وزارة التربية والتعليم
MINISTRY OF EDUCATION

ترخيص المهن التعليمية
Educational Professions Licensure

Physics

Study Guide- Specialization Test

(Grade 9 – Grade 12) Teachers

Year 2020

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Educational Professions Licensure

Physics Study Guide

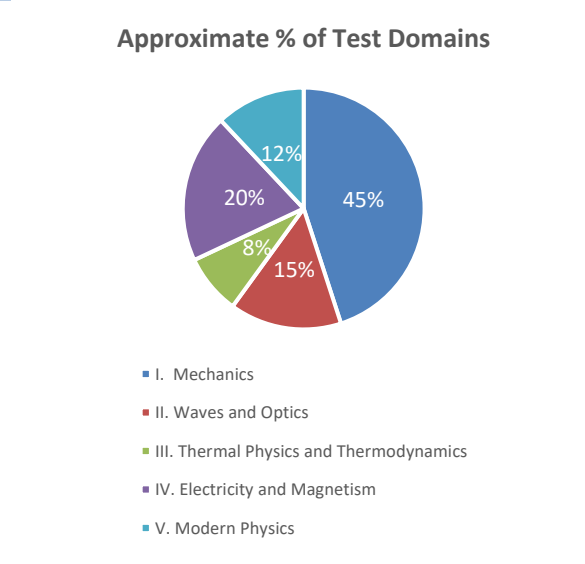
The Teacher Licensing System in the Ministry of Education of the United Arab Emirates is one of the educational priorities that aim at optimizing investment in teachers in order to help them to achieve the objectives of the ministry and to improve educational outcomes.

The Physics Test for teachers is one of the Professional teacher's license requirements for those who are teaching grade 9 to grade 12 physics.

Test Overview

Test Name	Physics Grade 9- 12 teachers
Number of questions	100
Test Duration	2.5 hours
Format of questions	Multiple Choice questions
Test Delivery	Computer delivered

Content Domain	Approximate Percentage of Test	Approximate Number of Questions
I. Mechanics	45 %	45
II. Waves and Optics	15 %	15
III. Thermal Physics and Thermodynamics	8%	8
IV. Electricity and Magnetism	20%	20
V. Modern Physics	12%	12



Test Specifications

I. Mechanics

This domain measures examinee's understanding on Translational Motion, Rotational Motion and Fluids Mechanics.

A. Translational Motion

Examinee should be able to analyze, interpret and describe the motion of objects in 1D and 2D Translational Motion in terms of kinematics and dynamics laws and laws of conservation: conservation of energy and conservation of momentum.

A.1 Examinee should be able to apply all the laws of kinematics and dynamics in order to interpret, analyze and describe translational motion for objects in different arrangements and situations. This section may include:

1. 1D Translational Motion Kinematics Quantities.
2. Kinematics Equations in Uniform Linear Motion.
3. Newton's Laws of Motion.
4. Universal Gravitation and Kepler's laws of Planetary Motion.
5. 2D Translational Motion Kinematics Quantities.
6. Projectile Motion.
7. Uniform Circular Motion and Satellite Motion.

A.2 Examinee should be able to evaluate the work done by a force or multiple forces on a given system to the changes in that system, total energy and power, and apply the law of conservation of energy to describe, analyze and solve problems that are difficult to analyze using Newton's Laws of Motion. This section may include:

1. Work done by constant or varying force.
2. Energy.
3. Power.
4. Conservation of Energy.

A.3 Examinee should be able to use the law of conservation of 1D and 2D linear momentum to describe, analyze and solve the motion of situations that are difficult to analyze using Newton's Laws of Motion such as collisions and explosions in 1D and 2D. This section may include:

1. Center of Mass.
2. Linear Momentum.
3. Impulse.
4. Conservation of linear Momentum.
5. Collisions.

B. Rotational Motion

Examinee should be able to analyze, interpret and describe the rotational motion of an extended rigid object about a fixed axis in terms of kinematics and dynamics laws and laws of conservation: conservation of angular energy and conservation of angular momentum.

B.1 Examinee should be able to apply all the laws of kinematics and dynamics in order to interpret, analyze and describe rotational motion of an extended rigid object about a fixed axis in different arrangements and situations. This section may include:

1. Rotational Motion Kinematics Quantities
2. Moment of Inertia.
3. Torque.
4. Newton's Second Law for Rotation and Static Equilibrium.

B.2 Examinee should be able to relate the work done by a torque or multiple torques on a given system to the changes in that system's total angular energy and use the law of conservation of angular energy to describe, analyze and solve problems that are difficult to analyze using Newton's Laws of Motion. This section may include:

1. Work Done by constant or varying Torque.
2. Angular Energy and Conservation of Angular Energy.
3. Angular Momentum and Conservation of angular Momentum.

C. Fluids Mechanics

Examinee should be able to analyze, interpret and describe the properties of fluids at rest and in motion using laws of fluids mechanics such as Pascal's Principle, Archimedes' Principle and Bernoulli's Equation.

C.1 Examinee should be able to analyze, predict and describe the properties of fluids at rest. This section may include:

1. Pascal's Principle.
2. Archimedes' Principle and Law of Floatation.

C.2 Examinee should be able to analyze, predict and describe the properties and the behavior of ideal fluids in motion. This section may include:

1. Fluids Flow
2. Bernoulli's Equation

II. Waves and Optics

This domain measures examinee's understanding of oscillations, waves (Mechanical waves and electromagnetic waves) and optics (geometric optics and physical optics).

A. Waves

Examinee should be able to analyze, interpret and describe different types of oscillations and explain how repeated oscillations cause periodic waves (travelling wave or standing waves) with unique properties and characteristics.

A.1 Examinee should be able to distinguish and analyze different types of oscillations: ideal oscillations, damping oscillations and forced oscillations and describe them mathematically and graphically and identify the conditions for each type of oscillations.
This section may include:

1. Simple Harmonic Motion
2. Damped Oscillations
3. Driven (Forced) Oscillations and Resonance

A.2 Examinee should be able to describe and represent different mechanical waves properties and characteristics mathematically and graphically and analyze the wave behavior of these waves such as standing waves, doppler effect, superposition and reflection.
This section may include:

1. Mechanical Waves Representations and Characteristics.
2. Mechanical Waves Behavior.
3. Sound in Motion (Doppler Effect).

B. Optics

Examinee should be able to analyze and describe the behavior and the properties of light, along with its interactions with the matter and with the instruments which are used to detect it.

B.1 Examinee should be able to analyze, describe and explain the phenomena of light wave where ray approximation of geometric optics is not valid such as interference, diffraction, and polarization.
This section may include:

1. Electromagnetic Waves
2. Polarization
3. Interference
4. Diffraction.

B.2 Examinee should be able to use ray diagrams to analyze, identify and describe the image properties and characteristics that are formed by different types of mirrors and thin lenses and explain the operation of different optical instruments and devices.

This section may include:

1. Reflection
2. Refraction
3. Mirrors
4. Thin Lenses
5. Optical instruments and devices.

III. Thermal Physics and Thermodynamics

This domain measures examinee's understanding of thermal physics concepts and quantities and thermodynamics systems, processes and laws.

A. Thermal Physics

Examinee should be able to define fundamental physical quantities (internal energy, temperature, heat) that characterize thermodynamic systems.

A.1 Examinee should be able to define and measure temperature in different temperature scales and describe how temperature change alters dimensions of materials (thermal expansion). This section may include:

1. Temperature Scales
2. Thermal Equilibrium
3. Thermal Expansion

A.2 Examinee should be able to distinguish between heat (thermal energy transfer) and temperature and describe how phase change and heat transfer occur. This section may include:

1. Quantity of Heat and Specific Heat Capacity.
2. Calorimetry and Phase Changes.
3. Mechanisms of Heat Transfer.

B. Thermodynamics

Examinee should be able to describe ideal gases and their behavior using the kinetic molecular theory of gases and use thermodynamics laws to characterize and define processes and directions of thermodynamics systems.

B.1 Examinee should be able to use the kinetic-molecular theory to explain the empirical gas laws (observations) and the behavior of ideal gases. This section may include:

1. Ideal Gas Laws.
2. Kinetic Molecular Theory.

B.2 Examinee should be able to use laws of thermodynamics to define physical quantities that characterize thermodynamics systems in equilibrium such as temperature, energy and entropy and describe the relationships between these quantities. This section may include:

1. First Law of Thermodynamics.
2. Second Law of Thermodynamics.

IV. Electricity and Magnetism

This domain measures examinee's understanding of static and current electricity, magnetism and the interaction between electricity and magnetism (electromagnetism).

A. Electricity

Examinee should be able to demonstrate an understanding of all the phenomena and application related to static and current electricity.

A.1 Examinee should be able to analyze and explain the phenomena and properties related to stationary or slow-moving electric charges. This section may include:

1. Electric Charge
2. Electrostatic Force
3. Electric Field
4. Electric Flux
5. Electric Potential and Electric Potential Energy.
6. Capacitors, Capacitance and Dielectrics

A.2 Examinee should be able to describe the motion of electric charges in conductors and distinguish between practical DC and AC circuits in terms of characteristics and applications. This section may include:

1. Electric Current
2. Direct Current (DC) Electric Circuits
3. Alternating Current (AC) Electric Circuits.

B. Magnetism

Examinee should be able to demonstrate an understanding of the concept of magnetism and magnetism related phenomena and explain how electricity could be generated from magnetism.

B.1 Examinee should be able to analyze, explain and describe all phenomena associated with natural magnets and electromagnets such as magnetic field, magnetic forces, magnetic flux, magnetic torque. This section may include:

1. Magnet and Electromagnet Properties
2. Magnetic Field
3. Magnetic Flux
4. Magnetic Force
5. Magnetic Torque

B.2 Examinee should be able to explain the concept of electromagnetic induction, that electricity could be generated from magnetism and use it to explain the operation of electromagnetic induction applications such as transformers and electric generators. This section may include:

1. Electromagnetic Induction Laws
2. Electromagnetic Induction Applications
3. Inductance and Inductors.

V. Modern Physics

This domain measures examinee's understanding of the concepts and the implications of the branch of physics that was developed in the early 20th century and onward, such as the theory of relativity and quantum physics.

A. The Theory of Relativity

Examinee should be able to distinguish between the special theory of relativity and the general theory of relativity and use them to explain many modern physics phenomena such as nuclear physics, astronomy and cosmology.

A.1 Examinee should be able to explain the implications of Einstein's Special Theory of Relativity and describe how Newtonian mechanics failed to explain properly the motion of objects whose speeds approach that of light. This section may include:

1. Einstein's Special Theory of Relativity Postulates.
2. Relativity of Simultaneity.
3. Relativity of Time Intervals.
4. Relativity of Length.
5. Relativistic Momentum
6. Mass-Energy Equivalence

B. Quantum Physics and Atomic Physics

Examinee should be able to use the quantum theory to explain the nature and behavior of matter and energy at the atomic level that the classical physics failed to, such as light wave-particle duality and the modern atomic structure model.

B.1 Examinee should be able to describe and explain the Dual Nature of Light and Matter and explain the experiments that proved the light-matter duality. This section may include:

1. Blackbody Radiations
2. Photoelectric Effect
3. The Compton Effect
4. Matter Waves: de Broglie wavelength
5. Heisenberg Uncertainty Principle
6. Quantum Physics Application.

B.2 Examinee should be able to explain how the quantum physics theory helped in understanding the modern atomic model (Bohr Model). This section may include:

1. Atomic Models.
2. Atomic Spectra.

C. Nuclear Physics

Examinee should be able to describe the atomic nuclei and their constituents, interactions and radiations when they are unstable.

C.1 Examinee should be able to describe the properties and the structure of the atomic nucleus and distinguish between natural transmutation and artificial transmutation. This section may include:

1. Nuclear Atom Structure and Properties
2. Natural Transmutations: Natural Spontaneous Radioactivity.
3. Rate of Radioactive Decay
4. Artificial Transmutations: Induced Nuclear Reactions

C.2 Examinee should be able to describe the nature of the particles that constitute matter and radiation and distinguish between elementary particles and composite particles. This section may include:

1. Elementary Particles.
2. Composite Particles.

Required Mathematics Knowledge and Skills

A. Arithmetic:
   - **Candidates should be able to:**
     - Use decimal and scientific notations expressions.
     - Perform addition, subtraction, multiplications and divisions using signed and unsigned numbers.
     - Use scientific calculators to perform arithmetic operations.
     - Deal with means, powers including reciprocals and square roots, exponentials and logarithms (log and ln), sines, cosines, tangent and the inverse functions.
     - Specify appropriate number of significant figures.

B. Algebra:
   - **Candidates should be able to:**
     - Manipulate (rearrange) an equation in terms of a specified quantity- change the subject of the equation.
     - Solve algebraic equations (find the solution) of first-degree (linear equation) and second-degree (quadratic equation) including equations that has logarithmic and exponential function.
     - Evaluate an equation by substitution (substituting the value of a given quantity).
     - Check the units' consistency of an equation.
     - Formulate an equation to represent models of physical situations/scenario.

C. Geometry and trigonometry:
   - **Candidates should be able to:**
     - Find the areas, volumes and circumference of different of triangles (right angled, isosceles) circles, rectangles, cylinders and spheres.
     - Use Pythagoras' theorem, similarity of triangles, the angle sum of a triangle.
     - Use sines, cosines and tangents (especially for 0°, 30°, 45°, 60°, 90°).
     - Convert from degrees to radians and vice versa.

D. Vectors:
   - **Candidates should be able to:**
     - Perform vector addition, subtraction, multiplication.
     - Find the resultant of two coplanar vectors.
     - Resolve vectors into their perpendicular components.

E. Graphs:
   - **Candidates should be able to:**
     - Extract information from graphs as required.
     - Interpret the meaning of the graph variables and scales (units).
     - Find the slope, intercept and intersection for linear graphs.
     - Find the line best fit for a set of data points presented graphically.
     - Write the linear equation form $y = mx + c$ and rearrange relationships into linear form where appropriate.
     - Find the area below a curve where the area has physical significance.

F. Integration and Derivative
   - **Candidates should be able to:**
     - Perform common derivatives such as:
       - Polynomials
       - Trig functions
       - Inverse trig functions
       - Exponential/Logarithm Functions
     - Perform common integrals such as:
       - Polynomials
       - Trig functions
       - Inverse trig functions
       - Exponential/Logarithm Functions
       - Miscellaneous
     - Perform integration using standard integration techniques such as:
       - u Substitution
       - Integration by Parts
       - Trig Substitutions
       - Partial Fractions

Sample Questions

1.

While you are driving your car on the highway at a speed of 20.0 m/s, a police car is moving towards you from behind at a speed of 40.0 m/s.
If the police car siren produces a sound of frequency 500 Hz and speed 340 m/s, what frequency do you hear for the siren sound?

بينما تقود سيارتك على الطريق السريع بسرعة 20.0 متر/ثانية، تقترب من خلفك سيارة شرطة بسرعة 40.0 متر/ثانية وصّفارتها تصدر صوتا بتردد 500 هيرتز وسرعة 340 متر/ثانية، ماهو التردد الذي تسمعه لصّفارة الشرطة؟

A. 417 Hz

B. 533 Hz

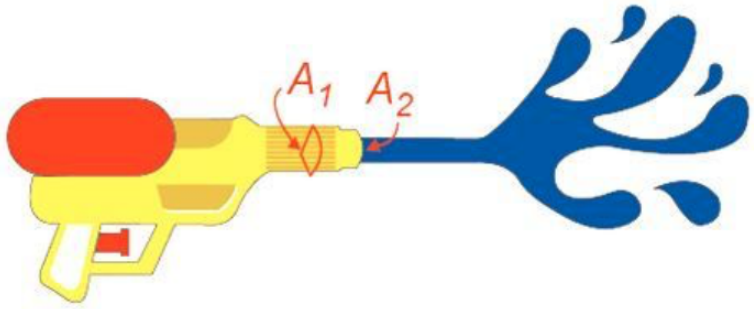
C. 600 Hz

D. 527 Hz

2.

A water gun shoots water at a speed of 20 m/s through the opening of the gun, if the cross-sectional area of the gun opening is $A_2 = 8 \times 10^{-5}\ m^2$,while the area of the gun tube $A_1 = 4 \times 10^{-4}\ m^2$ as shown in the illustration bellow, what is the pressure that was applied to the trigger?

مدفع الماء يضخ الماء بسرعة 20 متر/ثانية من خلال فوهة المدفع، إذا كانت مساحة مقطع فتحة المدفع تساوي $A_2 = 8x10^{-5}$ متر^2 ، بينما مساحة مقطع أنبوب المدفع $A_1 = 4x10^{-4}$ متر^2 كما في الشكل، ما هو الضغط الذي تم بذله على مفتاح المدفع؟



A. 8000 Pa

B. 3.01×10^5 Pa

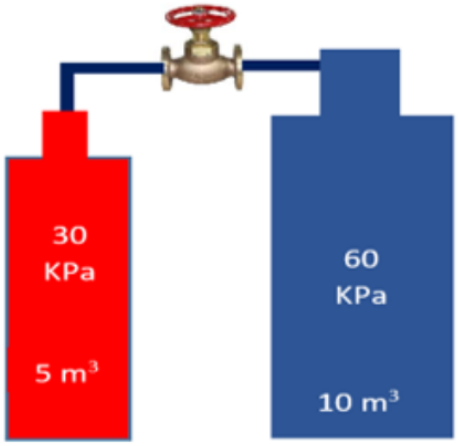
C. 2.93×10^5 Pa

D. 1.92×10^5 Pa

3.

The illustration shows two gas cylinders connected together with a valve. When the valve is closed the small cylinder has a volume of 5 m^3 and a pressure of 30 KPa, the big cylinder has a volume of 10 m^3 and a pressure of 60 KPa.
What will be the pressure of the two cylinders when the valve is opened?

الصورة أدناه تشير إلى إسطوانتين من الغاز موصولتان ببعضهما عن طريق صمام. عندما يكون الصمام مغلق، كان حجم الإسطوانة الصغرى يساوي 5 متر^3 وضغطها 30 كيلوباسكال، بينما حجم الإسطوانة الكبيرة يساوي 10 متر^3 وضغطها 60 كيلوباسكال. ما هي قيم الضغط للإسطوانتين عندما يتم فتح الصمام؟



A. 50 KPa

B. 30 KPa

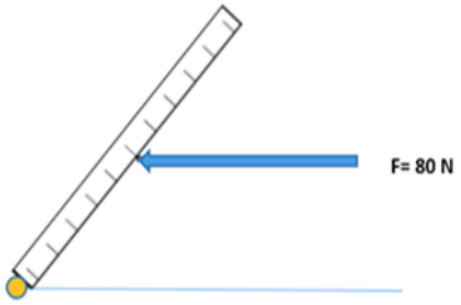
C. 60 KPa

D. 90 KPa

4.

A 2m rod makes an angle of 60° with the horizontal axes as shown in figure below. An 80N force is applied to the center of the rod and makes it rotates around its pivot point.
What is the torque of the rod?

الشكل أدناه يشير إلى قضيب طوله 2 مترويصنع زاوية 60 درجة مع المحورالأفقي كما في الشكل أدناه. تُؤثر قوة قيمتها 80 نيوتن على مركز القضيب مما يسبب له دوران حول نقطة الإرتكاز.
ما هو العزم المؤثر على القضيب؟



A. 69.3 N. m

B. 80.2 N. m

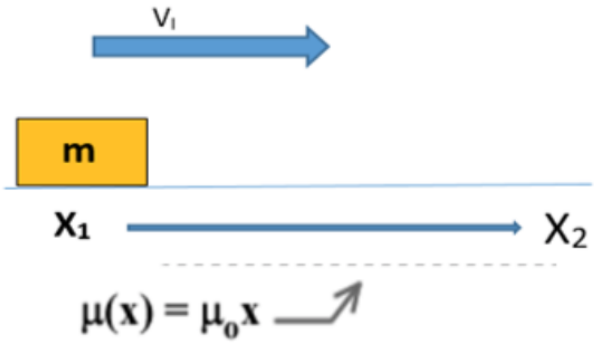
C. 55.1 N. m

D. 60.3 N. m

5.

A boy is trying to push a 5kg box along a rough surface, the coefficient of friction between the box and the surface is changing with the distance and given by the function $\mu(x) = \mu 0\ x$, if $\mu 0 = 100$.
What is the work done by the force of friction on the box when it moves from $x_1 = 0$ to $x_2 = 2$ m?

يحاول طفل دفع صندوق كتلته 5 كغم على سطح خشن، معامل الاحتكاك بين الصندوق والسطح يتغير مع المسافة ويُعطى بالدالة $\mu(x) = \mu 0\ x$ حيث $\mu 0 = 100$.
ما الشغل المبذول من قوة الاحتكاك على الصندوق عندما يتحرك الجسم من $x_1=0$ إلى $x_2= 2$ متر؟



A. -7340 J

B. -1000 J

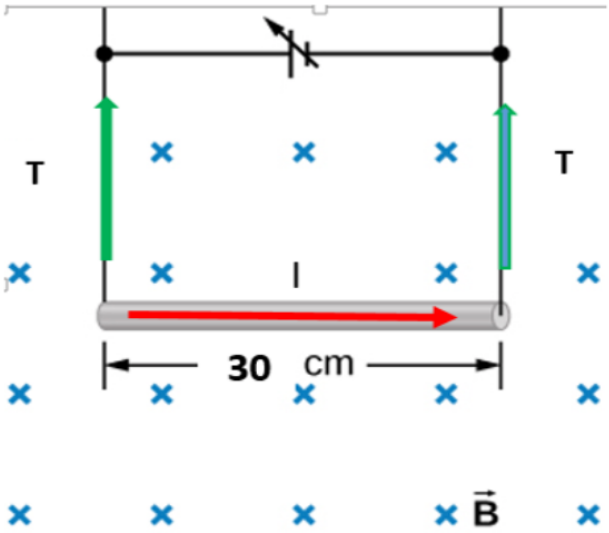
C. -5500J

D. -9800 J

6.

A 30cm and 20g wire is suspended horizontally with two flexible strings in a magnetic field strength of 2T as shown in the following illustration.
What is the magnitude of the current that is induced in the suspended wire which will remove the tension in the strings?

تم تعليق سلك طوله 30 سم وكتلته 20 غم بشكل أفقي بخيطين مرنين ضمن مجال مغناطيسي شدته 2 تسلا كما في الشكل أدناه.
ما هي قيمة التيار التأثيري المُتولد في السلك المُعلق من أجل أن يُلغي الشد في الخيطين؟



A. 0.33A

B. 0.50A

C. 0.61A

D. 0.44A

7.

A 500ml vinegar bottle is filled at 20°C, a small space in the cylindrical neck with diameter of 25mm and height 2cm is left empty as shown in the following illustration. If the bottle temperature is raised to 30°C, what is the new height of the empty space in the bottle's neck?

تم ملئ عبوة حجمها 500 ميللتر بسائل خل التفاح عند 20 درجة مئوية، يوجد حيز صغير فارغ في عنق العبوة إرتفاعه 2 سم وقطره 25 ميللمتر كما في الشكل أدناه.
إذا إزدادت درجة حرارة العبوة إلى 30 درجة مئوية، ما هو الإرتفاع الجديد للحيز الفارغ في عنق العبوة؟

A. 1.6 cm

B. 0.5 cm

C. 1.9 cm

D. 0.8 cm

8.

The mean life-time of a muon is 2.2μs but muons entering the Earth's atmosphere at 99.9% the speed of light will experience time dilation.
What is the dilated life-time of these muons?

يصل متوسط العمر الميون 2.2μs ، مع العلم أن الميونات تدخل الغلاف الجوي للأرض بسرعة 99.9% من سرعة الضوء وبذلك تعاني من تمدد الزمن.
ما هو العمر المتمدد لهذه الميونات؟

A. 49.2 μs

B. 15.6 μs

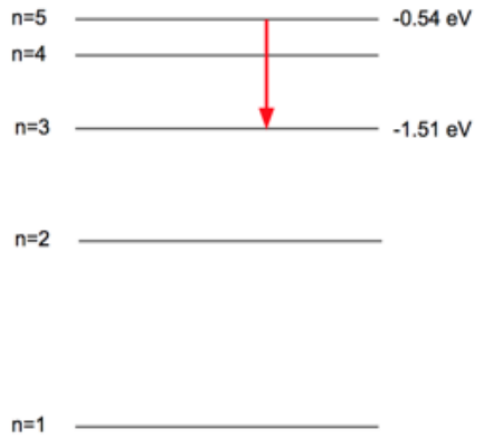
C. 22.0 μs

D. 69.6 μs

9.

The diagram shows some energy levels in a hydrogen atom. What will be the frequency of the photon released when an electron drops from n = 5 to n = 3?

الشكل أدناه يوضح بعض مستويات الطاقة في ذرة الهيدروجين. ماذا سيكون تردد الفوتون المُنطلق عندما يهبط الإلكترون من المستوى 5 إلى المستوى 3 ؟



A. 1.46×10^{33} Hz

B. 1.30×10^{14} Hz

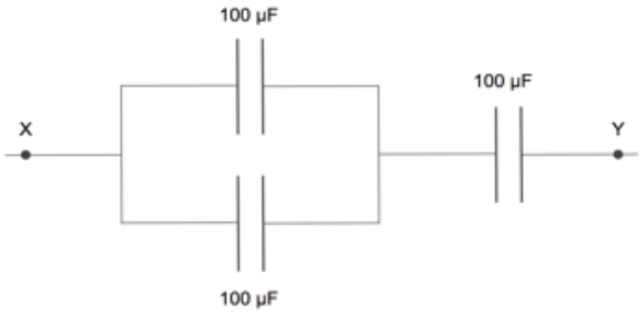
C. 3.64×10^{14} Hz

D. 2.34×10^{14} Hz

10.

Three 100 μF capacitors are connected in a network as shown in the diagram. What is the net capacitance between points X and Y?

تم وصل ثلاث مكثفات سعة كل منها 100 ميكرو فاراد كما في الشكل أدناه. ما هي السعة المكافئة بين النقطتين X و Y؟



A. 66.7 μF

B. 33.3 μF

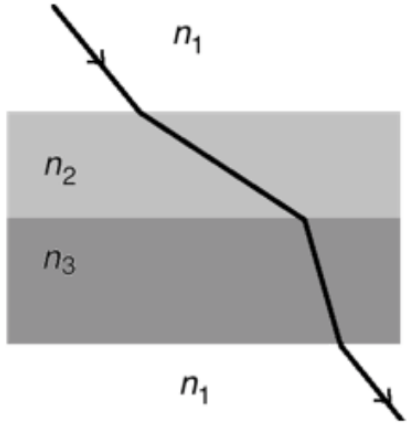
C. 100 μF

D. 300 μF

11.

The figure show a light ray refracted by 3 media. What is the relation between the refractive indices?

الشكل أدناه يشير إلى انكسار شعاع ضوئي خلال ثلاث أوساط. ما هي العلاقة بين معاملات الانكسار للأوساط؟



A. $n_2 < n_1$ and $n_3 < n_2$

B. $n_2 < n_1 < n_3$

C. $n_3 < n_1 < n_2$

D. $n_1 < n_2$ and $n_2 < n_3$

12.

Which force is responsible for beta minus decay?

ما هي القوة المسؤولة عن انحلال بيتا السالبة؟

A. Nuclear Strong Force — القوة النووية القوية

B. Nuclear Weak Force — القوة النووية الضعيفة

C. Gravitational Force — قوة الجاذبية

D. Electromagnetic Force — القوة الكهرومغناطيسية

Answer Key

1. B
2. C
3. A
4. A
5. D
6. A
7. A
8. A
9. D
10. A
11. B
12. B