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المملكة المغربية
وزارة التعليم العالي
والبحث العلمي والابتكار

Royaume du Maroc
Ministère de l'Enseignement Supérieur,
de la Recherche Scientifique et de l'Innovation

Reference framework

for the joint competition for access to the faculties of Medicine, Pharmacy and Dentistry

- July 2022 -

- The competition for access to the faculties of Medicine, Pharmacy and Dentistry consists of four components.
    - Component 1: Life Sciences test (Biology);
    - Component 2: Physics test;
    - Component 3: Chemistry test;
    - Component 4: Maths test.

- The duration of each test is 45 min
- Each component consists of 20 multiple choice questions (*MCQ*);
- Each multiple choice question has only one correct answer;
- Questions will be scored using a weighting ranging from 1 to 3.
- A mark less than or equal to 5/20 in one of these tests will be an eliminatory note;
- The use of calculators is not allowed.

Component 1: Life Sciences test (Biology)

The domain of Assessment of Learning Outcomes in **Life Sciences** (Biology) targets two important levels of mastery: **Mastery of knowledge and mastery of scientific reasoning.**

The first level evaluates the candidate's knowledge in the field of **"genetics"** the field of "**The organic matter consumption and the flow of energy at the cellular level"** and the field of "**immunology**".

As for the second level, it allows the evaluation of scientific reasoning, in other words, the ability to use study and action processes and tools (laws, procedures, operational acts, etc.).

1. Areas and sub-areas of knowledge covered by the competition test

Area 1: The organic matter consumption and the flow of energy at the cellular level.		
Sub-areas	**Content**	**Coverage**
The reactions responsible for the release of the stored energy in organic matter in the cell	- Notion of respiration; - Notion of fermentation; - The main stages of glycolysis; - Energy yield from glycolysis; - Mitochondrion structure and ultra-structure; - The main stages of the Krebs cycle; - Energy yield of the Krebs cycle; - Electron Transport Chain and oxidative phosphorylation; - Energy yield of respiration; - The main stages of fermentation; - Energy yield of fermentation; - Energy efficiency.	**20%**
The role of the skeletal striated muscle in energy conversion	- The myogram: the muscle twitch, the complete and incomplete tetanus; - Thermal and chemical phenomena accompanying the muscle contraction; - Skeletal muscle structure and ultra-structure; - Molecular structure of the myofilaments; - Source of the energy necessary for the muscle contraction; - Muscle contraction mechanism; - Metabolic pathways of ATP regeneration.	

Area 2 : Genetics		
Sub-areas	**Content**	**Coverage**
The notion of genetic information	- The role of chromosomes in the transmission of genetic information from one cell to another: • phases of mitosis in plant and animal cells; • The cell cycle. - The chemical nature of genetic material: • Composition and structure of chromosomes and DNA; • Mechanism of DNA replication. - The notions of inherited characteristics/traits, gene, allele and mutation; - The relationship between trait -protein and gene-protein; - The meaning of gene mutation; - The genetic code.	**60%**
The gene expression mechanisms: Protein synthesis stages	- Structure of mRNA. - Transcription. - Translation (initiation, elongation and termination).	
Genetic engineering: its principles and techniques	- The stages of gene transfer - the notion of genetic transformation: • natural gene transfer from *Agrobacterium Tumefaciens* to a plant. • techniques and steps of transferring a gene to a bacterium; - Some examples of applying the genetic engineering principles: • industrial production of human insulin; • Industrial production of toxic proteins to fight against harmful insects.	
The transmission of genetic information through sexual reproduction	- Stages/phases of meiosis; - Karyotypes of diploid species; - Role of meiosis and fertilisation in allelic recombination/ recombination of alleles (genetic recombination of homologous chromosomes by linkage/crossing-over and chromosomes independent assortment) and in karyotype stability across generations.	
Mendel's laws of the transmission of hereditary characteristics/traits in the diploid organisms	- Mendel's laws of the transmission of hereditary characteristics/traits; - Monohybridism/ Monohybrid Cross; - Dihybridism/dihybrid cross; - Pure lineage and wild type, homozygosity and heterozygosity, hybridisation, test cross/back cross; - Punnett squares; - Autosomal heredity (independent of sex) and sex-linked heredity; - Dominance, codominance and lethal gene. - Unlinked genes (genes of independent assortment); - Linkage/crossing-over, genetic recombination of homologous	

	chromosomes by linkage/crossing-over and genetic diversity. - Gene maps.	
Human genetics	- Notions of pedigree and karyotype. - Hereditary autosomal diseases. - Hereditary sex-linked diseases. - Chromosomal abnormalities and their consequences. - Chromosomal interpretation of hereditary diseases; - Techniques of prenatal diagnosis of chromosomal anomalies.	
Population genetics	- Criteria of genetic equilibrium of population - The evolutionary factors and their impact on the genetic structure of a population - Criteria specifying of a species. Definition of a species	

Area 3: Immunology		
Sub-areas	**Content**	**Coverage**
Concept of self and non-self	- Definition of the major histocompatibility complex (MHC) proteins and determination of its role; - The notion of self; - The cell surface markers on human red blood cells of the ABO Blood Groups; - The notion of non-self and modified self; - The genetic characteristics of the (MHC) proteins.	**20%**
The ways how the human organism protects the self	- Notion of immune response; - The nonspecific immune response: inflammatory response, phagocytosis and complement system; - The adaptive (acquired) immunity response - both humoral and cell-mediated: • The elements responsible for this response; • The mechanisms and characteristics of the specific immune response (specificity and immunological memory); - The organs of the immune system; - Origin of immune cells and lymphocyte maturation sites; - The phases and mechanisms of the specific immune response (induction, amplification and effector phases); - Cellular cooperation.	
Some dysfunctionings of the immune system	- Elements and mechanisms of allergy due to immediate hypersensitivity; - The acquired immunodeficiency syndrome: • HIV structure and its infection cycle; • Action of HIV on $CD4^+$ T cells; • HIV evolution and progression to AIDS.	
Ways of helping the immune system	- Vaccination ; - Serotherapy; - Bone marrow transplantation.	

2. The levels of mastery (skills) targeted by the competition test

The test targets two levels of mastery: The restitution of knowledge and scientific reasoning using multiple-choice questions (MCQ).

The level of mastery. (Skills)		Weight
Knowledge Retrieval	This level aims to assess the candidate's level of knowledge related to the consumption of organic matter and energy flow, genetics and immunology.	**50%**
Scientific reasoning	This level aims to evaluate, in the candidate, the degree of mastery of study and action processes and tools (laws, procedures, operational acts, ...).	**50%**

Component 2: Physique

The field of the evaluation of acquired **Physics** targets two important levels of mastery: Use of resources and Scientific reasoning.

The first level aims to check the level of mastery of the use of resources (essential learning acquired during lessons and practical work);

As for the second level, it allows to assess the mastery of scientific reasoning.

1. Domain major and sub-domains contents targeted by the competition

The content table presents the domains of content subject to the assessment and the list of essential learning outcomes (knowledge and know-how) relating to each content area. This knowledge and know-how constitute the minimum threshold to be assessed by candidates.

First Major Part : Physics		
Sub-areas	**Learning outcomes**	**Coverage**
The First Topic: Waves	**1-Progressive Mechanical Waves** - Define a mechanical wave and its wave speed. - Define a transverse wave and a longitudinal wave. - Define a progressive wave. - Know the relationship between elongation of a point from the propagation medium and the source elongation: $y_M(t) = y_S(t-\tau)$. - Exploit the relationship between time delay, distance and wave speed. - Exploit experimental documents and data in order to determine: * distance and wavelength ; * time delay; * wave speed. - Suggest a schema of experimental set-up (mounting) to measure time delay or to determine the wave speed during the wave propagation. **2- Periodic Progressive mechanical waves** - Recognise a periodic progressive wave and its period. - Define sinusoidal progressive wave, period, frequency and wavelength. - Know (recall) and use the relationship $\lambda = v.T$ - Know the condition to have the diffraction phenomenon: aperture/slit length is less or equal wavelength. - Know (recall) the characteristics of the diffracted wave. -Define a dispersive medium. - Exploit the experimental documents to recognise the diffraction phenomenon and highlight the characteristics of the diffracted wave. - Suggest a schema of an experimental set-up to highlight the phenomenon of the diffraction in the case of audible and ultrasonic mechanical wave.	**20%**

	3- Propagation of a light wave - Know that light has a wave aspect, based on the diffraction phenomenon. - Know the influence of the size of the slit (opening) or of the obstacle on the diffraction phenomenon. - Exploit a document or a diffraction pattern in the case of light waves. - Know (recall) and exploit the relationship: $\lambda = c/\upsilon$. - Define a monochromatic and a polychromatic light. - Know the boundaries of wavelengths and their colours for the visible spectrum in the vacuum. - Know that the frequency of a monochromatic radiation does not change as it passes from one transparent medium to another. - Know that the transparent media are more or less dispersive. - Know (recall) and exploit the relationship: $n = c/v$ - Determine (find out) the refractive index of transparent medium for a given frequency. - Suggest the schema of an experimental set-up allowing us to highlight the diffraction phenomenon in the case of light waves. -Know (recall) and exploit the relationship $\theta = \lambda/a$; and know the units and the meaning of θ and λ. - Exploit experimental measurements to verify the relationship $\theta = \lambda/a$.	
The Second Topic: Nuclear Transformations	**1. Radioactive Decay** - Know the meaning (significance) of the symbol ${}^{A}_{Z}X$ and give the composition of the corresponding nucleus. - Recognise the isotopes of a chemical element. - Recognise the areas of stability and instability of the nuclei on the N-Z diagram. - Exploit the N-Z diagram - Define a radioactive nucleus. - Know and exploit the two laws of conservation. - Define the radioactivity: α , β^+ & β^- and the $\gamma - radiation$. - Write the equation of a nuclear reaction by applying the two conservation laws. - Recognise the type of radioactivity using the equation of a nuclear reaction. - Know and exploit the law of the radioactive decay, and exploit its curve. - Know that 1Bq is equal to one decay per second. - Define the time constant τ and the half-life $t_{1/2}$. - Exploit the relationships between τ , $t_{1/2}$ and λ (decay constant). - Use the dimensional analysis to determine the units of λ and τ. - Determine the suitable radioactive element in order to date a given event. **2. Nuclei, Mass and Energy** - Define and calculate the mass defect and the binding energy. - Define and calculate the binding energy per nucleon and exploit it.	**15%**

	- Use different units of mass, energy and the relationships between their units. - Exploit Aston's curve to identify the most stable nuclei. -Know the relationship of the mass-energy equivalence; and calculate the energy of mass. - Establish the energy balance ΔE of a nuclear reaction using: mass energies and/or binding energies and/or the energy diagram. - Calculate the energy released (produced) by a nuclear reaction: $E_{pro} = \lvert\Delta E\rvert$. - Recognise some applications of radioactivity. - State some risks of radioactivity.	
The Third Topic: Electricity	**1. RC Dipole** - Represent the voltages (Electric Potential Difference) u_R and u_C using the receiver convention; and show the polarity of capacitor plates. - Know and exploit the relationship $i = \frac{dq}{dt}$ for a capacitor in receiver convention. - Know and exploit the relationship q = C.u. - Know the capacitance of a capacitor, its unit F and their submultiples μF, nF *and* pF. - Determine the capacitance of a capacitor graphically or by calculation. - Know the capacitance of the equivalent capacitor in series or in parallel assemblies**;** and recall the interest of each one. - Find out the differential equation and verify its solution when the RC dipole is submitted to a step voltage. - Determine the voltage expression $u_C(t)$ between capacitor terminals when the RC dipole is submitted to a step voltage, and deduce both the expression of the current intensity in the circuit and the capacitor charge. - Recognise and represent the variation curves of $u_C(t)$ between the capacitor terminals and different physical quantities associated to it, and exploit them. - Recognise that the voltage between capacitor terminals is a continuous function of time at t=0, and the current intensity is a discontinuous function at t=0. - Know and exploit the time-constant expression. - Use the dimensional analysis (dimensional equations). - Exploit experimental documents in order to: * recognise the observed voltages. * highlight the influence of R and C on the charging and the discharging processes.	**35%**

	*determine the time-constant and charge duration. *determine the state type (transient or steady) and the time interval for each one. - Suggest the schema of the experimental assembly that allows studying the response of the RC dipole submitted to a step voltage. - Know the interest of an assembly highlighting a RC dipole submitted to a step voltage - Know how to connect an oscilloscope and a datalogger to monitor different voltages. - Determine the influence of R and C and the amplitude of the step voltage on the RC dipole response. - Know and exploit the expression of the electric energy stored in a capacitor. **2. *RL* Dipole** - Represent the voltages (Electric Potential Difference) u_R and u_L using the receiver convention. - Know and exploit the voltage expression $u = r.i + L.\frac{di}{dt}$ between the inductor's (coil) terminals using the receiver convention. - Know the meaning of the physical quantities involved in the expression of the voltage u between the inductor's terminals and their units. - Determine the two characteristics of the inductor (the inductance L, the resistance r) exploiting experimental results. - Find out the differential equation and verify its solution when the RL dipole is submitted to a step voltage. - Determine the current intensity expression $i(t)$ when the RL dipole is submitted to a step voltage, and deduce the voltage expressions between the inductor's terminals and the resistor terminals. - Recognise and represent the variation curves of current intensity $i(t)$ in terms of time across the inductor and different physical quantities associated to it, and exploit them. - Know that the inductor delays the establishment and the rupture of the current; and that the current intensity is a continuous function but the voltage between their terminals is a discontinuous function at t=0. - Know and exploit the time-constant expression. - Use the dimensional analysis (dimensional equations). - Exploit experimental documents in order to: * recognise the observed voltages;	

	* highlight the influence of R and L on the response of a RL dipole; * determine the time-constant. - Suggest the scheme of the experimental assembly that allows studying the response of the RL dipole which is submitted to a step voltage. - Know the interest of an assembly highlighting a RL dipole submitted to a step voltage. - Know how to connect an oscilloscope and a datalogger to monitor different voltages. - Determine the influence of R and L and the amplitude of the step voltage on the RL dipole's response. - Know and exploit the expression of the magnetic energy stored in an inductor. **3. RLC Series Circuit** - Recognise the three oscillation states: undamped (periodic), the underdamped (pseudo-periodic) and the overdamped (non-periodic). - Recognise and represent the variation curves of the voltage between the capacitor terminals in terms of time for the three states mentioned above; and exploit them. - Find out the differential equation verified by the voltage between the capacitor terminals or for its charge $q(t)$ in the negligible damping case and verify its solution. - Know and exploit the expression of the charge $q(t)$ and deduce the current's intensity expression $i(t)$ flowing in the circuit and exploit it. - Know and exploit the natural period expression. - Explain energetically the three regimes. - Know and exploit the energetic diagrams. - Know and exploit the expression of the total energy in the circuit. - Find out the differential equation for the voltage between the capacitor terminals or for its charge $q(t)$ in the damping case. - Know the role of the oscillation maintenance device which compensates the energy dissipated by Joule effect in the circuit. - Find out the differential equation for the voltage between the capacitor terminals or for its charge $q(t)$ in the RLC circuit that is maintained by using a generator delivering a voltage which is proportional to the current intensity: $u_G(t) = k.i(t)$ - Exploit experimental documents in order to: * recognise the observed voltages; * recognise the oscillation states;	

	* highlight the influence of R, L and C on the oscillation phenomenon; * determine the values of the period and the natural period. - Suggest the scheme of the experimental assembly that allows the study of the free oscillations in the RLC series circuit**.** - Know how to connect an oscilloscope and a datalogger to monitor different voltages.	
The Fourth Topic: Mechanics	**1. Newton's Laws** - Know and exploit expressions of the instantaneous velocity vector and the acceleration vector. - Know the unit of acceleration. - Know the components of the acceleration vector in Cartesian coordinate system and in Frenet frame. - Exploit the dot product $\vec{a}.\vec{v}$ to determine the nature of motion (accelerated or decelerated). - Know the Galilean frame of reference. - Know Newton's second law $\Sigma\overrightarrow{F_{ext}} = m.\frac{\Delta\overrightarrow{V_G}}{\Delta t}$ and $\Sigma\overrightarrow{F_{ext}} = m.\overrightarrow{a_G}$ and its range of validity. - Recognise the role of mass in the inertia of a system - Apply Newton's second law to determine the kinetic quantities $\overrightarrow{v_G}$ and $\overrightarrow{a_G}$ and dynamic quantities and exploit them. - Know and use Newton's third Law. - Use of the dimensional analysis (dimensional equations). **2. Applications** - Define the vertical free fall. - Apply Newton's second law to find out the differential equation of a solid's centre of inertia motion in vertical free fall and solve it. - Know and exploit the characteristics of the uniformly accelerated straight line motion and its parametric equations (t is the parameter). - Exploit the velocity-time graph: $v_G = f(t)$. - Select the appropriate frame of reference to study motion. - Apply Newton's second law to find out the differential equation of a system's centre of inertia motion in horizontal or inclined plane and determine the characteristics of kinetic and dynamic quantities of motion.	**30%**

- Exploit a document representing the path (trajectory) of a projectile in a uniform gravitational field to:

  * determine the type of the motion (plane);

  * represent the velocity and the acceleration vectors;

  * determine the initial conditions and some parameters characterizing motion.

- Apply Newton's second law in the case of a projectile to:

  * find out differential equation of motion;

  * deduce the parametric equations of motion and exploit them;

  * establish the equation of the path (trajectory), find out the expressions of the range and the maximum height of the path and exploit them;

3. Oscillating Systems

- Know the oscillatory motion.

- Recognise the free oscillations

- Recognise the damping of oscillations, their different types and their states.

- Know that in the case of a weak damping (underdamped state) , the period is close to the natural period.

- Know the characteristics of the restoring force exerted by a spring on a solid in motion.

- Exploit the curves: $x_G(t)$, $v_G(t)$ and $a_G(t)$.

- Apply Newton's second law to an oscillating system (solid-spring body) to establish the differential equation of motion and verify its solution in cases where the oscillating system is in horizontal position.

- Determine the type of motion of the oscillating system (solid-spring); write the equations: $x_G(t)$, $v_G(t) = \frac{dx}{dt}$ and $\ddot{x}_G(t)$ and exploit them.

- Know the meaning of the physical quantities involved in the expression of the parametric equation $x_G(t)$ of the oscillating system (solid-spring) and determine them using the initial conditions.

- Establish the expression of the natural period of the oscillating system (solid-spring).

- Know and exploit both the expression of the natural period and that of the natural frequency of the oscillating system (solid-spring).

- Determine the two types of damping (solid and fluid) through the shape of the displacement-time graph $x_G(t)$.

- Recognise the driver (exciter), the resonating system, the mechanical

	resonance phenomenon and their production conditions. - Recognise the influence of damping on the resonance state. **4. Energy Aspects** - Determine the work of an external force exerted by a spring. - Know and exploit the expression of the elastic potential energy. - Know and exploit the relation between the work of a force applied by a spring and the elastic potential energy change. - Know and exploit the expression of the mechanical energy of a solid-spring system. - Exploit the conservation and the non-conservation of the mechanical energy of a solid-spring system. - Exploit the energy diagrams.	

2. Levels of mastery targeted by the competition

The test targets two skill levels: **Resources use** and **Scientific reasoning** using multiple choice questions (**MCQ**).

Mastery levels		Weight
Resources use	This level aims to assess, in the candidate, the degree of mastery of knowledge and skills relating to the fields: - Waves; - Nuclear transformations; - Electricity; - Mechanics.	**70%**
Scientific reasoning	This level aims to assess, in the candidate, the degree of mastery of the elements of the scientific approach (critical thinking, argumentation, etc.).	**30%**

Component 3: Chemistry

The field of the evaluation of acquired Chemistry targets two important levels of mastery: Use of resources and Scientific reasoning.

The first level aims to check the level of mastery of the use of resources (essential learning acquired during lessons and practical work),

As for the second level, it allows to assess the mastery of scientific reasoning.

1. Domain major and sub-domains contents targeted by the competition

The content table presents the domains of content subject to the assessment and the list of essential learning outcomes (knowledge and know-how) relating to each content area. This knowledge and know-how constitute the minimum threshold to be assessed by candidates.

First Major Part : Chemistry		
Sub-areas	**Learning outcomes**	**Coverage**
The First Topic: Fast and Slow Transformations of a Chemical System	**1. Fast and slow transformations** - Write the equation of the reaction associated with a redox (oxidation-reduction) transformation, and identify the two pairs involved. - Determine from experimental results the effect of kinetic factors on the rate of reaction. **2. Temporal Monitoring of a Chemical Transformation – Rate of Reaction** - Justify the different operations carried out during the monitoring of the time-evolution of a system and exploit the experimental results. - Determine the point of equivalence during a titration and exploit it. - Exploit the different curves of time-evolution of the amount of substance of a chemical species, or its concentration, or the advancement of reaction. - Draw the progress table of a reaction and exploit it. - Know the expression of the volumetric rate of reaction. - Know the kinetic factors : Concentration of reactants and temperature. - Know the effect of reactant concentration and the temperature on the volumetric rate of reaction. - Explain qualitatively the reaction rate change using one of the plotted evolution's curves. - Determine graphically the value of the volumetric rate of reaction. - Define the half-life $t_{1/2}$ of a chemical reaction. - Determine the half-life $t_{1/2}$ of the chemical reaction graphically or through exploiting the experimental results. - Know the influence of the concentration of the reactants and temperature on the half-life reaction.	**15%**

The Second Topic: Non-Completion Transformations of a Chemical System	**1. Reversible chemical transformations** - Define an acid and a base according to Bronsted. - Write the equation of the acid-base reaction and identify the two pairs involved. - Determine the pH for an aqueous solution. - Calculate the final progress of the reaction that occurs between an acid and water taking into consideration the value of both the concentration and this acid's pH aqueous solution; then, compare it with the maximum progress. - Define the final progress rate of a reaction, and determine it using experimental data. - Know the influence of dilution on the final progress rate of a reaction. **2. Equilibrium State of a Chemical System** - Use the relationship linking the conductance G of a solution part to the effective molar concentrations [Xi] of Xi ions in the solution. - Know that when the state of equilibrium of the system is reached, the amount of substances will remain steady, and that this equilibrium state is dynamic. - Give and exploit the expression of the reaction quotient Q_r through the reaction equation. - Know that, the reaction quotient in equilibrium $Q_{r,eq}$, associated with the reaction equation of a chemical system, takes a value independent of concentrations, called equilibrium constant K. - Know that, for a given transformation, the final progress rate depends on the equilibrium constant and the initial state of the chemical system. **3. Transformations associated with the acid-base reactions in aqueous solution** - Know that the ionic product of water K_e, is the equilibrium constant associated with the equation of the reaction of water autoprotolysis (self-ionization of water). - Know the relationship $pK_e = -\log K_e$ - Determine the nature of aqueous solution (acid, basic or neutral) based on its pH value. - Determine the pH value of aqueous solution based on the molar concentration of ions H_3O^+ or HO^-. - Write and exploit the expression of the acid dissociation constant K_A associated with the reaction of an acid with water. - Know the relationship $pK_A = -\log K_A$. - Determine the equilibrium constant associated with the equation of acid-base reaction using the acid dissociation constants of existing pairs. - Indicate the predominant chemical species taking into consideration pH of aqueous solution and pK_A of the pair acid/base. - Represent and exploit the predominance diagrams of acidic and basic chemical species existing in aqueous solution.	**40%**

	- Write the equation of titration reaction (use only one arrow) - Know the experimental set-up of an acid-base titration. - Exploit the curve or the results of the titration. - Determine and exploit the point of equivalence. - Justify the choice of a suitable indicator to determine the equivalence.	
The Third Topic: Evolution Direction of a Chemical System	**1. Spontaneous evolution of a chemical system** - Calculate the value of the quotient of reaction Q_r of a chemical system in given state. - Determine the direction of spontaneous evolution of a chemical system. **2. Spontaneous transformations in batteries and recovery of energy** - Draw a cell diagram / diagram of an electrochemical cell (battery) - Determine the direction flow of the charge carriers in a cell using the criterion of spontaneous evolution. - Interpret the functioning of a battery based on: the direction of electric current flow, the electromotive force (emf), the electrode reactions, the polarity of electrodes or the movement of charge carriers. - Write the half-equation that occurred in each electrode (use double arrows) and write the overall equation of the reaction during the battery functioning (use one arrow). - Establish the relationship between the amount of substance of chemical species produced or consumed, the current intensity and the operating duration of a battery. Exploit this relationship to determine other quantities (quantity of charge, progress of the reaction, change of the mass...).	**20%**
The Fourth Topic: Control Method of the Evolution of Chemical Systems	**1. Esterification and hydrolysis reactions** - Recognise in the formula of a chemical compound the organic functional groups: -OH (hydroxyl); $-CO_2H$ (carboxyl) ; $-CO_2R$ (ester); -CO-O-CO- (anhydride). - Write the esterification and the hydrolysis equation. - Find the corresponding carboxylic acid and alcohol from the structural formula of an ester. - Name the esters containing at most five carbon atoms. - Know the characteristics of esterification and hydrolysis: non-complete and slow transformations. - Write and exploit the expression of the equilibrium constant K corresponding to the equations of the esterification and hydrolysis reactions. - Know that a catalyst is a chemical species that increases the rate of a chemical reaction without changing the equilibrium state of the system. - Know that the abundance of one reactant or the removing of one	**25%**

	product displaces the equilibrium state of the system in the forward direction. - Determine the composition of reaction mixture at a given time. **2. Control of the Evolution of the Chemical Systems by Changing a Reactant or by Catalysis** - Justify the choice of experimental equipment to be used: reflux apparatus, fractional distillation, crystallisation and vacuum filtration. - Recognise safety rules. - Suggest experimental protocol and justify its steps. - Write the equation of the reaction of an anhydrous acid with an alcohol and that of the basic hydrolysis of an ester. - Know the characteristics of the reaction of an anhydrous acid with an alcohol: fast and complete. - Calculate the yield of a chemical transformation. - Recognise the hydrophilic part and the hydrophobic part of a carboxylate ion (long chain). - Know the accelerant and selective catalyst roles.	

2. Levels of mastery targeted by the competition

The test targets two skill levels: **Resources use** and **Scientific reasoning** using multiple choice questions (MCQ).

Mastery levels		Weight
Resources use	This level aims to assess, in the candidate, the degree of mastery of knowledge and skills related to the following areas: - rapid and slow transformations of a chemical system; - non-total transformations of a chemical system; - direction of evolution of a chemical system; - method of controlling the evolution of chemical systems..	**70%**
Scientific reasoning	This level aims to assess, in the candidate, the degree of mastery of the elements of the scientific approach (critical thinking, argumentation, etc.).	**30%**

Component 4 : Mathematics

- ✓ **The math test in this competition is a multiple choice quiz.**
- ✓ **This 45-minute test consists of 20 independent questions, two by two.**
- ✓ **Each question has five answers including exactly one exact answer.**

The questions will focus on content and skills that relate to the following areas:

1. Domain and sub-domain of skills covered by the competition test :

First main domain: Analysis		
Sub-domain	**Learning outcomes**	**Coverage**
Numerical Sequences	- Use geometric sequences and arithmetic sequences to study examples of sequences. - Use the limits of the reference sequences and the convergence criteria in order to determine the limits of numerical sequences. - Determine the limit of the composite of a numerical sequence and a continuous function (Sequence in the form $v_n = f(u_n)$) - Study the convergence of a sequence (u_n) in the form $u_{n+1} = f(u_n)$ where f is a continuous function on an interval I verifying $f(I) \subset I$ and determine its limit. - Use numerical sequences to solve various problems from mathematic.	**60%**
Continuity, differentiation, study of functions and calculus of integral	- Study the continuity and the differentiabilityof a numerical function at a point. - Study the continuity and the differentiabilityof a numerical function on an interval. - Determine the image of an interval or a segment by a continuous function or by a continuous and strictly monotonic function. - Apply the Intermediate Value Theorem to study some equations and inequations or to study the sign of some expressions… - Apply the Intermediate Value Theorem, in the case of a continuous and strictly monotonic function on an interval, to prove the uniqueness of the solution of the equation: $f(x) = \lambda$	

	- Study the Differentiability of a numerical function at a point and on an interval. - Determine the derivative function of a numerical function. - Determine the monotonicity of a function. - Determine the sign of a function using its variations table. - Solve application problems about minimum values and maximum values. - Use the first derivative and the second derivative to study a numerical function and to prove some inequalities… - Determine the primitive functions of usual functions. - Use derivation formulas to determine the primitive functions of a function on an interval. - Master the algebraic calculation on Logarithms and exponentials. - Master and solve logarithmic equations, inequalities and systems. - Recognize and apply the decimal logarithm (in particular to solve equations in the form $10^x = a$ and inequalities in the form $10^x \leq a$ or $10^x \geq a$) - Master and apply the basic limits of the Napierian exponential function. - Master and apply the basic limits of the Napierian logarihm function. - Master the study of functions containing the Napierian exponential function and the Napierian logarithm. - Solve the differential equation: $y' = ay + b$ - Solve the differential equation: $y'' + ay' + by = 0$ - Use a primitive function or the technique of integration by parts in order to calculate the integral of a function. - Use the integral properties. - Calculate the domain's area delimited by two curves in the plane. - Calculate the volume of the solid of revolution generated by the rotation of the curve of a function about the x-axis.	

Second main domain: Algebra and Geometry		
Sub-domain	**Learning outcomes**	**Coverage**
Complex numbers	- Master algebraic calculations on the complex numbers (In their writings : algebraic, trigonometric and exponential) - Go from the algebraic form to the trigonometric form of a complex number and inversely. - Linearize trigonometric monomials using the exponential form of a complex number. - Interpret, using the complex tool, the following geometrical concepts: distance between two points, measurement of angles, collinearity of points, collinearity and orthogonality of vectors. - Express the translation, the homothety and the rotation using complex tools. - Recognize a translation , homothety or rotation from their complex expressions. - Using complex numbers to solve geometric problems (collinearity, orthogonality…). - Solve a second degree equation with one variable and real coefficients. - Solve equations which lead to a second degree equation with one variable and real coefficients.	**40%**
Geometry in space	- Express and prove the orthogonality of two vectors using the Scalar product. - Express vectorially the orthogonality and its properties. - Express analytically the orthogonality and its properties. - Determine an equation of a plan defined by a point and a normal vector. - Determine a parametric representation of a straight line passing through a point and orthogonal to a plane. - Study the set of points $M(x,y,z)$ such that : $x^2+y^2+z^2+ax+by+cz+d=0$ - Determine a Cartesian equation of a sphere defined by its center and its radius. - Recognize the set of points M in space verifying	

	$\overrightarrow{MA}.\overrightarrow{MB}=0$. - Use the distance of a point to a plane to solve geometrical problems (relative positions of a plane and a sphere and of a straight line and a sphere…). - Calculate the area of a triangle using the cross product. - Determine the equation of a plane defined by three non collinear points. - Use the distance of a point to a straight line to solve geometrical problems. - Apply the cross product to solve geometrical problems	
Calculating probabilities	- Using the appropriate counting model according to the studied situation. - Calculate the probability of the union of two events, the probability of the opposite event of an event and the probability of the intersection of two events. - Calculate the conditional probability and use it to determine the probability of the intersection of two events. - Recognize the independence of two events. - Determine the law of probability of a random variable and calculate its diverse parameters. - Recognize the binomial law and apply it in various situations.	

2. The levels of skills targeted by the competition test :
The test targets three levels of skills :

Skill Level	Weight
Direct application of knowledge (a definition, a property, a theorem, an algorithm, a formula, a technic, ...)	**30 %**
Evoke and apply non-explicit knowledge in a question in familiar situation.	**50 %**
Deal with unfamiliar situations using knowledge synthesis and results.	**20 %**