UNIT 1 - NEWTONIAN MECHANICS

ADV. PHYSICS 2

Content

- Motion in a circle
- Angular displacement, angular velocity
- Acceleration in uniform circular motion
- Gravitational fields
- Gravitational potential
- Circular orbit, geostationary orbit

Resources & ICT

- Textbook
- Study guide
- Keynote
- Online resources available from BM website
- Internet research

Types of assessment

- Exercises from study guides and online textbooks
- Structured questions from past papers
- Questions from A-Level paper 5
- Judgements on effort and attitude towards learning

Students to Know

- The definition of a radian
- The equations for linear velocity, centripetal acceleration and centripetal force
- Newton's law of gravitation

Students to Understand

- The centripetal acceleration in the case of uniform motion in a circle
- Gravitational field is an example of a field of force; gravitational field strength is defined as force per unit mass
- Geostationary orbits and their application

Students to be able to Do

- Describe qualitatively motion in a curved path due to a perpendicular force
- Express angular displacement in radians
- Use the concept of angular velocity to solve problems
- Define potential at a point as the work done in bringing unit mass from infinity to the point
- Analyse circular orbits in inverse square law fields by relating the gravitational force to the centripetal acceleration it causes

Cross curricular links

- Astronomy; planetary motion, gravitational attraction of stars
- Chemistry; discussion of the gravitational force between electrons and nucleus
- Art; images of Earth from above as seen from geostationary satellites

Differentiation incl. EAL

- Extension tasks for students who previously studied material or have a good grasp of it
- Group work considerations; mixed ability

Learning styles activities

- Lectures
- Individual and group exercises
- Quizzes
- Test
- Presentation production
- Poster production

NASA / Public domain

Global citizenship, internationalism, local environment

- Discussion about space conquest
- The International Space Station: international scientists working together towards a common aim
- Acquiring a better understanding of our local environment thanks to satellite imaging

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September - 3 weeks

UNIT 2 - THERMODYNAMICS

ADV. PHYSICS 2

Content

- Ideal gases
- Gas laws
- Mathematical description of the behaviour of gases
- Temperature and molecular energy
- Thermal equilibrium
- Specific heat capacity
- Latent heat
- First law of thermodynamics

Resources & ICT

- Textbook
- Study guide
- Keynote
- Online resources available from BM website
- Internet research

Types of assessment

- Exercises from study guides and online textbooks
- Structured questions from past papers
- Questions from A-Level paper 5
- Judgements on effort and attitude towards learning

Students to Know

- Thermal energy is transferred from a region of higher temperature to a region of lower temperature
- The concept of absolute zero
- The basic assumptions of the kinetic theory of gases
- The processes of melting, boiling and evaporation
- The equations using latent heat and specific heat capacity

Students to Understand

- Regions of equal temperature are in thermal equilibrium
- There is an absolute scale of temperature which does not depend on the property of any particular substance
- The concept of internal energy

Students to be able to Do

- Solve problems using the equation of state for an ideal gas
- Use the kinetic theory of gas to deduce relationships between pressure and mean square velocity
- Recall the first law of thermodynamics expressed in terms of the change in internal energy, the heating of the system and the work done on the system

Cross curricular links

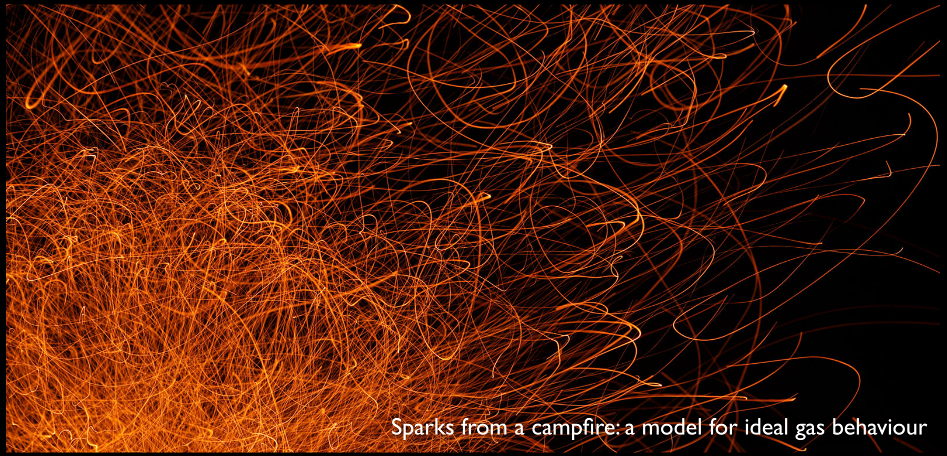
- Mathematics; derivation of gas' equations
- Chemistry; improvement of the understanding of gases reactivity; the kinetic theory of matter
- Biology; the importance of the high specific heat capacity of water in biological systems

Differentiation incl. EAL

- Extension tasks for students who previously studied material or have a good grasp of it
- Group work considerations; mixed ability

Learning styles activities

- Lectures
- Individual and group exercises
- Quizzes
- Test
- Presentation production
- Poster production



Sparks from a campfire: a model for ideal gas behaviour

Global citizenship, internationalism, local environment

- Using thermodynamics laws to explain the principle of heat pumps and refrigerants
- Discussion of the advantages and drawbacks of heat pumps as sources of heat in private housing

October - 3 weeks

UNIT 3 - OSCILLATIONS

ADV. PHYSICS 2

Content

- Periodic motion
- Simple Harmonic Motion
- Circular motion & SHM
- Phase difference
- Displacement-time graphs and derivations
- Energy changes in SHM
- Damping
- Forced oscillations
- Resonance

Resources & ICT

- Textbook
- Study guide
- Keynote
- Online resources available from BM website
- Internet research

Types of assessment

- Exercises from study guides and online textbooks
- Structured questions from past papers
- Questions from A-Level paper 5
- Judgements on effort and attitude towards learning

Students to Know

- The definitions of the following terms: amplitude, period, frequency, angular frequency and phase difference
- Simple Harmonic Motion is defined by the equation $a = -\omega^2 x$
- Practical examples of damped oscillations with reference to the degree of damping; practical examples of forced oscillations and resonance

Students to Understand

- $x = x_0 \sin \omega t$ is a solution to the equation $a = -\omega^2 x$
- Simple examples of free oscillations
- The derivations of velocity and acceleration expressions from the displacement-time graph
- The interchange between kinetic and potential energy during simple harmonic motion

Students to be able to Do

- Investigate the motion of an oscillator using graphical methods
- Express the period in terms of both frequency and angular frequency
- Describe, with graphical examples, the changes in displacement, velocity and acceleration during SHM

Cross curricular links

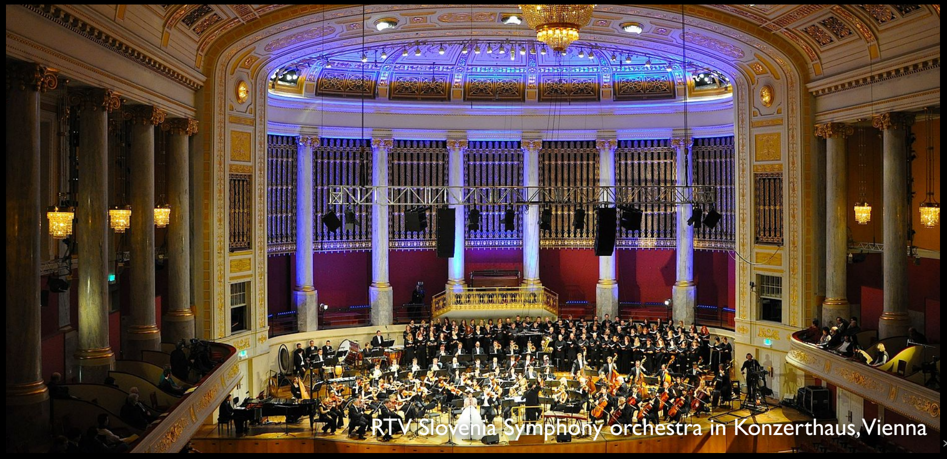
- Chemistry; model for vibration of atoms in solid state
- Economics; the costs of resonance
- Mathematics; derivation of sine and cosine curves

Differentiation incl. EAL

- Extension tasks for students who previously studied material or have a good grasp of it
- Group work considerations; mixed ability

Learning styles activities

- Lectures
- Individual and group exercises
- Quizzes
- Test
- Presentation production
- Poster production



RTV Slovenia Symphony orchestra in Konzerthaus, Vienna

Global citizenship, internationalism, local environment

- Images from the presentation are referring to local examples (suspension springs on mountain bikes) and to international examples (vibrations on a dirt road in the Australian outback)
- Resonance as a useful phenomenon: orchestra

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November - 3 weeks

UNIT 4 - ELECTRICITY & MAGNETISM

ADV. PHYSICS 2

Content

- Electric fields & electric forces
- Electric potential
- The electron volt
- The Millikan experiment
- Comparison between electric and gravitational fields
- Capacitance
- Capacitors in series and in parallel circuits
- Energy stored by a capacitor
- Magnetic fields
- Flux pattern
- The motor effect
- Magnetic flux density
- Charged particles in motion
- Circular motion in a magnetic field
- Electromagnetic induction
- Magnetic flux
- Flux changes & flux linkage
- Faraday's and Lenz's laws
- Alternating current
- RMS current & RMS voltage
- Transformers
- Rectification

Resources & ICT

- Textbook
- Study guide
- Keynote
- Online resources available from BM website
- Internet research

Types of assessment

- Exercises from study guides and online textbooks
- Structured questions from past papers
- Questions from A-Level paper 5
- Judgements on effort and attitude towards learning

Students to Know

- The field due to a solenoid may be influenced by a ferrous core
- A force might act on a current-carrying conductor placed in a magnetic field
- The definition of magnetic flux density and the tesla, magnetic flux and the weber, magnetic flux linkage
- How beams of charged particles are deflected by uniform fields
- Simple applications of electromagnetic induction, transformers...
- The use of diodes in rectification

Students to Understand

- A magnetic field is a field of force produced either by current-carrying conductors or by permanent magnets
- The main principles of the determination of *e* by Millikan's experiment
- The experimental evidence for quantisation of charge
- How electric and magnetic fields can be used in velocity selection

Students to be able to Do

- Represent a magnetic field by means of field lines
- Sketch flux patterns due to a long straight wire, a flat circular solenoid and a long solenoid
- Recall and solve problems using $F = F = BI\ell \sin\theta$ and $F = Bqv \sin\theta$
- Recall and solve problems using Faraday's law of electromagnetic induction and Lenz's law

Cross curricular links

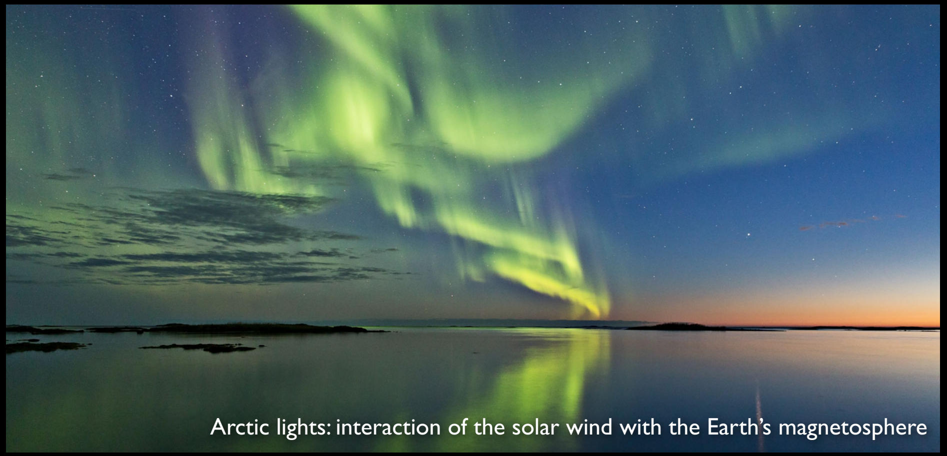
- Chemistry; charges on protons and electrons; working principle of a mass spectrometer
- History; conducting scientific experiments in the 19th century and beginning of 20th century: Ørsted, Faraday, Lenz, Millikan *et al.*

Differentiation incl. EAL

- Extension tasks for students who previously studied material or have a good grasp of it
- Group work considerations; mixed ability

Learning styles activities

- Lectures
- Individual and group exercises
- Quizzes
- Test
- Presentation production
- Poster production


Arctic lights: interaction of the solar wind with the Earth's magnetosphere

Global citizenship, internationalism, local environment

- TOK: international collaboration around scientific topics; development of the theories and laws of electromagnetism

November-December - 4 weeks

UNIT 5 - MODERN PHYSICS

ADV. PHYSICS 2

Content

- Charged particles
- Quantum physics
- Photoelectric effect
- Work function
- Light diffraction
- Wave-particle duality
- Energy levels in atoms
- Emission & absorption spectra
- Nuclear physics
- Mass defect & binding energy
- Mass-energy equivalence
- Radioactive decay
- Half-life & decay constant

Resources & ICT

- Textbook
- Study guide
- Keynote
- Online resources available from BM website
- Internet research

Types of assessment

- Exercises from study guides and online textbooks
- Structured questions from past papers
- Questions from A-Level paper 5
- Judgements on effort and attitude towards learning

Students to Know

- The particulate nature of electromagnetic radiation
- The significance of the threshold frequency
- The existence of discrete electron energy levels in isolated atoms
- The difference between emission and absorption line spectra
- The order of magnitude of the EM radiations from radio waves to γ-ray
- The random and spontaneous nature of nuclear decay

Students to Understand

- The photoelectric effect provides evidence for the particulate nature of light; interference and diffraction provide evidence for the wave nature of light
- Why the maximum kinetic energy of photoelectrons is independent of intensity while the current is proportional to the intensity
- The simple model for the nuclear atom

Students to be able to Do

- Explain photoelectric phenomena in terms of photon energy and work function energy
- Recall and use the equation for the de Broglie wavelength $\lambda = h/p$
- Solve problems using the equations for exponential decay
- Recall and use $E = hf$

Cross curricular links

- Chemistry; radioactive elements
- Mathematics; exponential decay and associated terms and equations
- Biology; use of radionuclide as biological tracers; absorption spectrum; photosystems

Differentiation incl. EAL

- Extension tasks for students who previously studied material or have a good grasp of it
- Group work considerations; mixed ability

Learning styles activities

- Lectures
- Individual and group exercises
- Quizzes
- Test
- Presentation production
- Poster production


1927 Solvay Conference on Quantum Mechanics

Benjamin Couprie / Public domain

Global citizenship, internationalism, local environment

- The Nobel prize as an example of international recognition for scientific breakthrough: Marie Skłodowska-Curie, Albert Einstein,...
- The reaction of the scientific community to Albert Einstein's *Annus Mirabilis* papers in 1905: important discoveries concerning the photoelectric effect, Brownian motion and the special theory of relativity

January - 3 weeks

UNIT 6 - GATHERING & COMMUNICATING INFORMATION

ADV. PHYSICS 2

Content

- Direct sensing
- Electric sensors
- Sensing devices
- Processing
- Properties of the op-amp
- Op-amp in circuits
- Relays & LED
- Digital meters
- Remote sensing
- X-rays production
- X-rays imaging
- Computed Tomography Scanning
- Piezoelectric transducers
- Uses of ultrasound
- Principle & use of MRI
- Communicating information
- Modulation
- Signal analysis
- AM vs. FM
- Data conversion & transmission
- Satellite communication
- Signal attenuation
- Fixed and mobile phone network
- Block diagram of a mobile phone

Resources & ICT

- Textbook
- Study guide
- Keynote
- Online resources available from BM website
- Internet research
- CIE-published booklet

Types of assessment

- Exercises from study guides and online textbooks
- Structured questions from past papers
- Questions from A-Level paper 5
- Judgements on effort and attitude towards learning

Students to Know

- An electronic sensor consists of a sensing device and a circuit that provides an output voltage
- The characteristics of light-dependant resistors, negative temperature coefficient thermistors, piezoelectric transducers and strain gauges; the characteristics of output devices such as relays and LEDs
- The meaning of amplitude modulation (AM) and frequency modulation (FM)

Students to Understand

- The main properties of an ideal operational amplifier
- The effect of negative feedback on the gain of an op-amp
- The virtual earth approximation
- The uses of X-rays, Computed Tomography (CT scanning), ultrasound and Magnetic Resonance Imaging in medicine

Students to be able to Do

- Recall the circuit diagrams for both the inverting and non-inverting amplifier
- Use the equations for the voltage gain of inverting and non-inverting circuits
- Recall the advantages of the transmission of data in digital form
- Calculate attenuation expressed in dB and in dB per unit length
- Describe the use of satellites in communication

Cross curricular links

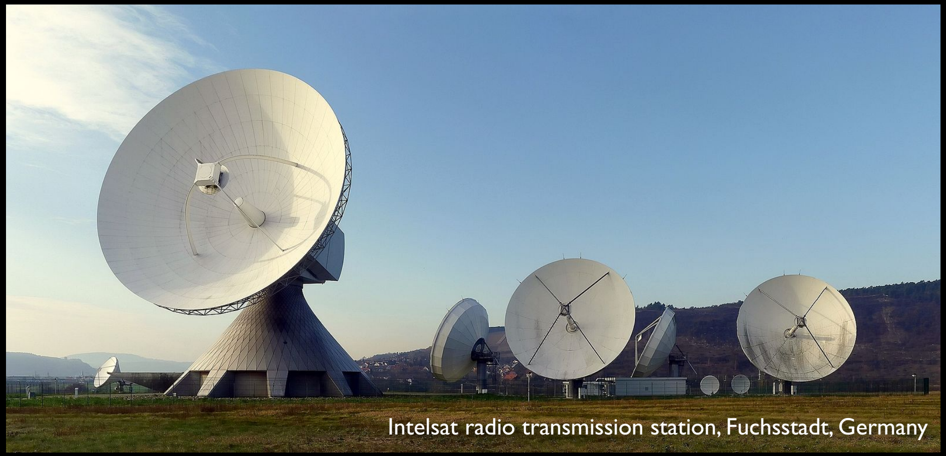
- Biology; medical science analytical techniques: ultrasound, X-rays and Computed Tomography, Magnetic Resonance Imaging; negative feed-back in biological systems; biological transducers
- Mathematics; calculation of attenuation; concept of decibel and logarithmic scale

Differentiation incl. EAL

- Extension tasks for students who previously studied material or have a good grasp of it
- Group work considerations; mixed ability

Learning styles activities

- Lectures
- Individual and group exercises
- Quizzes
- Test
- Presentation production
- Poster production



Intelsat radio transmission station, Fuchsstadt, Germany

Author

Global citizenship, internationalism, local environment

- Comparison of mobile phone network density in different countries
- Everyday uses of op-amp-containing devices
- Evolution of medical care due to improvement of the non-invasive sensing techniques

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February-March - 6 weeks