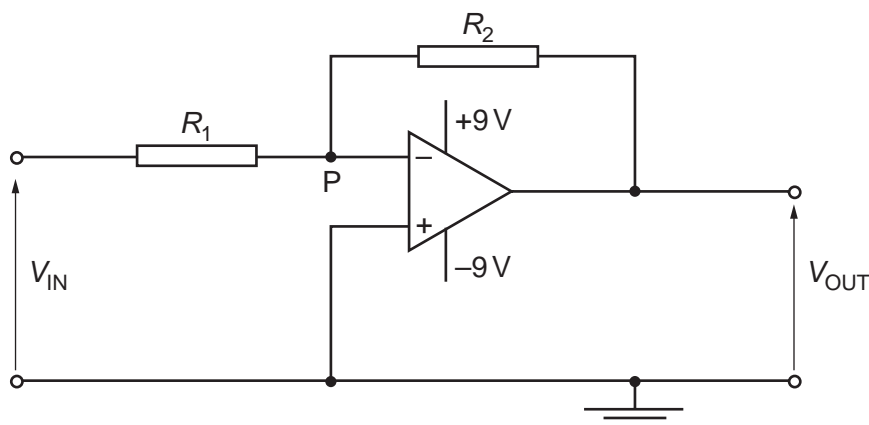


Fig. 10.1

- (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.

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

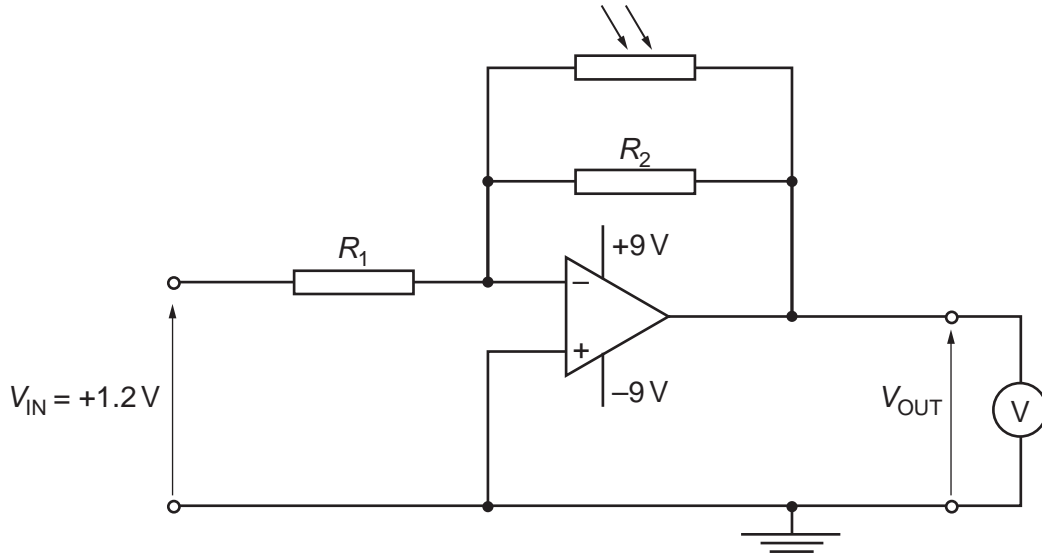


Fig. 10.2

The resistances R_1 and R_2 are $5.0\text{ k}\Omega$ and $50\text{ k}\Omega$ 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. $100\text{ k}\Omega$,

reading = V [3]

2. $10\text{ k}\Omega$.

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]