6

(a)

Fig. 6.1 shows a potential divider arrangement used for product testing that consists of a fixed resistor of resistance 4.0 kΩ and a variable resistor of maximum resistance 20 kΩ with a slide contact connected to terminal S.

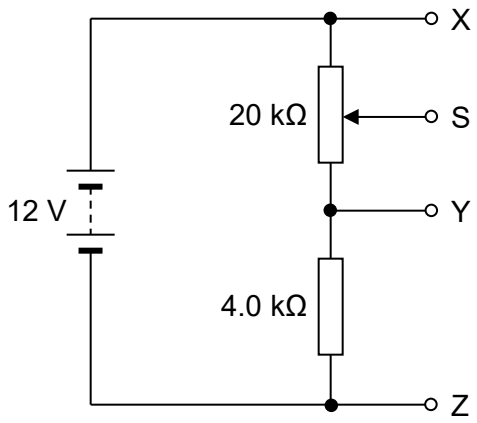

Fig 6.1

The e.m.f. of the battery is 12 V and it has negligible internal resistance. It is possible to obtain different continuously-variable ranges by selecting, as the output, particular pairs of terminals from S, X, Y and Z.

(i)

Calculate the voltage range obtainable between the terminals S and X.

voltage range =

to

V

[2]

(ii)

Hence, or otherwise, calculate the voltage range between the terminals S and Z.

voltage range =

to

V

[1]

(iii)

The slide contact S is set at the mid-point of the 20 kΩ resistance track. If a voltmeter of resistance of 10 kΩ is then connected between S and Y, calculate the reading on the voltmeter.

voltmeter reading =

V

[2]

(b)

To test a special bicycle lock that comes with an alarm, an ideal voltmeter is connected to the lock. When the lock detects that someone is tampering with it, it will emit a loud siren and two warning lights will start flashing. The siren and warning lights are connected to a cell as shown in Fig. 6.2. The siren has a resistance of 1.5 Ω and each warning light has a resistance of

2.4 Ω.

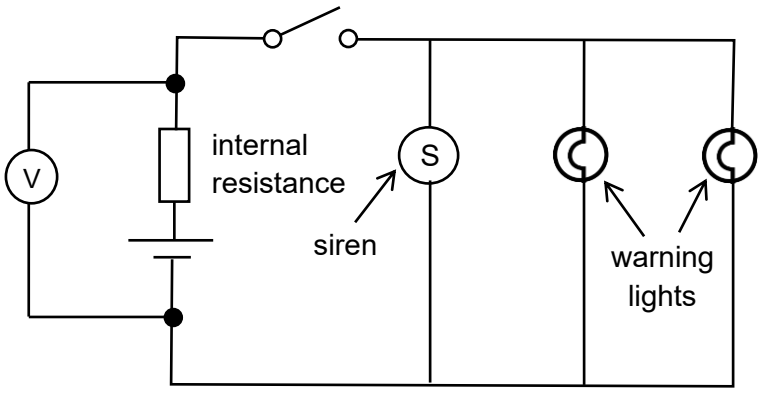

Fig 6.2

(i)

When the switch is opened, the voltmeter reading is 3.0 V. When the switch is closed, the voltmeter reading changes to 1.7 V.

Determine the internal resistance of the battery.

internal resistance =

Ω

[3]

(ii)

If another battery with the same electromotive force but which has significantly higher internal resistance is used, state and explain the impact on

1.

the loudness of the siren

2.

the brightness of the warning lights

[2]