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Welcome to AQA GCSE Physics!

This book has been written for you by the people who will be marking your exams, very experienced teachers and subject experts. It covers everything you need to revise for your exams and is packed full of features to help you achieve the very best that you can.

Key words are highlighted in the text and are shown like this. You can look them up in the glossary at the back of the book if you’re not sure what they mean.

Where you see this icon, you will know that this topic involves How Science Works – a really important part of your GCSE.

These questions check that you understand what you’re learning as you go along. The answers are all at the back of the book.

Many diagrams are as important for you to learn as the text, so make sure you revise them carefully.

Anything in the Higher boxes must be learned by those sitting the Higher Tier exam. If you’re sitting the Foundation Tier, these boxes can be missed out.

The same is true for any other places that are marked [H].

At the end of each chapter you will find:

End of chapter questions

These questions will test you on what you have learned throughout the whole chapter, helping you to work out what you have understood and where you need to go back and revise.

And at the end of each unit you will find:

AQA Examination-style questions

These questions are examples of the types of questions you will answer in your actual GCSE, so you can get lots of practice during your course.

You can find answers to the End of chapter and AQA Examination-style questions at the back of the book.
1.1 Infrared radiation

- Infrared waves are part of the electromagnetic spectrum. They are the part of the spectrum just beyond visible red light. We can detect infrared radiation with our skin – it makes us feel warm.
- All objects emit infrared radiation.
- The hotter an object is the more infrared radiation it emits in a given time.

1. How does the temperature of an object affect the rate at which it emits infrared radiation?

- Infrared radiation can travel through a vacuum, as in travelling through space. This is how we get energy from the Sun.

2. What is a vacuum?

Examiner’s tip

Remember that the transfer of energy by infrared radiation does not involve particles.

Detecting infrared radiation

Key words: infrared radiation, emit

1.2 Surfaces and radiation

- Dark, matt surfaces are good absorbers of infrared radiation. An object painted dull black and left in the Sun will become hotter than the same object painted shiny white.

1 Why are houses in hot countries often painted white?

- Dark, matt surfaces are also good emitters of infrared radiation. So an object that is painted dull black will transfer energy and cool down more quickly than the same object painted shiny white.

2 Why are the pipes on the back of a fridge usually painted black?

- Light, shiny surfaces are good reflectors of infrared radiation.

Key words: absorber, emitter, reflector

Key points

- Infrared radiation is energy transfer by electromagnetic waves.
- All objects emit infrared radiation.
- The hotter an object is the more infrared radiation it emits in a given time.

- Dark, matt surfaces emit infrared radiation more quickly than light, shiny surfaces.
- Dark, matt surfaces absorb infrared radiation more quickly than light, shiny surfaces.
- Light, shiny surfaces reflect more infrared radiation than dark, matt surfaces.
1.3 States of matter

Key points

- Flow, shape, volume and density are the properties used to describe each state of matter.
- The particles in a solid are held next to each other, vibrating in their fixed positions.
- The particles in a liquid move about at random and are in contact with each other.
- The particles in a gas move about randomly and are much farther apart than particles in a solid or liquid.

The three states of matter are solid, liquid and gas. We can make a substance change between these states by heating or cooling it.

In a solid, the particles vibrate about fixed positions so the solid has a fixed shape.

In a liquid, the particles are in contact with each other but can move about at random, so a liquid doesn’t have a fixed shape and can flow.

1. How is the arrangement of the particles in a liquid different from that in a solid?

In a gas, the particles are usually far apart and move at random much faster, so a gas doesn’t have a fixed shape and can flow. The density of a gas is much less than that of a solid or liquid.

2. How is the arrangement of the particles in a gas different from that in a liquid?

The arrangement of particles in a solid, a liquid and a gas.

Key words: solid, liquid, gas

1.4 Conduction

Key points

- Conduction occurs mainly in solids. Most liquids and all gases are poor conductors.
- If one end of a solid is heated, the particles at that end gain kinetic energy and vibrate more. This energy is passed to neighbouring particles and in this way the energy is transferred through the solid.
- This process occurs in metals.
- In addition, when metals are heated their free electrons gain kinetic energy and move through the metal, transferring energy by colliding with other particles. Hence all metals are good conductors.

1. Why are saucepans often made of metal with wooden handles?

2. Why are materials that trap air good insulators?

Key words: conduction, conductor, free electron, insulator

Examiner’s tip

Know some examples of insulators and how they are used.
2.3 Moments in balance

Key points

- For an object in equilibrium, the sum of the anticlockwise moments about any point = the sum of the clockwise moments about that point.
- To calculate the force needed to stop an object turning we use the equation above.

\[ M \]

P3

Student Book pages 230–231

1. If someone sits in the centre of a seesaw, the moment about the pivot is zero. Why?

2. Aimie sits 2m from the centre of a seesaw. Leo weighs twice as much as Aimie. How far from the centre must he sit to balance the seesaw?

Examiner’s tip

In calculations, be careful with units. If all the distances are given in centimetres, the unit of moment will be the newton-centimetre.

Bump up your grade

Be sure to add together all the clockwise moments and all the anticlockwise moments. It may help to tick them off if they are on a diagram, so you do not miss any out.

Key word: principle of moments

2.4 Stability

Key points

- The line of action of the weight of an object acts through its centre of mass.
- If the line of action of the weight lies outside the base of an object, there will be a resultant moment and the object will tend to topple over.

1. Why does hanging heavy bags from the handle of a pushchair make it more likely to topple over?

Higher

- The wider the base of an object, and the lower its centre of mass, the further it has to tilt before the line of action of the weight moves outside the base. So the stability of an object is increased by making its base wider and its centre of mass lower.

2. Why do ten-pin bowling pins have a narrow base and a high centre of gravity?

Key word: resultant moment
Using physics to make things work

2.5 Hydraulics

Key points

- Pressure is given by the equation: \( P = \frac{F}{A} \)

Where:
- \( P \) is the pressure in pascals, \( \text{Pa} \) (or \( \text{N/m}^2 \))
- \( F \) is the force in newtons, \( \text{N} \)
- \( A \) is the cross-sectional area at right angles to the direction of the force in metres squared, \( \text{m}^2 \).

- Liquids are virtually incompressible and the pressure in a liquid is transmitted equally in all directions. This means that a force exerted at one point on a liquid will be transmitted to other points in the liquid. This is made use of in hydraulic systems.

- The force exerted by a hydraulic pressure system depends on:
  - the force exerted on the system
  - the area of the cylinder on which this force acts on
  - the area of the cylinder that exerts the force.

- The use of different cross-sectional areas on the effort and load sides of a hydraulic system means that the system can be used as a force multiplier. Therefore, a small effort can be used to move a large load.

AQA Examiner’s tip

Remember that a hydraulic pressure system is usually used as a force multiplier. So if you calculate that the force produced by such a system is less than the effort applied to the system you have made a mistake.

Examiner’s tip

What is the pressure exerted on the ground by a person of weight 300 N if the area of their feet in contact with the ground is 0.04 m²?

What properties of a liquid make it useful in a hydraulic system?

Maths skills

In a hydraulic pressure system, a force of 25 N is applied to a piston of area 0.50 m². The area of the other piston is 1.5 m². Calculate the pressure transmitted through the system and the force exerted on the other piston.

\[ P = \frac{F}{A} \]

\[ P = \frac{25 \text{ N}}{0.5 \text{ m}^2} \]

\[ P = 50 \text{ Pa} \]

Pressure transmitted is 50 Pa.

\[ F = P \times A \]

\[ F = 50 \text{ Pa} \times 1.5 \text{ m}^2 \]

\[ F = 75 \text{ N} \]

Force exerted on the other piston is 75 N.

Key words: pressure, hydraulic pressure

A hydraulic car jack
1 The diagram shows a seesaw. The centre of mass of the seesaw is at its centre.

a What is meant by ‘centre of mass of the seesaw’? (1 mark)

b A child of weight 460 N sits 2.0 m from the pivot. A second child sits on the other side of the pivot and the seesaw becomes balanced.

i Why must the second child sit on the other side of the pivot? (2 marks)

ii The weight of the second child is 575 N. How far away from the pivot must the second child sit for the seesaw to become balanced?

Show clearly how you work out your answer and give the unit. (4 marks)

c Explain what would happen if the children were to sit one at each end of the seesaw. (2 marks)

2 In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The diagram shows a moving coil loudspeaker. The loudspeaker contains a moveable coil attached to a diaphragm. The diaphragm fits loosely over a cylindrical permanent magnet. An amplifier produces a varying, alternating current in the coil.

Explain how the loudspeaker makes use of the motor effect to produce a sound wave. (6 marks)

3 The diagram shows a human eye.

Light enters the eye and is focused on the retina.

a Explain how the amount of light entering the eye is controlled. (2 marks)

b Explain how the light is brought to focus on the retina. (2 marks)
4 The diagram shows the basic structure of a step-down transformer.

- Explain how the transformer works. (5 marks)
- The transformer is used to change the 230 V mains supply to a 12 V supply to operate a model train.
  - There are 30 turns on the secondary coil. Calculate the number of turns on the primary coil.
    Write down the equation you use and show clearly how you work out your answer. (3 marks)
  - The current drawn from the mains electricity supply by the transformer is 0.048 A. Calculate the current through the model train.
    Assume that the transformer is 100% efficient.
    Write down the equation you use. Show clearly how you work out your answer and give the unit. (2 marks)

5 A doctor wants to look inside a patient’s stomach, without operating on him.
- The doctor uses an endoscope. The endoscope contains bundles of optical fibres.
  Explain how visible light and bundles of optical fibres are used in the endoscope to look inside the patient’s stomach. (3 marks)
- The tube below the stomach is called the small intestine. The doctor wants to take an X-ray picture of the small intestine. Before the picture is taken, the patient is given a drink containing barium, a substance that absorbs X-rays.
  - Explain why a normal X-ray will not allow the doctor to see the small intestine. (2 marks)
  - Explain why giving the patient barium allows the doctor to see the small intestine on an X-ray picture. (2 marks)
  - During this procedure the radiographer stands behind a lead screen. Explain why the radiographer needs to stand behind a lead screen but the patient does not. (4 marks)
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