6 Mark Style Heat Calculation Questions for GCSE Physics

1. A 1200 g block of ice is at 0°C. How much energy is needed to melt it and then heat the resulting water to 100°C? The specific latent heat of fusion of ice is 334,000 J/kg, and the specific heat capacity of water is 4,200 J/kg°C.

Energy to melt ice:	$\Delta E = m\, l_f$	1200 g = 1.2 kg	*[1 mark]*
	= 1.2 x 334,000 = 400,800 J		*[1 mark]*
Energy to heat to 100°C:	$\Delta E = m\, c\, \Delta\theta$		
	= 1.2 x 4200 x 100 = 504,000 J		*[1 mark]*
Total Energy:	400,800 + 504,000 = **904,800 J**		*[1 mark]*

[4 marks]

2. A 3 kg block of aluminum is heated from 25°C to 660°C (its melting point), and then it is completely melted. The specific heat capacity of aluminium is 900 J/kg°C, and the specific latent heat of fusion is 397,000 J/kg. Calculate the total energy required to heat the block and melt it completely.

Energy to heat aluminium to 660°C:	$\Delta\theta$ = 660°C – 25°C = 635°C	*[1 mark]*
	$\Delta E = m\, c\, \Delta\theta$ = 3 x 900 x 635 = 1,714,500J	*[1 mark]*
Energy to melt aluminium:	$\Delta E = m\, l_f$ = 3 x 397,000 = 1,191,000J	*[1 mark]*
Total Energy:	1,714,500 + 1,191,000 = **2,905,500 J**	*[1 mark]*

[4 marks]

3. How much energy is required to convert 1.5 kg of ice at -10°C to water vapour at 100°C? The specific heat capacity of ice is 2,100 J/kg°C, the specific latent heat of fusion of ice is 334,000 J/kg, the specific heat capacity of water is 4,200 J/kg°C, and the specific latent heat of vaporization of water is 2,260,000 J/kg.

To heat ice to 0°C:	$\Delta E = m\, c\, \Delta\theta$	= 1.5 x 2,100 x 10	= 31,500 J	*[1 mark]*
To melt ice:	$\Delta E = m\, l_f$	= 1.5 x 334,000	= 501,000 J	*[1 mark]*
To heat water from 0°C to 100°C:	$\Delta E = m\, c\, \Delta\theta$	= 1.5 x 4200 x 100	= 630,000 J	*[1 mark]*
To vaporize water:	$\Delta E = m\, l_v$	= 1.5 x 2,260,000	= 3,390,000 J	*[1 mark]*
Total Energy:	31,500 + 501,000 + 630,000 + 3,390,000 = **4,552,500 J**			*[1 mark]*

[5 marks]

4. A 1.2 kg block of a material is heated from 20°C to its melting point of 800°C. It is then melted completely, requiring a total of 850,000 J of energy. The specific heat capacity of the material is 400 J/kg°C. Calculate the specific latent heat of fusion of the material.

To heat the block to 800ºC: $\Delta\theta = 800 - 20 = 780$ºC *[1 mark]*

$\Delta E = m\,c\,\Delta\theta = 1.2 \times 400 \times 780 = 374{,}400$ J *[1 mark]*

To melt the material: $\Delta E = 850{,}000 - 374{,}000 = 475{,}600$ J remaining *[1 mark]*

$\Delta E = m\,l_f$

$475{,}600 = 1.2 \times l_f$ *[1 mark]*

$475{,}600 / 1.2 = l_f$ = **396,333** *[1 mark]* **J/kg** *[1 mark]*

[6 marks]

5. A 600 g block of ice at -5°C is heated until 250,000 J of energy is supplied. If the specific heat capacity of ice is 2,100 J/kg°C, the specific latent heat of fusion of ice is 334,000 J/kg, and the specific heat capacity of water is 4200 J/kgºC, calculate the final temperature of the water.

Energy to heat ice to 0ºC: m = 0.600 kg *[1 mark]* $\Delta E = m\,c\,\Delta\theta = 0.600 \times 2100 \times 5 = 6300$ J *[1 mark]*

Energy to melt ice: $\Delta E = m\,l_f = 0.600 \times 334{,}000 = 200{,}400$ J *[1 mark]*

Remaining energy: 250,000 – 6300 – 200,400 = 43,300 J *[1 mark]*

Determine the final temp: $\Delta E = m\,c\,\Delta\theta$

$43{,}300 = 0.600 \times 4200 \times \Delta\theta$

43,300 / (0.600 x 4200) = $\Delta\theta$ *[1 mark]*

= **17.2ºC** *[1 mark]* *[6 marks]*

6. A 2 kg block of ice at -10°C is heated until 167,000 J of energy is supplied. The specific heat capacity of ice is 2,100 J/kg°C, and the specific latent heat of fusion of ice is 334,000 J/kg. How much of the ice is remaining after this energy is supplied?

Energy to heat ice to 0ºC: $\Delta E = m\,c\,\Delta\theta = 2 \times 2100 \times 10$ *[1 mark]* = 42000 J *[1 mark]*

Energy remaining: 167,000 – 42,000 = 125,000 J *[1 mark]*

Calculate mass of melted ice: : $\Delta E = m\,l_f$

125,000 = m x 334,000

125,000 / 334,000 = m *[1 mark]*

= 0.37 kg *[1 mark]*

Remaining ice: 2kg – 0.37kg = **1.63 kg** *[1 mark]* *[6 marks]*