A Level · OCR · Physics

23 mins 2 questions

Structured Questions

Kinetic Theory of Gases

Kinetic Theory of Gases / Kinetic Theory of Gases Equation / The Boltzmann Constant / Average Kinetic Energy of a Molecule / Internal Energy of an Ideal Gas

Medium (1 question)	/11
Hard (1 question)	/12
Total Marks	**/23**

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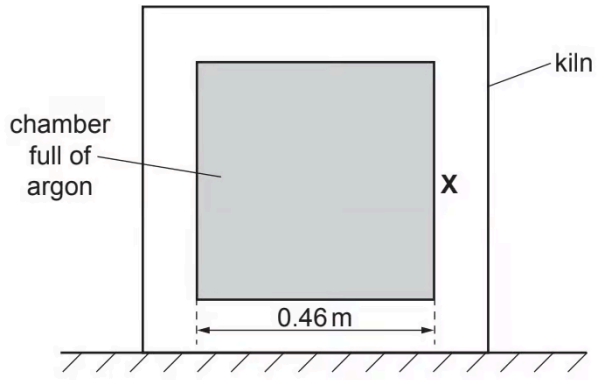
Medium Questions

1 (a) A kiln used to harden ceramics is shown below.



The internal chamber is a cube. Each side of this cube has length 0.46 m. The chamber is sealed and full of argon. Argon behaves as an ideal gas.

The kiln is initially at 20 °C. The argon in the kiln has an initial pressure of 100 kPa.

i) Calculate the amount of argon *n* in the chamber in moles.

n = ... mol **[2]**

ii) The temperature of the kiln is increased from 20 °C to 1300 °C.

Calculate the pressure in kPa at 1300 °C.

pressure = ... kPa **[2]**

.....

.....

.....

.....

(4 marks)

(b) The temperature of the kiln is 1300 °C.

A single atom of argon is travelling horizontally towards the vertical side **X** of the chamber.

The initial speed of this atom is 990 m s^{-1}. After collision, it rebounds at the same speed.

i) Calculate the change in momentum Δp of this atom.

Mass of argon atom = 6.6×10^{-26} kg

Δp = ... kg m s^{-1} **[2]**

ii) Assume that this atom does not collide with any other argon atoms inside the chamber.

Instead, it travels horizontally, making repeated collisions with the opposite vertical walls of the chamber.

1 Show that the atom makes about 1000 collisions with side **X** in a time interval of 1.0 s.

[1]

2 Calculate the average force F on side **X** made by the atom.

F = ... N **[2]**

iii) Without calculation, explain how your answer to **(ii)2** could be used to estimate the total pressure exerted by the atoms of the argon gas in the kiln.

[2]

(7 marks)

Hard Questions

1 (a) This question is about an electric cooker, which consists of an oven and an electromagnetic induction hob.

The oven is not sealed, so the air inside remains at atmospheric pressure of 1.0×10^5 Pa. The volume of the oven is 0.065 m^3. The air inside the oven behaves as an ideal gas.

The temperature of the oven increases from room temperature to 200 °C.

Show that the internal energy of the air in the oven is the same at **all** temperatures of the oven. Support your answer with an explanation of the motion of the air molecules in terms of kinetic theory.

[6]

(6 marks)

(b) The electromagnetic induction hob is shown in **Fig. 4.1**.

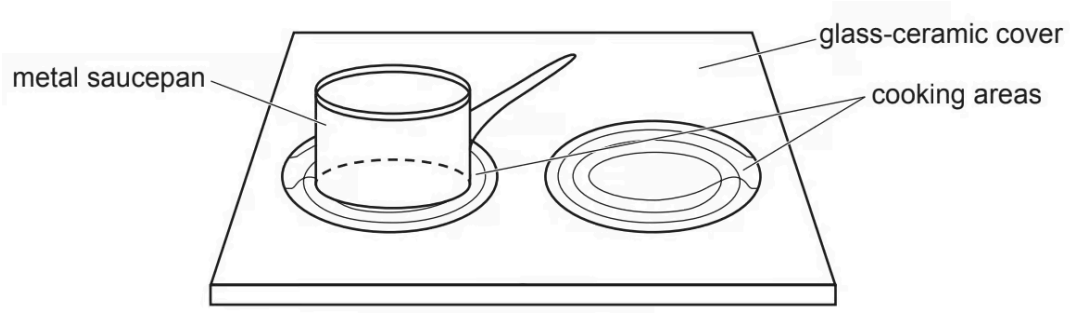


Fig. 4.1

Each cooking area has a coil below the glass-ceramic cover. When switched on, the coils carry a high-frequency **alternating** current.

A metal saucepan is placed above one of the coils. A large alternating current is induced in the saucepan base, and this causes the saucepan to heat up.

i) **Fig. 4.2** shows one of the coils at a time when the current is in the direction indicated by the arrows.

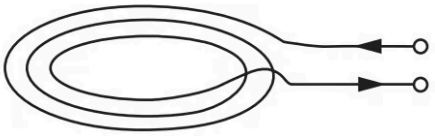


Fig. 4.2

On **Fig. 4.2**, sketch the magnetic field pattern for the current-carrying coil.

[2]

ii) **Fig. 4.3** shows the path of the large alternating current induced in the metal base of the saucepan.

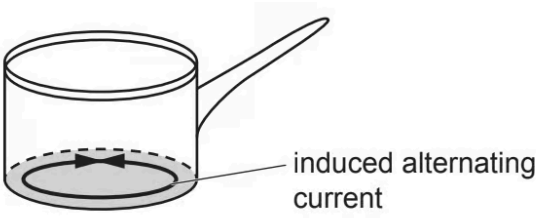


Fig. 4.3

Explain the origin of this large current.

[2]

iii) Explain why it would be safe for a person to place a hand on the cooking area before the saucepan is put onto it.

[2]

(6 marks)