I I S "Curie-Sraffa" Milano PROGRAMMAZIONE DI "FISICA"
BIENNIO LICEO SCIENTIFICO
OPZIONE CAMBRIDGE

FINALITA'

Lo studio della fisica secondo la modalità prevista dal percorso Cambridge IGCSE consente agli studenti di:

- comprendere meglio il mondo tecnologico, con un interesse informato in materia scientifica
- riconoscere l'utilità (e le limitazioni) del metodo scientifico e come applicarlo ad altre discipline
- e nella vita di tutti i giorni
- sviluppare atteggiamenti pertinenti, come l'interesse per l'accuratezza e la precisione, l'obiettività, l'integrità, l'indagine, iniziativa e inventiva
- sviluppare l'interesse e la cura per l'ambiente
- comprendere meglio l'influenza e le limitazioni poste sullo studio scientifico dalla società, dall'economia,
- tecnologia, etica, comunità e ambiente
- sviluppare una comprensione delle competenze scientifiche essenziali sia per ulteriori studi che per la vita quotidiana.

OBIETTIVI

AO1: conoscenza e comprensione

Gli studenti dovrebbero essere in grado di dimostrare conoscenza e comprensione di:

1. fenomeni scientifici, fatti, leggi, definizioni, concetti e teorie
2. vocabolario scientifico, terminologia e convenzioni (compresi simboli, quantità e unità)
3. strumenti e apparecchi scientifici, comprese le tecniche di funzionamento e gli aspetti di sicurezza
4. applicazioni scientifiche e tecnologiche con le loro implicazioni sociali, economiche e ambientali.

AO2: gestione delle informazioni e risoluzione dei problemi

Gli studenti dovrebbero essere in grado, a parole o usando altre forme di presentazione scritte (cioè simboliche, grafiche e numeriche), di:

1. individuare, selezionare, organizzare e presentare informazioni da una varietà di fonti
2. tradurre le informazioni da un modulo all'altro
3. manipolare dati numerici e di altro tipo
4. utilizzare le informazioni per identificare modelli, segnalare tendenze e trarre inferenze
5. presentare spiegazioni motivate per fenomeni, modelli e relazioni
6. fare previsioni e ipotesi
7. risolvere i problemi, inclusi alcuni di natura quantitativa.

AO3: abilità sperimentali e di indagine

Gli studenti dovrebbero essere in grado di:

1. dimostrare la conoscenza di come utilizzare in sicurezza tecniche, apparati e materiali (anche in seguito a sequenze di istruzioni)
2. pianificare esperimenti e indagini
3. fare e registrare osservazioni, misurazioni e stime
4. interpretare e valutare osservazioni e dati sperimentali
5. valutare i metodi e suggerire possibili miglioramenti.

METODOLOGIA

IN CLASSE

- Lezioni frontali e partecipate.
- Esercitazioni individuali scritte.

- Attività di gruppo.

IN LABORATORIO

- Esercitazioni cattedratiche guidate dall'insegnante - Esercitazioni di gruppo.
- Uso di risorse informatiche (foglio di calcolo, simulazioni) e audiovisive (DVD didattici).
- Elaborazione di tabelle e costruzione di grafici.

TESTO IN ADOZIONE: D. Sang, M. Follows, S. Tarpey, "PHYSICS for Cambridge IGCSE" Coursebook, ed. Cambridge University Press

VERIFICA E VALUTAZIONE

Per quanto riguarda il numero e la tipologia di verifiche da svolgere si veda il verbale n.1 dell'anno in corso. Si prevedono in particolare:

1. Verifiche strutturate con test a risposta chiusa
2. Quesiti con risposte brevi
3. Semplici elaborazioni calcolative
4. Relazioni scritte delle esercitazioni di laboratorio
5. Verifiche di recupero in classe, in laboratorio o con rientri pomeridiani, nel caso in cui i risultati parziali del lavoro risultino insoddisfacenti.

Criteri di valutazione

	CONOSCENZE	COMPETENZE	CAPACITÀ'
1 - 2 3 - 4	Incompleta rispetto ai livelli minimi definiti dal programma, per mancanza di impegno nello studio personale e per gravi difficoltà di comprensione anche negli aspetti più semplici	Labili reminiscenze basate sul lavoro in classe. Espressione inglese inadeguata	Lettura del libro di testo Partecipazione passiva all'attività di laboratorio
5	Incompleta rispetto ai livelli minimi definiti dal programma, per difficoltà di comprensione degli aspetti più complessi	Memorizzazione incompleta o temporanea delle definizioni e delle formule fondamentali. Espressione inglese insufficiente, utilizzo impreciso della terminologia specifica in lingua inglese.	Comprensione del libro di testo Esposizione orale limitata agli enunciati e alle formule Partecipazione passiva al gruppo di lavoro in laboratorio, esposizione schematica scritta delle esperienze Soluzione guidata di problemi applicativi
6 *	Corrispondenti ai livelli minimi definiti dal programma	Memorizzazione stabile delle definizioni e delle formule fondamentali. Espressione inglese sufficiente, utilizzo base della terminologia specifica in lingua inglese.	Comprensione del libro di testo Esposizione orale dei temi più significativi Soluzione guidata di problemi applicativi Integrazione nel gruppo di

			lavoro in laboratorio ed esposizione sintetica scritta delle esperienze
7-8	Corrispondenti ai livelli minimi definiti dal programma, arricchite da conoscenze di interesse culturale o tecnologico	Memorizzazione stabile delle definizioni e delle formule fondamentali e della loro deduzione. Espressione inglese discreta, utilizzo adeguato della terminologia specifica in lingua inglese.	Padronanza consapevole dei temi più significativi associata a capacità di esposizione Soluzione autonoma di problemi applicativi Organizzazione del gruppo di lavoro in laboratorio ed esposizione esauriente scritta delle esperienze
9 – 10	Completa e personalmente e criticamente approfondita conoscenza	Memorizzazione stabile delle definizioni e delle formule fondamentali, della loro deduzione e dei loro legami logici. Ottima espressione inglese, utilizzo completo e preciso della terminologia specifica in lingua inglese.	Lo studente definisce e discute l'argomento proposto con competenza, proprietà e ricchezza di mezzi espressivi; sviluppa sintesi concettuali organiche e personali; produce elaborati completi, ordinati, rigorosi e approfonditi

* corrisponde agli obiettivi minimi

PROGRAMMAZIONE ANNUALE
CLASSE 2 LICEO DELLE SCIENZE APPLICATE – OPZIONE CAMBRIDGE

2. Properties of waves, including light and sound

2.1 General wave properties

- Demonstrate understanding that waves transfer energy without transferring matter
- Describe what is meant by wave motion as illustrated by vibration in ropes and springs and by experiments using water waves
- Use the term wavefront
- Give the meaning of speed, frequency, wavelength and amplitude
- Distinguish between transverse and longitudinal waves and give suitable examples
- Describe how waves can undergo:
- reflection at a plane surface
- refraction due to a change of speed
- diffraction through a narrow gap
- Describe the use of water waves to demonstrate reflection, refraction and diffraction
- Recall and use the equation $v = f\lambda$
- Describe how wavelength and gap size affects diffraction through a gap
- Describe how wavelength affects diffraction at an edge

2.2 Light

2.2.1 Reflection of light

- Describe the formation of an optical image by a plane mirror, and give its characteristics
- Recall and use the law angle of incidence = angle of reflection
- Recall that the image in a plane mirror is virtual
- Perform simple constructions, measurements and calculations for reflection by plane mirrors

2.2.2 Refraction of light

- Describe an experimental demonstration of the refraction of light
- Use the terminology for the angle of incidence and angle of refraction and describe the passage of light through parallel-sided transparent material
- Recall and use the definition of refractive index *n* in terms of speed
- Recall and use the equation $\frac{sen\,\hat{\imath}}{sen\,\hat{r}} = n$
- Give the meaning of critical angle
- Describe internal and total internal reflection
- Recall and use $sen\,\hat{\imath} = \frac{1}{n}$
- Describe and explain the action of optical fibres particularly in medicine and communications technology

2.2.3 Thin converging lens

- Describe the action of a thin converging lens on a beam of light
- Use the terms principal focus and focal length
- Draw ray diagrams for the formation of a real image by a single lens
- Describe the nature of an image using the terms enlarged/same size/diminished and upright/inverted
- Draw and use ray diagrams for the formation of a virtual image by a single lens
- Use and describe the use of a single lens as a magnifying glass
- Show understanding of the terms real image and virtual image

2.2.4 Dispersion of light

- Give a qualitative account of the dispersion of light as shown by the action on light of a glass prism including the seven colours of the spectrum in their correct order
- Recall that light of a single frequency is described as monochromatic

2.3 Electromagnetic spectrum

- Describe the main features of the electromagnetic spectrum in order of wavelength
- State that all e.m. waves travel with the same high speed in a vacuum
- Describe typical properties and uses of radiations in all the different regions of the electromagnetic spectrum including:
    - radio and television communications (radiowaves)
    - satellite television and telephones (microwaves)
    - electrical appliances, remote controllers for televisions and intruder alarms (infra-red)
    - medicine and security (X-rays)
- Demonstrate an awareness of safety issues regarding the use of microwaves and X-rays
- State that the speed of electromagnetic waves in a vacuum is 3.0×10^8 m / s and is approximately the same in air

2.4 Sound

- Describe the production of sound by vibrating sources
- Describe the longitudinal nature of sound waves
- State that the approximate range of audible frequencies for a healthy human ear is 20 Hz to 20 000 Hz
- Show an understanding of the term ultrasound
- Show an understanding that a medium is needed to transmit sound waves
- Describe an experiment to determine the speed of sound in air
- Relate the loudness and pitch of sound waves to amplitude and frequency
- Describe how the reflection of sound may produce an echo
- Describe compression and rarefaction
- State typical values of the speed of sound in gases, liquids and solids

3. Electricity and magnetism

3.1 Simple phenomena of magnetism

- Describe the forces between magnets, and between magnets and magnetic materials
- Give an account of induced magnetism
- Distinguish between magnetic and non-magnetic materials
- Describe methods of magnetisation, to include stroking with a magnet, use of d.c. in a coil and hammering in a magnetic field
- Draw the pattern of magnetic field lines around a bar magnet
- Describe an experiment to identify the pattern of magnetic field lines, including the direction
- Distinguish between the magnetic properties of soft iron and steel
- Distinguish between the design and use of permanent magnets and electromagnets
- Explain that magnetic forces are due to interactions between magnetic fields
- Describe methods of demagnetisation, to include hammering, heating and use of a.c. in a coil

3.2 Electrical quantities

3.2.1 Electric charge

- State that there are positive and negative charges
- State that unlike charges attract and that like charges repel
- Describe simple experiments to show the production and detection of electrostatic charges
- State that charging a body involves the addition or removal of electrons
- State that charge is measured in coulombs
- State that the direction of an electric field at a point is the direction of the force on a positive charge at that point
- Describe an electric field as a region in which an electric charge experiences a force

- Describe simple field patterns, including the field around a point charge, the field around a charged conducting sphere and the field between two parallel plates (not including end effects)
- Give an account of charging by induction
- Distinguish between electrical conductors and insulators and give typical examples
- Recall and use a simple electron model to distinguish between conductors and insulators

3.2.2 Current

- State that current is related to the flow of charge
- Use and describe the use of an ammeter, both analogue and digital
- State that current in metals is due to a flow of electrons
- Show understanding that a current is a rate of flow of charge and recall and use the equation $I = Q / t$
- Distinguish between the direction of flow of electrons and conventional current

3.2.3 Electromotive force

- State that the e.m.f. of an electrical source of energy is measured in volts
- Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit

3.2.4 Potential difference

- State that the potential difference (p.d.) across a circuit component is measured in volts
- Use and describe the use of a voltmeter, both analogue and digital
- Recall that 1 V is equivalent to 1 J / C

3.2.5 Resistance

- State that resistance = p.d. / current and understand qualitatively how changes in p.d. or resistance affect current
- Recall and use the equation $R = V / I$
- Describe an experiment to determine resistance using a voltmeter and an ammeter
- Relate (without calculation) the resistance of a wire to its length and to its diameter
- Sketch and explain the current-voltage characteristic of an ohmic resistor and a filament lamp
- Recall and use quantitatively the proportionality between resistance and length, and the inverse proportionality between resistance and cross-sectional area of a wire

3.2.6 Electrical working

- Understand that electric circuits transfer energy from the battery or power source to the circuit components then into the surroundings
- Recall and use the equations $P = IV$ and $E = IVt$

3.3 Electric circuits

3.3.1 Circuit diagrams

- Draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), heaters, thermistors, light-dependent resistors, lamps, ammeters, voltmeters, galvanometers, magnetising coils, transformers, bells, fuses and relays
- Draw and interpret circuit diagrams containing diodes

3.3.2 Series and parallel circuits

- Understand that the current at every point in a series circuit is the same
- Give the combined resistance of two or more resistors in series
- State that, for a parallel circuit, the current from the source is larger than the current in each branch
- State that the combined resistance of two resistors in parallel is less than that of either resistor by itself
- State the advantages of connecting lamps in parallel in a lighting circuit

- Calculate the combined e.m.f. of several sources in series
- Recall and use the fact that the sum of the p.d.s across the components in a series circuit is equal to the total p.d. across the supply
- Recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit
- Calculate the effective resistance of two resistors in parallel

3.3.3 Action and use of circuit components

- Describe the action of a variable potential divider (potentiometer)
- Describe the action of thermistors and light dependent resistors and show understanding of their use as input transducers
- Describe the action of a relay and show understanding of its use in switching circuits
- Describe the action of a diode and show understanding of its use as a rectifier
- Recognise and show understanding of circuits operating as light-sensitive switches and temperature-operated alarms (to include the use of a relay)

3.4 Dangers of electricity

- State the hazards of:
  - damaged insulation
  - overheating of cables
  - damp conditions
- State that a fuse protects a circuit
- Explain the use of fuses and circuit breakers and choose appropriate fuse ratings and circuit-breaker settings
- Explain the benefits of earthing metal cases

3.5 Electromagnetic effects

3.5.1 Electromagnetic induction

- Show understanding that a conductor moving across a magnetic field or a changing magnetic field linking with a conductor can induce an e.m.f. in the conductor
- Describe an experiment to demonstrate electromagnetic induction
- State the factors affecting the magnitude of an induced e.m.f.
- Show understanding that the direction of an induced e.m.f. opposes the change causing it
- State and use the relative directions of force, field and induced current

3.5.2 a.c. generator

- Distinguish between direct current (d.c.) and alternating current (a.c.)
- Describe and explain a rotating-coil generator and the use of slip rings
- Sketch a graph of voltage output against time for a simple a.c. generator
- Relate the position of the generator coil to the peaks and zeros of the voltage output

3.5.3 Transformer

- Describe the construction of a basic transformer with a soft-iron core, as used for voltage transformations
- Recall and use the equation $(V_p / V_s) = (N_p / N_s)$

- Understand the terms step-up and step-down
- Describe the use of the transformer in high-voltage transmission of electricity
- Give the advantages of high-voltage transmission
- Describe the principle of operation of a transformer
- Recall and use the equation *IpVp= Is Vs* (for 100% efficiency)
- Explain why power losses in cables are lower when the voltage is high

3.5.4 The magnetic effect of a current

- Describe the pattern of the magnetic field (including direction) due to currents in straight wires and in solenoids
- Describe applications of the magnetic effect of current, including the action of a relay
- State the qualitative variation of the strength of the magnetic field over salient parts of the pattern
- State that the direction of a magnetic field line at a point is the direction of the force on the N pole of a magnet at that point
- Describe the effect on the magnetic field of changing the magnitude and direction of the current

3.5.5 Force on a current-carrying conductor

- Describe an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing:
    - the current
    - the direction of the field
- State and use the relative directions of force, field and current
- Describe an experiment to show the corresponding force on beams of charged particles

3.5.6 d.c. motor

- State that a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by:
    - increasing the number of turns on the coil
    - increasing the current
    - increasing the strength of the magnetic field
- Relate this turning effect to the action of an electric motor including the action of a split-ring commutator

5. Atomic physics

5.1 The nuclear atom

5.1.1 Atomic model

- Describe the structure of an atom in terms of a positive nucleus and negative electrons
- Describe how the scattering of α-particles by thin metal foils provides evidence for the nuclear atom

5.1.2 Nucleus

- Describe the composition of the nucleus in terms of protons and neutrons
- State the charges of protons and neutrons
- Use the term proton number *Z*
- Use the term nucleon number *A*
- Use the term nuclide and use the nuclide notation ${}^{A}_{Z}X$
- Use and explain the term isotope
- State the meaning of nuclear fission and nuclear fusion
- Balance equations involving nuclide notation

5.2 Radioactivity

5.2.1 Detection of radioactivity

- Demonstrate understanding of background radiation
- Describe the detection of α-particles, β-particles and γ-rays (β + are not included: β-particles will be takento refer to β –)

5.2.2 Characteristics of the three kinds of emission

- Discuss the random nature of radioactive emission
- Identify α, β and γ-emissions by recalling
    - their nature
    - their relative ionising effects
    - their relative penetrating abilities

  (β+ are not included, β-particles will be taken to refer to β-)
- Describe their deflection in electric fields and in magnetic fields
- Interpret their relative ionising effects
- Give and explain examples of practical applications of α, β and γ-emissions

5.2.3 Radioactive decay

- State the meaning of radioactive decay
- State that during α- or β-decay the nucleus changes to that of a different element
- Use equations involving nuclide notation to represent changes in the composition of the nucleus when particles are emitted

5.2.4 Half-life

- Use the term half-life in simple calculations, which might involve information in tables or decay curves
- Calculate half-life from data or decay curves from which background radiation has not been subtracted

5.2.5 Safety precautions

- Recall the effects of ionising radiations on living things
- Describe how radioactive materials are handled, used and stored in a safe way

6. Space physics

6.1 Earth and the solar system (treated in science)
6.2 Stars and the universe
6.2.1 The Sun as a star (treated in science)
6.2.2 Stars (treated in science)
6.2.3 The Universe

- Know that the Milky Way is one of many billions of galaxies making up the Universe and that the diameter of the Milky Way is approximately 100 000 light-years
- Describe redshift as an increase in the observed wavelength of electromagnetic radiation emitted from receding stars and galaxies
- Know that the light emitted from distant galaxies appears redshifted in comparison with light emitted on the Earth
- Know that redshift in the light from distant galaxies is evidence that the Universe is expanding and supports the Big Bang Theory
- Know that microwave radiation of a specific frequency is observed at all points in space around us and is known as cosmic microwave background radiation (CMBR)
- Explain that the CMBR was produced shortly after the Universe was formed and that this radiation has been expanded into the microwave region of the electromagnetic spectrum as the Universe expanded
- Know that the speed v at which a galaxy is moving away from the Earth can be found from the change in wavelength of the galaxy's starlight due to redshift
- Know that the distance of a far galaxy d can be determined using the brightness of a supernova in that galaxy
- Define the Hubble constant H0 as the ratio of the speed at which the galaxy is moving away from the Earth to its distance

from the Earth; recall and use the equation $H0 = \frac{v}{d}$

- Know that the current estimate for H0 is 2.2×10^{-18} per second
- Know that the equation $\frac{d}{v} = \frac{1}{H0}$ represents an estimate for the age of the Universe and that this is evidence for the idea that all the matter in the Universe was present at a single point

(*) Gli obiettivi minimi sono indicati con sottolineatura; il raggiungimento degli obiettivi minimi comporta la sufficienza.
Libro di testo: D. Sang, M. Follows, S. Tarpey, “PHYSICS for Cambridge IGCSE” Coursebook, ed. Cambridge University Press