Physics

Question	Maximum Mark	Mark Awarded
#1	8	
#2	12	
#3	15	
#4	16	
Total	51	

#1

7. (a) State two assumptions that must be made about the molecules of an ideal gas in order to derive the kinetic theory equation: [2]

$$p = \frac{1}{3}\rho\overline{c^2}$$

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(b) A cylinder of volume 5.0×10^{-2} m^3 contains 2.20 mol of argon gas (relative molecular mass, M_r = 39.9) at a pressure of 250 kPa.

(i) Calculate the rms speed of the argon molecules. [3]

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(ii) I. State what would happen to the rms speed if the kelvin temperature of the gas in the cylinder were doubled, justifying your answer. [2]

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II. Explain briefly whether or not your answer to *(b)* (ii) I. would still apply if some gas escaped from the cylinder while the temperature was being raised. [1]

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Question taken from Eduqas examination paper 842101, June 2018

#2

(a) Explain, in terms of molecules, how a gas exerts a pressure on the walls of its container, and why this pressure increases with temperature. [6 QER]

(b) A cylinder of volume $0.020\,m^3$ contains $0.091\,kg$ of nitrogen gas (relative molecular mass = 28) at a pressure of 3.9×10^5 Pa. Calculate:

(i) the rms speed of the molecules; [3]

(ii) the temperature of the gas. [3]

Question taken from Eduqas examination paper 842101, June 2017

#3

6. *(a)* Vadim uses a ruler to measure the sides of a copper block. He records the measurements as:

length = 50 ± 1 mm,   breadth = 42 ± 1 mm,   height = 36 ± 1 mm.

Using an electronic balance he measures the mass of the block as 670.85 ± 0.01 g.

Use Vadim's data to answer the following.

(i) Determine a value for the density of copper in kg m^{-3} and the **absolute** uncertainty in this value. [4]

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(ii) Determine the number of atoms per m^3 of copper. The uncertainty is **not** required. The atomic mass of copper is 63.5 u. [2]

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(b) (i) I. Calculate the number of molecules per m^3 for a gas (assumed to be ideal) at a temperature of 15 °C and a pressure of 101 kPa. [3]

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II. When asked why there are far fewer gas molecules per m^3 than atoms per m^3 in the copper block, a student replies, "Each molecule of the gas takes up much more space." Discuss whether or not he is right. [2]

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(ii) I. Two gases have molecular masses $m_{(1)}$ and $m_{(2)}$. Show clearly that when the gases are at the same temperature, the ratio of the rms speeds of their molecules is: [2]

$$\frac{c_{\text{rms}(1)}}{c_{\text{rms}(2)}} = \sqrt{\frac{m_{(2)}}{m_{(1)}}}$$

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II. Calculate the percentage difference in the rms speeds of nitrogen and oxygen molecules in the same sample of air. Take the percentage difference to be defined as:

$$\frac{\text{rms speed for nitrogen} - \text{rms speed for oxygen}}{\text{rms speed for oxygen}} \times 100\%$$

[Molecular mass for nitrogen = 28.0 u. Molecular mass for oxygen = 32.0 u.]
[2]

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Question taken from Eduqas examination paper 842101, June 2019

#4

(a) (i) Show that the mean kinetic energy of (monatomic) gas molecules at a temperature of 1500 K is approximately 3×10^{-20} J. [2]

(ii) At 1500 K, sodium is a gas of monatomic molecules, each of mass 3.82×10^{-26} kg. Calculate their rms speed. [2]

(b) A sodium molecule moving at 6.40 km s^{-1} to the East collides with an almost stationary sodium molecule.

(i) Discuss whether a molecule with a speed of 6.40 km s^{-1} could be present at some instant in sodium gas at 1500 K and, if so, how it could have acquired this speed. [3]

(ii) After the collision one of the two molecules is moving to the East at 4.39 km s^{-1}. Calculate the speed and direction of motion of the other molecule. [2]

(iii) Determine whether or not the collision is elastic. [3]

(iv) Explain how Newton's 3rd law applies to the collision. [1]

(v) Soon after the collision in *(b)*, one of the molecules gives out a photon of wavelength 589 nm. Evaluate whether or not the momentum of the photon significantly affects the molecule's velocity. [3]

Question taken from Eduqas examination paper 842101, November 2020