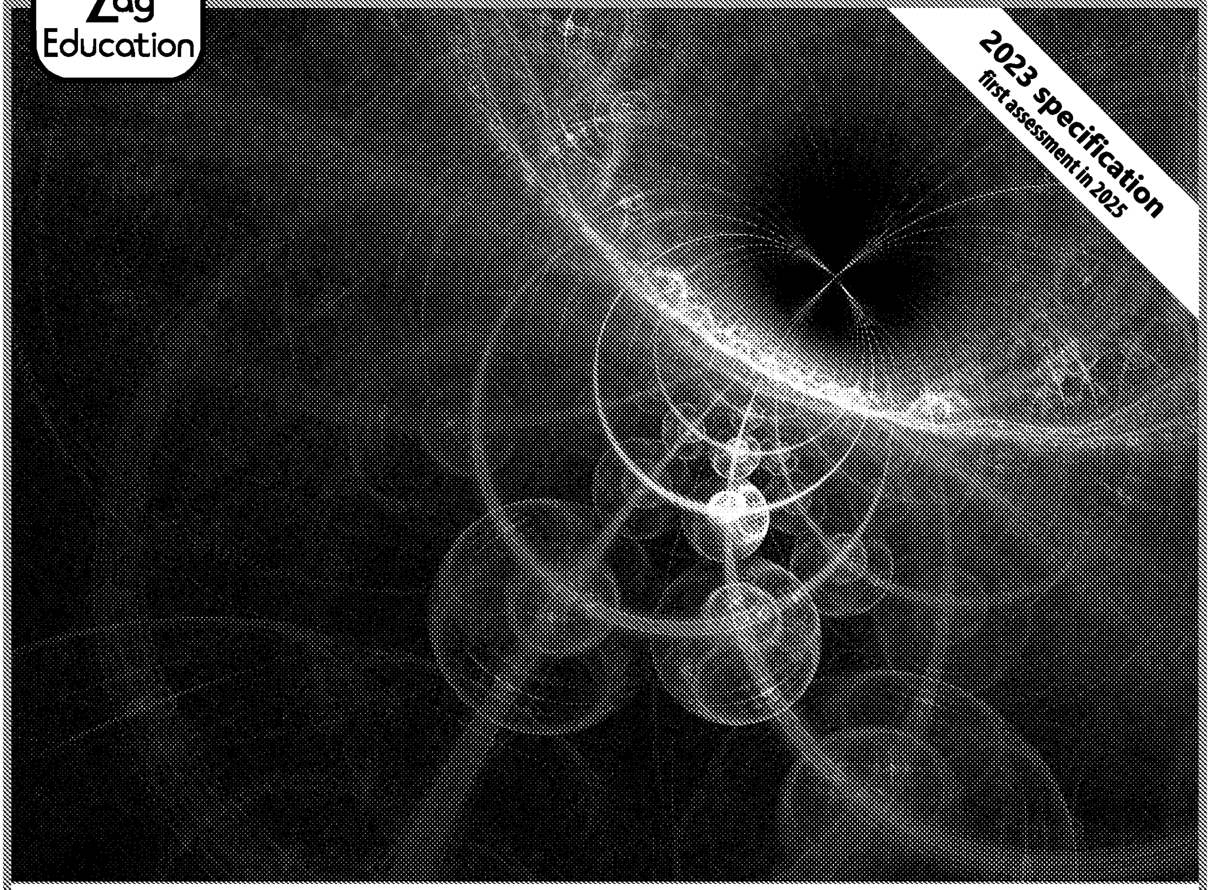
Zig Zag Education

Physics International Baccalaureate Diploma Programme



2023 specification
first assessment in 2025

Topic Tests
for IB Physics
E. Nuclear and Quantum Physics

zigzageducation.co.uk

POD 12407

Contents

Teacher's Introduction

These topic tests have been designed to help you and your students assess their knowledge of a topic after you have taught each part of **Theme E – Nuclear and Quantum Physics (Topics E.1–E.5)** of the **IB Physics Diploma Programme (standard level (SL) and higher level (HL))**. This part of the course includes the following topics:

1. Structure of the atom
2. Quantum physics **(Additional Higher Level)**
3. Radioactive decay
4. Fission
5. Fusion and stars

Each topic test closely follows the content of the specification and includes:

- **Multiple-choice questions**: These are not in exam style, and the purpose of these is to test different elements, knowledge and skills from the specification in a variety of styles. Question types include general recall, explanation of key concepts, data analysis and mathematical methods.
- **Structured-answer questions**: Where appropriate, topics may contain one or more extended-response questions to prepare students for what they might meet in the exam, and to test exam skills. Question types include long-form explanations and short-answer questions.

Mathematical skills are also covered in these topic tests.

The table below shows the content, specification reference and number of marks allocated to each test.

Topic	Test title	Marks per section (SL)	Marks per section (HL)
E.1 Structure of the atom	Multiple-choice questions	8	11
	Structured-answer questions	21	28
	Total	**29**	**39**
E.2 Quantum physics **(Additional Higher Level)**	Multiple-choice questions	-	8
	Structured-answer questions	-	23
	Total	**-**	**31**
E.3 Radioactive decay	Multiple-choice questions	8	10
	Structured-answer questions	10	25
	Total	**18**	**35**
E.4 Fission, E.5 Fusion and stars	Multiple-choice questions	11	11
	Structured-answer questions	26	26
	Total	**37**	**37**

Tests have been designed to take approximately 30–40 minutes to complete. Students are able to see the number of marks awarded for each question, allowing them to gauge the level of detail they will require for the answers. Full answers with marks are included at the end of each test. Additionally, it makes the resource a suitable tool for students to use independently.

The topic tests are suitable for a classroom assessment, revision aid or homework task and are, therefore, suitable for use immediately after a topic is completed in class or at the end of teaching the course.

It is recommended that students have access to a calculator to complete the questions.

We hope you find these tests useful during your teaching.

December 2023

E.1 Structure of the atom

Multiple-choice questions

1. Which of the following is the best evidence for the particulate nature o
   - A. Compton scattering ☐
   - B. Geiger–Marsden–Rutherford experim ☐
   - C. Rutherford scattering ☐
   - D. Diffraction of partic ☐

2. What c used as evidence for the discrete energy levels in atoms?
   - A. Continuous spectrum in emission and absorption spectra ☐
   - B. Line spectra in emission and absorption spectra ☐
   - C. The presence of protons and neutrons in the nucleus ☐
   - D. Electrons orbiting the nucleus ☐

3. What is the SI unit for Planck's constant?
   - A. J m ☐
   - B. Kg m s^{-1} ☐
   - C. J s ☐
   - D. No units ☐

4. The Geiger–Marsd ford scattering experiment led to what?
   - A. Th co the electron ☐
   - B. T k model of hadrons ☐
   - C. The discovery of the nucleus ☐
   - D. Evidence for wave–particle duality ☐

5. What is the nuclear notation of an alpha particle?
   - A. Nucleon number: 0, proton number: +1 ☐
   - B. Nucleon number: 2, proton number: 4 ☐
   - C. Nucleon number: 0, proton number: -1 ☐
   - D. Nucleon number: 4, proton number: 2 ☐

6. What is the velocity of a ground sta le n moving in a circular or
   - A. 1.19×10^{3} ms^{-1} ☐
   - B. 1.38×10^{7} ms^{-1} ☐
   - C. 2 0^{6} ☐
   - D. 7. $^{-8}$ ms^{-1} ☐

7. An electron orbiting a hydrogen nucleus is promoted from the ground
What is the difference in energy?

A. -12.1 eV ☐
B. 1.5 eV ☐
C. -1.5 eV ☐
D. 12.1 eV ☐

8. Electromagnetic radiation is incident on a metal surface. If the intensi
halved, what happens to the number of photoelectrons?

A. Stays the same ☐
B. Doubles ☐
C. Is halved ☐
D. No photons emitted ☐

Additional higher level (HL)

9. When firing high-energy alpha particles at a nucleus, some follow a p
What is the reason for this?

A. Electrons have a negative charge
B. The atom is mainly empty space
C. Electromagnetic force overcomes the strong nuclear force
D. The strong nuclear force overcomes electromagnetic repulsion

10. If a nucleus has nucleon number A and radius R, what is the nucleo
radius halved?

A. A ☐
B. A/2 ☐
C. A/4 ☐
D. A/8 ☐

11. Which of the following is true when an alpha particle is approaching t
approach in an alpha particle scattering experiment?

A. The distance of closest approach will always be an underestimate
B. The kinetic energy of the alpha particle is equal to the potential en
C. The kinetic energy of the nucleus is equal to the potential energy
D. The distance of closest approach is equal to the radius of the nucl

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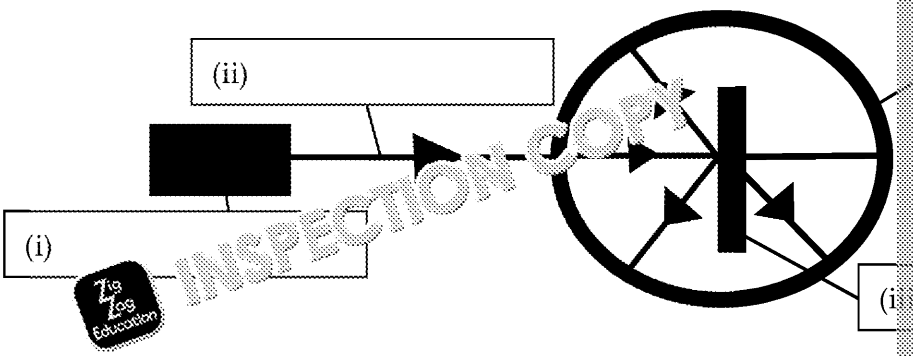
Structured-answer section

1. a) Label each part of the Rutherford alpha particle scattering experi



b) How did this experiment lead to our understanding and develop

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2. Complete the table to show the properties of subatomic particles.

Subatomic particle	Charge	
Proton	(i) ____________	
Neutron	0	(ii
Electron	(iii) ____________	

3. a) (i) State what is meant by the ground state.

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(ii) An electron is promoted to an excited state. Describe why th

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b) (i) The Bohr model is based on the hydrogen atom. Using a dia

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(ii) Calculate the energy released when an electron transitions fr
n = 2 state. Give your answer in joules

4. a) Calculate how many electron volts there are in 4.8×10^{-19} J.

b) Calculate the wavelength of a photon with 4.8×10^{-19} J of energy.

Additional higher level (HL)

5. Explain why the Bohr model of the atom is considered to be a simplif how it fails to describe atomic behaviour.

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6. Explain what 'quantisation of angular momentum' means in quantum led to the development of the Bohr model of the atom.

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Total for se

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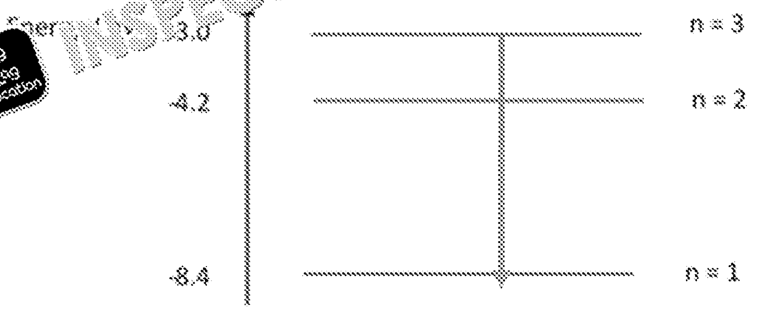
Preview of Questions Ends Here

E.2 Quantum physics (Additional Higher Level)

Question		Answer
Multiple-choice questions		
1		A – Photons have a rest mass of zero
2		B – Photoelectric effect
3		C – Minimum frequency for photoelectrons to be released from a me
4		A – 1.08×10^{-19} J
5		D – Diffraction of electrons by the double slit experiment
6		[illegible] $\times 10^{-9}$ m
7		[illegible] The wavelength is zero
8		B – 1.33×10^{-14} m
Structured-answer section		
1 a)	(i)	Occupying state above the ground state [1]
	(ii)	Photon collides with electron [1]. Photon has energy equal to energ ground state and excited state [1].
b)	(i)	One-to-one interaction between photon and electron [1] Electrons exist in discrete energy levels [1] Photon must have enough energy to promote electron to higher ene
	(ii)	n = 1: -13.6 eV [1] n = 3: $\frac{-13.6}{3^2} = -1.51\ eV$ [1] ΔE = -1.51 – (-13.6) = 12.09 eV [1] 12.09 eV = $12.09 \times 1.6 \times 10^{-19} = 1.93 \times 10^{-18}$ J [1]
2 a)		n = 3 to n = 1 (largest energy, shortest wavelength) NOT n = 1 to n =  -8.4 – (-3.0) = -5.4 eV [1]
b)		Energy to ionise: 8.4 eV [1] 8.4 – 2.1 = 6.3 eV [1] 6.3 eV = 1.01×10^{-18} J [1] $v = \sqrt{(\frac{2E}{m})} = 1.49 \times 10^{6}\ ms^{-1}$ [1]
3		(i) Photoelectric effect [1] (ii) Light [1] (iii) Work function [1] **FINAL TWO CAN BE IN ANY ORDER:** Directions [1] Velocities [1]
4		The classical wave theory of light would predict that if the intensity then at some point there is enough energy for emission to occur [1] This does not take into account that electrons only absorb energy in

Preview of Answers Ends Here