Circuits

1. What is meant by the statement that a battery has an e.m.f. of 6 V?

2. A cell has an e.m.f. of 1.5 V. How much electrical energy does a charge of 12 C possess as it leaves the cell?

3. How much electrical energy does a car battery of e.m.f. 12 V give to each electron passing through it? (*electron charge = 1.6 x 10^{-19}C*)

4. A battery supplies 480 J of energy to 16 C of charge. What is the e.m.f. of the battery?

5. Find the e.m.f. in each of the following cases:
   (a) 24 J of energy given to 0.8 C of charge
   (b) 12 μC of charge supplied with 7.2 J of energy?

6. How much energy is provided in each of the following cases:
   (a) a charge of 48 mC passing through a 6.0 V supply
   (b) a charge of 500 μC passing through a 1.5 V cell
   (c) an electron passing through a 3 V battery?

7. How much charge passes through a 12 V battery which supplies 4800 J of energy?

8. A current of 5.0 A flows for 10 minutes. How much charge is transferred?

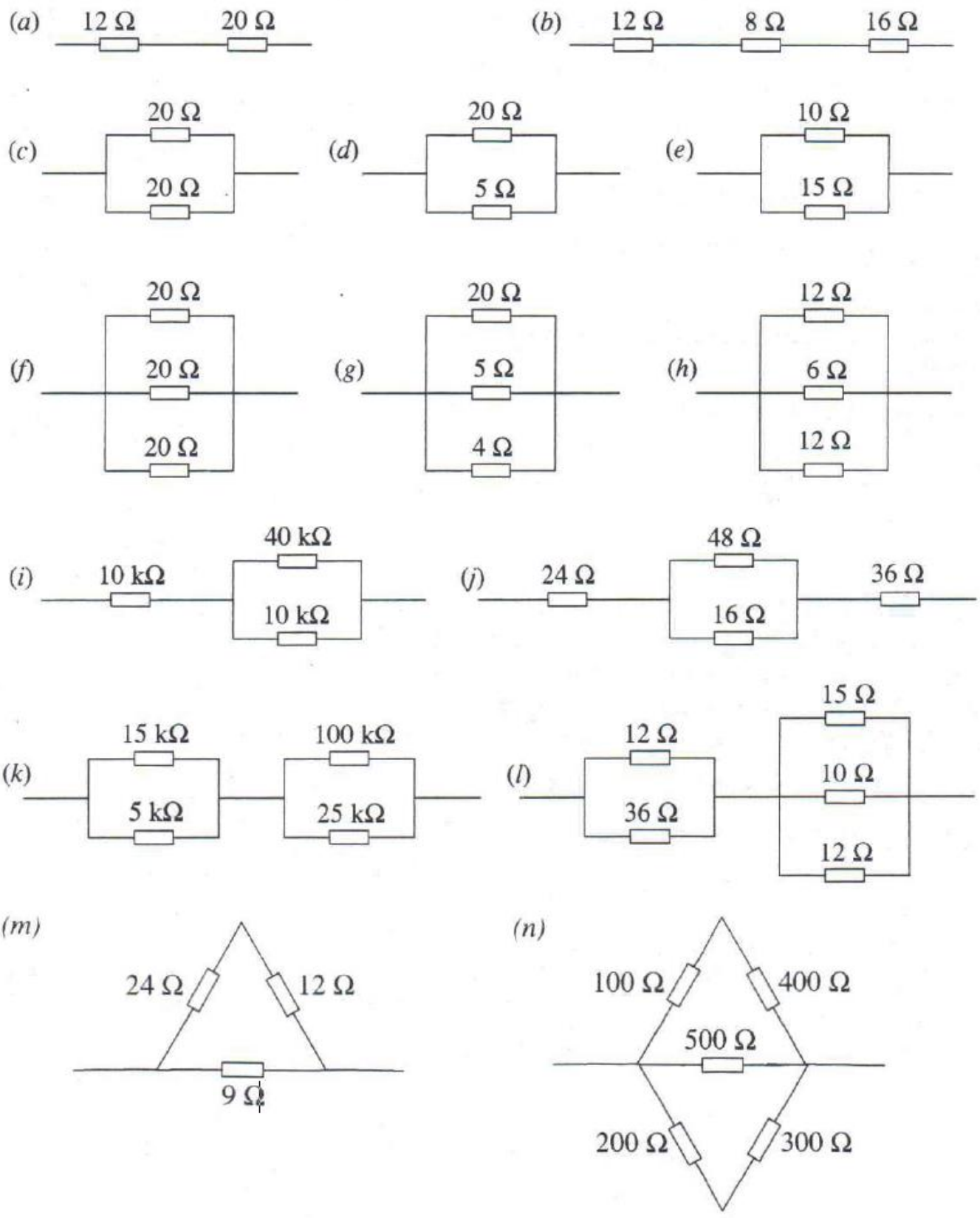
9. For how long must a current of 25 mA flow in order to transfer 96 500C of charge?

10. A charge of 240 C passes through a resistor in 3 minutes. What is the current?

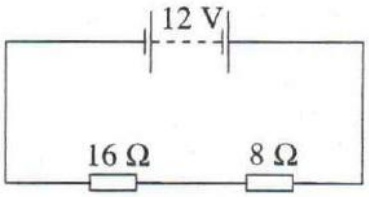
11. A 24 V battery is connected to a lamp and a current of 2.5 A flows for a time of 20 minutes.
    (a) How much charge passes through the lamp?
    (b) How much energy is transferred?
    (c) What is the power dissipated in the lamp?

12. A current of 2.4 A flows when a heating element is connected to a 12 V battery. If 288 kJ of heat energy is produced in the element, find
    (a) the amount of charge which has passed through the element
    (b) how long the current has been switched on.

13. Find the total resistance of the following combinations of resistors



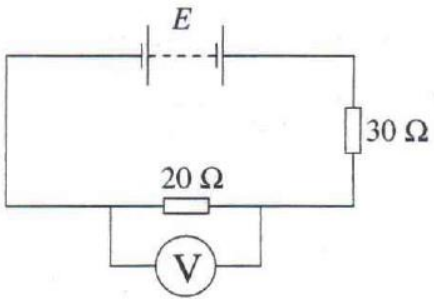
14. Two resistors are connected in series to a battery of e.m.f. 12 V as shown.



(a) What is the total resistance of the circuit?
(b) What is the current delivered by the battery?
(c) What is the potential difference across each resistor?

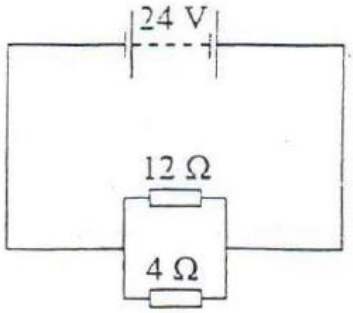
15. A 6.0 V supply is connected across a 10 kΩ resistor and a thermistor in series. What is the resistance of the thermistor if a voltmeter across it reads 0.50 V?

16. A battery is connected to two resistors in series as shown. If the current delivered by the battery is 0.20 A, find :



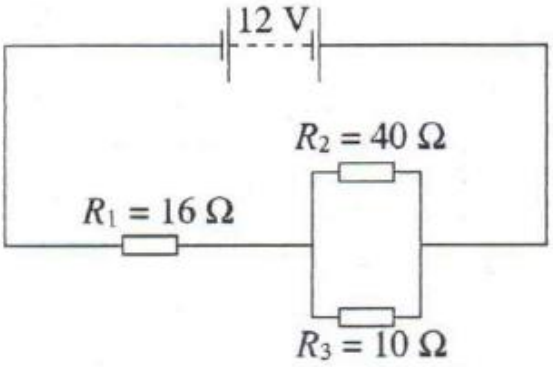
(a) the e.m.f. of the battery
(b) the reading on the voltmeter.

17. A bulb marked "6 V, 24 W" is to be used with a 12 V car battery. It is connected in series with a protecting resistor. What value of resistance would be required to allow the bulb to operate at its correct brightness?



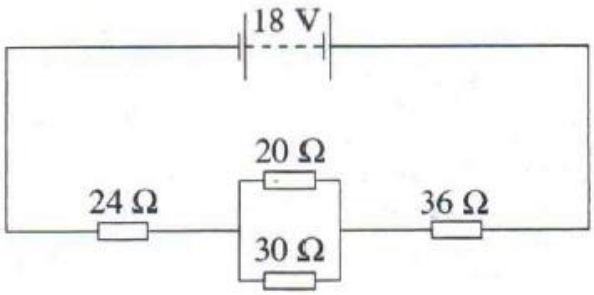
18. A 24 V battery is connected as shown to two resistors in parallel.
(a) What is the combined resistance of the resistors?
(b) What is the current drawn from the battery?
(c) What is the current through each resistor?

19. The diagram shows a 12 V battery connected to three resistors.

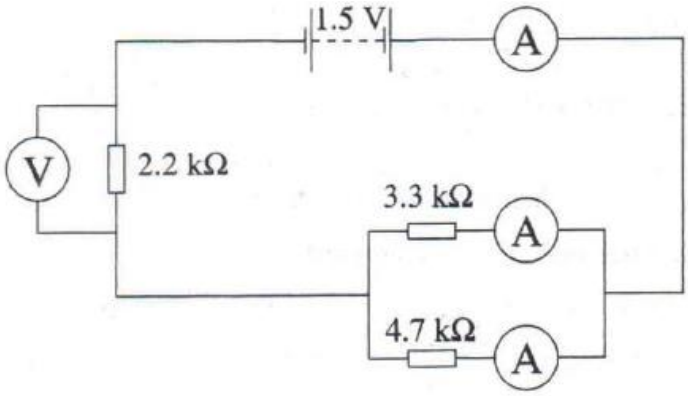


(a) What is the total resistance in the circuit?
(b) What is the current delivered by the battery?
(c) What is the potential difference across resistors R2 and R3?
(d) What is the current in (i) R2 and (ii) R3?

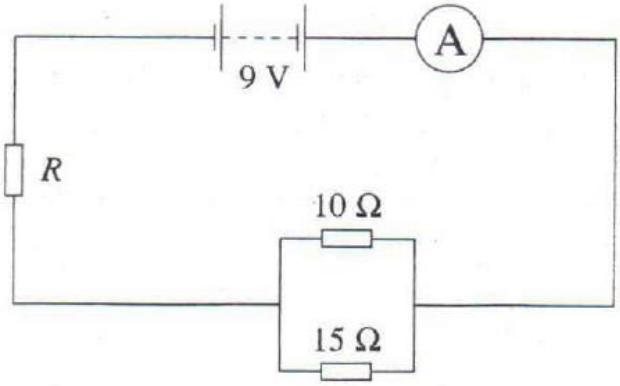
20. Find the current flowing through each resistor in the circuit opposite.



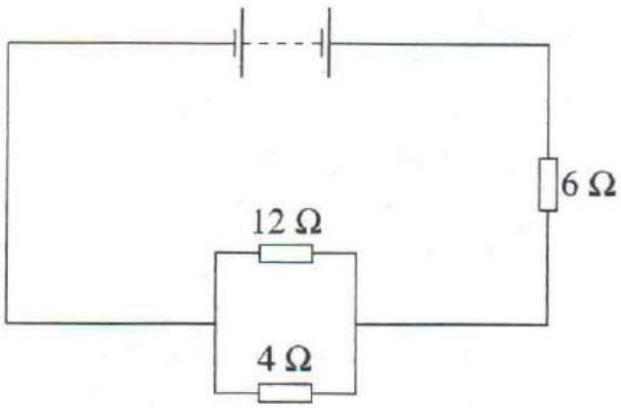
21. Find the reading on each meter in the circuit below.



22. In the circuit opposite the ammeter reads 0.25 A.
What is the value of resistor R?



23. In the circuit below a current of 2.0 A flows through the 12 Ω resistor.

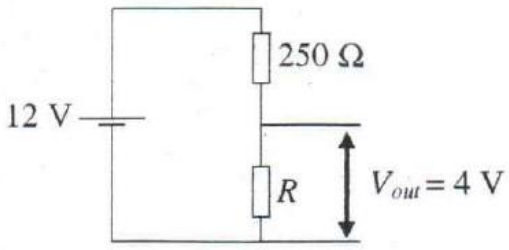


(a) What is the current in the 4 Ω resistor?
(b) What is the current in the 6 Ω resistor?
(c) What is the e.m.f. of the supply?

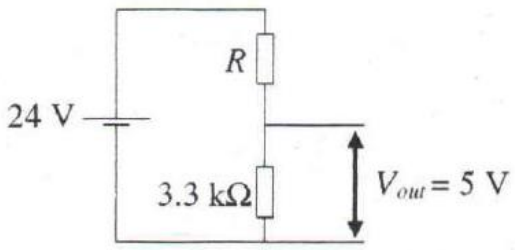
Potential Dividers

24. What value of R is required to produce the output shown :

(a)

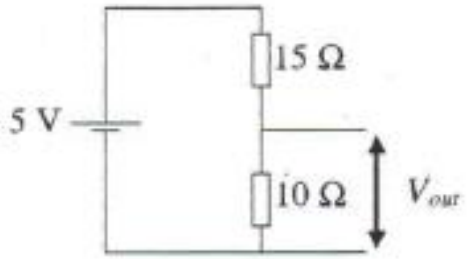


(b)

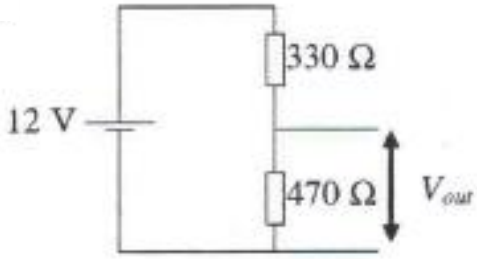


25. Find the output V_{out} from each of the following potential dividers :

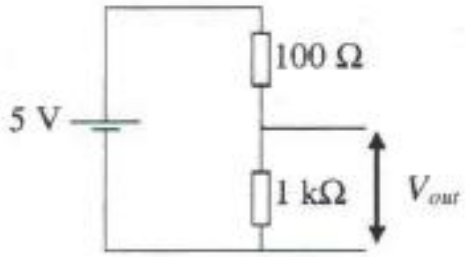
(a)



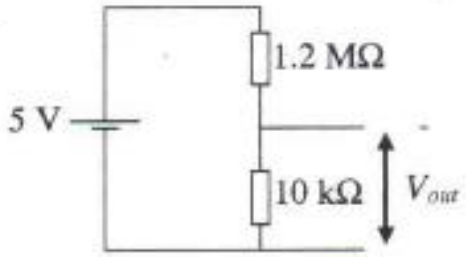
(b)



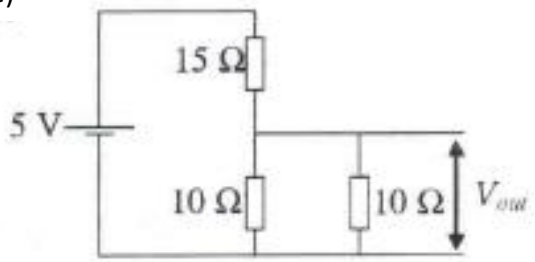
(c)



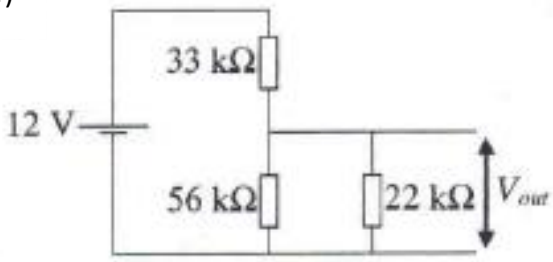
(d)



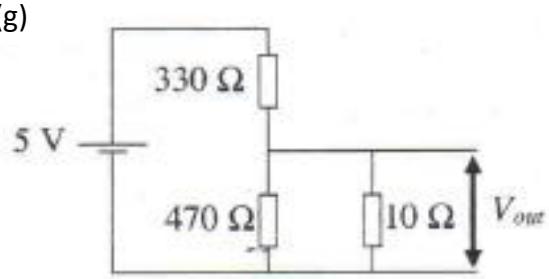
(e)



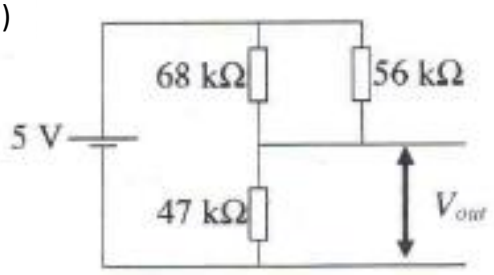
(f)



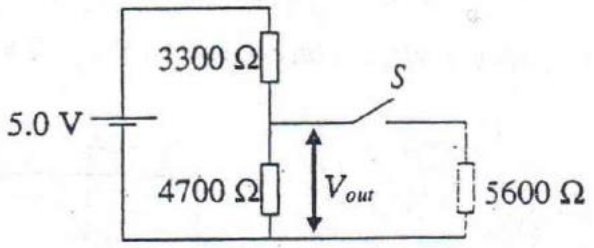
(g)



(h)



26. A pupil sets up a potential divider circuit as shown. She calculates that resistors of 3300 Ω and 4700 Ω will give the required output. She then connects a load resistor of 5600 Ω to the output of the potential divider.



(a) What is the output voltage V_{out} before the switch is closed?

(b) What is the output once the switch is closed?

(c) Find the value of the resistance which must replace the 4700 Ω resistor when S is closed in order to give the desired output as calculated in part (a).

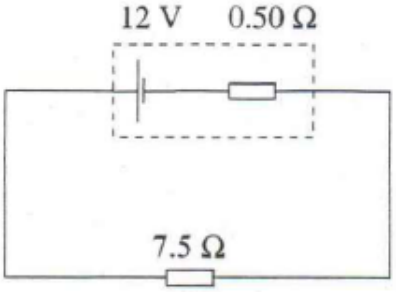
Internal Resistance

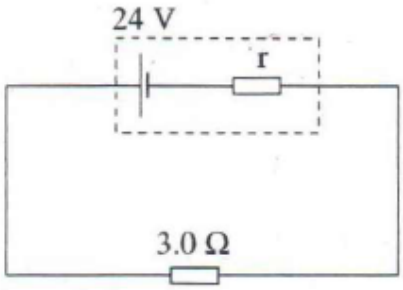
27. A battery has an e.m.f. of 12 V and an internal resistance of 0.50 Ω. The battery is connected to a load resistor of 7.5 Ω.

(a) How much current is drawn from the battery?

(b) What is the potential difference at the terminals of the battery?

(c) Calculate the 'lost volts'.





28. A battery of e.m.f. 24 V is connected to a load resistance of 3.0 Ω as shown.
The current drawn from the battery is found to be 6.0 A.

(a) What is the p.d. at the terminals of the battery?

(b) What is the internal resistance of the battery?

29. A cell of e.m.f. 1.5 V and internal resistance 0.60 Ω is connected to a 3.3 Ω resistor.

(a) Calculate the current drawn from the cell.

(b) Find the terminal p.d.

(c) If the terminals of the cell are accidently shorted, what current will flow?

30. A car battery has an e.m.f. of 12.4 V and an internal resistance of 0.06 Ω.
What is the short circuit current?

31. A battery of e.m.f. 6.0 V delivers a current of 24 A when its terminals are short circuited.
What is the internal resistance of the battery?

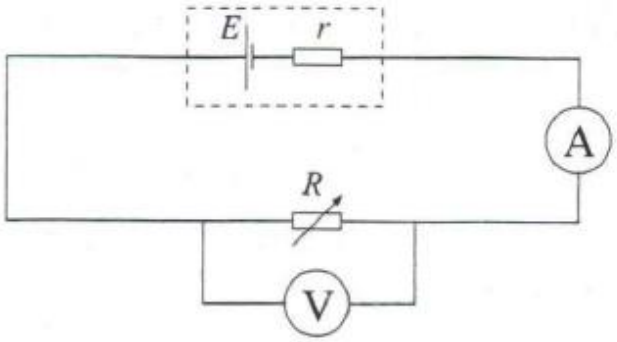
32. A cell of e.m.f. 1.5 V and internal resistance 0.50 Ω is connected to a load resistor of 4.5 Ω. Find the power dissipated in (a) the load resistor and (b) the cell.

33. A power supply has an e.m.f. of 1.6 V and an internal resistance of 0.25 Ω. What will be the p.d. at the terminals when the supply is delivering a current of 2.4 A?

34. A battery of e.m.f. 12 V has a terminal p.d. of 10.5 V when connected to a load resistor of 2.8 Ω. What is the internal resistance of the battery?

35. A high resistance voltmeter connected across a cell reads 1.53 V when the cell is open circuit and 1.32 V when the cell is connected to a circuit drawing a current of 0.42 A. What is the internal resistance of the cell?

36. The circuit below was set up to investigate the relationship between V, the terminal p.d. of a cell, and I, the current drawn from it.



By varying the value of the load resistance R, the results in the table were obtained.

I (Amps)	V (Volts)
0.20	2.7
0.40	2.4
0.60	2.1
0.80	1.8
1.0	1.5

(a) Draw a graph of V against I.

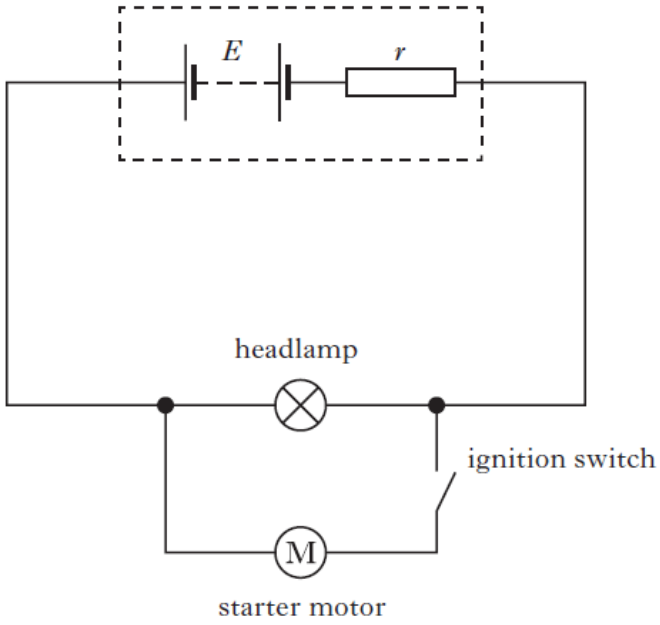
(b) Use the graph to find

(i) the e.m.f. of the cell

(ii) the internal resistance of the cell.

(c) Calculate the current which would flow if the load resistance was reduced to zero.

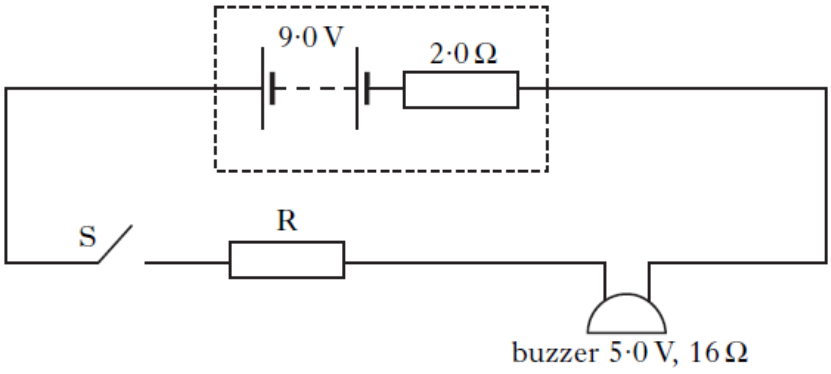
37. A technician connects a battery to a headlamp in parallel with a starter motor as shown.



The technician notices that the headlamp becomes dimmer when the ignition switch is closed and the starter motor operates.
Explain why this happens.

38. An alarm circuit in a smoke detector contains a battery of e.m.f. 9.0 V and internal resistance 2.0 Ω.

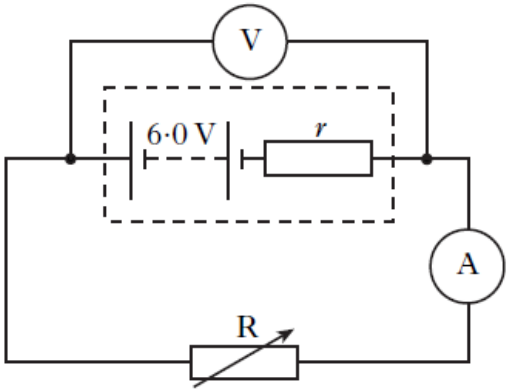
The circuit is shown.



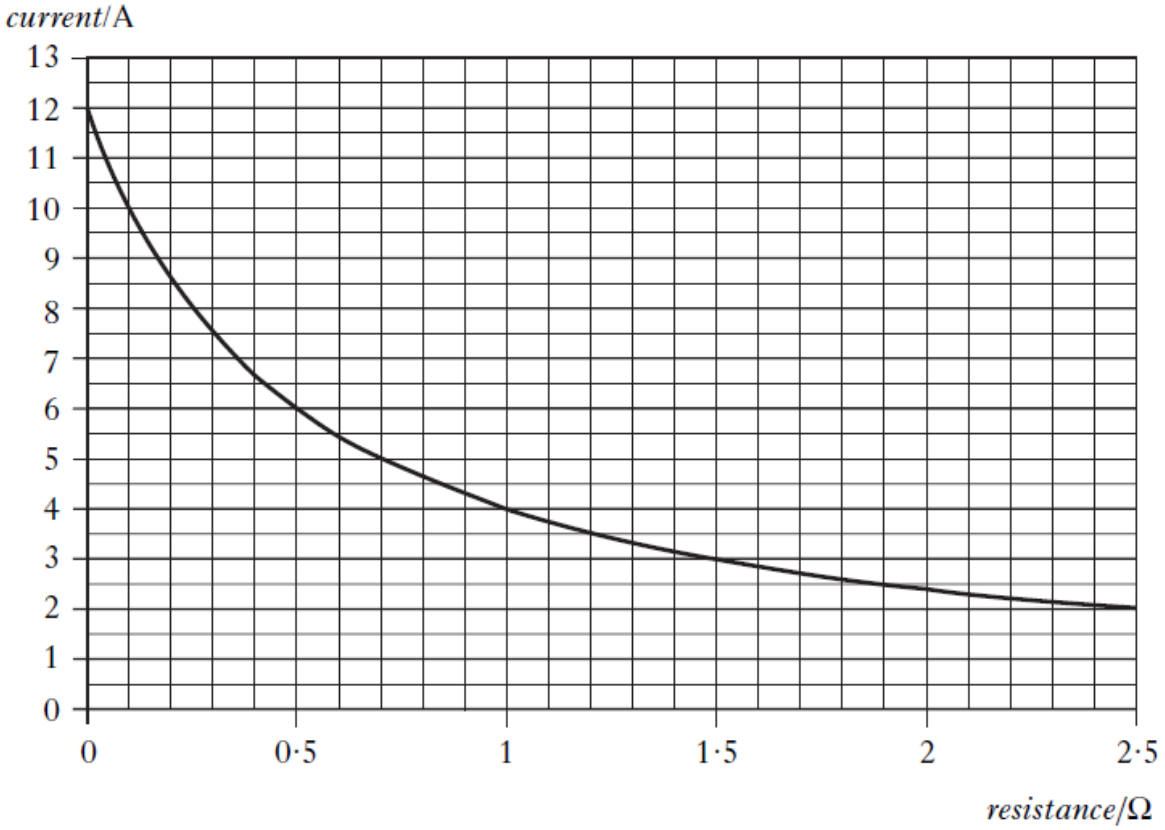
When the smoke is detected, switch S closes and the buzzer operates. The buzzer has a resistance of 16 Ω and an operating voltage of 5.0 V.

Calculate the value of resistor R required in this circuit.

39. A battery of e.m.f. 6.0 V and internal resistance, r, is connected to a variable resistor R as shown.



The graph shows how the current in the circuit changes as the resistance of R increases.



(a) Use information from the graph to calculate:

(i) the lost volts in the circuit when the resistance of R is 1.5 Ω.

(ii) the internal resistance, r, of the battery.

(b) The resistance of r is now increased.

What effect, if any, does this have on the lost volts?

You must justify your answer.