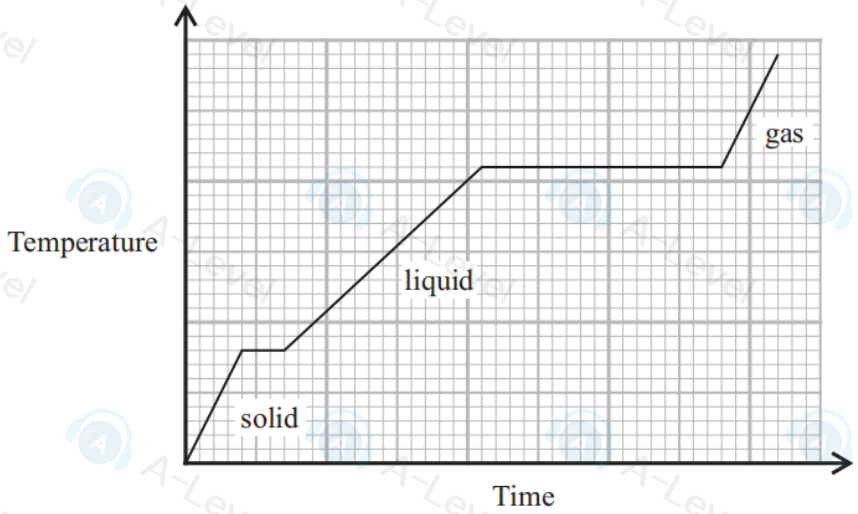
10 Energy is supplied at a constant rate to a material. The material is initially solid.

As energy is supplied, the solid melts to form a liquid and finally the liquid turns into a gas. The mass remains constant during the heating process.

The graph shows how the temperature changed with time.



Which of the following is correct?

☒ **A** specific heat capacity of solid > specific heat capacity of liquid

☒ **B** specific heat capacity of solid > specific heat capacity of gas

☒ **C** specific heat capacity of solid = specific heat capacity of liquid

☒ **D** specific heat capacity of solid = specific heat capacity of gas

(Total for Question 10 = 1 mark)

8 A container is filled with a mixture of two gases, X and Y, at constant temperature. Each molecule of gas X has twice the mass of each molecule of gas Y.

The ratio $\frac{\text{r.m.s. velocity of molecules in gas X}}{\text{r.m.s. velocity of molecules in gas Y}}$ is

☒ **A** $\frac{1}{\sqrt{2}}$

☒ **B** $\frac{1}{2}$

☒ **C** 1

☒ **D** $\sqrt{2}$

(Total for Question 8 = 1 mark)

8 A mixture of helium gas and hydrogen gas is kept at room temperature.

Which of the following is correct?

- ☒ **A** The mean kinetic energy of the helium molecules is greater than the mean kinetic energy of the hydrogen molecules.
- ☒ **B** The mean kinetic energy of the helium molecules is less than the mean kinetic energy of the hydrogen molecules.
- ☒ **C** The mean square velocity of the helium molecules is greater than the mean square velocity of the hydrogen molecules.
- ☒ **D** The mean square velocity of the helium molecules is less than the mean square velocity of the hydrogen molecules.

(Total for Question 8 = 1 mark)

DO NOT WRITE IN THIS AREA

6 A container is filled with a mixture of two gases, X and Y.

The root mean square velocity of molecules in gas X is twice the root mean square velocity of molecules in gas Y.

The temperature of the gas mixture is constant.

What is the ratio $\frac{\text{mass of molecules of gas X}}{\text{mass of molecules of gas Y}}$?

- ☒ **A** $\frac{1}{4}$
- ☒ **B** $\frac{1}{\sqrt{2}}$
- ☒ **C** $\frac{1}{2}$
- ☒ **D** 1

(Total for Question 6 = 1 mark)

DO NOT WRITE IN THIS AREA

1 Ice at 0 °C melts into water at 0 °C.

Which row of the table gives the changes in mean molecular kinetic energy and mean molecular potential energy as the ice melts?

	Mean molecular kinetic energy	Mean molecular potential energy
☒ **A**	no change	no change
☒ **B**	no change	increases
☒ **C**	increases	no change
☒ **D**	increases	increases

(Total for Question 1 = 1 mark)

DO NOT WRITE IN THIS AREA

9 Two gas cylinders have the same volume. One cylinder contains nitrogen gas. The other cylinder contains oxygen gas.

Both gases are at the same temperature and pressure.

Which of the following statements is **not** correct?

- ☒ **A** Each cylinder contains the same number of molecules.
- ☒ **B** The average molecular kinetic energy is the same for each gas.
- ☒ **C** The density of gas is the same in each cylinder.
- ☒ **D** The internal energy is the same for each gas.

(Total for Question 9 = 1 mark)

16 An electric kettle contains $4.25 \times 10^{-4}\,m^3$ of water. The temperature of the water is 22°C.

The kettle is switched on. The water takes 85 s to reach a temperature of 100°C.

(a) Show that the power of the kettle is about 1600 W.

specific heat capacity of water = $4190\,J\,kg^{-1}\,K^{-1}$
density of water = $998\,kg\,m^{-3}$

(4)

DO NOT WRITE IN THIS AREA

(b) The water boils at 100°C.

Calculate the time now taken for 75% of the water to boil away.

specific latent heat of vaporisation of water = $2.26 \times 10^6 \text{ J kg}^{-1}$

(3)

.....

.....

.....

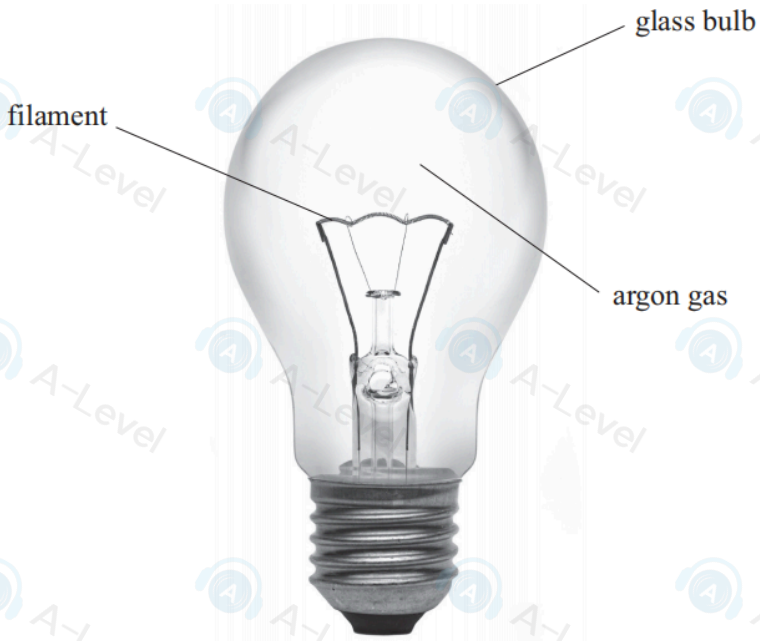
.....

.....

Time taken = ...

(Total for Question 16 = 7 marks)

19 A filament bulb contains argon gas to extend the lifetime of the filament.



(Source: © mauritius images GmbH / Alamy Stock Photo)

While the bulb is off, the argon gas inside the bulb is at a temperature of 290 K. The pressure of the argon gas inside the bulb is 75% of atmospheric pressure.

volume of bulb = $1.25 \times 10^{-4}\,m^3$
atmospheric pressure = $1.03 \times 10^{5}\,Pa$

(a) Calculate the number of argon atoms in the bulb.

(3)

Number of argon atoms = ...

DO NOT WRITE IN THIS AREA

(b) While the bulb is on, the pressure of the argon gas is 83% of atmospheric pressure.

The manufacturer states that the temperature of the gas inside the bulb is about 60°C while the bulb is on.

Assess whether this statement is accurate.

(3)

DO NOT WRITE IN THIS AREA

(c) (i) While the bulb is on, radiation is emitted by the filament. This radiation has a peak power output at a wavelength, λ_{max}, of 1100 nm.

Calculate the power output of the bulb.

surface area of filament = $1.55 \times 10^{-5}\ m^2$

(3)

Power output of bulb = ...

DO NOT WRITE IN THIS AREA

(c) (i) While the bulb is on, radiation is emitted by the filament. This radiation has a peak power output at a wavelength, λ_{max}, of 1100 nm.

Calculate the power output of the bulb.

surface area of filament = $1.55 \times 10^{-5}\,m^2$

(3)

Power output of bulb = ...

(ii) Suggest why the actual power output of the bulb may be lower than the value calculated.

(1)

(Total for Question 19 = 10 marks)

15 A teacher used liquid nitrogen to demonstrate low temperature physics.

The teacher dropped a peeled banana at room temperature into a flask of liquid nitrogen.

(a) Explain why the liquid nitrogen boiled when the banana was submerged in the liquid nitrogen.

(2)

(b) During the demonstration, the liquid nitrogen remained at its boiling point in a large flask. The teacher estimated that at least 0.5 kg of liquid nitrogen was needed to cool the banana from room temperature to the temperature of the liquid nitrogen.

Assess the accuracy of the teacher's estimate.

latent heat of vaporisation of nitrogen = $1.98 \times 10^5\,J\,kg^{-1}$
boiling point of liquid nitrogen = 77.4 K
specific heat capacity of banana = $1.76 \times 10^3\,J\,kg^{-1}\,K^{-1}$
mass of banana = 0.118 kg
room temperature = 292 K

(3)

(Total for Question 15 = 5 marks)