# Essential Pre-Uni Physics G1.1

GCSE P P P A Level P P P

Give your answer to 3 significant figures. Remember that $0\,^\circ\mathrm{C} = 273\,\mathrm{K}$ (no $^\circ$ in $\mathrm{K}$).

Convert $23\,^\circ\mathrm{C}$ into $\mathrm{K}$.

# Essential Pre-Uni Physics G2.1

A Level

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

Don’t forget that one mole of gas contains $6.02 \times 10^{23}$ molecules, and that the mass of this amount is called the ‘molar mass’.

What is the volume of a mole of gas at atmospheric pressure ($1.01 \times 10^5\,\mathrm{Pa}$) and at $20\,^\circ\mathrm{C}$? Give your answer to two significant figures.

Gameboard:

**STEM SMART Physics 28 - Gases & Kinetic Theory**

# Essential Pre-Uni Physics G2.2

A Level

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

Don’t forget that one mole of gas contains $6.02 \times 10^{23}$ molecules, and that the mass of this amount is called the ‘molar mass’.

Calculate the density of nitrogen gas at atmospheric pressure and at $20\,^{\circ}\mathrm{C}$ if the molar mass of nitrogen is $0.028\,\mathrm{kg}$.

Gameboard:

**STEM SMART Physics 28 - Gases & Kinetic Theory**

# Essential Pre-Uni Physics G2.3

A Level

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

Don’t forget that one mole of gas contains $6.02 \times 10^{23}$ molecules, and that the mass of this amount is called the ‘molar mass’.

How many molecules of gas do you need in a $100\,\mathrm{cm}^3$ cylinder to exert a pressure of $1.0 \times 10^8\,\mathrm{Pa}$ at a temperature of $800\,^\circ\mathrm{C}$? Give your answer to 2 significant figures.

Gameboard:

**STEM SMART Physics 28 - Gases & Kinetic Theory**

# Essential Pre-Uni Physics G2.5

GCSE P P P A Level P P P

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

Don't forget that one mole of gas contains $6.02 \times 10^{23}$ molecules, and that the mass of this amount is called the 'molar mass'.

A tyre contains $800\,\mathrm{cm}^3$ of air at a pressure of about $5.0 \times 10^5\,\mathrm{Pa}$ at $9.0\,^\circ\mathrm{C}$. After a cycle ride, the volume is $810\,\mathrm{cm}^3$ and the temperature is now $25\,^\circ\mathrm{C}$. Assuming that none of the gas has leaked, what is the new pressure?

Gameboard:

**STEM SMART Physics 28 - Gases & Kinetic Theory**

# Essential Pre-Uni Physics G2.6

A Level

C C C

Physical constants which may be necessary to answer the problems on this page can be found within the hint tabs.

Don’t forget that one mole of gas contains $6.02 \times 10^{23}$ molecules, and that the mass of this amount is called the ‘molar mass’.

A tyre contains $800\,\mathrm{cm}^3$ of air at a pressure of about $5.0 \times 10^5\,\mathrm{Pa}$ at $9\,^\circ\mathrm{C}$. After a cycle ride, the volume is $760\,\mathrm{cm}^3$, the temperature is now $25\,^\circ\mathrm{C}$, and the pressure is $4.0 \times 10^5\,\mathrm{Pa}$. What percentage of the gas molecules have leaked out?

Gameboard:

**STEM SMART Physics 28 - Gases & Kinetic Theory**

# Gas Laws, Density and Kinetic Energy 32.2

A Level

| Element | Molar mass / $\mathrm{g\,mol^{-1}}$ |
|---|---|
| H | 1 |
| S | 32 |
| O | 16 |

What is the density of a sulfuric acid gas cloud on Venus if the temperature is $467\,^{\circ}\mathrm{C}$ and the pressure is $9308\,\mathrm{kPa}$? The chemical formula for sulfuric acid is $\mathrm{H_2SO_4}$.

Gameboard:
**STEM SMART Physics 28 - Gases & Kinetic Theory**

# Gas Laws, Density and Kinetic Energy 32.6

A Level

Calculate the mean kinetic energy of molecules in a gas at $15\,^{\circ}\mathrm{C}$.

Gameboard:

**STEM SMART Physics 28 - Gases & Kinetic Theory**

# Gas Laws, Density and Kinetic Energy 32.8

A Level

Within a gas mixture at equilibrium, the mean kinetic energy of each type of molecule is the same. This is because the temperature is uniform. In a mixture of helium (molecular mass $m = 4.00\,\text{u}$) and nitrogen ($m = 28.0\,\text{u}$),

## Part A Which molecules move faster

state which molecules move faster.

- Nitrogen
- Helium
- They both move at the same speed.

## Part B Ratio

calculate the ratio of their mean square speeds $\overline{c^2_{\text{helium}}} \,/\, \overline{c^2_{\text{nitrogen}}}$.

Gameboard:

**STEM SMART Physics 28 - Gases & Kinetic Theory**

# Earth Radiation Balance

A Level

C C C

The main source of energy on Earth is radiation from the sun. By using a simplified model, we can find the expected temperature of the Earth if it had no atmosphere. To do this, we assume that the Earth is in thermal equilibrium. This means that the amount of energy that the Earth receives from the sun is equal to the amount of energy radiated by the Earth.

## Part A Power radiated by the Sun

Treat the sun as a black body with emission temperature of $T_{\text{Sun}} = 5778\,\text{K}$. What is the total power radiated by the Sun?

Assume that the radius of the sun is $R_{\text{Sun}} = 6.96 \times 10^{8}\,\text{m}$.

## Part B Solar constant

The solar constant $S_0$ is defined as the total radiation energy received at the Earth per unit area per unit time, on a surface which is perpendicular to a line joining the centres of the Earth and the Sun. Neglect the effect of the atmosphere. Calculate the solar constant.

Mean distance from the Earth to the sun: $149.6 \times 10^{6}\,\text{km}$.

## Part C Temperature of the Earth: equation

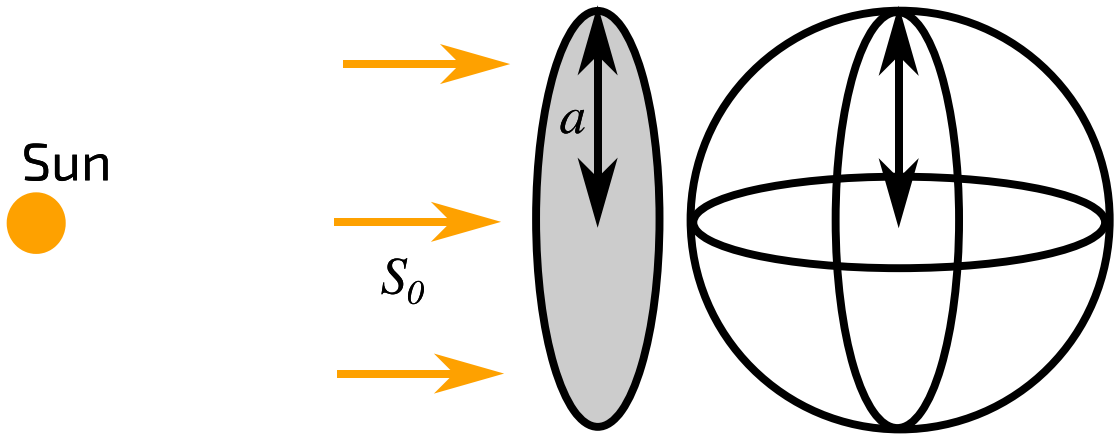


**Figure 1:** The Earth receiving radiation from the sun.

By treating the Earth as a black body with an average albedo of $\alpha$, calculate the equilibrium temperature of the Earth.

The following symbols may be useful: `S_0, T_Earth, alpha, sigma`

## Part D Temperature of the Earth: number

Using the equation from part C, calculate the equilibrium temperature of the Earth $T_{\text{Earth}}$.

Use the value of the solar constant which is measured by satellites: $S_0 = 1361\ \text{W m}^{-2}$ and take $\alpha = 0.31$.

## Part E Grey body model

What do you notice about the temperature calculated in part D?

Given the observed surface temperature of the Earth of $15\,^{\circ}\text{C}$, calculate the emmissivity of the Earth.

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