

# 3.1 Thermal Concepts

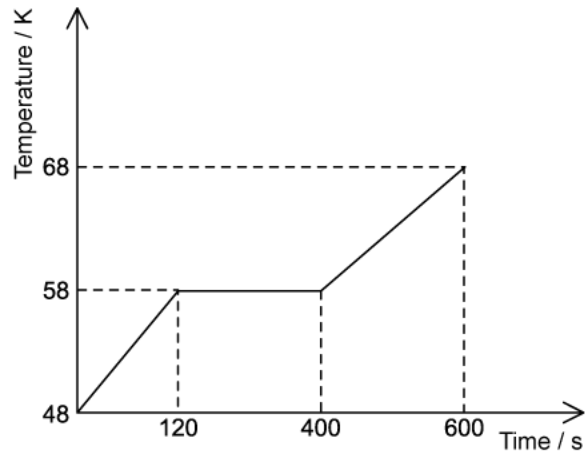
## Question Paper

Course	DPIB Physics
Section	3. Thermal Physics
Topic	3.1 Thermal Concepts
Difficulty	Medium

**Time allowed:** 20  
**Score:** /10  
**Percentage:** /100

### Question 1

A heater applies a constant power of  $150\text{m}$  to a solid material with a specific heat capacity of  $1.8 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$ . The graph below shows how the temperature of the material varies with time as the solid melts and becomes a liquid.



What is the specific latent heat of fusion of the substance?

- A.  $4.2 \times 10^3 \text{ J kg}^{-1}$
- B.  $6.0 \times 10^3 \text{ J kg}^{-1}$
- C.  $4.2 \times 10^4 \text{ J kg}^{-1}$
- D.  $6.0 \times 10^4 \text{ J kg}^{-1}$

[1 mark]

### Question 2

Liquid iron solidifies without a change in temperature.

Which of the following is correct for the molecules in the solid phase compared with molecules in the liquid phase?

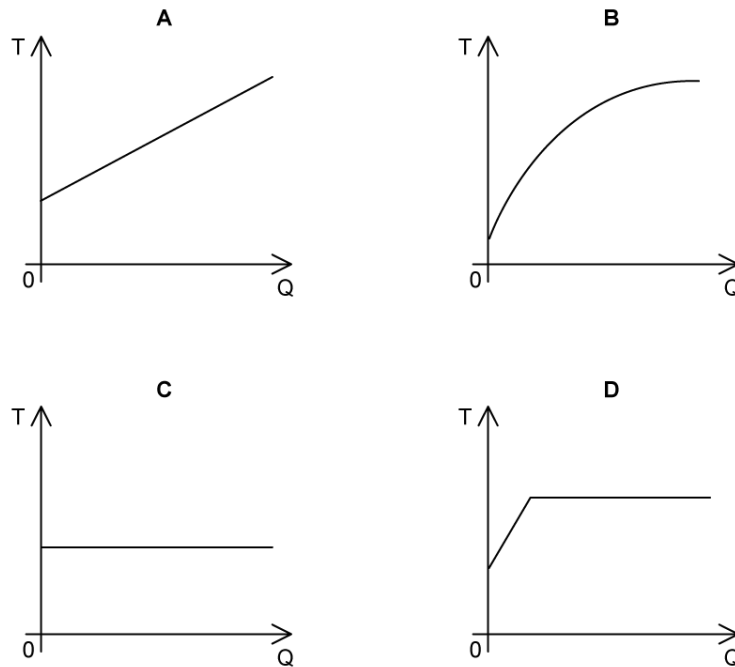
	Potential energy	Kinetic energy
A.	same	same
B.	same	less
C.	less	less
D.	less	same

[1 mark]

### Question 3

A liquid is initially at its boiling point. Energy is continuously supplied to the liquid at a uniform rate until it has completely evaporated.

Which graph shows how the temperature of the liquid,  $T$ , varies with the energy,  $Q$ , supplied to the liquid?



[1 mark]

### Question 4

In a refrigerator, 2 kg of water cools from  $30\text{ }^{\circ}\text{C}$  to  $0\text{ }^{\circ}\text{C}$  and then freezes to form ice also at  $0\text{ }^{\circ}\text{C}$ . The whole process takes 4000 seconds.

The specific heat capacity of water is  $4200\text{ J kg}^{-1}\text{ K}^{-1}$ .

The specific latent heat of fusion of ice is  $3.4 \times 10^5\text{ J kg}^{-1}$ .

What is the power required by the refrigerator during this process?

- A. 233 W
- B. 240 W
- C. 932 W
- D. 260 W

[1 mark]

### Question 5

A 2 kW kettle supplies energy to a water of mass 1 kg. The initial temperature of the water is 20 °C. The specific heat capacity of water can be taken to be  $4000 \text{ J kg}^{-1} \text{ K}^{-1}$ .

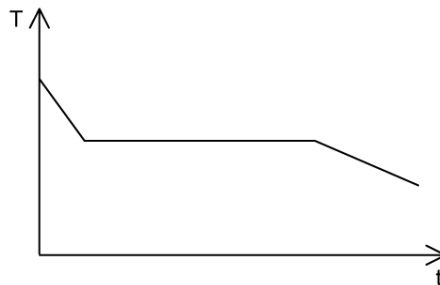
How long does it take for the water to start boiling?

- A. 80 s
- B. 120 s
- C. 160 s
- D. 210 s

[1 mark]

### Question 6

A substance loses energy at a constant rate. The graph shows how the temperature,  $T$ , of the substance varies with time,  $t$ , as the state of the substance changes from liquid to solid.



What can be deduced about this substance from the graph shown?

- A. The specific latent heat of fusion of the substance is greater than its specific latent heat of vaporization
- B. The specific heat capacity of the liquid is lower than the specific heat capacity of the solid
- C. The specific latent heat of fusion of the substance is less than its specific latent heat of vaporization
- D. The specific heat capacity of the liquid is greater than the specific heat capacity of the solid

[1 mark]

### Question 7

Aluminium melts at  $660\text{ }^{\circ}\text{C}$ . A mass  $m$  of solid aluminium is initially at a temperature of  $645\text{ }^{\circ}\text{C}$ . The aluminium is heated and melts into liquid aluminium and continues to be heated up to a final temperature of  $720\text{ }^{\circ}\text{C}$ .

- Specific latent heat of fusion of aluminium =  $L_f$
- Specific heat capacity of solid aluminium =  $c_S$
- Specific heat capacity of liquid aluminium =  $c_L$

Which expression gives the energy needed for this change to occur?

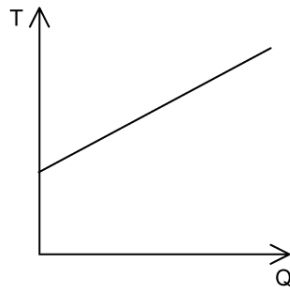
- A.  $m(15c_S + L_f + 60c_L)$
- B.  $m(c_S + 15L_f + 75c_L)$
- C.  $m(15c_S + 60L_f + c_L)$
- D.  $m(15c_S + L_f + 75c_L)$

[1 mark]

### Question 8

The graph shows how the temperature  $T$  of a liquid varies with energy  $Q$  supplied to the liquid at a constant rate  $P$ .

The gradient of the graph is  $z$  and the liquid has a specific heat capacity,  $c$ .



What is the mass of the liquid?

- A.  $zc$
- B.  $\frac{1}{zc}$
- C.  $\frac{p}{c}$
- D.  $\frac{z}{c}$

[1 mark]

### Question 9

A sealed cylinder contains water at  $10\text{ }^{\circ}\text{C}$  and ice at  $0\text{ }^{\circ}\text{C}$ . The system has been thermally isolated from the surroundings. The ice and the water reach thermal equilibrium.

What happens to the total internal energy of the system in order for equilibrium to be reached?

- A. It reduces
- B. It increases
- C. It increases until the ice has melted and then remains constant
- D. It remains constant

[1 mark]

### Question 10

A flask contains a mass  $m$  of a fluid. When  $2000\text{ J}$  of heat is provided the temperature of the water and the flask increases by  $10\text{ K}$ .

The mass of the fluid is doubled, and the experiment is repeated. This time  $4500\text{ J}$  is required to increase the temperature by  $10\text{ K}$ .

The specific heat capacity of the fluid is  $5000\text{ J kg}^{-1}\text{ K}^{-1}$ .

What is the value of  $m$ ?

- A.  $5\text{ g}$
- B.  $25\text{ g}$
- C.  $40\text{ g}$
- D.  $50\text{ g}$

[1 mark]