إلى السيدات والسادة:

مديرة ومديري الأكاديميات الجهوية للتربية والتكوين

المديرات والمديرين الإقليميين

مفتشات ومفتشي التعليم الثانوي التأهيلي

مديرات ومديري الثانويات التأهيلية العمومية والخصوصية

الموضوع: **المسالك الدولية للبكالوريا المغربية - خيار انجليزية: الإطار المرجعي لاختبار الامتحان الوطني الموحد للبكالوريا.**

مادة الفيزياء والكيمياء - شعبة العلوم التجريبية - مسلك علوم الحياة والأرض.

المراجع : - قرار وزير التربية الوطنية والتكوين المهني رقم 52.16 صادر في 23 ربيع الأول 1437 (04 يناير 2016) بتغيير وتتميم- - قرار وزير التربية الوطنية والتعليم العالي وتكوين الأطر والبحث العلمي رقم 2385.06 بتاريخ 23 رمضان 1427 (16 أكتوبر 2006) في شأن تنظيم امتحانات نيل شهادة البكالوريا ؛

- مقرر وزير التربية الوطنية رقم 16-029 صادر في13 ماي 2016 موافق ل 06 شعبان 1437 بشأن دفتر مساطر تنظيم امتحانات نيل شهادة البكالوريا؛
- مذكرة رقم 39 بتاريخ 26 فبراير 2010 في شأن الأطر المرجعية لاختبارات الامتحان الوطني الموحد للبكالوريا؛
- مذكرة رقم 14/105 بتاريخ 05 يونيو 2014 في شأن تحيين الأطر المرجعية لاختبارات الامتحان الوطني الموحد للبكالوريا.

سلام تام بوجود مولانا الإمام،

وبعد، فمواصلة للجهود الرامية إلى الرفع من جودة التكوين، وانسجاماً مع التوجهات الهادفة إلى تحسين الممارسة التقويمية والرفع من مصداقيتها، وضماناً لمصداقية نتائج امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية وموثوقيتها، وكذا جعل القرارات المترتبة عنها تعكس بدقة أداء المترشحات والمترشحين، وفي سياق إرساء المسالك الدولية للبكالوريا المغربية، عملت الوزارة على إعداد الأطر المرجعية الخاصة **باختبار مادة الفيزياء والكيمياء**، قصد اعتمادها في بناء مواضيع اختبارات المواد المعنية بالامتحان المذكور ابتداءً من الموسم الدراسي الحالي 2017- 2018.

هذا وقد تمّ إعداد الأطر المرجعية المعنيّة والمصادقة عليها من طرف لجن وطنية تخصصية.

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1. الأهداف

تَتحدد الأهداف من اعتماد الأطر المرجعية في:

- التّحديد الأدق لما يجب أن يستهدفه الامتحان الوطني الموحد لنيل شهادة البكالوريا المغربية للمسالك الدولية من كفايات ومهارات ومضامين وذلك بهدف التوجيه الأنجع لتدخلات مختلف الفئات المعنية بإعداد المترشحين والمترشحات لاجتياز هذا الامتحان؛
- الرّفع من درجة صلاحية امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية بجعله أكثر تغطية وتمثيلية للمنهاج الرسمي؛
- تدقيق الأساس التعاقدي للامتحان بالنسبة لجميع الأطراف المعنية من أساتذة وتلاميذ ولجن إعداد المواضيع؛
- اعتماد معيار وطني موحد لتقويم مواضيع امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية.

2. بنية الإطار المرجعي

يَستند وضع الأطر المرجعية لمواضيع امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية على التحديد الدقيق والإجرائي لمعالم التحصيل النموذجي للتلاميذ عند نهاية الدراسة بمسالك البكالوريا المغربية للمسالك الدولية وذلك من خلال:

- ضَبط المجالات المقررة بمرجع التكوين مع حصر درجة الأهمية بالنسبة لكل مجال من مجالاتها ؛
- تحديد الكفايات والمهارات والقدرات المسطرة تحديداً إجرائياً، بالنسبة لكل مستوى مهاري داخل المنهاج الرسمي؛
- تَحديد شروط الإنجاز.

3. توظيف الإطار المرجعي

تُوظّف الأطر المرجعية في بناء مواضيع الاختبارات المتعلقة بمختلف المواد المعنية بالامتحان وذلك بالاستناد إلى المعايير التالية:

1. **التغطية** : أن يغطي موضوع الامتحان كل المجالات المحددة في الإطار المرجعي الخاص بكل مادة دراسية.
2. **التمثيلية** : أن تعتمد درجة الأهمية المحددة في الإطار المرجعي لكل مجال من مجالات المواد الدراسية ولكل كفاية أو مستوى مهاري في بناء موضوع الاختبار وذلك لضمان تمثيلية هذا الأخير للمنهاج الرسمي المقرر.

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3. **المطابقة** : أن يتم التحقق من مطابقة الوضعيات الاختبارية للمحددات الواردة في الإطار المرجعي على ثلاث مستويات:

- الكفايات والمهارات؛
- المواد الدراسية ومجالاتها؛
- شروط الإنجاز.

هذا، وحتّى يحقق هذا الإجراء الأهداف المتوخاة منه، باعتباره خطوة أساسية للرفع من صلاحية وموثوقية امتحان نيل شهادة البكالوريا المغربية للمسالك الدولية، يشرفني أن أطلب منكم الحرص على تنفيذ ما يلي:

- استنساخ هذه المذكرة وتوزيعها على المعنيين بالموضوع، مع العمل على إطلاع مختلف المترشحين والمترشحات لامتحان نيل شهادة البكالوريا المغربية للمسالك الدولية على فحواها؛
- تَمكين السيدات والسادة المفتشات والمفتشين من عقد اجتماعات ولقاءات تربوية لإطلاع المتدخلين المعنيين على مضامين الأطر المرجعية مع التأكيد على ضرورة اعتماد هذه الأخيرة في تأطير المكلفين بإعداد اقتراحات مواضيع الامتحان الوطني الموحد لنيل شهادة البكالوريا المغربية للمسالك الدولية ابتداء من دورة 2018؛
- دَعوة السيدات والسادة المفتشات والمفتشين إلى تنظيم لقاءات تربوية مع السيدات والسادة الأستاذات والأساتذة لاعتماد هذه الأداة في التخطيط للتدريس وتوظيفها في إعداد فروض المراقبة المستمرة.

واعتباراً للأهمية البالغة التي يكتسيها هذا الموضوع، فإني أهيب بالجميع، كل من موقعه، إيلاءه كل الاهتمام والعناية اللازمتين.

والسلام.

عن الوزير وبتفويض منه
الكاتب العام
لقطاع التربية الوطنية
يوسف بلقاسمي

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Royaume du Maroc

Ministère de l'Education Nationale et de la Formation Professionnelle

A Reference Framework for the National Baccalaureate Exam

International Options of the Moroccan Baccalaureate

English Option

Subject: Physics and Chemistry

Section: Experimental Sciences

Stream: Life and Earth Sciences

February, 2018

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I- Introduction

The Ministry of National Education and Vocational Training has prepared a reference framework related to the subject of Physics and Chemistry, a methodology tool aiming to ameliorate, specify and adapt assessment tools to the requirements of the Official Guidelines of Physics and Chemistry.

II- Objectives

The objectives of this reference framework are the following:

- synchronising the vision of different national Baccalaureate exam commissions concerning the acquired knowledge and skills regardless of different school textbooks of Physics and Chemistry in use.
- providing equal opportunities by improving the degree of final exam validity through a comprehensive syllabus and thorough programme coverage.
- adopting the same framework by all stakeholders so that exam preparation could be achieved jointly and in the spirit of a contract involving teachers, learners and review panels.
- offering a resource tool that could serve as evaluation of final exams.
- providing guidelines for the preparation of continuous assessment and therefore exploiting the results in order to subsequently enable learners to master school curricula content and basic skills inherent in these programmes.

III- The layout of the Framework:

This framework is based on a precise and operational definition of learners' educational background knowledge in Physics and Chemistry at the end of secondary school. This would be achieved through:

- ✓ Determining the contents of Physics and Chemistry programmes and their corresponding importance in terms of weighting and grading.
- ✓ Giving an operational definition of skills and competencies set by specifying the degree of importance of each level of competence.
- ✓ Determining the conditions of programme completion.

IV- The purpose of the framework:

This Reference Framework serves as a basic document for designing Physics and Chemistry Baccalaureate tests taking into account the following criteria:

- ✓ **Programme Coverage**

  The final exam paper should cover all programme contents of the subject defined in the framework.

- ✓ **Representativeness**

  The construction of the examination paper should consider the weighting of each area and the weighting of each skill level as defined in the Frame of Reference for a better representation of current syllabi.

- ✓ **Alignment with the Standards :**

  Ensure that the evaluation situations are in conformity with:
  - Skills and abilities;
  - Content;
  - Conditions of implementation.

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V- Contents

This framework is considered as a comprehensive contractual document; it consists of the following:

1. Types of assessment and exam layout;
2. Table of contents:
   - List of target resources (knowledge and skills) to be assessed;
   - Content areas and weighting;
3. Table of skill levels, their components and their weighting;
4. Specification table

Appendix:

- Physics and Chemistry Programme;
- List of laboratory work/experiments;
- Targeted skills.

1. Types of assessment and exam layout:

Summative assessment in the second year Baccalaureate cycle aims to cover a set of elements and check the candidate's level of mastery of these elements through familiar or new learning situations associated with the basic learning acquired in the classroom. These situations have to be tested through the themes. These exercises, which may gradually increase in difficulty, can start with an assessment situation and can be subdivided into independent parts.

The theme-based exercises should be related to the basic learning acquired in the classroom during courses and laboratory work, and should also be based on familiar situations and syntheses. They allow using both knowledge and skills related to the compounds of the school programme and the adoption of the scientific approach as suggested by skill levels. All this is well defined in this reference framework.

While dealing with the testing situations targeted by this summative assessment, the knowledge and the know-how to be tested should be exploited through scientific applications closely related to the real world and to the different parts of the programme with the possibility of expanding the assessment of the knowledge and skills to include physical or chemical quantities related to the fundamental quantities mentioned in the Framework.

1.1. Types of Assessment:

The exam paper may present test situations designed to assess the knowledge and the know-how using test items such as:

- MCQ (multiple choice questions);
- T/F (True/False);
- Matching…;
- Short-answer questions;
- Essay questions;
- Synthesis questions, Complex issues (whose solutions require the use of knowledge and know-how related to one or more areas).

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1.2. The Structure of the National Exam Paper:

✓ **The Exam Paper Components :**

- The Physics and Chemistry national Baccalaureate exam paper covers the whole programme and takes place at the end of the secondary school education.
- The Physics/Chemistry national exam test paper, Experimental Sciences section, for Life-Earth sciences streams – consists of 3 or 4 thematic exercises:

✓ **Completion Time:** three (3) hours.

✓ **The candidate is authorized to use:** a non-programmable scientific calculator, writing and drawing pens and pencils.

✓ **Correction Grid**: It should include the number of the test item and the mark assigned to it; the questions numbers; the answer key corresponding to each question; the mark assigned to each question; a column mentioning the question reference according to the Framework of Reference.

2. Table of Content areas:

The table of contents presents the content areas targeted by the assessment and the list of essential objectives (knowledge and skills) related to each content area. This knowledge and skills constitute the minimum threshold for candidates to be tested on.

This table also highlights the importance of weighting of each content, based on the time allotted to the completion of that content in the syllabus.

List of the required knowledge and skills

First Major Part: Physics

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 displacement of a point from the propagation medium and the source displacement: $y_M(t) = y_S(t-\tau)$.
- Exploit the relationship between time delay, distance and wave speed.
- Exploit experimental documents and data in order to determine:
  * distance;
  * time delay;
  * wave speed.
- Suggest a scheme 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 scheme of an experimental set-up to highlight the phenomenon of the diffraction in the case of audible and ultrasonic mechanical wave.

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: $\lambda = \frac{c}{v}$.
- Define a monochromatic and a polychromatic light.

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- Know the boundaries of wavelengths and their colours for the visible spectrum in the vacuum.
- Know thatthe 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: $n = \frac{c}{v}$
- Determine (find out) the refractive index of transparent medium for a given frequency.
- Suggest the scheme 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 corresponding composition of the 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. Nucleus, Mass and Energy

- Define and calculate the mass defect and the binding energy.
- Define and calculate the binding energy per nucleon and exploit it.
- Use different units of mass, energy and the relationships between their units.
- Exploit the binding energy per nucleon curve (Aston curve) to identify the most stable nucleus.
-Know the relationship of the mass-energy equivalence;and calculate the energy of mass.

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- Write the equations of the nuclear reactions by applying the two conservation laws.
-Recognise the type of nuclear reaction using the reaction equation.
- 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: $E_{pro} = |\Delta E|$.
- Recognise some applications of radioactivity.
- State some risks of radioactivity.

The Third Topic:Electricity

1- RC Dipole (RC Circuit)

- 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 orin parallelassemblies; and recallthe 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 intensity current 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.
  *determine the time-constant and charge duration.
  *determine the state type (transient or steady) and the time interval for each one.
- Suggest the scheme of the experimental assembly that allowsstudying the response of the RC dipole submitted to a step voltage.
- Know how to connect an oscilloscope and a data logger 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.

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2. RL Dipole (RL Circuit)

- 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 quantitiesinvolved 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 appearance and the disappearance 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 how to connect an oscilloscope and a data logger 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 aninductor.

3. RLC Series Circuit

- Recognisethe undamped (periodic), the underdamped (pseudo-periodic) and the overdamped (non-periodic)states.
- 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 for 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.

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- 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 compensatesthe 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 dampingstates;
  * 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 data logger 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 $\Sigma\overrightarrow{F_{ext}} = m.\dfrac{\Delta\overrightarrow{V_G}}{\Delta t}$ 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.

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- 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.
- 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 pathand 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 exploitboth 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.

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Second Major Part: Chemistry

The First Topic:Fast and Slow Transformations of a Chemical System

1. Fast and slow transformations

- Write the equation of the reaction associated with aredox (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.
- Exploitthe different curves of time-evolution of the following:
  theamount of substance of a chemical species, its concentration, the progress of a reaction, andpressure .
- Draw the progress table ofa reaction and exploit it.
- Know the expression of the volume rate of reaction.
- Know the effect of reactant concentration and the temperature on the volumetric rate of reaction.
- Explain qualitatively the reaction rate change using 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.

The Second Topic:Non-Completion Transformations of a Chemical System

3. 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 theconcentration 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.

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4. Equilibrium State of a Chemical System

- Use the relationship linking the conductance G of a solution partto 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.

5. 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 constantK_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 pair acid/base.
- Exploit the predominance and distribution diagrams of acidic and basicchemical species existing in aqueous solution.
- Write the equation of titration reaction (useonly 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

6. 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.

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7. 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-equationthat occurredin 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 speciesproduced or consumed, the current intensity and the operating durationof a battery. Exploit this relationship to determine other quantities (quantity of charge, progress of the reaction, change of the mass...).

The Fourth Topic:Control Method of theEvolution of Chemical Systems

8. 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 hydrolysisequation.
- 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 catalystis 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 product displaces the equilibrium state of the system in the forward direction.
- Determine the composition of reaction mixture ata given time.

9. 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 carboxylateion (long chain).
- Know theaccelerant and selective catalyst roles.

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Contents and their weighting

The following table highlights the weighting of each content.

Principal Part	Topic	Weight
PHYSICS	Waves	14 %
	Nuclear Transformations	8 %
	Electricity	19 %
	Mechanics	26 %
CHEMISTRY	Fast and Slow Transformations of a Chemical System	7 %
	Non-completion transformation of a chemical system	11 %
	Evolution direction of a chemical system	7 %
	Control method of the evolution of chemical systems	8 %

3-Table Containing Skill Levels, their Components and their Weighting

In addition to assessingthe knowledge and skills inherentinthe different parts of the program at the end of the second year of the high school (Baccalaureate cycle), the credential assessment will focus on a set of fundamental skills in science, three classified levels as shown in the following table:

Skill level	Components	Weight
Using resources (Knowledge and skills)	• Know and use: symbols - conventions - units - physical quantity order - definitions - laws - principles - models - formulae - relationships… • Describe and explain a phenomenon. • Predict the evolution of a physical phenomenon or a chemical system.	60%
Applying an experimental solution	• Suggest an experimental process. • Suggest the scheme of an experimental set-up. • Distinguish different parts of an experimental set-up and determine the function of each part. • Exploit experimental data, analyse and draw conclusions. • Predict the possible risks in experimental situation and use appropriate security measures	15 %
Solving the problem	• Mobilize necessary resources. • Organize resolution steps. • Use mathematical tools, curves and tables. • Construct a logical deduction or prove it. • Describe and analyse data or scientific results, and present practical conclusions. • Give an opinion or express a critical view.	25%

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4- Specification Table

The table of specification presents:

- The contents and their weighting;
- The skill levels and their weighting;
- Contents and skill levels expressed as a percentage.

Major Part	Topics / Skill levels	Usingresources	Applying an experimental solution	Solving the problem	TOTAL
		60%	15 %	25 %	
PHYSICS	Waves	8,4 %	10 %	3,5 %	14 %
	Nuclear Transformations	4,8%		2%	8 %
	Electricity	11,4 %		4,75 %	19 %
	Mechanics	15,6 %		6,5%	26 %
CHEMISTRY	Fast and Slow Transformations of a Chemical System	4,2%	5 %	1,75%	7 %
	Non-completion transformation of a chemical system	6,6%		2,75 %	11 %
	Evolution direction of a chemical system	4,2%		1,75 %	7 %
	Control method of the evolution of chemical systems	4,8 %		2%	8 %
TOTAL		60 %	15 %	25 %	100 %

Appendix1: Physics and Chemistry Program

First Major Part : Physics

Introduction :

Questions asked to a physicist

- Some physics activities and the role of physics in any society.
- Some questions asked to the physicist during his professional activities.

The First Topic: Waves

1. Progressive Mechanical Waves.

1.1. Definition of a mechanical wave speed.

1.2. Longitudinal waves, transverse, and their characteristics.

1.3. Monodimensional wave - time delay notion.

2. Periodic Progressive Mechanical Waves.

2.1. Notion of the periodic progressive mechanical wave: temporal periodicity, spatial periodicity.

2.2. Sinusoidal progressive wave: period, frequency and wavelength.

2.3. Highlight experimentally the diffraction phenomenon in the case of a sinusoidal mechanical wave.

3. Propagation of a Light Wave.

3.1. Highlight the diffraction of light experimentally.

3.2. Propagation of the light in the vacuum: wave model of the light.

3.3. Propagation of the light in transparent media: index of the media - highlight the light dispersion phenomenon by a prism.

The Second Topic: Nuclear Transformations

1. Radioactive decay

1.1. Stability and instability of nucleus: nucleus composition - isotopic - notation ${}^{A}_{Z}X$ - (N, Z) diagram.

1.2. Radioactivity:

- Radioactivity α, β^{+}, β^{-} and emissionγ.
- Conservation laws of the electric charge and the number of nucleons.

1.3. Radioactive decay law: changes in substance radioactive- importance of radioactivity - half-life - application to radioactive dating.

2. Nuclei - Mass and Energy

2.1. Equivalence " mass-energy ": mass defect - binding energy - units - binding energy per nucleon- equivalence " mass-energy " - Aston curve.

2.2. Mass balance and energy to nuclear transformation. Examples of radioactivity α, β^{+} and β^{-}.

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The Third Topic: Electricity

1. RC Dipole

1.1. The capacitor:

- Brief description of capacitor- symbol - plate charges – current intensity – algebraization in receiver convention for the physical quantities i, u and q.

- Relationship $i = \frac{dq}{dt}$ for a capacitor receiver convention.

- Relationship $q = C.u$ capacitance of a capacitor, its unit

- Association of capacitors in series and in parallel.

1.2. RC Dipole

- Response of the RC dipole to a voltage step:

* Experimental study.

* Theoretical study.

- Energy stored in a capacitor.

2. RL Dipole

2.1. The inductor (coil).

- Brief description of an inductor - symbol.

- Voltage (potential difference) between the inductor's terminals in receiver convention: $u = r.i + L.\frac{di}{dt}$.

- Inductance - its unit.

2.2. RL dipole.

- Response of the RL dipole to a voltage step:

  * Experimental study.

  * Theoretical study.

- Stored energy in an inductor.

3. Free oscillations in a RLC series circuit.

- Discharge of a capacitor through an inductor.

- The influence of damping - period.

- Energetic interpretation: The transfer of energy between the capacitor and the inductor, Joule effect..

- Analytical study in the case of a weak damping (negligible resistance) - Natural period.

- Maintenance of the oscillations:

  * Experimental study.

  * Theoretical study.

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The Fourth Topic: Mechanics

1. Newton's Laws.

1.1. Velocity vector – acceleration vector - acceleration vector in the Frenet frame.

1.2. Newton's second law: the role of mass - importance of the choice of frame of reference in the study of a solid centre of inertia motion - Galilean frame of reference.

1.3. Newton's third law: principle of reciprocal actions.

2. Applications:

2.1. Vertical free fall of a solid:

2.2. Motion of a solid on a horizontal plane and an inclined plane.

2.3. Motion of a projectile in the uniform gravitational field.

3. Oscillating Systems.

3.1. Presentation of oscillating mechanical systems.

- Physical pendulum, simple pendulum, torsion pendulum and the system (solid-spring) in free oscillations: equilibrium position, amplitude and natural period.
- Damping of oscillations.

3.2. Oscillating system (solid-spring):

- Restoring force exerted by a spring - differential equation of motion of a solid in the case of weak friction - natural period - damping.

3.3. Resonance phenomenon:

- Presentation of the experimental phenomenon: driver – resonating system - amplitude and period of oscillations - influence of damping - examples of mechanical resonance.

4. Energy Aspects.

- Work of an external force exerted by a spring - elastic potential energy.
- mechanical energy of the system (solid-spring).

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Second Major Part: Chemistry

Introduction:

Questions Asked to a Chemist

-some chemistry activitiesand the role of chemistry in society.

- Highlight some questions asked to a chemist during his professional activities.

The First Topic: Fast and Slow Transformations of a Chemical System

1. Fast and Slow Transformations.

- Recalling the pairs Ox/Red and writing the redox reactions equations. Use the symbol $\rightleftarrows$ when writing the half-equation characterizing the pair Ox/Red.
- Demonstrate experimentally fast and slow transformations.
- Demonstrate experimentally the kinetic factors: temperature and concentration of reactants.

2. Temporal Monitoring of a Chemical Transformation – Rate of Reaction

- Plot the curves of evolution of the amount of substance or the chemical species concentration or of the progress of a reaction during time: Use the progress table of a chemical system evolution and exploit them experimentally.
- Rate of reaction: Definition of volumetric rate of a reaction expressed in quantity of matter (amount of substance) per unit of time and volume: $v = \frac{1}{V}.\frac{dx}{dt}$ with x reaction progress and V volume of solution.
- Rate of reaction evolution during time.
- Half-Life of a reaction $(t_{1/2})$: its definition and method of determination – choice of the monitoring method of the transformation according to the $(t_{1/2})$ value.

The Second Topic: Non-completion transformation of a chemical system

3. Reversible chemical transformations.

- Introduction of the pH concept –measuring pH.
- Demonstrate experimentally that the final progress is different from the maximal progress, in a given chemical transformation.
- Modelling a non-completion chemical transformation by two reversible and simultaneous reactions using the writing : $\rightleftarrows$ (double arrow)
- Characterization of a non-completion chemical transformation: progress $x_f < x_{max}$.
- Final progress rate of a reaction : $\tau = \frac{x_f}{x_{max}}$, with $\tau \leq 1$.

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4. State of Equilibrium of a Chemical System.

- The reaction quotient Qr:Literal expression as function of molar concentrations of chemical species dissolved for a given state of system.
- Generalisation in different cases: homogenous aqueous solution or heterogenic (presence of solids).
- Determination of the value of the reaction quotient Qr ,eq in an equilibrium state of a given system.
- Equilibrium Constant K associated with the equation of a reaction, at a given temperature.
- Influence of initial state of a system on the final progress rate of a reaction.

5. Transformations associated with acid-base reactions in aqueous solutions.

- Autoprotolysis (self-ionization) of water.
- The ionic product of water, K_e.
- pH scale: acid solution, basic solution and neutral solution.
- Acidity constant of an acid/ base pair,denoted KA.
- Comparison of the behaviours, in aqueous solution, of the acids or bases having the same concentration.
- Equilibrium constant associated with an acid-base reaction.
- Predominance and distribution diagrams of acidicand basicchemical species existing in aqueous solution.
- Range of colour change of the indicators' acid-base.
- pH-metric titration of an acid or a base in aqueous solution to determine the volume added to reach the equivalence and choose asuitable indicator.

The Third Topic: Direction of Evolution of a Chemical System

6. Spontaneous Evolution of a Chemical System

- Criterion of spontaneous evolution: over time, the value of the reaction quotientQ_r tends towards the equilibrium constant K.
- Illustration of this Criterionon acid-basic reactions and redox reactions.

7. Spontaneous transformations in electrochemical cells (batteries) and recovery of energy.

- Spontaneous transfer of electrons between chemical species (mixed or separated) of two Ox/Red pairs of metal ion/metal type, $M^{n+}/M(s)$.
- Components and operation of a an electrochemical cell : Observation of the direction of the electric current flow, measurement of electromotive force E (e.m.f.), motion of charge carriers, role of the salt bridge(electrolytic junction), electrode reactions.
- The cell is a system in disequilibrium during its operation as generator. During the spontaneous evolution, the value of the reaction quotient tends towards the equilibrium constant.
- The cell in equilibrium « Used cell »: maximum quantity of electricity charged in a circuit.

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The Forth Topic: Control Method of the Evolution ofChemical Systems

8. Esterification and Hydrolysis Reactions.

- Production of an ester using carboxylic acid and alcohol, writing the corresponding equation of the reaction.
- Hydrolysis of an ester, writing the corresponding equation of the reaction.
- Experimental demonstration of astate of equilibrium in the case of transformations involving esterification and hydrolysis reactions.
- Definition of the yield of a transformation.
- Definition of a catalyst.
- Control of reaction rate: temperature and catalyst.
- Control of final state of a system: abundance of a reactant or removing of a product.

9. Control of the evolution of chemical systemsby changing a reactant or byusing catalysis.

- **by changing a reactant**

- Synthesis of an ester using anhydride acid and alcohol
- Hydrolysis basic of esters: applications on the saponification of fatty bodies (Preparation of soap, Recognise its proprieties, links structure-proprieties).

- **by Using Catalysis**

Appendix 2: List of Practical Work

The First Principal Part: Physics

The First Topic: waves

Experiments	Objectives
1-Measuring the speed of a mechanical wave.	▪ Determine the speed of propagation : * of a mechanical wave along a string or on the surface of the water. * of a sound wave. ▪ Highlight the speed of propagation is independent of the shape of the wave.
2-Diffraction of a sound or ultrasonic wave.	▪ Monitor the diffraction of a sound or ultrasonic wave. ▪ Highlight the maximum and minimum values of the amplitude of waves.
3-Diffraction of light waves.	▪ Highlight the phenomenon of diffraction experimentally. ▪ Verify the relationship: $\theta = \frac{\lambda}{a}$.
4-Dispersion of white light.	▪ Determine the refractive index of a transparent medium.

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The Third Topic: Electricity

Experiments	Objectives
1- Charging a capacitor by an ideal current generator. - Response of a RC dipole to a voltage step.	▪ Determine the capacitance of a capacitor. ▪ Highlight the influence of R and C on the response of RC dipole and measure the time constant.
2- Voltage between the terminals of an inductor in the case of applying a triangular voltage. - Response of a dipole RL to a voltage step	▪ Determine the inductance of an inductor (coil). ▪ Highlight the influence of R and L on the response of RL dipole and measure the time constant.
3- Free Oscillations in a RLC series circuit.	▪ Monitor the evolution of the current intensity. ▪ Monitor the different oscillations states. ▪ Monitor the influence of the resistance of the circuit on the state of oscillations

The Fourth Topic: Mechanics

Experiences	Objectives
1- Newton's Laws	▪ Verify Newton's second law experimentally.
2- Vertical free fall	Determine the relationship between instantaneous speed v and the time t. ▪ Resulting in relations v^2 (x) and x (t^2) characterizing the free fall without initial velocity.
3- Motion of a projectile in a uniform gravitational field.	▪ Highlight the factors influencing the trajectory of a projectile.
4- Oscillating system (solid - spring)	▪ Highlight the physical factors influencing the natural period of an oscillator. ▪ Highlight the damping phenomenon, the different types of damping and oscillations states.
5- Mechanical resonance.	▪ Study the influence of the driver (exciter) period on the amplitude of the resonating system. ▪ Study the influence of damping on the resonance.

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The Second Principal Part: Chemistry

Experiments	Objectives
1- Highlight kinetic factors	▪ Highlight the influence of reactant concentrations and temperature on therate of evolution of a chemical system.
2- Time monitoring of chemical reaction by measuring conductance.	▪ Measure the conductance of aqueous solution during and after the end of reaction; ▪ determiner the half-life of reaction $(t_{1/2})$.
3- Final progress of acid-base reaction.	▪ Measure the pH of both the hydrochloric acid solution and the ethanoic acid solution and determine the final reaction progress.
4- Determination of the chemical equilibrium constant measuring conductance.	▪ Calculate the final progress rate and the equilibrium constant of reaction of a weak acid with water.
5- Components and operation of a cell.	▪ Make electrochemical cells using the pairs M^{n+}/M type and deduce the spontaneous direction of transformations.
6- Esterification and Hydrolysis.	▪ Study the temporal evolution of esterification reaction. ▪ Determine the yield of esterification and the yield of hydrolysis in equilibrium.
7- Preparation and proprieties of soaps.	▪ Preparesoap by reaction betweencaustic soda and oil. ▪ Highlight some proprieties of the soap.

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Appendix 3: Targeted Skills

• **Waves**

- Using the wave model to interpret phenomena related to the propagation of mechanical or optical waves, and solving problem situations about the wave propagation.

• **Nuclear transformations**

- Modelling nuclear transformations and dating an action by applying the law of radioactive disintegration; doing the energy balance of a nuclear transformation and resolving problem situations about nuclear transformations.

- Knowing the importance of nuclear transformations in technological development and its likely effects on the environment and the precautionary measures to be taken.

• **Electricity**

- Modelling the behaviour of the capacitor and the inductor (coil) in an electrical circuit and analyzing their responses to a voltage step; studying the free oscillations in a series RLC circuit.

• **Mechanics:**

- Analyzing, monitoring and predicting the evolution of a mechanical system by adopting a simple model.

- Solving a problem situation related to a mechanical system in motion via a dynamic or energy study.

• **Fast and Slow Transformations of a Chemical System**

- Checking the reaction speed by acting on kinetic factors to accelerate the synthesis of chemical species, or to eliminate the effects of the products used, or to decrease the reaction rate to conserve food and protect it from decomposing.

Non-completion Transformation of a chemical System

- Using the final progress rate to distinguish between the total transformation and the non-completiontransformations and determining the composition of the final state of a chemical system using the equilibrium constant in different cases.

• **The Direction of evolution of a Chemical System**

- Using the criterion of evolution to determine the direction of the spontaneous evolution of a system and exploiting this sense to recover electrical energy in the case of redox reactions.

• **Control Method of the Evolution of Chemical Systems**

- Running an experimental protocol to manufacture specific chemical species and increase its yield by using a more efficient reactant and a suitable catalyst.