5 **(a)** **(i)** State Kirchhoff's second law.

.....

.....

..... [1]

(ii) State the conservation law that gives rise to Kirchhoff's second law.

..... [1]

(b) A circuit contains a cell of internal resistance r and two resistors of resistances R_1 and R_2, as shown in Fig. 5.1.

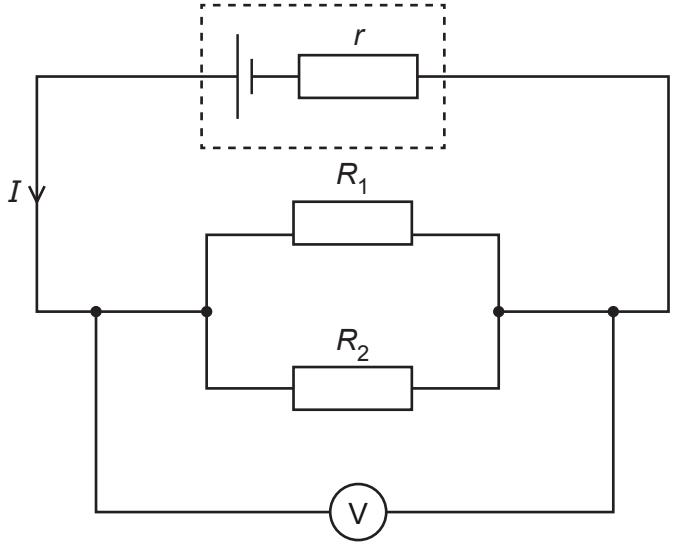

Fig. 5.1

The potential difference (p.d.) across the two resistors is V.

The current in the cell is I.

(i) Use Kirchhoff's laws to show that the total resistance R_T of the external circuit is given by

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}.$$

[2]

(ii) The electromotive force (e.m.f.) of the cell is 1.50 V.

When the values of R_1 and R_2 are 10 Ω and 15 Ω respectively, the p.d. measured by the voltmeter is 1.38 V.

Calculate the internal resistance r of the cell.

r = ... Ω [3]

(c) A third resistor is added in parallel with R_1 and R_2 in the circuit in Fig. 5.1.

State and explain the effect, if any, of this change on:

(i) the current in the cell

.....

.....

..... [2]

(ii) the p.d. measured by the voltmeter.

.....

.....

..... [2]

[Total: 11]