The report of the place of HIPST elements in the new (obligatory since the school year 2009/2010) Polish school curriculum of the subject named: "Physics and the Elements of Astronomy"

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Basic core of the general education in lower secondary, IIIth educational stage, which completing is necessary for the further education. Gymnasium ends with the special exam.

Aims of education – general requirements

I. Using of the physical quantities for description of known physical phenomena or solving the basic calculation tasks
II. Preparing and performing the experiments and making the conclusions on the base of observed results.
III. Finding and pointing the examples of phenomena described by known physical laws in the real world.
IV. Using the information from read texts and other popularised scientific sources.

N^o	Subject content	Detailed requirements Student:	Connection with history and philosophy of science	Notes
1.	Linear motion and forces	1) uses the term of velocity in description of motion, 2) recognizing the velocity and overshoot displacement from the dependencies of displacement and velocity on time and drawing these dependencies on the base of the verbal motion description, 3) points the examples of forces and recognising it in the different practical situations, 4) describes the behaviour of the physical bodies on the base of the Ist Newton's Law, 5) differentiates the mean and momentary velocity in non-uniform motion,	▪ Length units: foot, ell, mile, etc. ▪ Time units: talents (hours), mines (minutes), shekels (seconds) ▪ Units names descended from the names of Physicists: I. Newton; $1N = 1kg \cdot 1m / 1s^2$ ▪ I. Newton and his experiment with the vacuum pipe	

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1.	Linear motion and forces	6) uses the term of acceleration in description of the uniformly accelerated linear motion, 7) describes the behaviour of physical bodies on the base of the IInd Newton's Law, 8) uses the relation between the mass of physical body and acceleration and force in calculations, 9) uses the term of gravity force (weight), 10) describes the mutual interaction of physical bodies using the IIIrd Newton's Law, 11) explains the working of the first class lever, static block, wheel and axle, 12) describes the influence of motion resistance (drag, friction etc.) on the physical bodies movement	▪ Galileo's experiment – the movement of balls in the historical inclined plane ▪ a= F/m ▪ The story about an apple fallen down from the tree on the Newton's head ▪ Copernican heliocentric system ▪ Archimedes (defensive war machines, levers), bicycle – how it works, historical bicycles (Penny-Farthing bicycle) ▪ Construction of the mechanical vehicles – history, aero-dynamical shape.	
2.	Energy	1) uses the term of mechanical energy and knows its different forms, 2) uses the terms of **W**ork and **P**ower, 3) describes the influence of work done on the energy change, 4) uses the term of mechanical energy as a sum of kinetic and potential energies, 5) uses law of conservation of mechanical energy, 6) doing the qualitative analysis of the mechanical energy changes caused by doing of the work or flow of the heat, 7) explains the connection between the kinetic energy of molecules and temperature, 8) explains the heat flow in the phenomenon of thermal conduction and the role of the thermal isolation (materials),	▪ Units names derived form the names of Physicists: J. Joule, J. Watt. Unit: horsepower (HSP) ▪ Joule's experiment ▪ Units names derived form the names of Physicists: T.Kelvin, A.Celsius. ▪ Rumford's termoscope, Galileo's thermometer. ▪ Condensation of gases (Oxygen and Nitrogen): Z. Wróblewski & K. Olszewski.	

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2.	Energy	9) describes the phenomena: melting, freezing, vaporisation, condensation, sublimation, de-sublimation (deposition) 10) uses the terms: specific heat, specific melting heat, heat of vaporization 11) describes the movement of molecules in liquids and gases in the phenomenon of thermal convection.		
3.	The properties of the matter	1) analyses the differenced in the microstructure of solids, liquids and gases, 2) describes the structure of crystals on the example of the salt NaCl, 3) uses the term of density, 4) uses the dependence between the mass, density and volume in calculations for solids and liquids, calculates density of liquids and solids on the base of experimental results, 5) describes the surface tension phenomenon on the base of the chosen example, 6) uses the term of pressure (including hydrostatic and atmospheric pressure), 7) formulates the Pascal' Law with the examples of its use, 8) analyses and compares the values of buoyancy of the bodies dipped in water or gas, 9) Explains the phenomenon of floating of physical bodies on the base of Archimedes' Law.	▪ history of ideas of the matter's structure beginning from the ancient theory of atomists (Democritus and J. Dalton) ending on the molecular structure (theory of molecular motion of R. Brown – M. Smoluchowski and A. Einstein), ▪ an experiment with the special vas taken from the Lessons of Maria Sklodowska-Curie ▪ units names derived form the names of Physicists: B. Pascal ▪ Archimedes: the legend describing the way of checking of the genuineness of golden crown developed by Archimedes	3.

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4.	Electricity	1) describes how to electrify physical bodies by friction and contact, explains that this phenomenon is connected with the exchanging of the electrons, 2) analyses the direction of electrons movement, 3) makes the qualitative analysis of the charges identical (eg. electron – electron, proton-proton) and different (electron – proton) charges interactions, 4) differentiates the electric conductors and insulators and gives the examples of both types of bodies, 5) uses the law of conservation of the electric charge, 6) uses the term of electrical charge as a multiplicity of the charge of electron (elementary charge, 7) describes the flow of the electric current in conductors as the free electrons movement, 8) uses the term of the current intensity, 9) uses intuitively the term of the electric voltage, 10) uses the term of electric resistance, uses the Ohm's Law for the calculations in the case of the simple electric circuits, 11) uses the term of the Work and Power of electric current, 12) uses the term of the Work and Power of electric current, 13) converting the electrical energy value given in kWh to J and vice-versa,	▪ electrifying of amber by friction (amber = electron in Greek language - Thales of Miletus), Otto von Guericke - electrifying of sulfurs ball, the first electrostatic machines, Lichtenberg figures, Volta's electroscope, J. Thomson – electron, E. Rutherford – atom's nuclei, proton, J. Chadwick – neutron), ▪ C. Coulomb's Law, torsion balance mechanism (H. Cavendish), ▪ units names derived form the names of Physicists: C. Coulomb; 1C = 1A · 1s, ▪ conventional current and real flow of the electrons, ▪ units names derived form the names of Physicists: A. Amper;. 1A = 1C/ 1s, ▪ Units names derived form the names of Physicists: A. Volta; 1V = 1C /1F ▪ Units names derived form the names of Physicists: G. Ohm, ▪ Historical introduction to the Ohm's Law = U/R, ▪ Voltaic cell A. Volta; T. Edison, J. Swan, A. Łodygin, light bulb	

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4.	Electricity	14) constructing the simple electrical circuits and draws the circuit designs, 15) Knows the forms of energy into which electrical energy could be changed		
5.	Magnetism	1) names the magnetic poles of the solid magnets and describes the magnetic interactions between them, 2) describes the behavior of the magnetic needle in the presence of the magnet and knows how the compass is build and works, 3) describes the interactions of magnets and iron (Fe) and gives the examples of use of this interaction, 4) describes the effect of the electric wire on the magnetic needle, 5) describes the operation of electromagnet and the role of its core, 6) describes the interactions between magnet and electromagnet and explains the operation of the electric motor of the direct current.	▪ M. Faraday (has been studied the phenomenon of diamagnetism, discovered the phenomenon of paramagnetism), ▪ The first mentions of the compass as the magnetic spoon in China, 6th century BC, and of the compass with magnetic needle in China, 8th century, ▪ 4th century BC (China), Magnesia (Asia) – 1st century BC, ▪ Historical context of the H.Oersted's experiment, one of the school books proposes the historical scene for playing during the lesson, ▪ W. Sturgen ▪ H. Lorentz	

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6.	Harmonic motion and waves	1) describes the motion of simple gravity (mathematical) pendulum and the massive bob on the spring and analyses the energy changes during these motions, 2) uses the terms of amplitude (*A*), period (*T*), and frequency (*f*) of the harmonic motion, points the balance location and recognising *A* and *T* from the dependence *x(t)* for the body in the harmonic motion, 3) describes the mechanism of transferring the vibrations from one point to point in the physical body n the case of the mechanical waves (rope) and sound waves in the air, 4) uses the terms of amplitude (*A*), period (*T*), frequency (*f*), velocity (*v*) and wave's length (λ) for describing of the harmonic waves and uses the dependencies between these physical values for calculations, 5) describes the mechanism of the sound forming by the musical instruments, 6) knows how the sound's height and volume depend on the other physical values describing the phenomenon of the sound, 7) Uses the terms: infra- and ultrasound.	▪ Isochronous oscillations of the gravity pendulum – Galileo, ▪ Units names derived form the names of Physicists: H. Hertz, ▪ Mechanical resonance – Tacoma bridge in USA (November of 1940th year), ▪ Kundt's tube (measurement of the sound speed in gases and metals – forming the longitudinal standing waves, J. Lissajous' figures (tuning fork) ▪ History of the violin and guitar, ▪ Sonar (ASDIC) – constructed in France on 1918th formed the ultra waves.	

N°	Subject content	Detailed requirements Student:	Connection with history and philosophy of science	Notes
7.	Electromagnetic waves and optics	1) compares (lists common features and differences) propagation of the mechanical and electromagnetic waves, 2) explains the formation of the areas of shadow and half shadow knowing that light is the collection of rays which travel in straight lines in homogenous optical medium, 3) explains the formation of the of virtual images produced in the plane mirror, 4) using the law of reflection of light describes the phenomenon of the light dispersion when it is reflected from the rough surface, 5) Describes the focusing of rays in the curved mirror using the terms of focus and focal distance, 6) Constructs the images produced by curved mirrors, 7) Describes propagation of rays when they're travelling from the thinner to denser optical medium and vice versa, 8) describes the propagation of light in converging and concave lens (rays propagating parallel to the optical axis), uses the terms of focus and focal distance, 9) constructs the images formed by lens, differentiates the real and virtual, straight and reversed, magnified and decreased images, 10) explains the terms of myopic and hyperopic and explains the role of lens in the correction of visual impairments, 11) explains the phenomenon of light dispersion by prism,	▪ Wave optics (theory of light) development - Christian Huygens, Isaac Newton, Thomas Young, James Clerk Maxwell, Max Planck and finally Albert Einstein) ▪ Witelo, gnomons, solar clocks, „camera obscura", M.Kopernik (**gnomon-reflecting method**– „astronomical table") ▪ M.Kopernik (**gnomon-reflecting method** – „astronomical table") ▪ Archimedes – defence of Syracuse, former of the spherical mirrors, ▪ Optical instruments: hand lens, telescope, binoculars, microscope, spectacles, camera, refracting and reflecting telescopes. ▪ Spectacles for short-sighted and long-sighted people ▪ I.Newtons experiment – light dispersion ▪ Daltonism (J.Dalton), ▪ A.Michelson ▪ J. Maxwell, H. Hertz. Historical context of the discovering of the different types of electromagnetic radiation – when and by whom it has been discovered.	

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7.	Electromagnetic waves and optics	12) describes the white light as the mixture of the lights colours and the light emitted by laser as the one of the lights colours, 13) knows the approximated value of speed of the light in vacuum; knows that it is the maximum value of the information's transmission, 14) names the numerous electromagnetic waves (radio waves, microwaves, infra-red, visible light, ultraviolet, X rays) and knows where it could be used.		

Basic core of the general education in upper secondary, IVth educational stage, which completing allows to obtain the mature certificate after the passing the mature exam.

BASIC LEVEL

Aims of education – general requirements

- **I.** Using of the physical quantities for description of known physical phenomena or solving the basic calculation tasks
- **II.** Preparing and performing the experiments and making the conclusions on the base of observed results.
- **III.** Finding and pointing the examples of phenomena described by known physical laws in the real world.
- **IV.** Using the information from read texts and other popularised scientific sources.

Educational subjects – detailed requirements

N°	Subject content	Detailed requirements Student:	Connection with history and philosophy of science	Notes
1.	Gravitation and the elements of Astronomy	1) interprets the dependencies between the quantities in the Newton's law of gravitation for point masses and separated balls; 2) uses the terms of the first cosmic velocity and geostationary satellite; describes the motions of the artificial satellites around the Earth, recognises the gravitational force as a centripetal force, transforms the IIIrd Keplers Law to calculate the dependence between the period (T) of the motion and the orbit radius (r); 3) explains why the planets which could be seen from the Earth are moving in the background of the stars, 4) describes the rules of Earth-Moon and earth-planets distances' measurements based on the parallax and distances of the Earth from the nearest stars based on the annual (heliocentric) parallax, uses the terms of astronomical unit and light year;	▪ historical form of dependence between the gravitational interaction, mass and distance ▪ the history of discovery of Kepler's Laws ▪ to make the basic core complete in the subject of time measurements it is needed to extend its content of the history of time measurements, Copernicus' astronomical calendar, gnomon, ▪ observational logs (parallax) Tycho de Brache ▪ Erastotenes' calculation of the Earth-Moon distance	
2.	Atomic Physics	1) interprets the spectrum lines as the transitions between energy levels of the atoms 2) describes the atomic structure, basic and excited states of the atom 3) describes the photoelectric effect, uses law of conservation of energy to calculate the energy and velocity of photoelectrons	▪ Rydberg's experiment ▪ the theories/ideas of Democritus, Thomson, Bohr, Sommerfeld ▪ reconstruction of the experiment showing the photoelectric effect with use of the simple experimental set (big electroscope, zinc plate, the source of UV radiation)	

N°	Subject content	Detailed requirements Student:	Connection with history and philosophy of science	Notes
3.	Nuclear Physcis	1) names the properties of α, β, γ radiation, describes α and β decays (information about neutrino is not required), 2) describes the way how the γ radiation is emitted, uses the term of stabile and unstable nucleus, 3) describes the decay of radioactive isotope, 4) using the term: half-life; draws the plot of dependence of the number of decaying nuclei on time, 5) knows the idea of dating technique based on the isotopes' content in any item, e.g. radiocarbon dating, 6) describes the nuclear reactions using the laws of conservation of the number of nucleons, charge and energy, 7) describes chosen method of detection of ionizing radiation, 8) describes the nuclear fission of uranium 235U as a result of consuming of neutron; points the conditions necessary to induce the chain reaction; 9) describes the thermonuclear reactions in stars and in the H-bomb	▪ Rutherford's experiment ▪ the importance of Bequerel's, Piotr and Maria Curie's discoveries for development Fermi's experiment of creating the heavy isotopes ▪ the experiment of Irena Jolio-Curie ▪ usage of the electroscope, Geiger-Müller counter, Wilson chamber ▪ the nuclear reactor/atomic pile - Fermi, ▪ theoretical explanation of the radioactive decay phenomenon - Lise Meitner ▪ the crash of the atomic power plant in Chernobyl	Usage of adequate terms in the basic core **- half-life**

EXTENDED LEVEL

Aims of education – general requirements

- **I.** Knowledge and skills necessary to use of physical quantities and laws for describing the natural processes and phenomena.
- **II.** The analysis of texts and other popularised scientific sources and evaluation of their content from scientific point of view.
- **III.** Using and transforming of the information form the texts, tables, plots, schemes and drawings.
- **IV.** Constructing of the simple physical and mathematical models to describe and understand the observed phenomena.
- **V.** Planning and performing of the simple experiments and analysis of its results.

Educational subjects – detailed requirements

N°	**Subject content**	**Detailed requirements** **Student:**	**Connection with history and philosophy of science**	**Notes**
1.	Motion of the point mass	1) using the dependencies between the position, velocity and acceleration in uniform linear motion and uniformly accelerated linear motion for calculating of the motion parameters, 2) describes the free motion of the physical bodies using the first Newton's law, 3) explains the motion of physical bodies on the base of the second Newton's law, 4) uses the third Newton's law for describing the behaviour of physical bodies 5) uses the law of conservation of linear momentum for calculating the velocity of bodies during the inelastic collisions and jet phenomenon; 6) explains the differences between descriptions of the body motion in inertial and non-inertial frames of references;	▪ Galileo's experiment ▪ Newton's experiment ▪ experiment with the Heron's ball – aeolipile (Greek Partner) ▪ the experiment showing the Coriolis force (tracing-paper and tube), Foucault pendulum	

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2.	Rigid body mechanics	1) describes the circular motion of the rigid body around the axis going through the center of its mass (angular velocity, angular acceleration); 2) analyses the circular motion of the rigid body caused by the moment of force (Torque)	▪ Maxwell's pendulum ▪ Watt's centrifugal governor	
3.	Mechanical energy	1) calculates the value of kinetic and potential energies of the body in the homogenous gravitational field	▪ Maxwell's pendulum	
4.	Gravitation and elements of astronomy	1) interprets the dependencies between the quantities in the Newton's law of gravitation for point masses and separated balls, 2) uses the terms of the first cosmic velocity and geostationary satellite; describes the motions of the artificial satellites around the Earth, recognises the gravitational force as a centripetal force, transforms the IIIrd Keplers Law to calculate the dependence between the period (T) of the motion and the orbit radius (r), 3) explains why the planets which could be seen from the Earth are moving in the background of the stars, 4) describes the rules of Earth-Moon and earth-planets distances' measurements based on the parallax and distances of the Earth from the nearest stars based on the annual (heliocentric) parallax, uses the terms of astronomical unit and light year, 5) uses the Newton's law of universal gravitation for calculating the force of gravitational interactions between the point and spherical symmetric masses,	▪ historical form of dependence between the gravitational interaction, mass and distance ▪ the history of discovery of Kepler's Laws ▪ to make the basic core complete in the subject of time measurements it is needed to extend its content of the history of time measurements, Copernicus' astronomical calendar, gnomon, ▪ observational logs (parallax) ▪ Tycho de Brache ▪ Erastotenes' calculation of the Earth-Moon distance, ▪ the reconstruction of the Newton's way of ratiocination which led him to discover the law of universal gravitation is suggested	

N°	Subject content	Detailed requirements Student:	Connection with history and philosophy of science	Notes
4.	Gravitation and elements of astronomy	6) Calculates the periods of planets cycles and their distances from stars using the IIIrd Kepler's law for circular orbits;	▪ the reconstruction of the Kepler's way of ratiocination which led him to discover the IIIrd Kepler's law is suggested	
5.	Thermo-dynamics	1) describes isothermal, isobaric and isochoric processes, 2) analyses the first law of thermodynamic as a law of energy conservation, 3) analyses given thermo dynamical cycles, calculates the energy conversion efficiency of the heat engines using the transferred heat (Q) and work (W) done;	▪ Boyle – Mariotte's, Charles', Gay – Lucas laws ▪ Joule's experiment ▪ the first steam engine, internal combustion engine, Ott's engine, Diesel's engine	
6.	Harmonic motion and mechanical waves	1) describes the mechanical resonance phenomenon on the base of chosen examples, 2) uses the law of energy conservation in oscillations, describes the kinetic and potential energies transformation in this type of motion, 3) calculates the period (T) of oscillations of massive bob on the spring and simple gravity pendulum, 4) explains the diffraction of waves on the base of the Huygens–Fresnel principle, 1) describes the standing waves and their connection with the backward, 5) describes the Doppler's effect in the case of the source in motion in the frame of reference of immobile observer waves	▪ Newton's pendulum (Newton's cradle) ▪ isochronism of motion – observations, Galileo's experiment – it is needed to define explicite the phenomenon of isochronous oscillations, ▪ Hughens' experiment ▪ Experiment with Kundt's tube ▪ Doppler's experiment	

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7.	Electric field (Electrostatics)	1) uses the Coulomb's law for calculating of the electrostatic force between the point charges, 2) knows how to describe the electrostatic field of the flat capacitor, 3) explains what is the influence of the electrostatic field to the distribution of electric charges in the conductor; knows how lightning arrester and Faraday cage are working, 4) describes the electrostatic field using the field's lines	▪ Coulomb's torsion balance ▪ Volta's electroscope ▪ Franklin's experiment - Franklin's bell ▪ figures of Lichtenberg	
8.	Direct current	1) knows and uses the physical quantities: electromotive force and internal electrical resistance, 2) calculates the resistance of capacitor on the base of its electrical resistivity and geometrical dimensions, 3) draws the dependence between current intensity and voltage for resistor fitting the Ohm's law, 4) 4) describing the influence of temperature changes for the resistance of metals and semiconductors.	▪ voltaic pile, Ritter's pile, ▪ Ohm's experiment	
9.	Electrody-namics (Magentism)	1) analyses the electrodynamics' force acting of the conductor in magnetic field, 2) analyses the fact of voltage appearing on the ends of conductor during his movement in magnetic field, 3) describing the working of electric motor, 4) calculates the electromotive force appearing consequently of electromagnetic induction,	▪ Amper's swing ▪ Faraday's disc (homopolar generator) ▪ Faraday's experiment ▪ Oersted's experiment, right-hand rules	Elements of electronics are not represented

N°	Subject content	Detailed requirements Student:	Connection with history and philosophy of science	Notes
9.	Electrody-namics (Magentism)	5) uses the Lenz's law to indicate the direction of inductive current, 6) describes the construction and working of electrical generator and transformer, 7) Describes the working of diode as the rectifier.		
10.	Electromagnetic waves and optics	1) describes the Young's experiment, 2) describes and explains the phenomenon of polarization of light (as an effect of reflection or going throw the polariser), 3) draws and explains the construction of real and virtual images produced by converging and concave lens, 4) Uses the lens equation to calculate the location and magnification of images.	▪ Erastotenes - measurement of light's velocity ▪ Young's experiment ▪ palace, Louvre ▪ the history of spectacles, contact lens, microscope (constructed by Hans and Zacharias Janssens, the theory formulated by Abby (1878r.), ▪ telegraph, telephone, radio.	W I T E L O N
11.	Atomic Physics	1) interprets the spectrum lines as the transitions between energy levels of the atoms, 2) describes the atomic structure, basic and excited states of the atom, 3) describes the photoelectric effect, uses law of conservation of energy to calculate the energy and velocity of photoelectrons, 4) describes the mechanism of X-radiation's generation.	▪ Rydberg's experiment ▪ mention of the theories/ideas of Democritus, Thomson, Bohr, Sommerfeld ▪ reconstruction of the experiment showing the photoelectric effect with use of the simple experimental set (big electroscope, zinc plate, the source of UV radiation) ▪ Roentgen's experiment, visit in the X-ray lab	

Further, the lack of following topics has been noticed:

- molecular physics
- non-conventional energy sources
- semiconductors, superconductors, diodes, transistors, crystals, lasers.