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 20 V and zero internal resistance is connected in series with two resistors R_1 and R_2, as shown in Fig. 6.1.

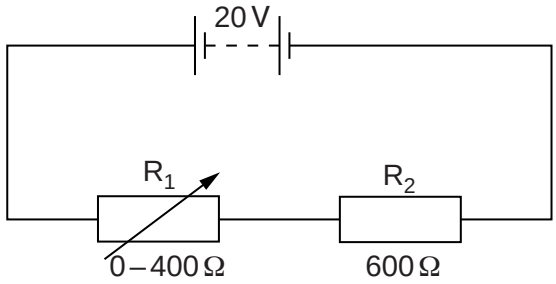

Fig. 6.1

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.

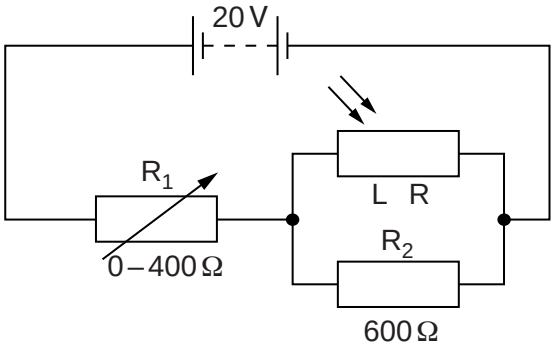

Fig. 6.2

When the light intensity is varied, the resistance of the LDR changes from 5.0 kΩ to 1.2 kΩ.

(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 400 Ω 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.

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.....

..... [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.

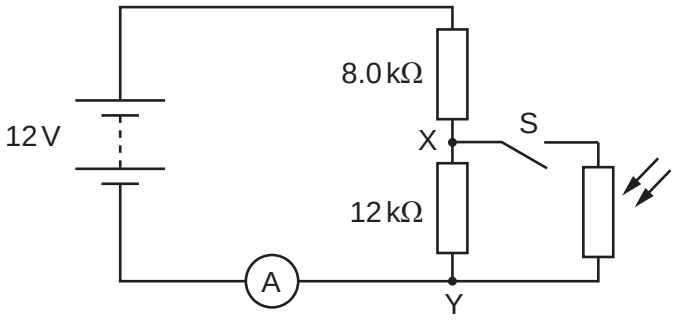

Fig. 4.1

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 Ω and a thermistor, as shown in Fig. 7.1.

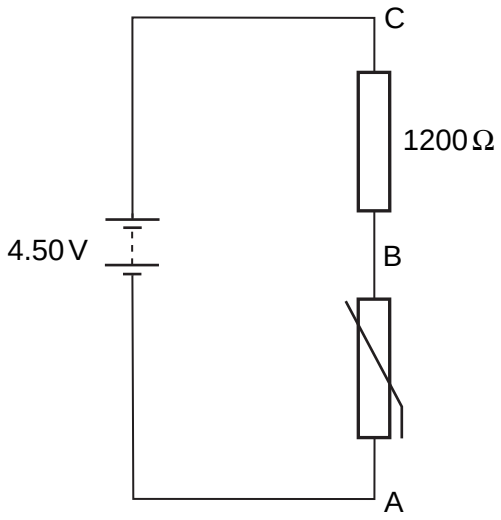

Fig. 7.1

(a) At room temperature, the thermistor has a resistance of 1800 Ω. 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.

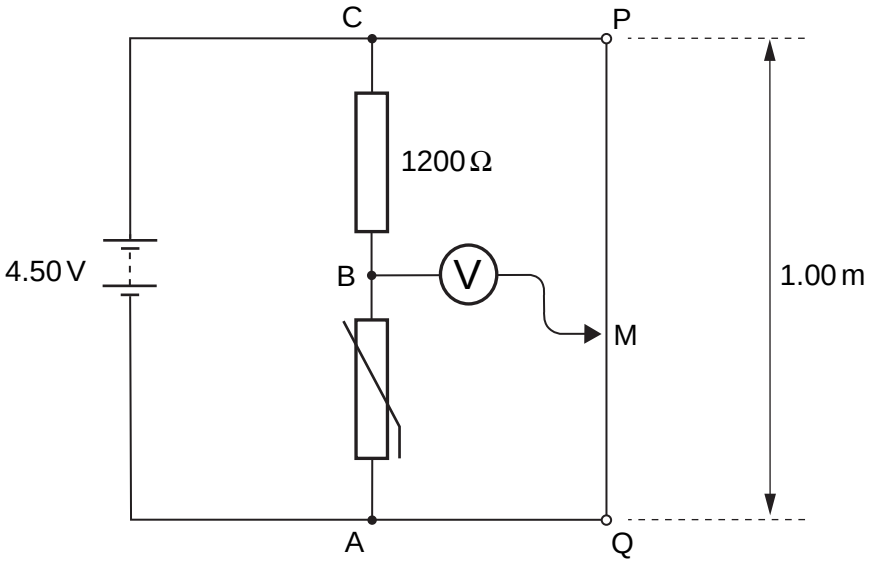

Fig. 7.2

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.

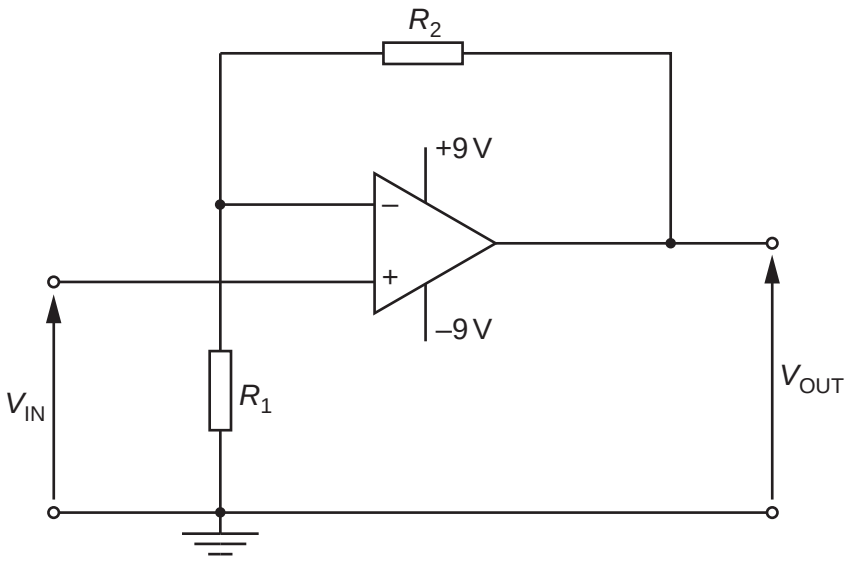

Fig. 9.1

(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 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]

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

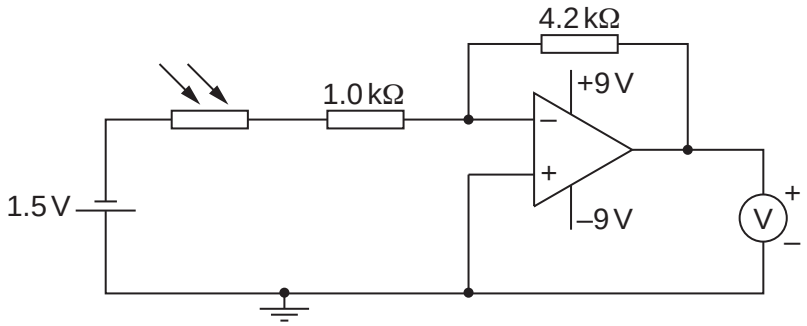

Fig. 9.1

(a) (i) On Fig. 9.1, mark, with the letter X, the virtual earth. [1]

(ii) Explain what is meant by a *virtual earth*.

.....

.....

.....

..... [3]

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

(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.

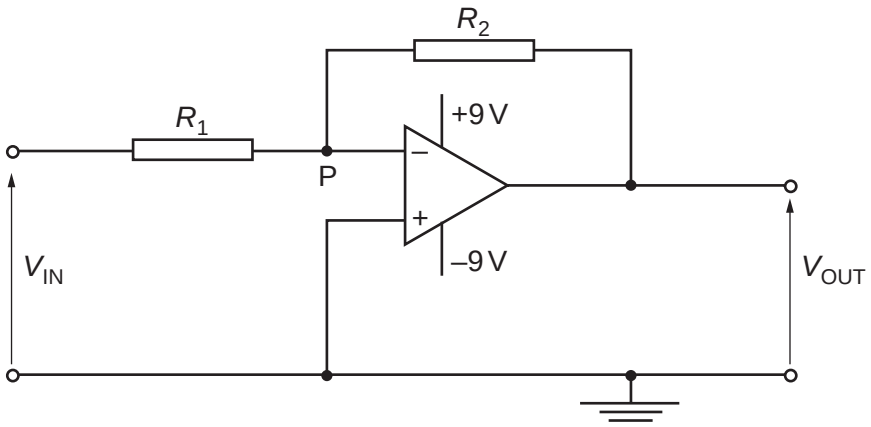

Fig. 10.1

(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.

[4]

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

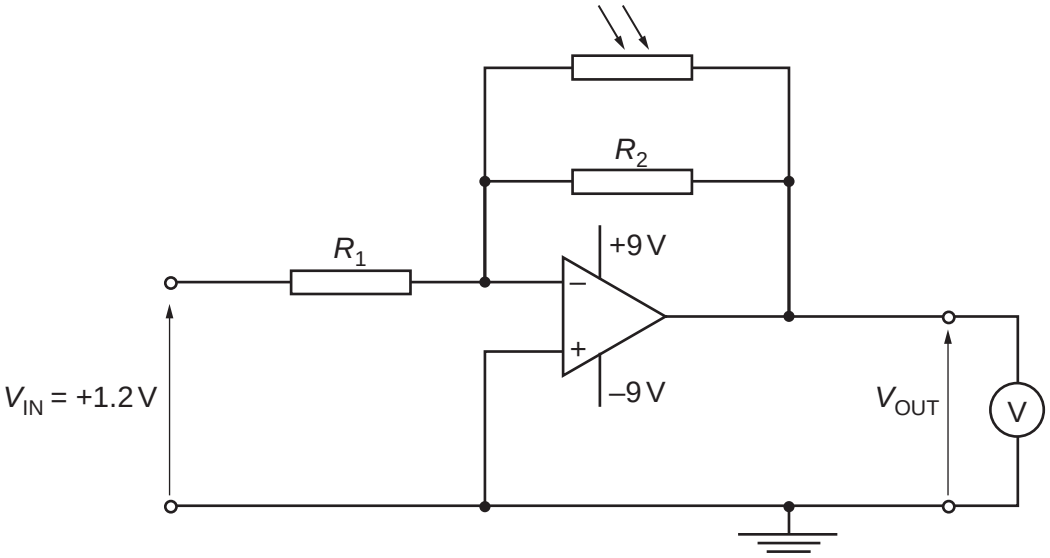

Fig. 10.2

The resistances R_1 and R_2 are 5.0 kΩ and 50 kΩ respectively.
The input voltage V_{IN} is +1.2 V. 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 kΩ,

reading = ... V [3]

2. 10 kΩ.

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]