الأطر المرجعية المكيفة الخاصة بالامتحان الوطني الموحد لنيل شهادة البكالوريا – دورة 2020 –

المسالك الدولية: خيار أنجليزية

الإطار المرجعي لمادة الفيزياء والكيمياء

شعبة العلوم التجريبية

مسلك العلوم الفيزيائية

First Principal 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

- Recognize 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 recognize 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 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: $\lambda = \frac{c}{\upsilon}$.
- Define a monochromatic and a polychromatic light.
- Know the boundaries of wavelengths and their colours for the visible spectrum in the vacuum.
- Know 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: $n = \frac{c}{v}$

- 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.
- Recognize the isotopes of a chemical element.
- Recognize 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.
- Recognize 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.
- Define the fission and fusion.
- Analyze the binding energy per nucleon curve (Aston curve) to emphasize the energetic interest of fission and fusion.
- Write the equations of nuclear fission and fusion by applying the two laws of conservation.
-Recognize 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: $E_{pro} = |\Delta E|$.
- Recognize some applications of radioactivity.
- State some risks of radioactivity.

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 $\mu F, nF \text{ and } pF$.
- 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 intensity current in the circuit and the capacitor charge.
- Recognize and represent the variation curves of $u_C(t)$ between the capacitor terminals and different physical quantities associated to it, and exploit them.
- Recognize 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:
  * recognize 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's type (transient or steady) and the time interval for each one.
- Suggest the scheme of the experimental assembly that allows studying the response of the 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.
- Find out the expression of the electric energy stored in a capacitor.
- Know and exploit the expression of the electric energy stored in a capacitor.

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 (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 terminals and the resistor terminals.
- Recognize 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:
  * recognize 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 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.
- find out the expression of the electro-magnetic energy stored in an inductor.
- Know and exploit the expression of the magnetic energy stored in a inductor.

3-RLC Series Circuit

- Define and recognize the undamped (periodic), the underdamped (pseudo-periodic) and the overdamped (non-periodic) states.
- Recognize and represent the variation curves of the voltage between 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 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:
  * recognize the observed voltages;
  * recognize the damping 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.

4-Applications:

- know the main processes necessary to transform information into oral or written messages.
- Know the transmission speed of the information.
- Know that the light is part of the electromagnetic waves and that it corresponds to specific boundaries of frequency.
- Know that for a transmitting antenna, the electromagnetic wave emitted has the same frequency as that the transmitted electrical signal.
- Know that in the receiving antenna, the electromagnetic wave generates an electric signal that has the same frequency.
- Know the mathematical expression of the sinusoidal voltage.
- Know that the transmission of information by electromagnetic waves takes place through energy transfer without transfer of matter.
- Know that the antenna can be used as both transmitter and receiver (the mobile phone for example).
- Know that the amplitude modulation process is to transform the modulated amplitude voltage to affine function of the modulating voltage.
- know the required conditions to avoid over modulation.
- Recognize the stages of the amplitude modulation.
- Exploit the different experimental obtained curves.
- Recognize the different stages of amplitude modulation and amplitude demodulation through their corresponding assembly schemes.
- Know the role of different used filters.
- Know and exploit the frequency spectrum.
- Know the stages of demodulation.
- Know the conditions allowing to get an amplitude modulation and a high quality detection envelope.
- Know the selective role of the LC (bung circuit) for the modulated voltage.
- Recognize the essential components required to assemble an AM radio, and their roles in the demodulation.

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 $\Sigma\vec{F}_{ext} = m.\dfrac{\Delta\vec{V}_G}{\Delta t}$ and $\Sigma\vec{F}_{ext} = m.\vec{a}_G$ and its range of validity.
- Recognize the role of mass in the inertia of a system
- Apply Newton's second law to determine the kinetic quantities $\vec{v}_G$ and $\vec{a}_G$ and dynamic quantities and exploit them.

- Know and use Newton's third Law.
- Use of the dimensional analysis (dimensional equations).

2-Applications

- Know and exploit the two models of frictional fluids (viscous forces): $\vec{F} = -k.v.\vec{i}$ and $\vec{F} = -k.v^2.\vec{i}$
- Exploit the curve $v_G = f(t)$ to determine:
  * the terminal speed;
  * the characteristic time τ ;
  * the initial state and the steady state.
- Apply Newton's second law to find out the differential equation of a solid's centre of inertia motion in frictional vertical fall.
- Know and apply the Euler's method to solve approximately differential equation.
- 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.

Second Principal 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 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 following:
  the amount of substance of a chemical specie, its concentration, the progress of a reaction, conductivity, conductance, pressure and volume.
- Draw the progress table of a 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.
- Interpret the effect of concentration of one of the reactants and/or temperature on the number of effective collisions per unit of time.

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.
- Interpret the chemical equilibrium state at a microscopic level.

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 use the expression of the reaction quotient Q_r through the reaction equation.
- Know that, the reaction quotient in equilibrium $Q_{r,eq}$, associated to 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_W, is the equilibrium constant associated with the equation of the reaction of water autoprotolysis (self-ionization of water).
- Know the relationship $pK_W = -\log K_W$
- 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 use 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 to the equation of acid-base reaction using the acid dissociation constants of existing pairs.
- Indicate the predominant chemical specie taking into consideration pH of aqueous solution and pK_A of pair acid/base.
- Exploit the predominance and distribution diagrams of acidic and basic chemical species existing in aqueous solution.
- 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 specie produced or consumed, the current intensity and the operating duration of a battery. Use this relationship to determine other quantities (quantity of charge, progress of the reaction, change of the mass...).