Past-paper walk-through

Practical circuits ▪ 10.1

eXercise

Questions in this set

- 9702/11 N25 Q35 ▪ 1 mark
- 9702/12 N25 Q34 ▪ 1 mark
- 9702/14 N25 Q33 ▪ 1 mark
- 9702/14 N25 Q37 ▪ 1 mark
- 9702/22 N25 Q5 ▪ 11 marks
- 9702/11 J25 Q37 ▪ 1 mark
- 9702/12 J25 Q35 ▪ 1 mark
- 9702/13 J25 Q36 ▪ 1 mark
- 9702/14 J25 Q33 ▪ 1 mark
- 9702/12 M25 Q34 ▪ 1 mark

Questions in this set

- 9702/12 M25 Q36 ▪ 1 mark
- 9702/21 N24 Q7 ▪ 8 marks

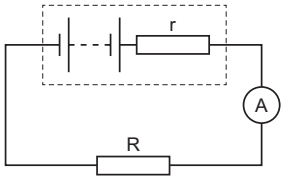
Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 35

9702/11 N25 ▪ Q35 ▪ 1 mark

35 The diagram shows a circuit with a battery connected to a resistor R. The battery has an internal resistance represented by resistor r.



A second resistor, identical to R, is connected in parallel with R.

Which row describes the changes to the potential difference (p.d.) across r and the current shown on the ammeter when the second resistor is connected?

		current shown

Question 35

	p.d. across r	current shown on ammeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

Solution 35

Answer: **D**

Why

- Adding an identical resistor in parallel halves the external resistance.
- The total circuit resistance falls, so the battery current rises – the ammeter reads more.
- A larger current through r means a larger p.d. across it, so both quantities increase.

Question 34

9702/12 N25 ▪ Q34 ▪ 1 mark

A cell of electromotive force (e.m.f.) E delivers a charge Q to an external circuit. Which statement is correct? **[1]**

A The energy dissipated in the external circuit is EQ.

B The energy dissipated within the cell is EQ.

C The external resistance is EQ.

D The total energy dissipated in the cell and the external circuit is EQ.

Solution 34

A The energy dissipated in the external circuit is EQ.

B The energy dissipated within the cell is EQ.

C The external resistance is EQ.

D The total energy dissipated in the cell and the external circuit is EQ. ✓

Why

- E.m.f. is the total energy the cell converts per unit charge.
- So EQ is the *total* energy, including what is dissipated inside the cell itself.
- The external circuit receives only VQ, which is less by the $I^2 r$ lost internally.

Question 33

9702/14 N25 ▪ Q33 ▪ 1 mark

The diagram shows an electrical circuit containing a light-dependent resistor (LDR).
What is the circuit diagram for this circuit? **[1]**

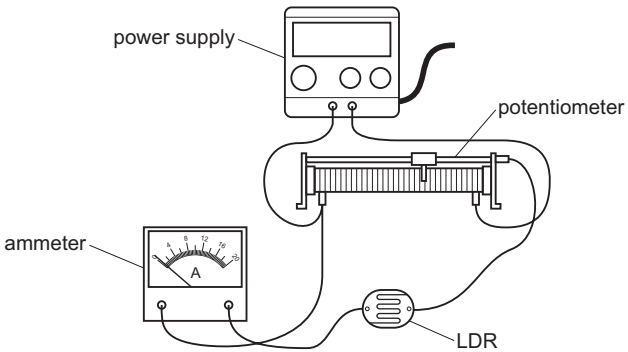
A Circuit diagram A

B Circuit diagram B

C Circuit diagram C

D Circuit diagram D

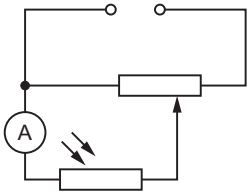
Question 33

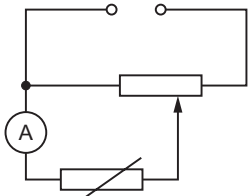


What is the circuit diagram for this circuit?

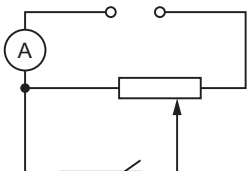
A **B**

Question 33

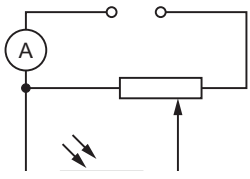




C



D



Solution 33

A Circuit diagram A ✓

B Circuit diagram B

C Circuit diagram C

D Circuit diagram D

Why

- A potentiometer uses all three terminals: the whole track across the supply, and the slider as the output.
- The ammeter has to be in series with the LDR so that the LDR's current passes through it.
- So look for the track connected across the supply with the ammeter in the LDR branch.

Question 37

9702/14 N25 ▪ Q37 ▪ 1 mark

The circuit diagram shows a battery with internal resistance *r*, two resistors, a switch and a voltmeter. The switch is open.

The switch is now closed.

What happens to the current in the battery, and what happens to the reading on the voltmeter, when the switch is closed? **[1]**

A current in battery: increases; reading on voltmeter: decreases

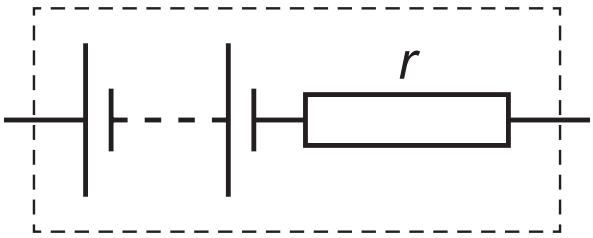
B current in battery: increases; reading on voltmeter: remains the same

C current in battery: remains the same; reading on voltmeter: decreases

D current in battery: remains the same; reading on voltmeter: remains the same

	current in battery	reading on voltmeter
A	increases	decreases
B	increases	remains the same
C	remains the same	decreases
D	remains the same	remains the same

Question 37



Solution 37

A current in battery: increases; reading on voltmeter: decreases ✓

B current in battery: increases; reading on voltmeter: remains the same

C current in battery: remains the same; reading on voltmeter: decreases

D current in battery: remains the same; reading on voltmeter: remains the same

Why

- Closing the switch brings the second resistor into the circuit in parallel, lowering the external resistance.
- A lower total resistance means a larger current from the battery.
- More current means more lost across r, so the terminal p.d. the voltmeter reads falls.

Question 5

9702/22 N25 ▪ Q5 ▪ 11 marks

Fig. 5.1 shows a circuit containing a battery, two fixed resistors X and Y, and a light-dependent resistor (LDR) Z.

The battery has electromotive force (e.m.f.) 5.0 V and internal resistance $4.7\ \Omega$. The current in X is I_1 and the current in Y is I_2.

The resistance of X is $100\ \Omega$. The resistance of Z varies with the intensity of light incident on it as shown in Fig. 5.2.

(a) State Kirchhoff's first law. **[1]**

(b)(i) Show that the terminal potential difference of the battery is 4.8 V. **[2]**

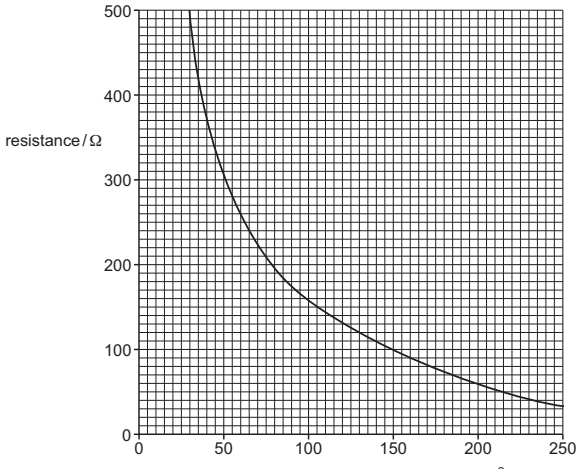
(b)(ii) Calculate the current I_2 in Y. **[3]**

(b)(iii) Calculate the power dissipated in Y. **[2]**

(b)(iv) The intensity of the light incident on Z decreases.

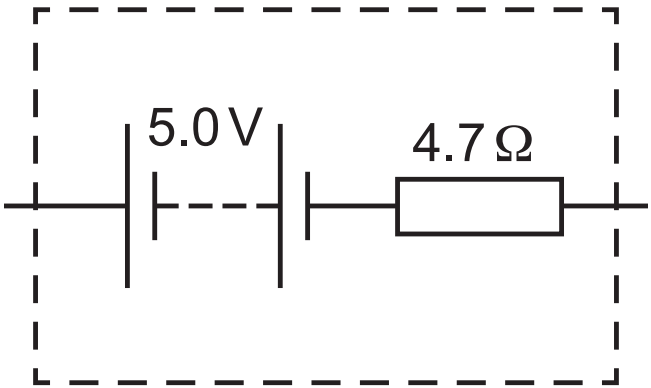
State and explain the effect on the terminal potential difference of the battery. **[3]**

Question 5



Question 5

Question 5



Solution 5

(a)

Mark scheme

- sum of current(s) into junction = sum of current(s) out junction or (algebraic) sum of current(s) at a junction is zero **B1**

Solution 5

(b)(i)

Worked steps

Terminal p.d. is what is left of the e.m.f. after the internal resistance takes its share.

- $V = E - Ir$, with the **total** current from the battery, $I = 38$ mA.
- $V = 5.0 - (38 \times 10^{-3} \times 4.7)$
- $V = 5.0 - 0.18 = 4.8$ V, as required.

Mark scheme

- (V =) E – Ir **C1**
- (V =) 5.0 – (38 × 10–3 × 4.7) = 4.8 (V) **A1**

Solution 5

(b)(ii) Worked steps

Find the current down the X-and-Z branch, then take it away from the total: Kirchhoff's first law does the rest.

- Read $R_Z = 120\ \Omega$ off the graph at the stated light intensity.
- X and Z are in series, so that branch has $100 + 120 = 220\ \Omega$ across the terminal p.d.
- $I_1 = \dfrac{4.8}{220} = 0.022$ A
- $I_2 = 38 \times 10^{-3} - 0.022$
- $I_2 = 0.016$ A

Solution 5

Mark scheme

- R(Z) = 120 Ω **C1**
- I2 = 38 × 10–3 – (4.8 / (100 + 120)) **C1**
- I2 = 0.016 A **A1**
- or
- R(Z) = 120 Ω
- (C1)
- R(EXT) = 4.8 / 38 × 10–3
- (= 126 Ω)

Solution 5

- 1 / R(Y) = 1 / 126 – 1 / (120 + 100)
- (R(Y) = 297 Ω)
- I2 = 4.8 / 297
- (C1)
- I2 = 0.016 A
- (A1)

Solution 5

(b)(iii)

Worked steps

Y is connected straight across the terminals, so the p.d. across it is 4.8 V.

- $P = I_2 V = 0.016 \times 4.8$
- $P = 0.077$ W

Mark scheme

- P = IV or P = I2R or P = V2 / R **C1**
- P = 0.016 × 4.8 or
- P = 0.0162 × (4.8 / 0.016) or
- P = 4.82 / (4.8 / 0.016)
- P = 0.077 W **A1**

Solution 5

(b)(iv)

Mark scheme

- resistance of the LDR / Z increases (as light intensity decreases) **B1**
- total resistance (of the circuit) increases or current in the battery decreases **M1**
- (potential difference across the internal resistor decreases so) the terminal potential difference increases **A1**

Question 37

9702/11 J25 ▪ Q37 ▪ 1 mark

A cell is connected in series with an ammeter and a variable resistor. A voltmeter is used to measure the p.d. across the variable resistor. The resistance of the variable resistor is varied, and the p.d. and the current are recorded.

The graph shows the variation with current of the p.d. across the variable resistor.

What is the internal resistance of the cell? **[1]**

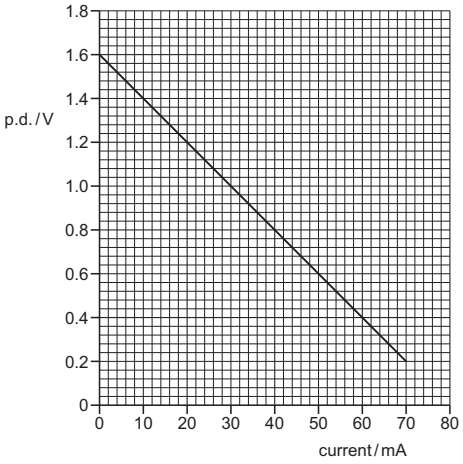
A $0.050\ \Omega$

B $1.6\ \Omega$

C $20\ \Omega$

D $23\ \Omega$

Question 37



Solution 37

A $0.050\ \Omega$

B $1.6\ \Omega$

C $20\ \Omega$ ✓

D $23\ \Omega$

Why

- The terminal p.d. obeys $V = E - Ir$, so a graph of V against I is a straight line of gradient $-r$.
- The line falls from 1.6 V at zero current to zero at 80 mA.
- $r = 1.6/(80 \times 10^{-3}) = 20\ \Omega$; B is the intercept, which is the e.m.f., not a resistance.

Question 35

9702/12 J25 ▪ Q35 ▪ 1 mark

The diagram shows a cell of internal resistance $1.0R$ connected to a variable resistor.
When the variable resistor has an initial resistance of $2.0R$, the current in the cell is I_1 and the terminal potential difference (p.d.) across the cell is V_1.
The variable resistor is now adjusted to a new resistance of $4.0R$.
What is the new current in the cell and the new terminal p.d. across the cell? **[1]**

A current: $0.50I_1$, terminal p.d.: $1.0V_1$

B current: $0.50I_1$, terminal p.d.: $1.2V_1$

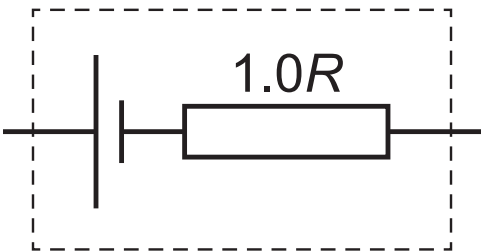
C current: $0.60I_1$, terminal p.d.: $1.0V_1$

D current: $0.60I_1$, terminal p.d.: $1.2V_1$

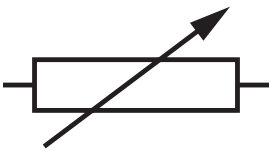
Question 35

	current	terminal p.d.
A	$0.50I_1$	$1.0V_1$
B	$0.50I_1$	$1.2V_1$
C	$0.60I_1$	$1.0V_1$
D	$0.60I_1$	$1.2V_1$

Question 35



Question 35



Solution 35

A current: $0.50I_1$, terminal p.d.: $1.0V_1$

B current: $0.50I_1$, terminal p.d.: $1.2V_1$

C current: $0.60I_1$, terminal p.d.: $1.0V_1$

D current: $0.60I_1$, terminal p.d.: $1.2V_1$ ✓

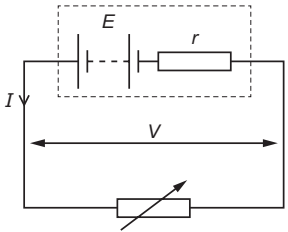
Why

- With $2.0R$ the current is $E/3.0R$ and the terminal p.d. is $\frac{2}{3}E$.
- With $4.0R$ the total is $5.0R$, so the current falls to $E/5.0R$.
- Less current means less lost across the internal $1.0R$, so the terminal p.d. rises to $\frac{4}{5}E$.

Question 36

9702/13 J25 ▪ Q36 ▪ 1 mark

36 A battery has an e.m.f. E and internal resistance r. The battery delivers a current I to a variable resistor and the p.d. across its terminals is V.



The variable resistor is adjusted so that I increases.

Why does V decrease?

Question 36

A The e.m.f. E decreases.

B The internal resistance r increases.

C The p.d. across r increases.

D The resistance of the variable resistor increases.

Solution 36

Answer: **C**

Why

- The terminal p.d. is $V = E - Ir$.
- E and r are properties of the battery and do not change when the resistor is adjusted.
- A larger I means a larger Ir lost inside, so V falls.

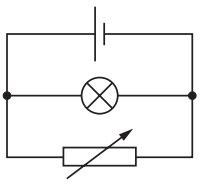
Question 33

9702/14 J25 ▪ Q33 ▪ 1 mark

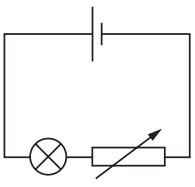
33 A cell of constant electromotive force (e.m.f.) and negligible internal resistance is separately connected into four different circuits.

In which circuit does the power dissipated by the lamp stay the same as the variable resistor is adjusted?

A

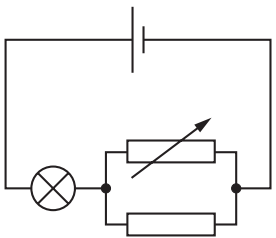


B

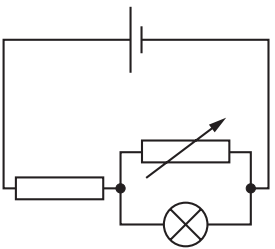


Question 33

C



D



Solution 33

Answer: **A**

Why

- The cell has negligible internal resistance, so anything connected straight across it always gets the full e.m.f.
- A lamp in parallel with the variable resistor therefore keeps the same p.d. however the resistor is set.
- Same p.d. across the same lamp means the same power; in the other circuits the resistor takes a share of the lamp's current or voltage.

Question 34

9702/12 M25 ▪ Q34 ▪ 1 mark

34 Which circuit symbol does **not** represent an electric component that is designed to emit sound waves?

A

B

C

D

Solution 34

Answer: **B**

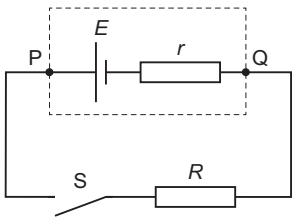
Why

- A loudspeaker (the horn), a bell and a buzzer (the two dome shapes) all work by pushing a diaphragm against the air.
- That is why each of their symbols opens outwards – the shape represents the radiating surface.
- The remaining symbol is a plain rectangular element with no diaphragm, so it is not designed to emit sound.

Question 36

9702/12 M25 ▪ Q36 ▪ 1 mark

36 A cell of electromotive force (e.m.f.) E and internal resistance r is connected in series with a switch S and an external resistor of resistance R.



The potential difference (p.d.) between P and Q is V.

Which statement is correct when S is changed from open to closed?

Question 36

A V increases because there is a p.d. across R.

B V decreases because there is a p.d. across r.

C V remains the same because the decrease of p.d. across r is balanced by the increase of p.d. across R.

D V remains the same because the sum of the p.d.s across r and R is still equal to E.

Solution 36

Answer: **B**

Why

- With the switch open no current flows, so nothing is lost across r and $V = E$.
- Closing the switch drives a current, so now Ir is dropped inside the cell.
- The terminal p.d. falls to $V = E - Ir$.

Question 7

9702/21 N24 ▪ Q7 ▪ 8 marks

7 (a) Fig. 7.1 shows two resistors connected in series with a cell of electromotive force (e.m.f.) 1.50 V and internal resistance 0.28 Ω. 1.0 Ω 1.50 V I 0.28 Ω R Fig. 7.1
One of the resistors has resistance 1.0 Ω. The other resistor has resistance R.
The terminal potential difference (p.d.) across the cell is 1.36 V.
(i) Show that the current I in the circuit is 0.50 A.
[2]
(ii) Calculate the combined resistance of the two resistors.
resistance = Ω [2]
(iii) Use your answer in (a)(ii) to determine resistance R.
R = Ω [1] , ,
(b) The circuit in Fig. 7.1 is disconnected and the two resistors are reconnected to the cell, now in parallel with each other.

Question 7

(i) On Fig. 7.2, complete the circuit diagram to show this arrangement. 1.50 V 0.28 Ω
Fig. 7.2
[1]
(ii) Explain, without calculation, whether the terminal p.d. across the cell is now less than, equal to or greater than 1.36 V [2]

, ,

(a)(i) Show that the current I in the circuit is 0.50 A. **[2]**

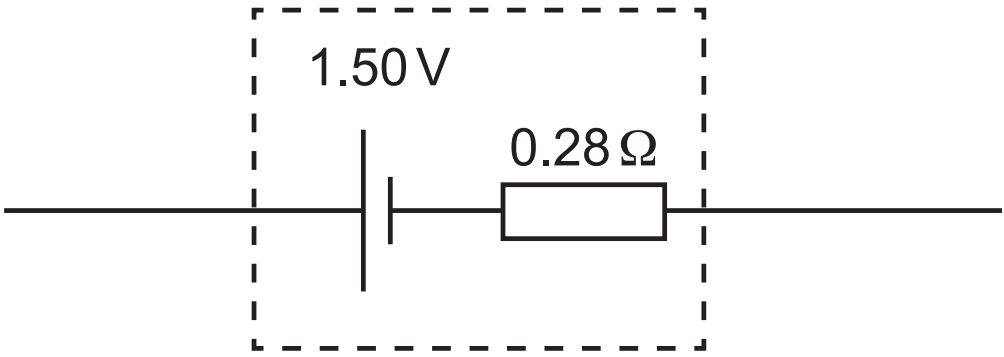
(a)(ii) Calculate the total resistance of the two resistors. **[2]**

(a)(iii) Calculate the resistance R. **[1]**

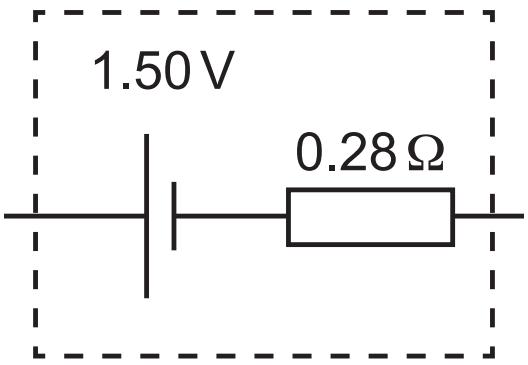
(b)(i) Draw a circuit diagram showing the same two resistors connected in parallel with the cell. **[1]**

(b)(ii) State and explain the effect of this change on the terminal potential difference of the cell. **[2]**

Question 7



Question 7



Solution 7

(a)(i) Worked steps

The "lost volts" across the internal resistance are the difference between the e.m.f. and the terminal p.d.

- Lost volts $= E - V = 1.50 - 1.36 = 0.14$ V
- All of that appears across r, so $I = \dfrac{0.14}{0.28}$
- $I = 0.50$ A, as required.

Solution 7

Mark scheme

- (V =) 1.50 – 1.36
- (= 0.14 V)
- current = V / R
- = 0.14 / 0.28 = 0.50 A

Solution 7

(a)(ii) Worked steps

- The terminal p.d. is across the two resistors together.
- $R_{\text{total}} = \dfrac{V}{I} = \dfrac{1.36}{0.50}$
- $R_{\text{total}} = 2.7\ \Omega$

Solution 7

Mark scheme

- resistance $=$ V / I
- $=$ 1.36 / 0.50
- $= 2.7\,\Omega$

Solution 7

(a)(iii)

Worked steps

- They are in **series**, so resistances simply add.
- $R = 2.7 - 1.0$
- $R = 1.7\ \Omega$

Mark scheme

- R = 2.7 – 1.0
- $= 1.7\,\Omega$

Solution 7

(b)(i)

Mark scheme

- two resistors correctly shown in parallel with cell and no other components

Solution 7

(b)(ii) Worked steps

Work through the chain: resistance, then current, then lost volts.

- In parallel the external resistance is **smaller** than either resistor, so smaller than before.
- A smaller external resistance means a **larger** current from the cell.
- A larger current means larger lost volts Ir inside the cell.
- So the terminal p.d. **decreases**.

Solution 7

Mark scheme

- (external) resistance is now smaller
- and
- (so) current (in cell) is greater / (external) resistance smaller fraction of total resistance / internal resistance larger fraction of
- total resistance
- (greater p.d. across internal resistance so) terminal p.d. is less