Ideal Gas Law & The Kinetic Theory Model

Question paper

Level	International A Level
Subject	Physics
Exam Board	Edexcel
Topic	Physics from Creation to Collaps
Sub Topic	Ideal Gas Law & The Kinetic Theory Model
Booklet	Question paper

Time Allowed: **42 minutes**

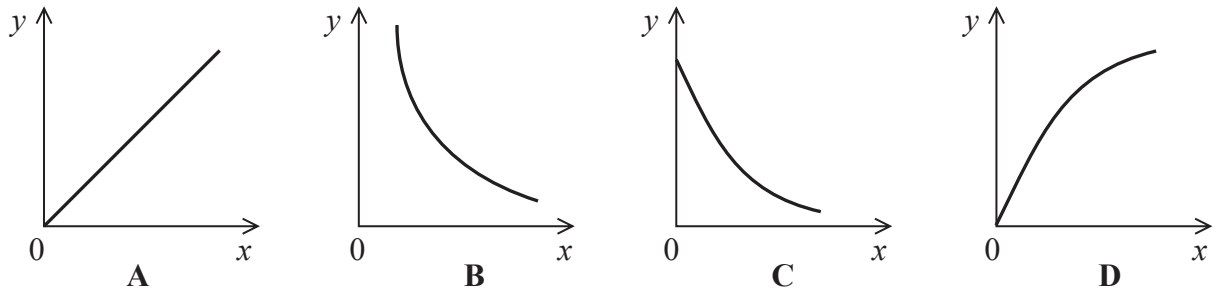
Score: **/35**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

Question 1 refer to the graphs below.



1 Which graph shows how the pressure varies with volume for a fixed mass of an ideal gas maintained at a constant temperature?

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 1 = 1 mark)

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2 Energy is supplied to a fixed mass of gas in a container and the mean squared speed of the gas molecules doubles.

The absolute temperature of the gas

☒ **A** remains constant

☒ **B** increases by a factor of $\sqrt{2}$

☒ **C** increases by a factor of 2

☒ **D** increases by a factor of 4

(Total for Question 2 = 1 mark)

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3 Absolute zero is the temperature reached when

☒ **A** an ideal gas liquefies.

☒ **B** an object is in deep space.

☒ **C** atoms have no kinetic energy.

☒ **D** a white dwarf ends its life.

(Total for Question 3 = 1 mark)

4 A mixture of helium He and hydrogen H_2 gases is maintained at a temperature of 300 K.

Which of the following is correct?

☒ **A** The average kinetic energy of the He molecules is greater than the average kinetic energy of the H_2 molecules.

☒ **B** The average kinetic energy of the He molecules is the same as the average kinetic energy of the H_2 molecules.

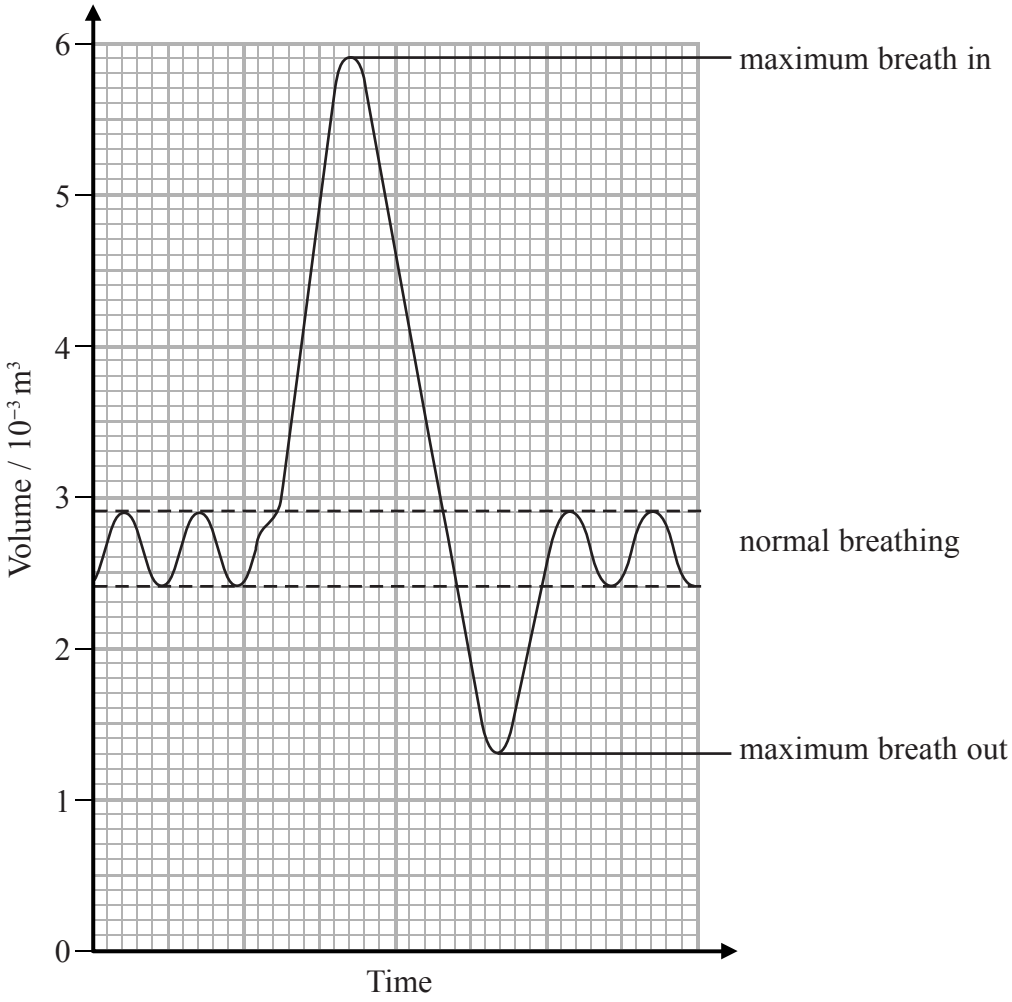
☒ **C** The average speed of the He molecules is greater than the average speed of the H_2 molecules.

☒ **D** The average speed of the He molecules is the same as the average speed of the H_2 molecules.

(Total for Question 4 = 1 mark)

5 A spirometer is a device used in medical tests to investigate breathing. The spirometer measures the volume of air entering and leaving the lungs.

A patient is asked to breathe normally, take a maximum breath in and a maximum breath out, then breathe normally again. The results are shown on the graph.



(a) Whilst in the lungs the air was at a temperature of 37.0 °C and a pressure of 1.02×10^5 Pa.

(i) Show that the number of air molecules expelled from the lungs between the maximum breath in and the maximum breath out is about 1×10^{23}.

(3)

(ii) Calculate the total kinetic energy of the air molecules expelled from the lungs between the maximum breath in and the maximum breath out.

(2)

Total kinetic energy of air molecules = ...

(iii) Explain why the internal energy of the air can be taken as the total kinetic energy of the molecules of the air.

(2)

(b) Air is a mixture of mainly nitrogen and oxygen. Oxygen molecules are more massive than nitrogen molecules. Nitrogen accounts for about 80% of the molecules in a given sample of air.

(i) Compare the mean square speed of the oxygen molecules to the mean square speed of the nitrogen molecules in a sample of air.

(2)

*(ii) The pressure exerted by the air in a sample is partly due to the oxygen molecules and partly due to the nitrogen molecules.

Explain why the nitrogen molecules would account for 80% of the pressure exerted by the air.

(3)

(Total for Question 5 = 12 marks)

6 The photograph shows an inflatable globe. This is a flexible plastic sphere on which a map of the world is printed. It is inflated by blowing into it like a balloon.

When fully inflated the globe has a volume of 6.55×10^{-2} m^3. At a temperature of 22°C the pressure exerted by the air in the globe is 1.05×10^5 Pa.

(a) On average there are 1.25×10^{22} molecules in each breath of air that we take.

Show that the number of breaths needed to fully inflate the globe is about 140.

(3)

(b) The fully inflated globe is left outside and its temperature rises from 22°C to 30°C. The volume of the globe remains constant.

Calculate the new pressure exerted by the air in the globe.

(2)

New pressure = ...

*(c) Including ideas of momentum, explain why the pressure exerted by the air in the globe increases.

(4)

(Total for Question 6 = 9 marks)

7 In 2013 an attempt by Jonathan Trappe to cross the Atlantic Ocean suspended from 370 helium-filled balloons had to be abandoned after 12 hours due to technical problems.

(a) Helium at a temperature of 18 °C was used to inflate each balloon to a volume of 8.5 m^3 at a pressure of 0.11 MPa.

Calculate the number of helium molecules that each balloon contained.

(2)

Number of helium molecules = ...

*(b) If a helium-filled balloon is left in direct sunlight the temperature, and hence the pressure, of the helium increases.

By considering the motion of the molecules in the helium gas, explain why the pressure increases.

(3)

(Total for Question 7 = 5 marks)

8 A typical car has an internal volume of 2.5 m^3. On a fine day the Sun heats the interior of the car from a temperature of 20 °C to a temperature of 55 °C.

(a) Calculate the number of molecules of air that must escape from the car if the pressure is to remain constant.

atmospheric pressure = 101 kPa

(4)

Number of molecules = ...

(b) State an assumption that you made.

(1)

.....

.....

(Total for Question 8 = 5 marks)