

Multi-step energy calculations

Worksheet



Exam question



Exam questions

1. Calculate the total energy transferred when 250 g of ice cubes at 0 °C are changed to steam at 100 °C.

Specific latent heat of fusion of ice = 334 000 J/kg °C

Specific heat capacity of water = 4200 J/kg °C

Specific latent heat of vapourisation of water = 2260 000 J/kg

2. A block of ice at -3 °C was heated. After 7500 J of energy was transferred to the ice, the ice had melted and reached a temperature of 5 °C . Calculate the mass of the ice.

Specific latent heat of ice = 2100 J/kg °C

Specific latent heat of fusion of ice = 334 000 J/kg °C

Specific heat capacity of water = 4200 J/kg °C



Answers



Exam question - review

1) Mass = 0.25 kg **(1)**

Ice melting = $0.25 \times 334000 = 83500 \text{ J}$ **(1)**

Temperature change = $100 - 20 = 80 \text{ }^\circ\text{C}$ **(1)**

Water heating = $0.25 \times 4200 \times 80 = 84000 \text{ J}$ **(1)**

Water boiling = $0.25 \times 2260000 = 565000 \text{ J}$ **(1)**

Total thermal energy = $83500 + 84000 + 565000 = \mathbf{732500 \text{ J}}$ **(1)**



Exam question - review

2)

Ice heating:

$$E = m \times 2100 \times 3 = m \times 6300 \text{ (1)}$$

Ice melting:

$$E = m \times 340000 \text{ (1)}$$

Water heating:

$$E = m \times 4200 \times 5 = m \times 21000 \text{ (1)}$$

Total thermal energy transfer:

$$7500 = m \times 6300 + m \times 340000 + m \times 21000 = m \times 361300 \text{ (1)}$$

$$m = 7500 / 361300 \text{ (1)}$$

$$m = \mathbf{0.02 \text{ kg (1)}}$$

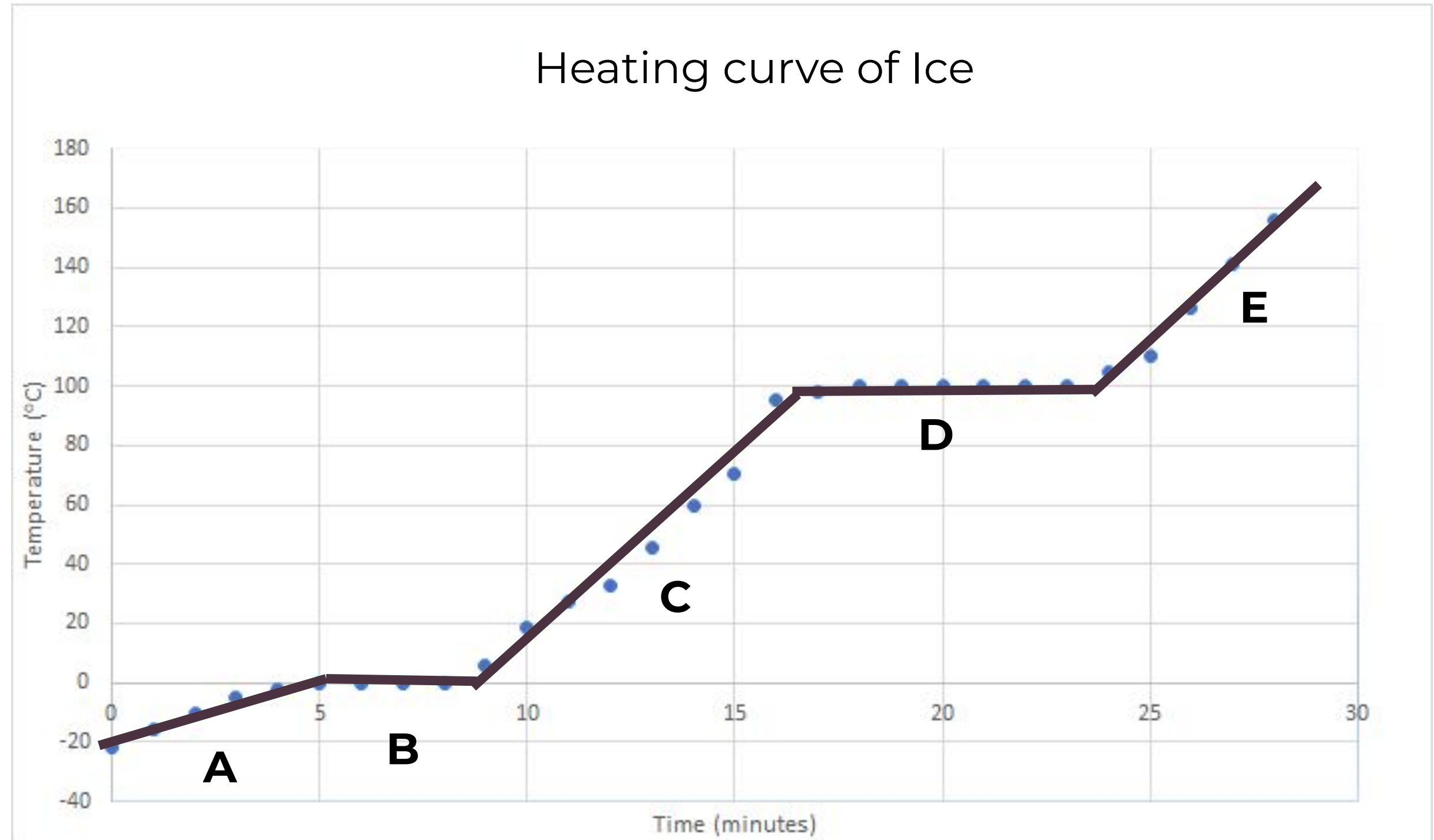


In lesson questions



Warm up

1. For each stage (A-E) write down if the kinetic store or potential store is increasing
2. Identify for each stage (A-E) if it relates to specific heat capacity or latent heat.



Image, Mr Charman



Independent practice

1. What mass of liquid hydrogen needs 910 000 J of heat energy to turn into a gas?
The specific latent heat of vapourisation of hydrogen is 455 000 J/kg
2. What is the mass of an unknown material with a specific latent heat of 14 000 J/kg if it takes 42 kJ to turn it into a liquid from a solid?
- 3. Challenge:** What mass of nitrogen gas is produced when 1.6×10^4 J is needed to turn it from a liquid to a gas? The specific latent heat of vapourisation of nitrogen is 2×10^5 J/kg.



Independent practice

1. What is the specific latent heat of copper if it requires 414 000 J of heat energy to melt 2 kg of copper?
2. What is the specific latent heat of lead if it requires 92 000 J of heat energy to melt 4 kg of lead?
- 3. Challenge** - what is the specific latent heat of aluminium if it requires 203 400 J of heat energy to melt 600g of aluminium?



Worked example 1

A kettle contains 0.2 kg of water at 20 °C. Work out the total thermal energy required to turn all of the water into steam.

Specific heat capacity of water = 4200 J/kg °C

Specific latent heat of vapourisation of water = 2260 000 J/kg **(5)**

Energy = J



Worked example 2

An ice cube has a mass of 50 g and a temperature of $-10\text{ }^{\circ}\text{C}$. Calculate the total thermal energy required to melt the ice cube.

Specific heat capacity of ice = $2100\text{ J/kg }^{\circ}\text{C}$

Specific latent heat of fusion of ice = $334\ 000\text{ J/kg}$

(5)

Energy = J



Worked example 3

An ice cube has a temperature of $-20.0\text{ }^{\circ}\text{C}$. The total thermal energy needed to raise the temperature of this ice cube to $0.0\text{ }^{\circ}\text{C}$ and completely melt the ice cube is 75200 J .

Specific heat capacity of ice = $2100\text{ J/kg }^{\circ}\text{C}$

Specific latent heat of fusion of ice = $334\,000\text{ J/kg}$

Calculate the mass of the ice cube.

(5)

Energy = J



Answers



Review

Warm up

1. For each stage (A-E) write down if the kinetic store or potential store is increasing.
A, C and E - kinetic energy store increasing. B and D - potential energy store increasing.
2. Identify for each stage (A-E) if it relates to specific heat capacity or latent heat.
A, C and E relate to specific heat capacity. B and D relate to latent heat.



Independent practice -review

1. What is mass of liquid hydrogen needs 910 000 J of heat energy to turn into a gas? The specific latent heat of vaporization of hydrogen is 455 000 J/kg. **2 kg**
2. What mass of an unknown material with a specific latent heat of 14 000 J/kg is produced when it takes 42 kJ to turn it into a liquid from a solid? **3 kg**
- 3. Challenge:** What mass of nitrogen gas is produced when 1.6×10^4 J is needed to turn it from a liquid to a gas? The specific latent heat of vaporisation of nitrogen is 2×10^5 J/kg.



Independent practice -review

1. What is the specific latent heat of copper if it requires 414 000 J of heat energy to melt 2 kg of copper? **207 000 J/kg**
2. What is the specific latent heat of lead if it requires 92 000 J of heat energy to melt 4 kg of lead? **23 000 J/kg**
- 3. Challenge** - what is the specific latent heat of aluminium if it requires 203 400 J of heat energy to melt 600g of aluminium? **339 000 J/kg**

1.

