Physics

Bridging the Gap

Leventhorpe
Welcome to Physics!

This pack has been designed to help you bridge the gap from GCSE to AS Level to make sure that you understand what you have let yourself in for and to make sure you are ready for your course in September.

You will start by looking at the topics covered in Year 12 in the Advancing Physics Course and then be given an idea of how the course will be structured, what resources are available and when you will be doing tests, exams and practical assessments.

Then you will review what you already know and be given some work to do to make sure you are all ready to start in September to give yourself the best chance of success.
How Hard is This Physics Course Going To Be?

Physics is one of the toughest A-levels you could have chosen!
The students who work the hardest do the best.

Over the course you will have around 5 hours of lessons a week that will cover all the theory and practical skills you need.
You will be given homework questions nearly every lesson and these will be expected to be completed by the next lesson in most cases.

At A-level, you are expected to be spending 5 hours every week out of class completing homework, reviewing your work and reading around the subject. Many other students around the country who you are competing against will be doing more.

If you are doing 4 AS-levels that means you have as a minimum 20 hours work out of lessons every week. There are NO free periods.

In addition to the lessons you receive, there is plenty of support available:

**Teachers:** Your teacher is the first point of call as they are the experts – we have 3 specialist Physics teachers who will always offer their time when they are available to help you in and out of lessons.

**Notes and questions:** We have produced a full set of notes that accompany each Topic. These notes are targeted to the specification and have questions which tie in with the learning objectives. You will be expected to print these off, organise these in a folder and add any extra notes that you write in or out of lessons. You will be expected to bring these along to lessons where we will check your progress regularly.
**Textbook:** You will be given a textbook. These have notes, questions, revision tips and quizzes.

Advancing Physics for OCR B

Series Editor Lawrence Herklots

Authors Lawrence Herklots, John Miller, Helen Reynolds

Oxford University Press (2015)

All past papers except for the most recent year are available with answers from OCR:

http://www.ocr.org.uk/qualifications/as-a-level-gce-physics-b-advancing-physics-h159-h559/
The First Year Course

The first year course includes the following Modules and Chapters:

1. Imaging, signalling and sensing
   Imaging; Signalling; Sensing

2. Mechanical properties of materials
   Testing materials; Looking inside materials

3. Waves and quantum behaviour
   Wave behaviour; Quantum behaviour

4. Space, time and motion
   Motion; Momentum, force and energy

5. Creating models
   Imaging; Modelling oscillations;
   The gravitational field; Our place in the Universe

6. Matter
   Simple models of matter; The Boltzmann factor.

Assessments and Intervention

At the end of each Topic you will be given a test which will be used to assess your progress. If you are not reaching your target grade you will placed in an Intervention programme which will require you to give up more time at home and a lunchtime to do catch up work.

There are also 12 required practicals (PAGS) which are done throughout the year in class and test your practical skills.

   1. Investigating motion
   2. Investigating properties of materials
   3. Investigating electrical properties
4. Investigating electrical circuits
5. Investigating waves
6. Investigating quantum effects
7. Investigating ionising radiations
8. Investigating gases
9. Investigating capacitors
10. Investigating simple harmonic motion
11. Investigation
12. Research skills

These are written up in a lab book and marked by your class teacher.

The full specification can be viewed and downloaded from OCR:

Be Prepared to Fail

Many students have difficulty in the first months of an A-level because they will not do well, possibly for the first time in their school lives. This is normal and a part of embracing the challenges of an A-level.

The grade boundaries at A-level are very different to those at GCSE. You will need 50% just to get an E and then it goes up a grade approximately every 5%.

Students who get an A at GCSE can expect to get B or C at A-level.
Students who get a B at GCSE can expect to get D or E at A-level.

Book list

The following books need to purchased and used to practise your skills and keep the GCSE content fresh in your mind.
Exercises from them will be used throughout your course.

1. Essential Maths Skills for A-level Physics

![Image of Essential Maths Skills for A-Level Physics](image1)

Published by CGP (2015)
Editors Emily Garrett, Rachel Marshall, Sam Pilgrim, Charlotte Whiteley, Sarah Williams

2. Head Start to A-level Physics

![Image of Head Start to A-Level Physics](image2)

Published by CGP (2015)
Author Richard Tattersall
Do I Need To Be Good At Maths?

The simple answer to this is yes – it helps.

BUT the course has been developed so that all of the physics in AS level can be explained with a good understanding of GCSE mathematics.

At A2 some more difficult maths is necessary to help explain concepts and analyse data but these skills will be developed as you study.

If you have chosen to do maths as one of your AS level courses then you will have an advantage, especially if you are taking mechanics modules as there is a big overlap, but it is not essential.

A summary of the mathematical requirements appears below:

1. **Arithmetic and numerical computation**
   (a) recognise and use expressions in decimal and standard form
   (b) use ratios, fractions and percentages
   (c) use calculators to find and use power, exponential and logarithmic functions
   (d) use calculators to handle sin x, cos x, tan x when x is expressed in degrees or radians

2. **Handling data**
   (a) use appropriate number of significant figures
   (b) find arithmetic means
   (c) make order of magnitude calculations

3. **Algebra**
   (a) understand and use the symbols = < > ~
   (b) change the subject of an equation
(c) substitute numerical values into algebraic equations using appropriate units for physical quantities
(d) solve simple algebraic equations

4. **Graphs**

(a) translate information between graphical, numerical and algebraic forms
(b) plot two variables from experimental or other data
(c) understand that $y = mx + c$ represents a linear relationship
(d) determine the slope and intercept of a linear graph
(e) draw and use the slope of a tangent to a curve as a measure of rate of change
(f) understand the possible physical significance of the area between a curve and the x axis and be able to calculate it or measure it by counting squares as appropriate
(g) use logarithmic plots to test exponential and power law variations
(h) sketch simple functions including $y = k/x; y = kx^2; y = \sin x; y = \cos x; y = e^{-x}$

5. **Geometry and trigonometry**

(a) calculate areas of triangles, circumferences and areas of circles, surface areas and volumes of rectangular blocks, cylinders and spheres
(b) use Pythagoras’ theorem, and the angle sum of a triangle
(c) use $\sin$, $\cos$ and $\tan$ in physical problems
(d) understand the relationship between degrees and radians and translate from one to the other
(e) use relationship for triangles:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$
Bridging the Gap

Everything at A-level builds on your GCSE knowledge, skills and understanding and so you will first need to review everything you have done in Core and Additional GCSE.

Some of you have an advantage in that you have also done separate sciences – you will also have to review this work.

For those of you who didn’t do separate sciences, you will have to look over this content for the first time.

On the following pages you will find checklists that include everything you need to know before we start the AS course. It will be your homework over the summer to ensure that you have revised it all thoroughly. Tick off the statements as you revise them.

At the back of the booklet we have some multiple choice questions, a quiz and some longer questions to work through. You must bring this booklet to your first physics lesson in September and hand it in to your teacher. They will mark it and give it back to you.
Core Physics

Heat Transfer

Are you able...

☐ To evaluate ways in which heat is transferred in and out of bodies and ways in which the rates of these transfers can be reduced.

Do you understand...

☐ Thermal (infra red) radiation is the transfer of energy by electromagnetic waves.

☐ All bodies emit and absorb thermal radiation.

☐ The hotter a body is the more energy it radiates.

☐ Dark, matt surfaces are good absorbers and good emitters of radiation.

☐ Light, shiny surfaces are poor absorbers and poor emitters of radiation.

☐ The transfer of energy by conduction and convection involves particles and how this transfer takes place.

☐ Under similar conditions different materials transfer heat at different rates.

☐ The shape and dimensions of a body affect the rate at which it transfers heat.

☐ The bigger the temperature difference between a body and its surroundings, the faster the rate at which heat is transferred.

Energy efficiency

Are you able...

☐ To describe the intended energy transfers/transformations and the main energy wastages that occur with a range of devices

☐ To calculate the efficiency of a device using:
  
  efficiency = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}

☐ To evaluate the effectiveness and cost effectiveness of methods used to reduce energy consumption.

Do you understand...

☐ Energy cannot be created or destroyed. It can only be transformed from one form to another form.

☐ When energy is transferred and/or transformed only part of it may be usefully transferred/transformed.

☐ Energy which is not transferred/transformed in a useful way is wasted.
Both wasted energy and the energy which is usefully transferred/transformed are eventually transferred to their surroundings which become warmer.

Energy becomes increasingly spread out and becomes increasingly more difficult to use for further energy transformations.

The greater the percentage of the energy that is usefully transformed in a device, the more efficient the device is.

**Electrical energy**

Are you able...

- To compare and contrast the particular advantages and disadvantages of using different electrical devices for a particular application.

- To calculate the amount of energy transferred from the mains using:
  \[ \text{energy transferred} = \text{power} \times \text{time} \]
  (kilowatt-hour, kWh) (kilowatt, kW) (hour, h)

- To calculate the cost of energy transferred from the mains using:
  \[ \text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour} \]

Do you understand...

- Examples of energy transformations that everyday electrical devices are designed to bring about.

- Examples of everyday electrical devices designed to bring about particular energy transformations.

- The amount of electrical energy a device transforms depends on how long the appliance is switched on and the rate at which the device transforms energy.

- The power of an appliance is measured in watts (W) or kilowatts (kW).

- Energy is normally measured in joules (J).

- Electricity is transferred from power station to consumers along the National Grid.

- The uses of step-up and step-down transformers in the National Grid.

- Increasing voltage (potential difference) reduces current, and hence reduces energy losses in the cables.

**Generating electricity**

Are you able...

- To compare and contrast the particular advantages and disadvantages of using different energy sources to generate electricity.

Do you understand...
In most power stations an energy source is used to heat water. The steam produced drives a turbine which is coupled to an electrical generator.

Common energy sources include coal, oil and gas, which are burned to produce heat and uranium/plutonium, in which nuclear fission produces heat.

Energy from renewable energy sources can be used to drive turbines directly.

Renewable energy sources used in this way include wind, the rise and fall of water due to waves and tides, and the falling of water in hydroelectric schemes.

Electricity can be produced directly from the Sun's radiation using solar cells.

In some volcanic areas hot water and steam rise to the surface. The steam can be tapped and used to drive turbines. This is known as geothermal energy.

Using different energy resources has different effects on the environment. These effects include the release of substances into the atmosphere, noise and visual pollution, and the destruction of wildlife habitats.

The advantages and disadvantages of using fossil fuels, nuclear fuels and renewable energy sources to generate electricity. These include the cost of building power stations, the start-up time of power stations, the reliability of the energy source, the relative cost of energy generated and the location in which the energy is needed.

**Electromagnetic spectrum**

Are you able...

- To evaluate the possible hazards associated with the use of different types of electromagnetic radiation

- To evaluate methods to reduce exposure to different types of electromagnetic radiation.

Do you understand...

- Electromagnetic radiation travels as waves and moves energy from one place to another.

- All types of electromagnetic waves travel at the same speed through a vacuum (space).

- The electromagnetic spectrum is continuous but the wavelengths within it can be grouped into types of increasing wavelength and decreasing frequency: gamma rays, X-rays, ultraviolet rays, visible light, infra red rays, microwaves and radio waves.

- Different wavelengths of electromagnetic radiation are reflected, absorbed or transmitted differently by different substances and types of surface.

- When radiation is absorbed the energy it carries makes the substance which absorbs it hotter and may create an alternating current with the same frequency as the radiation itself.

- Different wavelengths of electromagnetic radiation have different effects on living cells. Some radiations mostly pass through soft tissue without being absorbed, some produce heat, some may cause cancerous changes and some may kill cells. These effects depend on the type of radiation and the size of the dose.
The uses and the hazards associated with the use of each type of radiation in the electromagnetic spectrum.

Radio waves, microwaves, infra red and visible light can be used for communication.

Microwaves can pass through the Earth's atmosphere and are used to send information to and from satellites and within mobile phone networks.

Infra red and visible light can be used to send signals along optical fibres and so travel in curved paths.

Communication signals may be analogue (continuously varying) or digital (discrete values only, generally on and off). Digital signals are less prone to interference than analogue and can be easily processed by computers.

Electromagnetic waves obey the wave formula:

\[
\text{wave speed} = \text{frequency} \times \text{wavelength}
\]

(metre/second, m/s) (hertz, Hz) (metre, m)

Radioactivity

Are you able...

- To evaluate the possible hazards associated with the use of different types of nuclear radiation
- To evaluate measures that can be taken to reduce exposure to nuclear radiations
- To evaluate the appropriateness of radioactive sources for particular uses, including as tracers, in terms of the type(s) of radiation emitted and their half-lives.

Do you understand...

- The basic structure of an atom is a small central nucleus composed of protons and neutrons surrounded by electrons.
- The atoms of an element always have the same number of protons, but have a different number of neutrons for each isotope.
- Some substances give out radiation from the nuclei of their atoms all the time, whatever is done to them. These substances are said to be radioactive.
- Identification of an alpha particle as a helium nucleus, a beta particle as an electron from the nucleus and gamma radiation as electromagnetic radiation.
- Properties of the alpha, beta and gamma radiations limited to their relative ionising power, their penetration through materials and their range in air.
- Alpha and beta radiations are deflected by both electric and magnetic fields but gamma radiation is not.
- The uses of and the dangers associated with each type of nuclear radiation.
The half-life of a radioactive isotope is defined as the time it takes for the number of nuclei of the isotope in a sample to halve or the time it takes for the count rate from a sample containing the isotope to fall to half its initial level.

**Origins of the universe**

Are you able...

- To compare and contrast the particular advantages and disadvantages of using different types of telescope on Earth and in space to make observations on and deductions about the universe.

Do you understand...

- If a wave source is moving relative to an observer there will be a change in the observed wavelength and frequency.
- There is a red-shift in light observed from most distant galaxies.
- The further away galaxies are the bigger the red-shift.
- How the observed red-shift provides evidence that the universe is expanding and supports the big bang theory (that the universe began from a very small initial point).
- Observations of the solar system and the galaxies in the universe can be carried out on the Earth or from space.
- Observations are made with telescopes that may detect visible light or other electromagnetic radiations such as radio waves or X-rays
Additional Physics

Describing Movement

Are you able:

- To construct distance-time graphs for a body moving in a straight line when the body is stationary or moving with a constant speed
- To construct velocity-time graphs for a body moving with a constant velocity or a constant acceleration
- To calculate the speed of a body from the slope of a distance-time graph
- To calculate the acceleration of a body from the slope of a velocity-time graph
- To calculate the distance travelled by a body from a velocity-time graph

Do you understand that:

- The slope of a distance-time graph represents speed
- The velocity of a body is its speed in a given direction
- The acceleration of a body is given by:
  \[ \text{acceleration} = \frac{\text{change in velocity (metre/second, m/s)}}{\text{metre/second}^2 \text{ m/s}^2} \frac{\text{time taken for change (second, s)}}{\text{time taken for change (second, s)}} \]
- The slope of a velocity-time graph represents acceleration.
- The area under a velocity-time graph represents distance travelled.

Force and acceleration

Are you able:

- to draw and interpret velocity-time graphs for bodies that reach terminal velocity, including a consideration of the forces acting on the body
- to calculate the weight of a body using:
  \[ \text{weight} = \text{mass} \times \text{gravitational field strength} \]
  \( (\text{newton, N}) = (\text{kilogram, kg}) \times (\text{newton/kilogram, N/kg}) \)

Do you understand that:

- Whenever two bodies interact, the forces they exert on each other are equal and opposite
- A number of forces acting on a body may be replaced by a single force which has the same effect on the body as the original forces all acting together. The force is called the resultant force
- If the resultant force acting on a stationary body is zero the body will remain stationary
If the resultant force acting on a stationary body is not zero the body will accelerate in the direction of the resultant force.

If the resultant force acting on a moving body is zero the body will continue to move at the same speed and in the same direction.

If the resultant force acting on a moving body is not zero the body will accelerate in the direction of the resultant force.

Force, mass and acceleration are related by the equation:
\[ \text{resultant force} = \text{mass} \times \text{acceleration} \]
(newton, N) (kilogram, kg) (metre/second\(^2\), \(m/s^2\))

When a vehicle travels at a steady speed the frictional forces balance the driving force.

The greater the speed of a vehicle the greater the braking force needed to stop it in a certain distance.

The stopping distance of a vehicle depends on the distance the vehicle travels during the driver's reaction time and the distance it travels under the braking force.

A driver's reaction time can be affected by tiredness, drugs and alcohol.

A vehicle's braking distance can be affected by adverse road and weather conditions and poor condition of the vehicle.

The faster a body moves through a fluid the greater the frictional force which acts on it.

A body falling through a fluid will initially accelerate due to the force of gravity. Eventually the resultant force on the body will be zero and it will fall at its terminal velocity.

**Work and energy**

Are you able:

- to discuss the transformation of kinetic energy to other forms of energy in particular situations.

Do you understand that:

- When a force causes a body to move through a distance, energy is transferred and work is done.

- Work done = energy transferred.

- The amount of work done, force and distance are related by the equation:
  \[ \text{work done} = \text{force applied} \times \text{distance moved in direction of force} \]
  (joule, J) (newton, N) (metre, m)

- Work done against frictional forces is mainly transformed into heat.

- For an object that is able to recover its original shape, elastic potential is the energy stored in the object when work is done on the object to change its shape.
The kinetic energy of a body depends on its mass and its speed.

Calculate the kinetic energy of a body using the equation:

\[ \text{kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{speed}^2 \]

(joule, J) (kilogram, kg) (metre/second)², (m/s)²

Momentum

Are you able:

- to use the conservation of momentum (in one dimension) to calculate the mass, velocity or momentum of a body involved in a collision or explosion
- to use the ideas of momentum to explain safety features.

Do you understand that:

- Momentum, mass and velocity are related by the equation:
  \[ \text{momentum} = \text{mass} \times \text{velocity} \]
  (kilogram metre/second, kg m/s) (kilogram, kg) (metre/second, m/s)
- Momentum has both magnitude and direction
- When a force acts on a body that is moving, or able to move, a change in momentum occurs
- Momentum is conserved in any collision/explosion provided no external forces act on the colliding/exploding bodies

Force, change in momentum and time taken for the change are related by the equation:

\[ \text{force} = \frac{\text{change in momentum (kilogram metre/second, kg(m/s))}}{\text{time taken for the change (second, s)}} \]

Static electricity

Are you able:

- to explain why static electricity is dangerous in some situations and how precautions can be taken to ensure that the electrostatic charge is discharged safely
- to explain how static electricity can be useful.

Do you understand that:

- When certain insulating materials are rubbed against each other they become electrically charged. Negatively charged electrons are rubbed off one material onto the other
- The material that gains electrons becomes negatively charged. The material that loses electrons is left with an equal positive charge
- When two electrically charged bodies are brought together they exert a force on each other
- Two bodies that carry the same type of charge repel. Two bodies that carry different types of charge attract
Electrical charges can move easily through some substances, eg metals

The rate of flow of electrical charge is called the current

A charged body can be discharged by connecting it to earth with a conductor. Charge then flows through the conductor

The greater the charge on an isolated body the greater the potential difference between the body and earth. If the potential difference becomes high enough a spark may jump across the gap between the body and any earthed conductor which is brought near it

Electrostatic charges can be useful, for example in photocopiers and smoke precipitators and the basic operation of these devices

Current electricity

Are you able:

- to interpret and draw circuit diagrams using standard symbols. The following standard symbols should be known:

  - switch (open)
  - switch (closed)
  - cell
  - battery
  - diode
  - resistor
  - variable resistor
  - lamp
  - fuse
  - voltmeter
  - ammeter
  - thermistor
  - LDR

- to apply the principles of basic electrical circuits to practical situations.

Do you understand that:

- Current-potential difference graphs are used to show how the current through a component varies with the potential difference across it.

  A resistor at constant temperature
  A filament lamp
  A diode

  ![Graphs showing current-potential difference](image)

- The current through a resistor (at a constant temperature) is directly proportional to the potential difference across the resistor
Potential difference, current and resistance are related by the equation:

\[ \text{potential difference} = \text{current} \times \text{resistance} \]

\( (\text{volt, V}) \quad (\text{ampere, A}) \quad (\text{ohm, } \Omega) \)

The resistance of a component can be found by measuring the current through, and potential difference across, the component.

The resistance of a filament lamp increases as the temperature of the filament increases.

The current through a diode flows in one direction only. The diode has a very high resistance in the reverse direction.

The resistance of a light-dependent resistor (LDR) decreases as light intensity increases.

The resistance of a thermistor decreases as the temperature increases (ie knowledge of negative temperature coefficient thermistor only is required).

The current through a component depends on its resistance. The greater the resistance the smaller the current for a given potential difference across the component.

The potential difference provided by cells connected in series is the sum of the potential difference of each cell (depending on the direction in which they are connected).

For components connected in series:
- the total resistance is the sum of the resistance of each component
- there is the same current through each component
- the total potential difference of the supply is shared between the components.

For components connected in parallel:
- the potential difference across each component is the same
- the total current through the whole circuit is the sum of the currents through the separate components.

Mains electricity

Are you able:

- to recognise errors in the wiring of a three-pin plug
- to recognise dangerous practice in the use of mains electricity
- to compare potential differences of d.c. supplies and the peak potential differences of a.c. supplies from diagrams of oscilloscope traces
- to determine the period and hence the frequency of a supply from diagrams of oscilloscope traces.

Do you understand that:

- Cells and batteries supply current which always passes in the same direction. This is called direct current (d.c.)
An alternating current (a.c.) is one which is constantly changing direction. Mains electricity is an a.c. supply. In the UK it has a frequency of 50 cycles per second (50 hertz)

UK mains supply is about 230 volts

Most electrical appliances are connected to the mains using cable and a three-pin plug

The structure of electrical cable

The structure of a three-pin plug

Correct wiring of a three-pin plug

If an electrical fault causes too great a current the circuit should be switched off by a fuse or a circuit breaker

When the current in a fuse wire exceeds the rating of the fuse it will melt, breaking the circuit

Appliances with metal cases are usually earthed

The earth wire and fuse together protect the appliance and the user.

The live terminal of the mains supply alternates between positive and negative potential with respect to the neutral terminal

The neutral terminal stays at a potential close to zero with respect to earth

**Electrical energy and power**

Are you able:

- to calculate the current through an appliance from its power and the potential difference of the supply and from this determine the size of fuse needed.

Do you understand that:

- Electric current is the rate of flow of charge

- When an electrical charge flows through a resistor, electrical energy is transformed into heat energy

- The rate at which energy is transformed in a device is called the power

  \[
  \text{power} = \frac{\text{energy transformed (joule, J)}}{\text{time (second, s)}}
  \]

- Power, potential difference and current are related by the equation:

  \[
  \text{power} = \text{current (ampere, A)} \times \text{potential difference (volt, V)}
  \]

- Energy transformed, potential difference and charge are related by the equation:

  \[
  \text{energy transformed (joule, J)} = \text{potential difference (volt, V)} \times \text{charge (coulomb, C)}
  \]
The amount of electrical charge that flows is related to current and time by the equation:
\[ \text{charge} = \text{current} \times \text{time} \]
(coulomb, C) (ampere, A) (second, s)

Nuclear decay

Are you able:

- to explain how the Rutherford and Marsden scattering experiment led to the plum pudding model of the atom being replaced by the nuclear model.

Do you understand that:

- The relative masses and relative electric charges of protons, neutrons and electrons.
- In an atom the number of electrons is equal to the number of protons in the nucleus. The atom has no net electrical charge.
- Atoms may lose or gain electrons to form charged particles called ions.
- All atoms of a particular element have the same number of protons.
- Atoms of different elements have different numbers of protons.
- Atoms of the same element which have different numbers of neutrons are called isotopes.
- The total number of protons in an atom is called its atomic number.
- The total number of protons and neutrons in an atom is called its mass number.
- The effect of alpha and beta decay on radioactive nuclei.
- The origins of background radiation.

Nuclear fission and nuclear fusion

Are you able:

- to sketch a labelled diagram to illustrate how a chain reaction may occur.

Do you understand that:

- There are two fissionable substances in common use in nuclear reactors, uranium 235 and plutonium 239.
- Nuclear fission is the splitting of an atomic nucleus.
- For fission to occur the uranium 235 or plutonium 239 nucleus must first absorb a neutron
The nucleus undergoing fission splits into two smaller nuclei and 2 or 3 neutrons and energy is released.

The neutrons may go on to start a chain reaction.

Nuclear fusion is the joining of two atomic nuclei to form a larger one.

Nuclear fusion is the process by which energy is released in stars.
Choose the BEST answer to the following:

1. When you drop a ball it accelerates downward at 9.8 m/s\(^2\). If you instead throw it downward, then its acceleration immediately after leaving your hand, assuming no air resistance, is
   A. 9.8 m/s\(^2\).
   B. more than 9.8 m/s\(^2\).
   C. less than 9.8 m/s\(^2\).
   D. Cannot say, unless the speed of throw is given.

2. A heavy rock and a light rock in free fall (zero air resistance) have the same acceleration. The reason the heavy rock doesn’t have a greater acceleration is that the
   A. force due to gravity is the same on each.
   B. air resistance is always zero in free fall.
   C. inertia of both rocks is the same.
   D. ratio of force to mass is the same.
   E. None of these.

3. A karate chop delivers a force of 3000 N to a board that breaks. The force that the board exerts on the hand during this event is
   A. less than 3000 N.
   B. 3000 N.
   C. greater than 3000 N.
   D. Need more information.

4. When an increase in speed doubles the momentum of a moving body, its kinetic energy
   A. increases, but less than doubles.
   B. doubles.
   C. more than doubles.
   D. depends on factors not stated.
5. Big brother and little sister can balance on a seesaw because of balanced A. forces.  
B. moments.  
C. energies.  
D. All of these.  

6. The fact that the Moon always shows its same face to Earth is evidence that the Moon rotates about its axis about once per A. day.  
B. month.  
C. year.  
D. None of these, for the moon does not rotate about an axis.  

7. The mass of a classical atom comes mostly from its _____; and its volume from its ______.  
A. nucleons; nucleons.  
B. electrons; electrons.  
C. electrons; nucleons.  
D. nucleons; electrons.  

8. Consider a block of wood floating on water. If you push down on the top of the block until it’s completely submerged, the buoyant force on it A. increases.  
B. decreases.  
C. remains the same.  
D. depends on how far beneath the water surface it is pushed.  

9. The principal source of the Earth’s internal energy is  
A. tidal friction.  
B. gravitational pressure.  
C. radioactivity.  
D. geothermal heat.  

10. In a mixture of hydrogen, oxygen, and nitrogen gases at a given temperature, the molecules having the greatest average speed are those of A. hydrogen.  
B. oxygen.  
C. nitrogen.  
D. But all have the same speed on average.
11. Compared with the current in the white-hot filament of a common lamp, the current in the connecting wire is
A. less.
B. more.
C. the same.
D. Need more information.

12. As more lamps are connected in a series circuit, the current in the power source
A. increases.
B. decreases.
C. remains much the same.
D. Need more information.

13. A step-up transformer in an electrical circuit can step up
A. voltage.
B. energy.
C. Both of these.
D. Neither of these.

14. All of the following are electromagnetic waves EXCEPT
A. radio waves.
B. microwaves.
C. light waves.
D. X-rays.
E. None is outside the family; all are electromagnetic waves.

15. Compared with the sound you hear from the siren of a stationary fire engine, the sound you hear when it approaches you has an increased
A. speed.
B. frequency.
C. Both of these.
D. Neither of these.

16. Your friend states that under all conditions, any radio wave travels faster than any sound wave. You
A. agree with your friend.
B. disagree with your friend.
17. To view your full-face image in a steamy mirror, compared to the height of your face, the minimum height of the patch to wipe away is
A. one-quarter.
B. one-half.
C. the same.
D. dependent on your distance from the mirror.

18. Light reflecting from a smooth surface undergoes a change in
A. frequency.
B. speed.
C. wavelength.
D. All of these.
E. None of these.

19. Which of these changes when light refracts in passing from one medium to another?
A. Speed.
B. Wavelength.
C. Both of these.
D. Neither of these.

20. When white light passes through a prism, green light is bent more than
A. blue light.
B. violet light.
C. red light.
D. Two of these choices are correct.
E. None of these choices is correct.

21. When you look at the red petals of a rose, the colour light you're seeing is
A. red.
B. green.
C. white minus red.
D. a mixture of green and yellow.
E. cyan.
22. If the Sun collapsed to become a black hole, Planet Earth would
A. continue in its present orbit.
B. fly off in a tangent path.
C. likely be sucked into the black hole.
D. be pulled apart by tidal forces.
E. Both C and D.

23. Any atom that emits an alpha particle or beta particle
A. becomes an atom of a different element, always.
B. may become an atom of a different element.
C. becomes a different isotope of the same element.
D. increases its mass.

24. Suppose the number of neutrons in a reactor that is starting up doubles each minute, reaching one billion neutrons in 10 minutes. When did the number of neutrons reach half a billion?
A. 1 minute.
B. 2 minutes.
C. 5 minutes.
D. 9 minutes.
E. None of these.

25. The equation $E = mc^2$ indicates that energy
A. equals mass moving at the speed of light squared.
B. equals moving mass.
C. is fundamentally different than mass.
D. and mass are closely related.
Bridging the Gap - Quiz

Energy and energy resources
1. Thermal energy can be transferred in different ways.

Match the words in the list with the numbers 1 to 4 in the sentences.

A. electrons
B. liquids
C. particles
D. solids

Conduction occurs mainly in ...... 1 ...... All metals are good conductors because they have a lot of free ...... 2 ...... Convection occurs in gases and ...... 3 ...... Radiation does not involve ...... 4 ...... (4 marks)

Motion
2. The graph shows how far a marathon runner travels during a race.

(a) What was the distance of the race? ................................................................. (1)

(b) How long did it take the runner to complete the race? .............................................. (1)

(c) What distance did the runner travel during the first 2 hours of the race? .................. (1)

(d) For how long did the runner rest during the race? ................................................. (1)

(e) Ignoring the time for which the runner was resting, between which two points was the runner moving the slowest?

Give a reason for your answer. ......................................................................................... (2)
Speeding up Slowing down

3  a) When two objects interact, they exert .................. and .................. forces on each other.
   b) The unit of force is the .................. (symbol .....).
   c) A moving object acted on by a resultant force:
      i) in the same direction as the direction of its motion ..................,
      ii) in the opposite direction to its direction of motion ..................
   d) Resultant force = .................................. × ..................................
      (in ........) (in kg) (in ........) (11)

Work energy and momentum

4  The picture shows a catapult.

(a) When a force is applied to the stone, work is done in stretching the elastic and the stone moves backwards.
   (i) Write down the equation you could use to calculate the work done.
      ............................................................................................................. (1)
   (ii) The average force applied to the stone is 20 N. This moves it backwards 0.15 m.
        Calculate the work done and give its unit.
      .............................................................................................................
      .............................................................................................................
      ............................................................................................................. (3)

(b) The work done is stored as energy.
   (i) What type of energy is stored in the stretched elastic?
      ............................................................................................................. (1)
   (ii) What type of energy does the stone have when it is released?
      ............................................................................................................. (1)
Turning forces
5 There are many satellites orbiting the Earth in circular paths.
   (a) (i) What force provides the centripetal force that allows satellites to maintain their circular orbits?
   .................................................................................................................................................. (1)
   (ii) A satellite moving at a steady speed in a circular orbit is continuously accelerating. Explain why.
       .................................................................................................................................................. (2)
(b) Some satellites are in geostationary orbits.
   (i) What is meant by a geostationary orbit?
       .................................................................................................................................................. (1)
   (ii) What is the time period of a geostationary orbit?
       .................................................................................................................................................. (1)
   (iii) What type of satellite is usually put into a geostationary orbit?
        .................................................................................................................................................. (1)

Light and sound
6 (a) (i) Complete the diagram below to show what happens to the two rays of light after they enter the lens.
.................................................................................................................................................. (2)
   (ii) Put an F on the diagram to label the principal focus of the lens.
       .................................................................................................................................................. (1)
   (iii) What word can be used to describe this type of lens?
        .................................................................................................................................................. (1)
(b) (i) Complete the diagram below to show what happens to the two rays of light after they enter the lens.

(ii) Put an F on the diagram to label the principal focus of the lens.

(iii) What word can be used to describe this type of lens?

Electromagnetism

7 The diagram shows a transformer.

(a) Explain how an alternating current in the primary coil produces an alternating current through the lamp.

(b) The potential difference across the primary coil is 1.5 V. There are 6 turns on the primary coil and 24 turns on the secondary coil.

Calculate the potential difference across the lamp.
Stars and space

8 The sentences below describe the life cycle of a star such as the Sun.

A  The star contracts to form a white dwarf.
B  The star is in a stable state.
C  The star expands to form a red giant.
D  Gravitational forces pull dust and gas together and the star is formed.

(a) Put the sentences in the correct order.

(b) At which stage in its life is the Sun, A, B, C or D?

(c) What balances the gravitational forces to make a star stable?
Section A consists of a selection of A Level questions and the answers are provided. You will need to study the answers carefully and do further research to try and understand the solutions to the problems. Use the knowledge and understanding you gain to answer the questions in section B.

Your work will need to be handed in during your first week in September.

Section A

1. A battery of e.m.f 12 V and negligible internal resistance is connected to a resistor network as shown in the circuit diagram.

(a) Calculate the total resistance of the circuit.

(three parallel resistors) give \( \frac{1}{40} + \frac{1}{20} + \frac{1}{40} = \frac{1}{R} \)  \hspace{1cm} (1)

\( R = 10 \ \Omega \)  \hspace{1cm} (1)

10 \( \Omega \) and 50 \( \Omega \) in series gives 60 \( \Omega \)  \hspace{1cm} (3)

(b) Calculate the current through the 50 \( \Omega \) resistor.

\( V = IR \) gives \( 12 = I \times 60 \) and \( I = 0.2 \) A \hspace{1cm} (1)

(Total 4 marks)
2. In the circuit shown, the battery has negligible internal resistance.

(a) (i) If the emf of the battery = 9.0 V, \( R_1 = 120 \, \Omega \) and \( R_2 = 60 \, \Omega \), calculate the current \( I \) flowing in the circuit.

(use of \( V = IR \) gives) \( V = I(R_1 + R_2) \) (1)

\[
I = \frac{V}{R_1 + R_2} = \frac{9}{120 + 60} \\
= 0.05 \, \text{A} \, \checkmark
\] (1)

(ii) Calculate the voltage reading on the voltmeter.

\( V_{\text{out}} = IR_2 = 0.05 \times 60 = 3 \, \text{V} \) (1)
3. In an experiment to investigate the structure of the atom, α particles were aimed at thin gold foil in a vacuum. A detector was used to determine the number of α particles deflected through different angles.

(a) State two observations about the α particles detected coming from the foil.

- most alpha particles undeflected
- some through small angles
- (very) small (but significant) number deflected through greater than 90°

(b) State two features of the structure of the atom which can be deduced from these observations.

- atom mostly empty space (1)
- positive charge concentrated (1)
- in a volume much less than total volume [or radius] (1)

(Total 4 marks)

4. A neutral atom of carbon is represented by $^{14}_6$C.

(i) Name the constituents of this atom and state how many of each are present.

- protons and neutrons
- 6p, 8n / 6u and 8d quarks (1), 20u and 22d (1)
- 6 electrons

(ii) Carbon has several isotopes. Explain the term isotope.

- atoms with identical numbers of protons but different numbers of neutrons (1)
Section B

1. A battery of emf 24 V and negligible internal resistance is connected to a resistor network as shown in the circuit diagram in the diagram below.

(a) Show that the resistance of the single equivalent resistor that could replace the four resistors between the points A and B is 50 Ω.

(b) If $R_1$ is 50 Ω, calculate
   (i) the current in $R_1$.
   (ii) the current in the 60 Ω resistor.

(Total 8 marks)
Four resistors, each having resistance of 50 Ω, are connected to form a square. A resistance meter measured the resistance between different corners of the square. Determine the resistance the meter records when connected between the following corners.

(a) Between A and C, as in Figure 1.

![Figure 1](image)

(b) Between A and B, as in Figure 2.

![Figure 2](image)

(Total 5 marks)
3. In an experiment to investigate the structure of the atom, α particles are directed normally at a thin metal foil which causes them to be scattered.

(a) (i) In which direction will the number of α particles per second be a maximum?

(ii) State what this result suggests about the structure of the atoms in the metal.

(b) A small number of α particles are scattered through 180°. Explain what this suggests about the structure of the atoms in the metal.

(c) The figure shows the path of an α particle passing near a nucleus.

\[ \text{path of } \alpha \text{ particle} \rightarrow \bullet \text{ nucleus} \]
(i) Name the force that is responsible for the deflection of the $\alpha$ particle.

(ii) Draw an arrow on the diagram in the direction of the force on the $\alpha$ particle in the position where the force is a maximum.

(iii) The nucleus is replaced with one which has a larger mass number and a smaller proton number.

   Draw on the diagram the path of an $\alpha$ particle that starts with the same velocity and position as that of the $\alpha$ particle drawn.

(Total 8 marks)
4. (a) Name the constituent of an atom which

   (i) has zero charge,

   (ii) when removed leaves a different isotope of the element.

(b) An $\alpha$ particle is the same as a nucleus of helium, $^{4}_2 \text{He}$.

The equation

$$\begin{align*}
\text{Th}^{229}_{90} & \rightarrow \frac{X}{Y} \text{Ra} + \alpha \\
\end{align*}$$

represents the decay of thorium by the emission of an $\alpha$ particle.

Determine

(i) the values of $X$ and $Y$, shown in the equation,

$$X = \ldots \ldots \ldots \ldots \ldots \ldots \ldots$$

$$Y = \ldots \ldots \ldots \ldots \ldots \ldots \ldots$$

(ii) the ratio $\frac{\text{mass of } \frac{X}{Y} \text{Ra nucleus}}{\text{mass of } \alpha \text{ particle}}$

$$\ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots$$

$$\begin{align*}
\end{align*}$$

(3)
5. (a) State which interaction, strong or weak, is experienced by each of the following particles.

hadrons: 

leptons: 

(b) Give one example of a hadron and one example of a lepton.

hadron: 

lepton: 

(c) Hadrons are classified as either baryons or mesons. How many quarks are there in a baryon and in a meson?

baryon: 

meson: 

(d) (i) State the quark composition of a neutron.

(ii) Describe, in terms of quarks, the process of $\beta^-$ decay when a neutron changes into a proton.

(iii) Sketch a Feynman diagram to represent $\beta^-$ decay.