Atmospheric pressure

4.5.5.2 · Forces · revision notes

The atmosphere is a thin layer of air around the Earth, and air molecules colliding with surfaces create atmospheric pressure. You need to describe a simple model of the atmosphere and explain why atmospheric pressure decreases as height increases. This is in GCSE Physics only, not in Combined Science.

Key facts

- Atmosphere = thin layer of air around the Earth
- Atmospheric pressure is caused by air molecules colliding with surfaces
- Higher altitude → less air above → smaller weight of air → lower pressure
- Grade 7+ only A pressure difference gives a resultant force towards the lower-pressure side
- Air gets less dense with increasing altitude
- Atmospheric pressure at sea level ≈ 100 kPa (100 000 Pa)
- $F = p \times A$ (F in N, p in Pa, A in m^2)

Notes

A simple model of the atmosphere

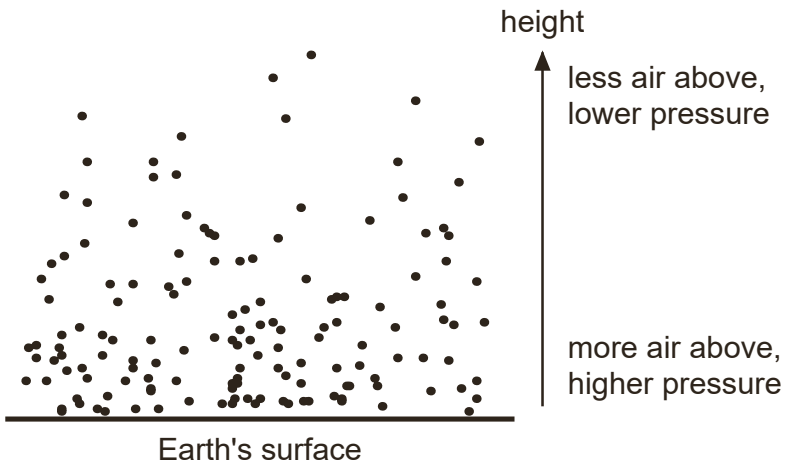
- The atmosphere is a thin layer of air around the Earth. It is thin compared with the size of the Earth: roughly 100 km deep, while the Earth's radius is about 6400 km.
- The atmosphere gets less dense with increasing altitude (height above sea level).
- Most of the air is close to the Earth's surface. The atmosphere has no sharp top edge: it gradually gets thinner.

What causes atmospheric pressure

- Air molecules move randomly and collide with surfaces. Each collision exerts a small force on the surface.
- Atmospheric pressure is the total force of these collisions on each square metre of the surface.
- It acts on every surface, at right angles to it, in all directions.
- At sea level, atmospheric pressure is about 100 000 Pa (100 kPa).

Why pressure decreases with height

- The number of air molecules, and so the weight of air, above a surface decreases as the height of the surface increases.
- So at any height there is less air above a surface than there is at a lower height.
- The air is also less dense, so fewer molecules collide with each square metre of a surface each second.
- So atmospheric pressure decreases as height increases.



The air gets less dense with height, and there is less air above, so the pressure falls.

Pressure differences Grade 7+ only

- You do not normally notice atmospheric pressure because the pressure inside your body balances it.
- If the pressure on one side of a surface is greater than on the other side, there is a resultant force towards the lower-pressure side.
- Example: a sealed, empty plastic bottle carried from the top of a mountain down to sea level gets squashed, because the outside pressure increases while the pressure of the air sealed inside was set at the lower mountain-top value.

How to answer each type of question

Describe a simple model of the atmosphere 2 marks **Grade 4**

1. Say it is a thin layer of air around the Earth (thin compared with the Earth's size).
2. Say how its density changes with altitude.

Example. Describe the Earth's atmosphere.

Model answer.

A thin layer of air around the Earth, thin compared with the size of the Earth (1).

It gets less dense as the altitude increases (1).

Explain why atmospheric pressure decreases with height

3 marks | Grade 5

1. Give the cause of atmospheric pressure: molecules colliding with a surface.
2. Say that higher up there is less air (a smaller weight of air) above.
3. Say that the air is less dense, so there are fewer collisions per second on each square metre.

Example. A climber measures the atmospheric pressure at the bottom and at the top of a mountain. The pressure at the top is lower.
Explain why.

Model answer.

Atmospheric pressure is caused by air molecules colliding with a surface (1).

At the top there is less air above the climber, so a smaller weight of air (1).

The air is less dense, so there are fewer collisions per second on each square metre (1).

Calculate the force due to atmospheric pressure

2 marks | Grade 7

1. Make sure the pressure is in Pa and the area in m^2.
2. Use $F = p \times A$.

Example. Atmospheric pressure is 101 000 Pa. A window has an area of 1.2 m^2.
Calculate the force of the air on one side of the window.

Model answer.

$F = 101\,000 \times 1.2$ (1)

$F = 121\,200$ N (1)

Explain an effect of a pressure difference

3 marks | Grade 8

1. Say what the pressure is on each side of the surface.
2. Say which side has the greater pressure, and so the greater force.
3. State the direction of the resultant force and its effect.

Example. An empty plastic bottle is sealed at the top of a high mountain. When it is carried down to sea level, the bottle is squashed.
Explain why.

Model answer.

The air inside the bottle is at the lower pressure of the mountain top (1).

At sea level the atmospheric pressure outside the bottle is greater (1)

so the force on the outside surface is greater than the force on the inside surface, giving a resultant inward force that squashes the bottle (1).

Don’t lose marks

- Saying pressure decreases with height 'because there is less gravity'. The key reason is that there is less air (a smaller weight of air) above.
- Describing the atmosphere as thick. It is a thin layer compared with the size of the Earth.
- Saying atmospheric pressure only acts downwards. It acts on surfaces in all directions.
- Saying the molecules 'push' without mentioning collisions with the surface.

More tips

Memory tricks

- Less air on top = less pressure. Think of a pile of mattresses: the bottom one is squashed the most.
- Sea level ≈ 100 kPa: about 100 000 N pushing on every square metre.
- Pressure differences always push from high to low.

Exam technique

- Use the key phrases 'air molecules collide with the surface' and 'less air (a smaller weight of air) above'.
- For 3-mark explanations, give the cause of the pressure, then what changes with height, then the effect on the pressure.
- Convert kPa to Pa before using F = p × A.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 4 — **Describe a simple model of the atmosphere**
The atmosphere is thin compared with the size of the Earth and gets less dense with increasing altitude.

Grade 4 — **State that atmospheric pressure decreases with height**
The higher you go, the lower the atmospheric pressure.

Grade 5 — **Explain what causes atmospheric pressure**
Air molecules collide with a surface, and each collision exerts a force on it.

Grade 5 — **Explain why pressure decreases with altitude**
The higher you go, the fewer air molecules there are above a surface, so the weight of air pressing on it is smaller.

Grade 7 — **Calculate forces due to atmospheric pressure**
Use F = p × A, e.g. 100 000 Pa on 0.50 m^2 gives 50 000 N.

Grade 8 — **Explain effects of pressure differences**
A resultant force acts from the higher-pressure side towards the lower-pressure side, e.g. a sealed bottle being squashed.

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