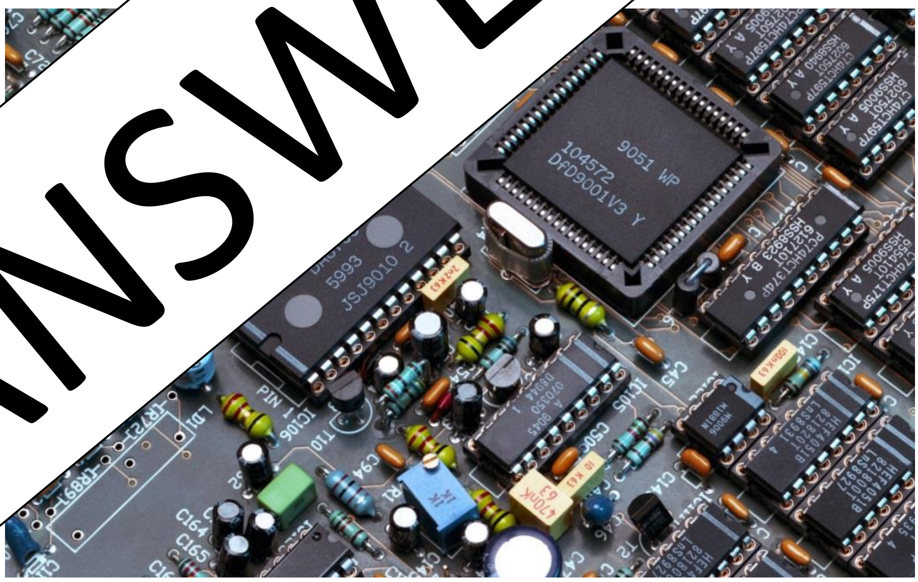
NATIONAL 5 PHYSICS

Unit 1
Electricity and Energy

ANSWERS

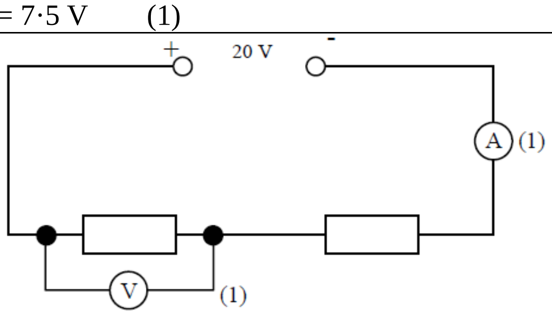


Exam Questions

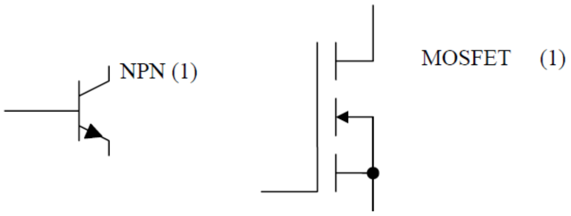
CONSERVATION OF ENERGY				
1		E_p = m g h (1) = 25 x 9.8 x 1.2 (1) = 290 J (1)	3	Sf, accept 300, 294
2		C	1	
3		E_k = ½ mv^2 (1) = 0.5 x 1.5 x 10^2 (1) = 75J	3	
4		E_P = m g h (1) = 8000 × 10 × 500 (1) = 40 000 000 J = 40 MJ (1)	3	
5	(a)	E_p = mgh (1) E_p = 750 × 10 × 7·2 (1) E_p = 54000 J (1)	3	
	(b) (i)	54000 J (1)	1	
	(b) (ii)	E_K = ½ mv^2 (1) 54000 = 0.5 × 750 × v^2 (1) v = 12 ms^{-1} (1)	3	
6	(a)	E_P = m g h (1) = 90 × 10 × 3 (1) = 2 700 J (1)	3	
	(b)	E_k = ½ m v^2 (1) = ½ × 90 × 82 (1) = 2 880 J (1)	3	
	(c)	Extra energy has been supplied (1) by (the work done) pedalling (1)	2	

ELECTRIC CHARGE CARRIERS AND ELECTRIC FIELDS				
1		dc – electrons* flow around a circuit in one direction only (1) ac – electrons'* direction changes/reverses after a set time (1) *Accept 'current'	2	
2		E	1	
3		D	1	
4		D	1	
5		Q = It (1) I = 1650/0.15 (1) = 1·1 × 10^4 A (1)	3	
6		D (1)	1	
7		C (1)	1	
8		in d.c. electrons/charges move in one direction only (1) in a.c. direction of movement of electrons/charges continually reverses (1)	2	

POTENTIAL DIFFERENCE (VOLTAGE)				
1		A (1)	1	
2		C (1)	1	

OHM'S LAW				
1		B	1	
2	(a)	R tot = 15 + 25 = 40 Ω (1) V = I R (1) 20 = I × 40 (1) I = 0·5 A (1)	4	
	(b)	V = I R (1) = 0·5 × 15 (1) = 7·5 V (1)	3	
	(c)		2	
3	(a)	I = 0·075 A (1) V = IR (1) 4·2 = 0·075 × R (1) R = 56 Ω (1)	4	
	(b)	stays the same (1) $\frac{1 \cdot 3}{0 \cdot 023} = 56 \cdot 5$ $\frac{3 \cdot 6}{0 \cdot 064} = 56 \cdot 25$ (1) or as the voltage increases the current increases by the same ratio or because it's a straight line through the origin	2	

PRACTICAL ELECTRICAL AND ELECTRONIC CIRCUITS				
1	(a)	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ **(1)** $= \frac{1}{4} + \frac{1}{2}$ **(1)** $\therefore R_T = 1{\cdot}3\ \Omega$ **(1)**	3	Accept 1 Ω, 1·33 Ω, 1·333 Ω
	(b)	RT = R1 + R2 (1) = 1·3 + 6 (1) = 7·3 Ω (1)	3	Consistent with (a) (1) **2** Accept 7·3 Ω, 7·33 Ω, 7·333 Ω
	(c)	(Voltage across 2 Ω resistor = Voltage across 4 Ω resistor) V = IR (1) = 0·1 × 4 (or 0·2 × 2) (1) = 0·4 V (1)	3	(2) max, if divide final answer by 2
2		E (1)	1	
3		A (1)	1	
4		D (1)	1	
5		A (1)	1	
6	(a)	Transistor (switch)	1	Ignore any prefix (eg bipolar, NPN, PNP)
	(b)	• (As temp increases,) input voltage to transistor increases • (above 0·7V) switching transistor on • Current in the (relay) coil (producing magnetic field). • (Relay) switch closes / activates, (completing the bell circuit/ operating the bell).	2	First bullet point may refer to voltage (output) from thermocouple or amplifier increasing but do not accept 'voltage' alone. Do not accept: 'transistor is saturated'
	(c)	$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2}$ (1) $\frac{1}{R_t} = \frac{1}{16} + \frac{1}{16}$ (1) Rt = 8 Ω (1)	3	If wrong equation used eg $R_t = \frac{1}{R_1} + \frac{1}{R_2}$ then zero marks Accept *imprecise* working towards a final answer $\frac{1}{R_t} = \frac{1}{16} + \frac{1}{16} = 8\ \Omega$ ← Accept Deduct (1) for wrong/missing unit Can be answered by applying product over sum method Can be answered using 'identical value' parallel resistors method: R = $\frac{\text{value for single resistor}}{\text{total no. of Rs in parallel}}$

7		A (1)	1	
8		A (1)	1	
9		C (1)	1	
10		C (1)	1	
11		B (1)	1	
12		B (1)	1	
13		D (1)	1	
14		D (1)	1	
15	(a)		2	
	(b)	(electronic) switch	1	
	(c)	voltage across 5·5 kΩ resistor = 9 - 2·4 = 6·6 V (1) $\frac{V_1}{V_2} = \frac{R_1}{R_2}$ (1) $\frac{2.4}{6.6} = \frac{R_1}{5500}$ (1) $R_1 = 2000\Omega$ (1) OR voltage across 5·5 kΩ resistor = 9 - 2·4 = 6·6 V V = IR 6.6 = I x 5500 I = 0.0012A V = IR 2.4 = 0.0012 x R R = 2000Ω	4	
16		D (1)	1	
17	(a)	Thermistor (1)	1	
	(b)	as temperature drops, voltage across thermistor rises or resistance of thermistor rises (1) when voltage goes above certain level MOSFET switches on (1) relay switch closes (and heater circuit is completed) (1)	3	
	(c)	to set the temperature at which the heater is switched on (1)	1	

ELECTRICAL POWER				
1		D	1	
2		A	1	
3		$P = I^2R$ (1) $= (200\times 10^{-3})^2 \times 20$ (1) $= 0\cdot8\ W$ (1)	3	deduct (1) for wrong/missing unit Watch for unit conversion errors – penalise unit error only once
4	(a)	Use Ohm's Law twice. Once to calculate the current, then once to find V_R. V = I R (1) for both equations 0.36 = I x 2000 (1) for both substitutions I = 0.00018 (A) V = I R = 0.00018 x 4800 = 8.64 V (1) for final answer	3	$\frac{V_1}{V_2} = \frac{R_1}{R_2}$ (1) $\frac{V_1}{0.36} = \frac{48000}{2000}$ (1) $V_2 = 8\cdot64\ V$ (1)
	(b)	$P = \frac{V^2}{R}$ (1) $3 = \frac{V^2}{48}$ (1) $V^2 = 144$ $V = 12\ V$ (1)	3	Do NOT accept V^2 =144 = 12V (max 1 mark)
5		Method 1 t = 1/250 = 0·004(s) (1) E = P t (1) 60 x 10^{-3} = P x 0.004 (1) P = 15 W (1) Method 2 $E_{Total} = 250 \times 60 \times 10^{-3}$ (J) (1) E = P t (1) 15 = P x 1 (1) P = 15 W (1)	4	If correct time correctly calculated or stated award (1) mark (this may appear anywhere in the answer). • If time is stated or calculated wrongly and no calculation shown then (1) mark maximum for the power equation. • If calculation for the time / energy is shown and calculation contains an arithmetic error then deduct (1) mark
6		C	1	
7		B	1	
8		D	1	
9		$R = V^2/P$ (1) V = 230V (1) $= 230^2/25$ (1) = 2116 Ω (1)	3	Sf range: 2000 2100 2120
10		$P = I^2 R$ (1) $2 = I^2 \times 50$ (1) $I^2 = 0\cdot04$ I = 0·2 A (1)	3	

SPECIFIC HEAT CAPACITY				
1		$c = 4180$ ($J\ Kg^{-1}\ C^{-1}$) (1) $E_h = c\ m\ \Delta T$ (1) = 4180 x 1.6 x 80 (1) = 535040 J (1)	4	(1) data mark for correct selection of **c** from 'Specific heat capacity of materials' table. If **any other value from this table** is used, then lose data mark but can still get (3) marks max if rest of calculation is correctly executed using this value. If any value of ***c*** used **not from this table** (including 4200) then only (1) max possible for correct selection of relationship. No s.f. issue (exact answer)
2		$Eh = cm\Delta T$ (1) = 4320 x 82 x 125 (1) = 44 280 000 J (1)	3	Must use value for c given in question, otherwise (1) mark max for equation sig. fig. range 1–4 40 000 000 44 000 000 44 300 000 44 280 000
3	(a) (i)	(33-21) = 12 °C	1	
	(ii)	(120,000-12,000) = 108,000 J	1	
	(iii)	$E_h = cm\Delta T$ (1) 108,000 = c x 2.0 x 12 (1) c = 4,500 $J\ kg^{-1}\ °C^{-1}$ (1)	3	Must be consistent with parts (i) + (ii)
	(b) (i)	Measured value of □□ too large OR ΔT too small (1) Heat lost to surroundings (or similar) * OR water not evenly heated (or similar) † (1)	2	*to air, from water, from equipment etc † or immersion heater not fully immersed Explanation must be offered
	(ii)	Insulate beaker **OR** Put lid on beaker **OR** Stir water **OR** Fully immerse heater	1	
	(c)	E = P t (1) 108,000 = P x (5 x 60) (1) P = 360 W (1)	3	If no conversions answer is 21,600. Also accept 22,000, Max (2) must be consistent with (a) (ii) or wrong physics
4		D	1	

5	(a)	$E_h = cm\Delta T$ (1) $c = \frac{2 \cdot 59 \times 10^7}{60 \times [(307 - (-173))]}$ (1) = 899 J/kg°C (1)	3	
	(b)	P = E/t (1) t = 2.50 x 10^7/1440 (1) = 18000 s (1)	3	
	(c)	288000/1440 (1) = 200 (rocks) (1)	2	
6	(a)	$E_H = c\ m\ \Delta T$ (1) = 2100 × 0·6 × 36 (1) = 45360 J (1)	3	
	(b)	$E_H = l\ m$ (1) = 2·34 × 10^5 × 0·6 (1) = 140 400 J (3)	3	
	(c) (i)	total E_H = 45 360 + 140 400 = 185 760 J (1) E = P t (1) 185 760 = 120 t (1) t = 1548 s (1)	4	
	(c) (ii)	No heat (energy) enters the ice cream (1)	1	
7	(a)	$E_H = c\ m\ \Delta T$ (1) = 4180 × 15 × 6 (1) E_H = 376200 J (1)	3	
	(b)	$E_H = c\ m\ \Delta T$ (1) 376200 = 480 × 0·75 × ΔT (1) ΔT = 1045 (ºC) (1) initial temperature of iron: = 1045 + 23 = 1068 ºC (1)	4	
	(c)	all heat energy retained within system OR no heat lost to surroundings (1) OR no steam created	1	
	(d)	greater (1) value of c less OR less heat required per degree temperature rise OR greater temperature rise for same energy input (1) Note: first mark only available if explanation attempted		
8	(a)	$E_H = c\ m\ \Delta T$ (1) E_H = 4180 × 10 × 80 (1) E_H = 3·34 × 106 J (1)	3	
	(b)	E = P t (1) 3·34 × 106 = 2·5 × 103 × t (1) t = 1340 s (1)	3	
	(c)	not all E_H used to heat water OR E_H lost to surroundings (1)	1	

GAS LAWS AND THE KINETIC MODEL				
1		C (1)	1	
2		B (1)	1	
3		C (1)	1	
4		A (1)	1	
5		A (1)	1	
6		D (1)	1	
7	(a)	P = F/A (1) $1{\cdot}01 \times 10^5 = 262/A$ (1) $A = 2{\cdot}59 \times 10^{-3}\ m^2$ (1)	3	
	(b)	Volume increases/expands/gets bigger because P decreases P α 1/ V PV = const. (1)	1	Look for this first
8	(a)	$P1V1 = P2V2$ (1) $1{\cdot}01 \times 10^5 \times 200 = P2 \times 250$ (1) $P2 = 8{\cdot}1 \times 10^4$ Pa (1)	3	Accept: P_2 = 8, 8·1, 8·08, 8·080 × 10^4 Pa OR 80 000, 81 000, 80 800 Pa
	(b)	Number of collisions on walls of jar is less frequent/less often (1) Average force (on walls) decreases (1) Pressure on walls of jar decreases (1)	4	Must have atoms/molecules/particles colliding with the (container) walls before any marks can be given For 'particles' accept 'molecules' Must be frequency, not just "less collisions" Any mention of Ek or speed of particles changing – max ½ mark
9	(a)	P/T | 347 | 347 | 346 | 348 | 348 (1) for all data Pressure and temperature are directly proportional when T is in Kelvin. OR P/T = 347 or "constant" (1)	2	
	(b)	As temperature increases, Ek of gas molecules/particles increases (1) (or molecules travel faster) and hit/collide with the walls of the container more often/frequently OR **with greater force (1)** pressure increases (1)	3	Must be Ek, not just "energy". Must have atoms/molecules/particles colliding with the (container) walls somewhere in the answer before any of last 2 marks can be awarded
		To ensure all the gas in the flask is heated evenly OR all the gas is at the same temperature (1)	3	

10	(a) (i)	P × V = 2000 1995 2002 2001 (1) P × V = constant (1) or P × V = 2000 or P1V1 = P2V2 or P = k/V	2	All 4 values needed
	(a) (ii)	Gas molecules collide with walls of container more often (1) so (average) force increases (1) pressure increases (1)	3	Must have atoms/molecules/ particles colliding with the (container) walls somewhere in the answer before any marks can be awarded pressure constant or decrease gets 0 molecules increasing or 'harder collisions' is WP so gets zero
	(b)	(As diver ascends) pressure decreases (1) volume of air in lungs will increase (1) (or pressure difference increases) so lungs may become damaged (1)	3	
11		$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ (1) $\frac{2.8 \times 10^6}{(19 + 273)} = \frac{P_2}{(5 + 273)}$ (1) $P_2 = 2.68 \times 10^6$ Pa (1)	3	

VARIOUS				
1	(a)	$I = \frac{P}{V}$ (1) $= \frac{60}{230}$ (1) $= 0 \cdot 26\ \text{A}$ (1)	3	Sig. fig. Range: 0·3, 0·26, 0·261
	(b) (i)	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ (1) $\frac{1}{R_T} = \frac{1}{46} + \frac{1}{92}$ (1) $R_T = 30 \cdot 67\ \Omega$ (1)	3	OR $R_T = \frac{R_1 R_2}{R_1 + R_2}$ $= \frac{46 \times 92}{46 + 92}$ $R_T = 30 \cdot 67\ \Omega$ If wrong equation used eg $R_T = \frac{1}{R_1} + \frac{1}{R_2}$ *then zero marks* Accept *imprecise* working towards a final answer. $\frac{1}{R_T} = \frac{1}{46} + \frac{1}{92} = 30 \cdot 67\ \Omega$ ↑ *accept* Sig. fig. Range: 30, 31, 30·7, 30·67 If answer left as 30 ⅔ then (-1) (sig fig error) If intermediate rounding of 1/46 and 1/92 then deduct (1) for arith error.

	(ii)	$P = \frac{V^2}{R}$ **(1)** $= \frac{230^2}{30 \cdot 67}$ **(1)** $= 1725$ W **(1)** Or calculate individual power of each heating element and add together	3	Must use value for *R*T from 3(b)(i) or fresh start with **correct** value. Alternative solution: $I = \frac{V}{R}$ $= \frac{230}{30 \cdot 67}$ $= 7 \cdot 5$ (A) THEN $P = IV$ $= 7 \cdot 5 \times 230$ $= 1725$ W (1) OR $P = I^2R$ $= 7 \cdot 5^2 \times 30 \cdot 67$ $= 1725$ W Award (1) for both equations Award (1) for all substitutions Award (1) for final answer $P = I^2R$ Award (1) mark for $= 7 \cdot 5^2 \times 30 \cdot 67$ final answer $= 1725$ W If $R = 138\ \Omega$ from b(i) then $P =$ 383W Sig figs depend on candidates answer to (b) part (i)
	(iii) (A)	S3 (only)	1	
	(iii) (B)	Greatest value of resistance/ lowest current/lowest power	1	Accept: 'heating element with greatest resistance has lowest power output/rating "because it has the biggest/largest resistance" DO NOT accept "bigger resistor" Can only get second mark if S3 selected.

<table>
<tr><td>2</td><td>(a)</td><td>$$I = \frac{V}{R}$$
$$= \frac{12}{64000}$$
$$= 1{\cdot}875 \times 10^{-4} \text{ (A)}$$
THEN
$$V = IR$$
$$= 1{\cdot}875 \times 10^{-4} \times 4000$$
$$= 0{\cdot}75 \text{ V}$$
Award (1) for both formulae

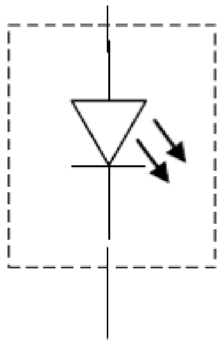
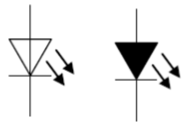
Award (1) mark for all substitutions correct

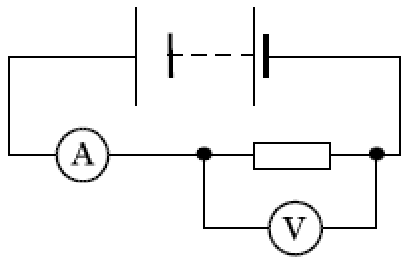
Award (1) mark for final answer</td><td>3</td><td>Alternatives:
$$V_1 = \frac{R_1}{R_1 + R_2} \times V_S$$
$$= \frac{4000}{4000 + 60000} \times 12$$
$$= 0{\cdot}75 \text{ V}$$
OR
$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$
$$\frac{12}{V_2} = \frac{64000}{4000} \text{ (1)}$$
$$V_2 = 0{\cdot}75 \text{ V (1)}$$
Only accept this method if the substitutions are for: the supply voltage, the total resistance, and the resistance of the LDR.
Award zero marks if this relationship is stated alone or implied by any other substitutions
eg $$\frac{12}{V_2} = \frac{60000}{4000}$$</td></tr>
<tr><td></td><td>(b)</td><td>Transistor (switch)</td><td>1</td><td>Ignore any reference to pnp or npn
NOT:
• Phototransistor
• MOSFET transistor
• Switch alone</td></tr>
<tr><td></td><td>(c)</td><td>• R of LDR increases
• V across LDR increases (above 0·7V)
• Transistor switches ON
• Relay coil is energised (which closes the relay switch and activates the motor)</td><td>2</td><td>All 4 bullet points needed for (2)

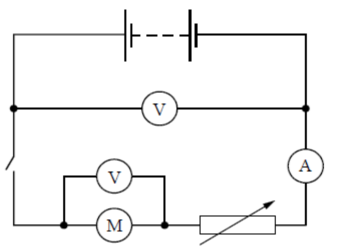
Must clearly identify:
• the resistance of LDR increasing
• the voltage across LDR increasing
• transistor on
• relay coil operates/is switched on/
• activated/magnetised</td></tr>
</table>

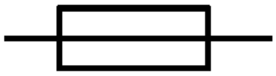
3	(a)	To reduce current in LED **OR** To reduce voltage across LED **OR** To reduce power to LED	1	
	(b)	$V = 6 – 2 = 4$ V (1) $V = IR$ (1) $4 = 0.1 \times R$ (1) $R = 40\ \Omega$ (1)	4	
	(c)	$P = I^2R$ (1) $P = V^2/R$ $= (0{\cdot}1)^2 \times 40$ (1) $= 4^2/40$ $= 0{\cdot}4$ W (1) $= 0{\cdot}4$ W $P = IV$ (1) $= 0{\cdot}1 \times 4$ (1) $= 0{\cdot}4$ W (1)	3	Must be consistent with (b)

4	(a) (i)	P = I V (1) 36 = I x 12 (1) I = 3 A (1)	3	Deduct (1) for wrong/missing unit
	(ii)	$48 = 12 + 12 + V_R$ $V_R = 24$ V (1)	1	Deduct (1) for wrong/missing unit
	(iii)	V = I R (1) 24 = 3 x R (1) R = 8 Ω (1)	3	Must use answers from 3 (a)(i) and (ii) or correct answers Deduct (1) for wrong/missing unit
	(b) (i)	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots\ldots$ (1) $\frac{1}{R_T} = \frac{1}{6} + \frac{1}{4} + \frac{1}{4}$ (1) $\frac{1}{R_T} = 0{\cdot}17 + 0{\cdot}25 + 0{\cdot}25$ $R_T = 1{\cdot}5\ \Omega$ (1)	3	If wrong equation used eg $R_t = \frac{1}{R_1} + \frac{1}{R_2}$ then zero marks Accept *imprecise* working towards a final answer $\frac{1}{R_T} = \frac{1}{6} + \frac{1}{4} + \frac{1}{4} = 1{\cdot}5\ \Omega$ ↑ accept deduct (1) for wrong/missing unit Can be answered by applying product over sum method. If applied twice. Accept 3/2 and 1 ½ Ω as final answer.
	(ii)A	The reading decreases/gets smaller/reduces	1	Any clear statement that the reading decreases
	B	The resistance increases (so the current decreases)	1	Explanation must link current **decrease** with increase of resistance

5	(a)		1	accept  Must have connecting wires at both ends. accept: • no line through middle • arrows could be either side • accept black (fill) triangle
	(b)	Protect the LED OR prevent damage to the LED OR limits the current OR reduces voltage across LED	1	(1) for a correct answer. Not: • 'voltage through/current across LED.' • To reduce voltage alone • To stop LED 'blowing'. • To reduce charge/power to LED • To prevent LED overheating
	(c)	$V_R = 6 - 1 \cdot 2 = 4 \cdot 8 \text{ V}$ (1) $V = IR$ (1) $4 \cdot 8 = 15 \times 10 - 3 \times R$ (1) $R = 320\ \Omega$ (1)	4	If error can be seen in subtraction to get V_R then can still get (3) marks **If no subtraction** and 6 V or 1·2 V used in calculation for R then (1) MAX for equation. Deduct (1) for wrong/missing unit This can also be answered using voltage divider method.
6	(a)	$E = Pt$ (1) $= 1500 \times 35$ (1) $= 52\ 500 \text{ J}$ (1)	3	Deduct (1) for wrong/missing unit Watch for unit conversion errors – penalise unit error only once
	(b)	$E = cm\Delta T$ (1) $52\,500 = 902 \times m \times (200 - 24)$ (1) $m = 0.33 \text{ kg}$ (1)	1	Must use value for Energy from 6(a) OR correct value. Must use value for c given in question or else (1) max for eqn Deduct (1) for wrong/missing unit Sig fig range: 0.3, 0.33, 0.331, 0.3307.
	(c)	Heat is • Lost OR • Radiated OR • escapes OR from the sole plate	1	Accept: • Heat is lost/radiated/ escapes to the surroundings • Some of the heat (energy) is used to heat other parts of the iron The explanation should indicate that heat is lost from/to... eg • power rating of iron is incorrect • inaccurate temperature readings etc.

7	(a)	$E_p = m\ g\ h$ (1) $= 0.50 \times 9.8 \times 19.3$ (1) $= 95$ J (1)	3	
	(b)	$E_c = c\ m\ \Delta T$ (1) $95 = 386 \times 0.50 \times \Delta T$ (1) $\Delta T = 0.5$ °C (1)	3	E_h must be consistent with (a). If any other value of 'c' used, only (1) for formula.
	(c) (i)	Less than.	1	If 'less than' is on its own = 0 marks. 'Less than' plus wrong explanation = 1 mark.
	(ii)	Some heat is lost to surroundings/ or equivalent.	1	'Heat loss to' must be qualified. Qualified sound loss OK eg on hitting the ground
8	(a)	 	3	**Must draw battery, not single cell.**
	(b)	$V = IR$ **(1)** $5.7 = 0.60 \times R$ **(1)** $R = 9.5\Omega$ **(1)**	3	
	(c) (i)	No	1	
	(ii)	In parallel the voltage is still the same/6V across each resistor so power is the same	1	
9	(a)	MOSFET	1	Transistor on its own = 0 Correct spelling required
	(b)	(Voltage) falls/decreases	1	Or equivalent Arrows not allowed

10	(a)		1	Must have **all** labels correctly positioned . (1) or (0) only
	(b)	Vr = Vs - Vmotor = 24 = 18 = 6(V) (1) Vr = I R (1) 6 = I x 2.1 (1) I = 2.9 A (1)	4	If arithmetic error can be seen in subtraction to get VR then deduct (1) mark. Candidate can still get next (3) marks. **If no subtraction** and 24 V or 18 V used in calculation for V then (1) MAX for equation. Deduct (1) for wrong/missing unit V = I x R sig. fig. range: 1–4 3A, 2·9A, 2·86A, 2·857A
	(c)	Q = I x t (1) = 3.2 x (10 x 60 x 60) (1) = 115 200 C (1)	3	Accept: 100000C, 120 000C, 115 000C, 115200C. If wrong or no conversion into seconds then deduct (1) mark.
	(d)	Accept • Change the polarity of the battery • Swap over the connections to the motor • Change **the direction** of the current • Reverse current • Swap battery terminals	1	Do not accept • "swap battery" alone. • Turn the battery around alone. • Swap the battery around alone. • Any answers relating to magnetic field (not relevant to this question) If > one answer apply ±rule.
11	(a)	Parallel	1	Only answer ignore spelling
	(b)	P = I V (1) 300 = I x 230 (1) I = 1.3 A (1) OR P = I V (1) 900 = I x 230 I = 3.9 A Current in one mat= 3.9/3 (1) I = 1.3A (1)	3	sig. fig. range: 1–3 1A 1·3A 1·30A
	(c)	P total = 3 x 300W = 900W (1) $P = V^2 / R$ (1) $900 = 230^2 / R$ (1) R = 59 Ω (1) Or I_{total} = 3 x 1.3 = 3.9 A (1) $P = I^2 R$ (1) $900 = 3.9^2 \times R$ (1) R = 59 Ω (1)	4	sig. fig. 1–3 range: 60Ω 59Ω 58·8Ω sig. fig. 1–3 range: 60Ω, 59Ω, 59·2Ω

12	(a) (i)	Lamp A	1	
	(ii)	It has the lowest resistance/highest current/greatest power	1	one of three
	(b)	$P = V^2/R$ (1) $= 24^2/2·5$ (1) $= 230$ W (1)	3	
	(c)		1	
	(d) (i)	12 V	1	unit required
	(ii)	$1/R_p = 1/R1 + 1/R2$ (1) $= 1/8 + 1/24$ (1) $R_p = 6\ \Omega$ (1)	3	
	(e) (i)	The motor speed will reduce	1	
	(ii)	The (combined) resistance (of the circuit) is now higher/current is lower. Voltage across motor is less Motor has less power	1	any one of four
13	(a) (i)	X = (NPN) transistor	1	0 marks for MOSFET or PNP transistor
	(ii)	To act as a switch	1	To turn on the buzzer 0 marks To operate the buzzer 0 marks
	(b)	Resistance of LDR reduces so voltage across LDR reduces Voltage across variable resistor/R increases When voltage across variable resistor/R reaches (0·7 V) transistor switches buzzer on.	3	Accept 'when voltage is high enough'
	(c)	80 units: resistance of LDR = 2500 (Ω) Total resistance = 2500 + 570 = 3070 (Ω) (1) -- $I = V/R$ (1) $= 5/3070$ (1) $= 1·63 \times 10^{-3}$ A or 1·63 mA (1)	4	1·6 mA 1·63 mA 1·629 mA
	(d)	The variable resistor is to set the light level at which the transistor will switch on or to set the level at which the buzzer will sound	1	