Question 34 (Answer: **A**)

- Both outer currents flow up towards the top node, so P carries their sum: $3.0 + 2.0 = 5.0$ A.
- Round the left loop the 1.0 V cell opposes the 9.0 V battery, so the driving e.m.f. is $9.0 - 1.0 = 8.0$ V.
- $8.0 = (3.0)(2.0) + 5.0R_P$, giving $R_P = 2.0/5.0 = 0.40\ \Omega$.

Question 37 (Answer: **C**)

- Two junctions are shown: the first gives $I_1 = I_2 + I_3$ and the second gives $I_3 = I_4 + I_5$.
- A, B and D are just those two relations rearranged.
- C adds I_3 to $I_4 + I_5$, but those already *are* I_3 – it counts the lower branch twice.

Question 37 (Answer: **A**)

- The first law concerns currents at a junction and follows from conservation of charge.
- The second law concerns e.m.f.s and p.d.s round a loop and follows from conservation of energy.
- Voltage is not itself a conserved quantity, which rules out B and D.

Question 36 (Answer: **C**)

- The battery sits directly across the $4R$, so the same e.m.f. appears across the chain beside it.
- That chain is $3R + 2R + R = 6R$ in series, carrying a current $E/6R$.
- The voltmeter reads across the $2R$: $V = (E/6R)(2R) = E/3$, so $E = 3 \times 2 = 6$ V.

5(a)	sum of current(s) into junction = sum of current(s) out junction **or** (algebraic) sum of current(s) at a junction is zero
5(b)(i)	line with negative gradient
	line from 0 °C to 100 °C, starting at (0, R_0) with negative gradient throughout and never reaching $R = 0$
5(b)(ii)	(resistance of T decreases so) total resistance (of circuit) decreases
	current in cell increases (so p.d. across internal resistance increases)
	terminal p.d. decreases (and resistance of R is constant) so current in R decreases
5(c)(i)	p.d. across r = 1.50 – (6.00 × 0.200) (= 0.30 V)
	current in cell = 0.30 / 0.12 = 2.5 A
5(c)(ii)	current in thermistor = 2.5 – 0.200 (= 2.3 A)
	resistance of T = (6.00 × 0.200) / 2.3 = 0.52 Ω

Question 36 (Answer: **B**)

- For two resistors in parallel, $1/R = 1/R_1 + 1/R_2$.
- Putting that over a common denominator gives $R = R_1R_2/(R_1 + R_2)$.
- A is the series formula; a parallel combination is always smaller than either resistor.

Question 37 (Answer: **A**)

- The first law says the algebraic sum of the currents at a junction is zero.
- Charge cannot pile up at a point, so what flows in must flow out – conservation of charge.
- Energy conservation is the *second* law, about e.m.f.s and p.d.s round a loop.

Question 35 (Answer: **C**)

- Each branch is a potential divider across the same 8.0 V.
- One midpoint sits at $8.0 \times 3R/4R = 6.0$ V and the other at $8.0 \times R/4R = 2.0$ V.
- The voltmeter reads the difference: $6.0 - 2.0 = 4.0$ V.

Question 34 (Answer: **A**)

- Currents in equalling currents out is Kirchhoff's first law.
- It follows from conservation of charge – charge cannot accumulate at a point.
- The loop rule is the second law, and that one follows from conservation of energy.

Question 35 (Answer: **B**)

- Total resistance is $V/I = 6.0/0.12 = 50\ \Omega$.
- The 30 Ω and 60 Ω in parallel give $30 \times 60/90 = 20\ \Omega$.
- So $R = 50 - 20 = 30\ \Omega$.

6(a)	$2.4 / 6.0 = 8 / (R + 8)$
	$R = 12\ \Omega$
	or $I = 2.4 / 8$ $= 0.30$ $R = (6 - 2.4) / 0.3$ or $R = (6 / 0.3) - 8$
	$R = 12\ \Omega$
6(b)	$V = I(\rho L / A)$ **or** $V = IR$ **and** $R = (\rho L / A)$
	I, ρ, A are constant (so $V \propto L$)
6(c)(i)	$V_{XP} / V_{XY} = L_{XP} / L_{XY}$ $E / 2.4 = 1.24 / 2.00$
	$E = 1.5$ V
6(c)(ii)	p.d. across XY / wire increases / p.d. across XP increases
	so P moved towards X / away from Y / to the left

Question 35 (Answer: **C**)

- Kirchhoff's first law: the current into a junction equals the current out.
- With 3 A in and 1 A out, wire R must carry $3 - 1 = 2$ A.
- $Q = It = 2 \times 5 = 10$ C; D assumes R carries the sum instead of the difference.