Do not write outside the box

0 2 A scientist cooled the air inside a container.

0 2 . 1 The temperature of the air changed from 20 °C to 0 °C

The volume of the container of air stayed the same.

Explain how the motion of the air molecules caused the pressure in the container to change as the temperature decreased.

[3 marks]

0 2 . 2 The air contained water that froze at 0 °C

The change in internal energy of the water as it froze was 0.70 kJ

The specific latent heat of fusion of water is 330 kJ/kg

Calculate the mass of ice produced.

Use the Physics Equations Sheet.

[3 marks]

Mass of ice = _____ kg

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0 2 . 3 The air also contained oxygen, nitrogen and carbon dioxide.

Oxygen boils at –183 °C and freezes at –218 °C
Nitrogen boils at –195 °C and freezes at –210 °C
Carbon dioxide sublimates at –78 °C

The scientist continued to cool the air to a temperature of –190 °C

What is the state of each substance at –190 °C?

[2 marks]

Tick (✓) **one** box for **each** row of the table.

Substance	**Solid**	**Liquid**	**Gas**
Oxygen			
Nitrogen			
Carbon dioxide			

Question 2 continues on the next page

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0 2 . 4 The air also contained a small amount of argon.

As the temperature of the air decreased from 20 °C to –190 °C the argon changed from a gas to a liquid to a solid.

Explain the changes in the arrangement and movement of the particles of the argon as the temperature of the air decreased.

[6 marks]

14

<table>
<tr><th>Question</th><th>Answers</th><th>Extra information</th><th>Mark</th><th>AO / Spec. Ref.</th><th>ID</th></tr>
<tr><td>02.1</td><td>pressure decreased

because molecules have less (kinetic) energy

so fewer collisions (with the wall/container each second)</td><td>

allow less speed/velocity

allow collide with less force

allow less force on the walls</td><td>1

1

1</td><td>AO2.1

6.3.3.1</td><td>E</td></tr>
<tr><td>02.2</td><td>

0.70 = m × 330
or
700 = m × 330 000

$m = \frac{0.70}{330}$
or
$m = \frac{700}{330\,000}$

m = 0.0021 (kg)</td><td>an answer of 0.0021(212121…) scores 3 marks

allow correct rearrangement using converted value(s) of E to J and/or L to J/kg

allow 0.0021(212121…)
allow correct calculation using converted value(s) of E and/or L

3 marks can only be awarded for m = 0.0021(212121…) (kg)</td><td>

1

1

1</td><td>AO2.1

6.3.2.2
6.1.1.3</td><td>E</td></tr>
<tr><td>02.3</td><td><table><tr><th>Substance</th><th>Solid</th><th>Liquid</th><th>Gas</th></tr><tr><td>Oxygen</td><td></td><td>✓</td><td></td></tr><tr><td>Nitrogen</td><td></td><td></td><td>✓</td></tr><tr><td>Carbon dioxide</td><td>✓</td><td></td><td></td></tr></table>2 correct answers scores 1 mark.
if more than one tick in a row, neither tick can score a mark</td><td></td><td>2</td><td>AO3/2b

6.3.1.1</td><td>E</td></tr>
</table>

02.4	**Level 3:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1.1 6.3.1.2	E
	Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4		
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2		
	No relevant content	0		
	Indicative content cooling • as the argon cools the particles slow down • particles in a liquid move slower than particles in a gas • particles in a solid move slower than particles in a liquid • as the liquid/solid cools the particles get closer together • as the liquid/solid cools the density increases gas to liquid • particles change from being spread apart to touching each other • particles will (collide with other particles more often and) change direction more often liquid to solid • particles change from a random arrangement to a regular pattern • particles change from moving freely to fixed positions • particles change from moving freely/randomly to vibrating explanation • (internal) energy (of the argon) decreases • (kinetic) energy (of the particles) decreases with temperature • (potential) energy (of the particles) changes with change of state (of the argon) • forces between particles in a gas are negligible/zero • attractive forces act between atoms when they are close to each other • attractive forces between particles are stronger in a solid than in a liquid to access level 3 there must be an explanation of changes to arrangement and movement of particles during either cooling or a change of state			

Total			**14**