

AS Physics 9702

Unit 10 · D.C. circuits

Worked answers

Try the separate worksheet first. These worked answers explain methods as well as results. Equivalent valid reasoning and sensible rounding may also be correct. Suggested marks are RevisionTown practice guidance, not Cambridge marking instructions.

Scope: Cambridge International AS Physics 9702, 2025–2027 learning outcomes. The published 2028–2030 AS scope has been checked separately and is substantively unchanged. Version: 11 October 2026.

U10-Q1 · 27 marks

Award one mark for each correctly recognisable labelled symbol, checking against the original symbol chart [27 total]. Essential distinctions: the cell has unequal plates but the capacitor equal plates; the battery repeats cell pairs; a.c. supply includes a wave mark; a junction has a dot; lamp has a cross; fixed resistor is rectangular; variable resistor has a diagonal arrow; thermistor has a bent diagonal line without an arrowhead; LDR arrows point inwards; LED arrows outwards; potentiometer has a separate sliding-contact lead. The heater is subdivided, switch has a movable contact, earth has diminishing bars, bell domes upwards and buzzer bowls downwards. Microphone and loudspeaker have their input/output outlines; M, G, A and V identify their devices; galvanometer has a pointer; oscilloscope a trace; diode has its cathode bar. The chart gives complete shapes and leads.

Figure for U10-Q1 — worked answer

U10-Q1 · Circuit symbols · Plate 1 of 3

Answer key: nine labelled symbols per plate



Cell



Battery of cells



Power supply



A.C. power supply



Junction of
conductors



Lamp



Fixed resistor



Variable resistor



Thermistor

Original standard-symbol drawings; each component is shown separately.

Figure for U10-Q1 — worked answer

U10-Q1 · Circuit symbols · Plate 2 of 3

Answer key: nine labelled symbols per plate



Light-dependent
resistor



Heater



Switch



Earth



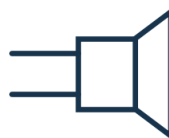
Electric bell



Buzzer



Microphone



Loudspeaker



Motor

Original standard-symbol drawings; each component is shown separately.

Figure for U10-Q1 — worked answer

U10-Q1 · Circuit symbols · Plate 3 of 3

Answer key: nine labelled symbols per plate



Generator



Ammeter



Voltmeter



Galvanometer



Potentiometer



Oscilloscope



Diode



Light-emitting diode



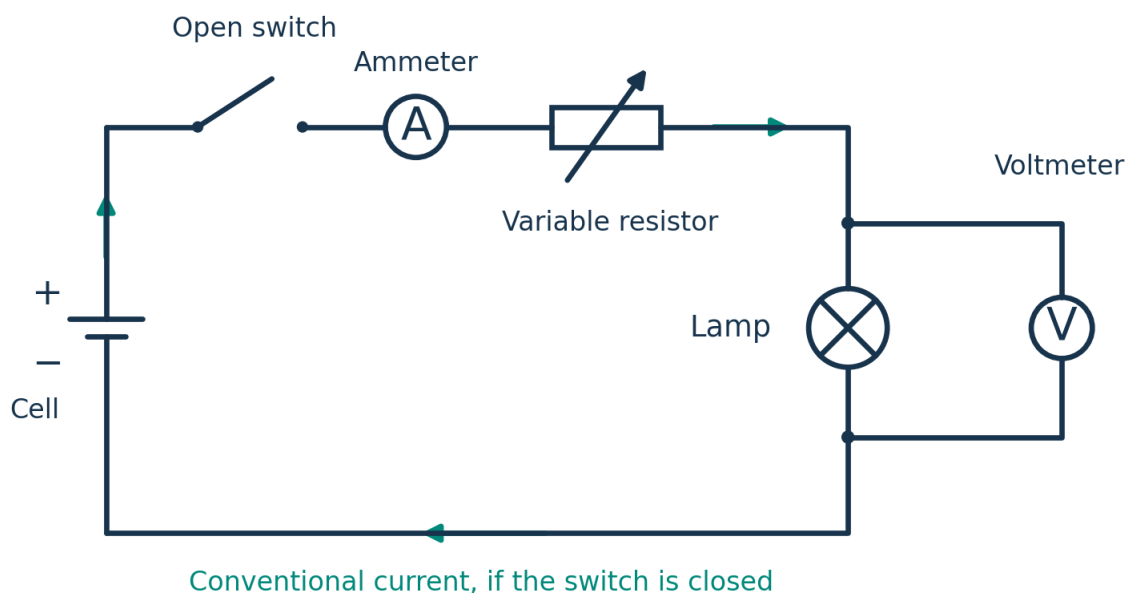
Capacitor

Original standard-symbol drawings; each component is shown separately.

U10-Q2 · 6 marks

(a) Draw the long cell plate to switch, then series ammeter A, variable resistor, lamp, and back to the short plate [2]. Connect the voltmeter V to the two lamp terminals as a separate parallel branch [1]. Show conventional current out of the positive terminal through the series components and back to negative [1]. (b)(i) The ammeter's very low resistance directly across the cell creates a near-short circuit, potentially causing excessive current and overheating the ammeter or source [1]. (ii) In this separate mistake, the voltmeter's high resistance in series greatly reduces the circuit current, so the lamp is not measured in its intended operating state; this arrangement does not cause the excessive-current fault in (i) [1].

Figure for U10-Q2 — worked answer

U10-Q2 · Completed circuit

The drawn switch is open, so no steady circuit current flows in this state.

The teal arrows show the direction after closing the switch.

U10-Q3 · 7 marks

(a) E.m.f. is energy supplied by a source per unit charge around the complete circuit [1]; $E = 420/35 = 12 \text{ V}$ [1]. (b) External energy is $420 - 70 = 350 \text{ J}$ [1]; $V = 350/35 = 10 \text{ V}$ [1]. E describes chemical-to-electrical energy supplied per charge, while terminal p.d. describes electrical energy available per charge to the external circuit; 2 J C^{-1} is dissipated internally [1]. (c) $E - V = Ir$, so $r = (12 - 10)/2.0 = 1.0 \Omega$ [2].

U10-Q4 · 7 marks

(a) $I = 8.4/(3.6 + 0.60) = 2.0 \text{ A}$ [1]. $V = IR = 7.2 \text{ V}$ [1]. $P_{\text{external}} = I^2 R = 14.4 \text{ W}$ and $P_{\text{internal}} = I^2 r = 2.4 \text{ W}$ [2]. (b) New $I = 8.4/(7.8 + 0.60) = 1.0 \text{ A}$, so $V = 8.4 - 1.0(0.60) = 7.8 \text{ V}$ [1]. Smaller current produces a smaller internal drop, so terminal voltage rises [1]. (c) A near-zero load can draw very large current and overheat the source or wires [1].

U10-Q5 · 6 marks

(a) Gradient = $(5.04 - 5.76)/(0.80 - 0.20) = -1.20 \text{ V A}^{-1}$ [1]. From $V = E - rI$, $r = 1.20 \Omega$ [1] and $E = 5.76 + 0.20(1.20) = 6.00 \text{ V}$ [1]. (b) $V = 6.00 - 0.50(1.20) = 5.40 \text{ V}$ [1]. (c) Change a suitably rated external load, measure series current and parallel terminal voltage, and keep within a safe current range [1]. Heating or changing state of charge may change the source's properties systematically [1].

U10-Q6 · 10 marks

(a) Total current entering a junction equals total leaving, from charge conservation [2]. The algebraic potential changes around a closed loop sum to zero, from energy conservation [2]. (b) Series: same I , $V = V_1 + V_2 = I(R_1 + R_2)$, so $R_{\text{eq}} = R_1 + R_2$ [2]. Parallel: same V , $I = V/R_1 + V/R_2 = V/R_{\text{eq}}$, so $1/R_{\text{eq}} = 1/R_1 + 1/R_2$ [2]. (c) Series gives 16Ω , larger than either; parallel gives $(4 \times 12)/(4 + 12) = 3.0 \Omega$, smaller than either [2].

U10-Q7 · 7 marks

(a) The parallel pair is $(6 \times 3)/(6 + 3) = 2.0 \Omega$ [1]. Total $R = 2.0 + 2.0 = 4.0 \Omega$; source $I = 15/4 = 3.75 \text{ A}$ [2]. (b) J is at $15 - 3.75(2.0) = 7.50 \text{ V}$ [1]. Branch currents are $7.50/6 = 1.25 \text{ A}$ and $7.50/3 = 2.50 \text{ A}$ [1]. (c) Junction: $1.25 + 2.50 = 3.75 \text{ A}$ [1]. Either loop: source rise 15 V equals 7.50 V across the series resistor plus 7.50 V across its parallel branch [1].

U10-Q8 · 8 marks

For the specified A-to-B traversal, $V = 9.0 + 3.0I_1$, $V = 3.0 + 6.0I_2$, and $V = 6.0I_3$ [3]. The junction equation is $I_1 + I_2 + I_3 = 0$ [1]. Hence $(V - 9)/3 + (V - 3)/6 + V/6 = 0$. Multiplying by 6 gives $4V - 21 = 0$, so $V = 5.25 \text{ V}$ [1]. $I_1 = -1.25 \text{ A}$, meaning B to A; $I_2 = +0.375 \text{ A}$ and $I_3 = +0.875 \text{ A}$, both A to B [3]. The entering current 1.25 A equals $0.375 + 0.875 \text{ A}$, checking charge conservation.

U10-Q9 · 7 marks

(a) $I = V_s/(R_{\text{upper}} + R_{\text{lower}})$ and $V_{\text{out}} = IR_{\text{lower}}$, giving $V_{\text{out}} = V_s R_{\text{lower}}/(R_{\text{upper}} + R_{\text{lower}})$ [2]. Output = $9.0 \times 6/(3 + 6) = 6.0 \text{ V}$ [1]. (b) The lower resistor and load are parallel: $R_{\text{lower,eq}} = 3.0 \text{ k}\Omega$ [1]. New output = $9.0 \times 3/(3 + 3) = 4.5 \text{ V}$ [1]. Source current = $9.0/6000 = 1.5 \text{ mA}$ [1]. (c) Current branches at J , so the original two resistors no longer carry the same current; use the lower parallel equivalent [1].

U10-Q10 · 8 marks

(a) Dim: $6.0 \times 12/(3 + 12) = 4.8 \text{ V}$; bright: $6.0 \times 3/(3 + 3) = 3.0 \text{ V}$ [2]. Brighter light lowers the lower-arm resistance and output [1]. (b) Now output is across the fixed lower resistor: dim = $6.0 \times 3/(12 + 3) = 1.2 \text{ V}$, bright = 3.0 V [2]. (c) Warming lowers NTC resistance: with thermistor below J the output falls, while with thermistor above J it rises [2]. The output is the lower resistance's fraction of the total; changing numerator as well as denominator gives the opposite trend from changing only the upper resistance [1].

U10-Q11 · 8 marks

(a) Zero galvanometer current means equal potentials at its terminals and the test e.m.f. equals the opposing wire drop [2]. $k = 1.50/0.600 = 2.50 \text{ V m}^{-1}$; $E = k(0.484) = 1.21 \text{ V}$ [2]. (b) No current is drawn from the test cell at null, so its internal voltage drop Ir is zero [1]. (c) $E = E_{\text{ref}} I_{\text{unknown}} / I_{\text{ref}}$. Maximum fractional uncertainty = $0.002/0.484 + 0.002/0.600 = 0.00747$ [1], or 0.747% [1]. Absolute uncertainty = $1.21 \times 0.00747 = 0.00903 \text{ V}$, approximately 0.009 V [1].

U10-Q12 · 8 marks

(a) $k = 2.00/1.00 = 2.00 \text{ V m}^{-1}$, so $l = 1.20/2.00 = 0.600 \text{ m}$ [2]. (b) The maximum available wire drop is only 2.00 V, below 2.40 V [1]. (c) Reversed test-cell polarity or a poor/open electrical connection can prevent balance [2]. Near a real balance the galvanometer deflects in opposite directions on the two sides; a broken connection can show zero everywhere and fails this check [1]. (d) $V_2/V_1 = I_2/I_1 = 0.525/0.350 = 1.50$ [1]. The wire potential gradient and the sensor circuits' operating conditions must remain unchanged during the comparison [1].

U10-Q13 · 3 marks

B is correct [1]. $I = E/(R + r)$ falls as R rises [1]; then $V = E - Ir$ rises because the internal drop is smaller [1]. A reverses both trends. C assumes terminal voltage follows current despite the changed external R . D treats the source as an ideal constant-current source rather than an e.m.f. with series resistance.

U10-Q14 · 3 marks

B is correct [1]: $V_{\text{out}} = V_s R_{\text{fixed}} / (R_{\text{NTC}} + R_{\text{fixed}})$ increases as R_{NTC} falls [1]. A misstates the NTC trend. C confuses the zero-current test branch with the still-powered main wire. D confuses current detection with voltage measurement and could cause excessive current [1 for the alternative errors].

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