Question Number	Answer		Mark
1(a)	Use of $P = \frac{\Delta W}{\Delta t}$ Use of $\Delta E = mc\Delta T$ ΔT = 17 K **Or** ΔT = 17 °C <u>Example of calculation</u> $\Delta W = P\Delta t = 650\text{W} \times (5 \times 60)\text{s} = 195\,000\,\text{J}$ $195\,000\,\text{J} = ((1.08\,\text{kg} \times 386\,\text{J kg}^{-1}\text{K}^{-1}) + (2.85\,\text{kg} \times 3890\,\text{J kg}^{-1}\text{K}^{-1}))\Delta T$ $\therefore \Delta T = \frac{195\,000\,\text{J}}{417\,\text{J K}^{-1} + 11090\,\text{J K}^{-1}} = 16.9\,\text{K}$	**(1)** **(1)** **(1)**	**3**
1(b)	Some (thermal) energy will be transferred to the surroundings [accept heat, accept lost to the surroundings, do **not** accept lost, do **not** accept some energy is transferred to the pan]	**(1)**	**1**
	Total for Question		**4**

<table>
<tr><th>Question Number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>2(a)</td><td>Either
Product of specific heat capacity and atomic mass checked (1)
All 3 materials checked (and product approximately the same) (1)

Or
At least 2 ratios of specific heat capacities calculated (1)
Corresponding ratios of atomic masses calculated (and approximately equal to specific heat capacity ratios) (1)

<u>Example of calculation</u>

<table>
<tr><th>Metal</th><th>S.h.c. / J kg^{-1} K^{-1}</th><th>Atomic mass / u</th><th>Product of s.h.c. and atomic mass</th></tr>
<tr><td>Aluminum</td><td>910</td><td>27.0</td><td>24600</td></tr>
<tr><td>Copper</td><td>386</td><td>63.5</td><td>24500</td></tr>
<tr><td>Silver</td><td>233</td><td>108</td><td>25200</td></tr>
</table></td><td>2</td></tr>
<tr><td>2(b)</td><td>If statement is correct,
Either
the energy to raise temperature of 1 kg is proportional to the number of atoms in 1 kg (1)
Number of atoms in 1 kg = 1/atomic mass (1)
Or
The larger the atomic mass the fewer the number of atoms in unit mass of material (1)
The fewer the number of atoms, the less energy needed to increase the temperature by unit amount (1)

If no other mark awarded, allow 1 mark for either a description of what internal energy is or a description of what specific heat capacity is.</td><td>2</td></tr>
<tr><td></td><td>Total for Question</td><td>4</td></tr>
</table>

Question Number	Answer		Mark
3(a)	Idea that internal energy is the sum of (Total) kinetic energy and potential energy of molecules/atoms	**(1)** **(1)**	**2**
3(b)(i)	Use of $\Delta E = mc\Delta\theta$ ΔE = 8100 (J) <u>Example of calculation:</u> $\Delta E = mc\Delta\theta = 175\times10^{-3}\,\text{kg}\times4200\,\text{J kg}^{-1}\,\text{K}^{-1}\times(85-74)\text{K} = 8090\,\text{J}$	**(1)** **(1)**	**2**
3(b)(ii)	Use of ΔE value from (i) in $\Delta E = mc\Delta\theta$ m = 0.030 kg No energy transferred to surroundings **Or** all energy transferred from tea used to heat milk <u>Example of calculation:</u> $\Delta E = mc\Delta\theta$ $8100\,\text{J} = m\times3900\,\text{J kg}^{-1}\,\text{K}^{-1}\times(74-4.5)\text{K}$ $\therefore \text{m} = \frac{8100\,\text{J}}{3900\,\text{J kg}^{-1}\,\text{K}^{-1}\times69.5\,\text{K}} = 0.0299\,\text{kg}$	**(1)** **(1)** **(1)**	**3**
	Total for question		**7**

Question Number	Answer	Mark
4(a)	Use of electrical power equation e.g. $P = \frac{V^2}{R}$ (1) R = 8.8 Ω (1) [Use of V=IR and P=VI gains mp1] <u>Example of calculation</u> $R = \frac{(230V)^2}{6000W} = 8.82\,\Omega$	**2**
4(b)	See 30 K [30 ^{o}C] **Or** 6000 J s^{-1} (1) Use of ΔE = mcΔθ [Do not penalise wrong temperature conversions, but Δθ must be a temperature difference] (1) $\frac{\Delta m}{\Delta t} = 0.048\,\text{kg}\,\text{s}^{-1}$ [accept 0.048 litre s^{-1} and other volume flow rates with correct units] (1) <u>Example of calculation</u> Δθ = (37.5 – 7.5) ^{o}C = 30 ^{o}C $\frac{\Delta m}{\Delta t} = \frac{6000\,\text{W}}{4200\,\text{J}\,\text{kg}^{-1}\,\text{K}^{-1} \times 30\,\text{K}} = 0.0476\,\text{kg}\,\text{s}^{-1}$	**3**
	Total for question	**5**

Question Number	Answer	Mark
5(a)	Use of $\Delta E = mc\Delta\theta$ **(1)** Energy = 780 J **(1)** <u>Example of calculation</u> $\Delta E = 34\times10^{-3}\text{ kg}\times490\text{ J kg}^{-1}\text{K}^{-1}\times(100-53)\text{K} = 783\text{J}$	**2**
5(b)	Heat / thermal energy is transferred from the sphere to the wax **(1)** Idea that the lead sphere has insufficient energy for melting the wax (e.g. The lead sphere transfers less heat / thermal energy (than the steel sphere). Credit a supporting calculation) **(1)**	**2**
	Total for question	**4**

Question Number	Answer	Mark
6(a)	Use of $P=IV$ **(1)** I = 9.1 A **(1)** <u>Example of calculation</u> $I=\frac{P}{V}=\frac{2100\text{ W}}{230\text{ V}}=9.13\text{ A}$	**2**
6(b)(i)	Use of $\Delta E = mc\Delta\theta$ (for t =1s) **(1)** θ = 51°C or 324 K **(1)** <u>Example of calculation</u> $\Delta\theta=\frac{\Delta E}{mc}=\frac{2100\text{ J}}{0.068\text{ kg}\times1010\text{ J kg}^{-1}\text{ °C}^{-1}}=30.6\text{ °C}$ θ = 30.6 + 20 = 50.6 °C	**2**
6(b)(ii)	Thermal energy (is transferred) to <u>air</u> (molecules) **(1)** Kinetic energy [E_k] of (air) molecules is increased **(1)**	**2**
	Total for question	**6**

Question Number	Answer		Mark
7(a)	Use of $\Delta E = mc\Delta\theta$ Energy transferred = 2.8×10^6 J Example of calculation $\Delta\theta$ = (60 – 15) = 45 ^{o}C $E = mc\Delta\theta = 15\,\text{kg} \times 4200\,\text{J kg}^{-1}\,\text{K}^{-1} \times 45\,\text{K} = 2.84 \times 10^6\ \text{J}$	**(1)** **(1)**	**2**
7 (b)(i)	Use of $P = \dfrac{\Delta W}{\Delta t}$ Time = 1100 s (Allow answers that use ΔW in range 2.5 MJ → 3.4 MJ. t = 1200s if 3MJ used and 1000s to 1360 s for allowed range,) Example of calculation $\Delta t = \dfrac{\Delta W}{P} = \dfrac{2.84 \times 10^6\ \text{J}}{2500\ \text{W}} = 1136\,s \approx 1100\,s$	**(1)** **(1)**	**2**
7 (b)(ii)	Idea that all energy supplied results in a rise in temperature [e.g. only water heated up **Or** no energy transferred to surroundings etc]	**(1)**	**1**
7(c)	Use of $P = IV$ Current = 11A Example of calculation $I = \dfrac{P}{V} = \dfrac{2500\ \text{W}}{230\ \text{V}} = 10.9\ \text{A}$	**(1)** **(1)**	**2**
	Total for question		**7**