1. (a) (i)

$$\text{current} = \frac{\text{power}}{\text{voltage}}$$
$$= \frac{650}{230}$$
$$= 2{\cdot}83 \text{ amperes}$$

(ii)

$$\text{charge} = \text{current} \times \text{time}$$
$$= 2\cdot83 \times 24 \times 60 \times 60$$
$$= 244512 \text{ C}$$

(b) Total resistance of the 2 lights in series = 1200 q

$$I = \frac{\text{voltage across 2 lights}}{\text{total R}}$$
$$I = \frac{12}{1200}$$
$$= 0{\cdot}01 \text{ Amperes}$$

Total current in circuit = 2 × 0·01 = 0·02A

2. (a) (i) X is a capacitor.

(ii) Increase the capacitance or resistance to decrease the rate at which the capacitor charges up

3. (a)

$$E_{KE} = \frac{1}{2}mv^2$$

$$E_{KE} = \frac{1}{2} \times 0\cdot05 \times 6^2$$

$$= 0{\cdot}9 \text{ Joules}$$

(b)

$$E_{KE} = E_{PE}$$

$$0\cdot9 = mgh$$

$$h = \frac{0\cdot9}{0\cdot05 \times 10}$$

$$h = 1{\cdot}8\text{m}$$

(c) Some of the kinetic energy changes to sound energy so the ball leaves the ground with less energy than it hit it thus reducing the height of the bounce.

4. **C**

5. C

6. (a) (i)

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$$p_2 = \frac{0 \cdot 995 \times 10^5 \times 1123}{1173}$$

$$\underline{p_2 = 0 \cdot 953 \times 10^5\,\text{Pa}}$$

(ii) As the temperature of the gas molecules decreases so does their kinetic energy They hit the walls less often with less force so the pressure decreases.

(b)

$$p_1 V_1 = p_2 V_2$$

$$0 \cdot 995 \times 10^5 \times 0 \cdot 12 = 0 \cdot 900 \times 10^5 \times V_2$$

$$\underline{V_2 = 0 \cdot 133\,\text{m}^3\,(3\,\text{sig. fig.})}$$

7. E

8. A

9. C

10. E

11. B

12. (a)

$$W = mg$$

$$m = \text{mass of bucket} + \text{mass of digger}$$

$$W = (500 + 750) \times 9.8$$

$$\underline{W = 12250\,\text{N}}$$

(b)

$$\text{Potential Energy} = mgh$$

$$E_{PE} = 1250 \times 9.8 \times 3$$

$$\underline{E_{PE} = 36750\,\text{J}}$$

(c) In reality energy would have been lost to the surroundings as heat **and/or** the hydraulic arms attached to the bucket adds to the weight raised and so would increase the final potential energy.

13. (a) (i) Aluminium has the highest specific heat capacity because it uses the most energy to raise the temperature of 1kg of the metal by 1°C.

(ii) Specific heat capacity of soft iron is $\frac{8000\text{J}}{12} = 666 \cdot 7\text{J/kg}^0\text{C}$

(any two suitable points from the graph may be used to calculate
the specific heat capacity)

Energy dissipated in the cast iron $= \text{cm}\Delta\text{T}$

$\text{E} = 2 \times 666 \cdot 7 \times 25$

$\underline{\text{E} = 33300\text{J}}$

(b)

$\text{E}_\text{H} = \text{cm}\Delta\text{T}$

$\text{E}_\text{H} = 0 \cdot 2 \times 4200 \times (100 - 23)$

$\underline{\text{E}_\text{H} = 64700\text{J}}$

14. (a)

Conductors	**Insulators**
Aluminium foil	Wooden cube
10p coin	Plastic rod

(b) (i)

$\text{Q} = \text{It}$

$\text{Q} = 0 \cdot 05 \times (60 \times 2)$

$\underline{\text{Q} = 6 \text{ coulombs}}$

(ii)

$\text{The number of electrons} = \frac{\text{total charge}}{\text{charge on one electron}}$

$\text{N} = \frac{6}{1 \cdot 6 \times 10^{-19}}$

$\text{N} = 3 \cdot 75 \times 10^{19}$

$\underline{\text{There are } 3 \cdot 75 \times 10^{19} \text{ electrons flowing in the circuit.}}$

(iii)

$\text{E} = \text{ItV}$

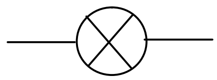
$\text{E} = 6 \times 1 \cdot 5$

$\underline{\text{E} = 9 \text{ joules}}$

(c) (i) The two negative charges would repel each other.

(ii) The positive and negative charge would attract each other.

15. (a)



(b) (i)

$$P = \frac{V^2}{R}$$

$$R = \frac{V^2}{P}$$

$$R = \frac{230^2}{100}$$

$$\underline{R = 529q}$$

(ii)

The total resistance in the circuit:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \qquad (\tfrac{1}{2})$$

$$\frac{1}{R_T} = \frac{1}{529} + \frac{1}{529}$$

$$\frac{1}{R_T} = 0 \cdot 00378 \qquad (\tfrac{1}{2})$$

$$\underline{R_T = 264 \cdot 5q} \qquad (1)$$

(iii)

$$I = \frac{V_{supply}}{R_T} \qquad (\tfrac{1}{2})$$

$$I = \frac{230}{264 \cdot 5} \qquad (\tfrac{1}{2})$$

$$\underline{I = 0 \cdot 869A} \qquad (1)$$

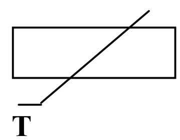
(c) The voltage of bulbs in series are shared across the supply voltage.

$$\text{Number of lamps} = \frac{\text{supply voltage}}{\text{operating voltage of each bulb}}$$

$$\text{Number of lamps} = \frac{12}{2}$$

$$\underline{\text{Number of lamps} = 6}$$

16. (a)



(b) (i) The resistance is 300Ω

(ii)

$$V_{thermistor} = \frac{R_{Thermistor}}{R_{Total}} \times V_{supply}$$

$$V_{thermistor} = \frac{300}{(300+100)} \times 12$$

$$\underline{V_{thermistor} = 9V}$$

(c) (i) X is a transistor.

(ii) At 200°C the resistance is 100Ω.

$$\text{Voltage across } 6\Omega \text{ resistor} = \frac{R_6}{R_{total}} \times V_{supply}$$

$$V = \frac{6}{(100+6)} \times 12$$

$$\underline{V = 0 \cdot 68V}$$

The transistor switches at 0·68V

(iii) When the base voltage of the transistor is 0·68V current flows from the emitter of the transistor to the collector. The relay coil becomes magnetised and this attracts the switch S to close and complete the circuit for the fan.

17. E

18. D

19. D

20. **B**

21. **D**

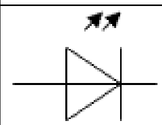
22.	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{500}{350} = \frac{V_2}{345}$ $V_2 = 493\ m^3$

23.	(a)	Q coulombs
	(b)	Q = It 200 I × (4 × 60 × 60) I = 0.014 A
	(c) (i)	Voltage is a measure of the energy given to the charges in the circuit.
	(c) (ii)	V = 12 ī 9.0 = 3.0 V V = IR 3.0 = 0.001 × R R = 3000 Ý

24.	(a)	V_{total} = V1 + V2 +V3 V_{total} = 3.0 + 2.0 + 4.0 V_{total} = 9.0 V
	(b)	10 mA
	(c)	V = IR 3.0 = 0.010 × R R = 300 Ω
	(d)	No change

25. D

26	(a)(i)	Both switches must be on for heater to come on
	(a)(ii)	Complete circuit back to battery
	(b)	Remains constant / same
	(c)	$P = IV$ $P = 5.0 \times 12$ $P = 60$ W

27	(a)	Electronic lock = solenoid Automatic fan = motor Public address system = loudspeaker Stand by indicator = LED
	(b)	
	(c)	V = 6.0 ï 1.5 = 4.5 V $V = IR$ $4.5 = 5.0 \times 10^{-3} \times R$ R = 900 q
	(d)	$Q = It$ $Q = 5.0 \times 10^{-3} \times 600$ $Q = 3.0$ C

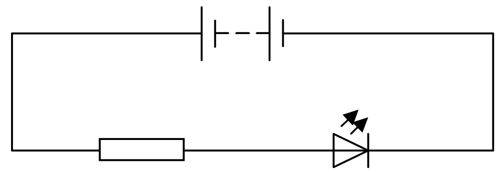
28	(a)	LED
	(b)	$V_0 = [R_2 / (R_1 + R_2)]\ V_s$ $V_0 = [2.4 / (21.6 + 2.4)]\ 3.0$ $V_0 = 0.30$ V
	(c)	As temperature rises the voltage over thermistor falls Voltage over 2.4 kq resistor rises When voltage over 2.4 kq resistor rises above 0.7 V the transistor switches on When transistor switches on the LED lights

Question		Marking Instructions
29	(a)	% eff = (useful output energy / input energy) × 100 40 = (useful output energy / 2.8×10^{10}) × 100 Useful output energy = 1.12×10^{10} J
	(b)	E = Pt $1.12 \times 10^{10} = 1.2 \times 10^{9} \times t$ t = 9.3 s

30. B

31. A

32	(a)	V = 230 (V) – P = IV 1150 = I × 230 I = 5·00 A
	(b)	V = IR 230 = 5·00 × R R = 46 Ω **or** $P = V^2/R$ $1150 = 230^2/R$ R = 46 Ω **or** $P = I^2R$ $1150 = 5{\cdot}00^2 \times R$ R = 46 Ω
	(c)(i)	can all be switched independently/ 230 V across each/ other reasonable answer
	(c)(ii)	$1/R = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$ 1/R = 1/46 + 1/46 + 1/46 + 1/46 R = 11·5 Ω
	(c)(iii)	V = IR 230 = I × 11·5 I = 20 A or I = 4 × 5·0 I = 20 A
	(c)(iv)	30 A rated greater than maximum current

33	(a)	 correct symbol correct polarity		
	(b)	V = 5·0 ī 1·5 = 3·5 (V) V = IR 3·5 = 0·010 × R R = 350 Ω		
	(c)(i)	40 mA		
	(c)(ii)	5·0 V		

34	(a)	renewable/source will not run out/does not produce greenhouse gases/other reasonable answer
	(b)	E = mgh $E = 1{\cdot}20 \times 10^5 \times 10 \times 50{\cdot}0$ $E = 6{\cdot}0 \times 10^7$ (J) P = E/t $P = 6{\cdot}0 \times 10^7/60$ $P = 1{\cdot}0 \times 10^6$ W
	(c)	$eff = P_o/P_i \times 100$ $eff = 400\,000/1{\cdot}0 \times 10^6 \times 100$ eff = 40%
	(d)	P = IV 400 000 = I × 8000 I = 50 A

35.	(a)	$E_h = cm\Delta T$ $E_h = 4180 \times 5{\cdot}0 \times 10$ $E_h = 2{\cdot}09 \times 10^5$ J
	(b)	P = E/t $P = 2{\cdot}09 \times 10^5 / (5 \times 60)$ P = 700 W
	(c)	P = IV 700 = I × 230

		$I = 3{\cdot}04$ A
	(d)	$Q = It$ $Q = 3{\cdot}04 \times (5 \times 60)$ $Q = 913$ C

36. (a)

$W = mg$
$W = 90 \text{ x } 9.8$
<u>$W = 882N$</u>

(b) (i)

$E_p = mgh$ or $E_p = W d$
$E_p = 90 \text{ x } 9.8 \text{ x } 400$ $E_p = 882 \text{ x } 400$
$E_p = 352{,}800$ J $E_p = 352{,}800$ J

Total Ep = 352800 x 3000
<u>Total Ep = 1058 MJ</u>

(ii)

$P_{out} = E \text{ x } t$
$P = 1058 \text{ x } 10^6 \text{ x } 60 \text{ x } 60$
$P = 3.81 \text{ x } 10^{12}$ W

Eff = Pout / Pin x 100
$67.5 = 3.81 \text{ x } 10^{12} / \text{Pin x}100$
$P_{in} = 3.81 \text{ x } 10^{12} / 0.675$
$P_{in} = 5.64 \text{ x } 10^{12}$ W

37. (a)

$E_P = m\,g\,h$
$E_P = 1{\cdot}2 \times 10 \times 0{\cdot}2$
<u>$E_P = 2{\cdot}4J$</u>

(b)

$E_K = E_P$
$\frac{1}{2} m v^2 = 2{\cdot}4$
$0{\cdot}5 \times 1{\cdot}2 \times v^2 = 2{\cdot}4$
$v = 2$ m/s