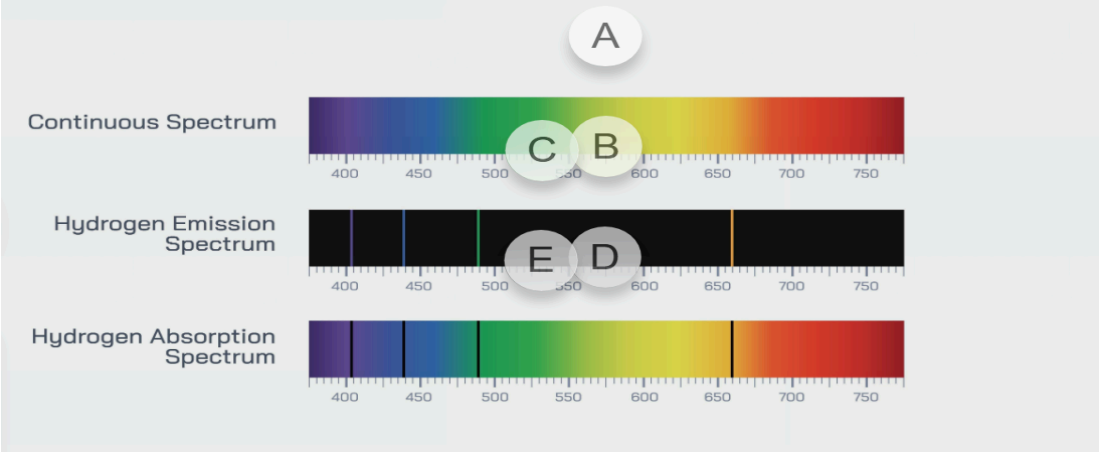
2012 HSC Q37e

Evaluate the contribution of the Bohr model to the development of our understanding of the structure of the atom. ***(7 marks)***

Background:



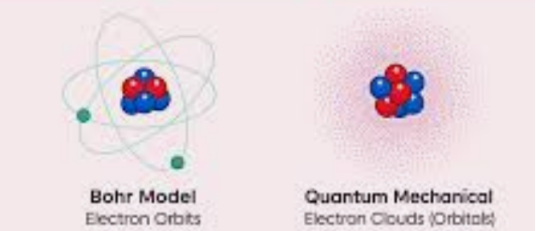
***A** is a continuous spectrum*

***B and C:** The **hydrogen emission spectrum** is produced when hydrogen gas is heated to a high temperature or an electric current is passed through it. Instead of a continuous band of colors, we see distinct colored lines on a black background. These lines represent the specific wavelengths of light **emitted** by the hydrogen atoms as the excited electrons fall back to lower energy levels. Each element has a unique emission spectrum, which acts like a fingerprint, allowing scientists to identify the elements present in a substance. For hydrogen in the visible range, we see a violet line, a blue-green line, and a red line.*

***D and E:** The **hydrogen absorption spectrum** is created when white light (containing all colors) passes through cool hydrogen gas. The gas **absorbs** light at specific wavelengths, which appear as dark lines on the continuous spectrum. Notably, the dark lines in the absorption spectrum are at the exact wavelengths as the bright lines in the emission spectrum. This is because the hydrogen atoms are absorbing the same specific energies of photons that they would emit when excited. This dual nature of emission and absorption is a fundamental principle in spectroscopy and quantum mechanics.*

***The Bohr model (1913)** depicts atoms with a central, positive nucleus surrounded by electrons in specific, quantized circular orbits, or "shells". Electrons can only occupy **discrete** energy levels, emitting or absorbing photons when jumping between them. The Bohr model resembles a planetary system but with fixed, non-radiating electron paths.*
This model failed to make correct predictions of larger-sized atoms than hydrogen.
** discrete = individually separate and distinct.*

***The Schrödinger model (1926)** is a quantum mechanical model of the atom that treats electrons as three-dimensional standing waves rather than particles in fixed orbits. It uses wave functions (psi) and the Schrödinger equation to calculate the probability of finding an electron in specific regions called orbitals. Unlike orbits, orbitals are visual models of the probability density of electrons in an atom. Different types of orbitals have different shapes and therefore electron density patterns.*
(While 'orbits' and 'orbitals' seem to share similarities, they are very different concepts.)



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CH: Evaluate the contribution of the Bohr model to the development of our understanding of the structure of the atom. ***(7 marks)***

I: "interpret " the question - what is it actually asking us to do?
Evaluate - Judgement based on positives and negatives against criteria (you come up with it based on the question) for the Bohr model and how it was used in progression of the model of the atom

P: So "plan"

- **What is Bohr's model?**
- **How is it good?**
- **How is it limited?**
- **What parts did we keep?**
- **Overall judgement of the contribution of the Bohr model**
- **What Tier 3 language do I need to use in my response to show that I understand the concepts?** (quantisation, defined orbits, emission lines, spectrum, electronic configuration, energy levels, electron shells)

The question is designed for you to *be succinct enough to write 2 lines per 1 mark*. Any more, you are waffling and not answering the question as concisely and to the point as you could be.
DO NOT EVER REWRITE THE QUESTION, unless you enjoy wasting your exam time and writing space.

Question 37 (e)

Criteria	Marks
• Demonstrates a thorough knowledge and understanding of the place of the Bohr model of the atom including both positive and negative aspects of the model • Demonstrates coherent and logical progression of scientific principles and ideas	6–7
• Demonstrates a sound knowledge and understanding of the place of the Bohr model of the atom, including positive and/or negative aspects of the model • Communicates some scientific ideas in a clear manner	4–5
• Demonstrates a basic knowledge and understanding of the place of the Bohr model of the atom, with limited reference to positive and negative aspects of the model • Communicates ideas in a basic form using general scientific terms	2–3
• Demonstrates a limited knowledge and understanding of the place of the Bohr model of the atom, and does not address positive and negative aspects of the model • Communicates simple ideas	1

One type of Worked Solution (as paragraphs)

The Bohr model of the atom proposed that the single electron of the atom was confined to defined orbits around the nucleus, it could not exist between those. For the electron to change to a different orbit, energy had to be absorbed (to go to a higher energy orbit) or emitted (to go to a lower energy orbit). The model was developed to use the quantisation of energy to explain the emission and absorption spectrum of hydrogen.

The model was and is valuable in explaining that sharp absorption or emission spectral lines were the result of discrete packets, quanta, of energy being absorbed to excite an electron to a higher energy level, or emitted as that electron returned to the ground state, and that no other changes in energy are allowed. The model was an important step towards understanding and accepting the quantum view of the atom, and in introducing the idea of energy levels (shells) to describe the electronic configuration of atoms.

The Bohr model, however, could not be applied to atoms other than hydrogen, and did not provide any explanation for the quantisation. These restrictions and limitations of the model were recognised by Bohr and the model was not meant to be used beyond the hydrogen atom, but the attractiveness of the simplicity of the model has ensured continued use and propagates the incorrect concept of electrons as particles orbiting a nucleus.

Another type of Worked Solution (as dot points) THIS IS ALSO ACCEPTABLE!

→ *The Bohr model of the atom was developed to use the quantisation of energy to explain the emission and absorption spectrum of hydrogen.*

→ *It proposed that the single electron of the atom was confined to defined orbits around the nucleus, somewhat analogous to a planet's orbit around its star.*

→ *For the electron to change to a different orbit, energy had to be absorbed (to go to a higher energy orbit) or emitted (to go to a lower energy orbit).*

→ *The energy absorbed or emitted is well-defined, giving rise to sharp absorption or emission lines. No other changes in energy are allowed.*

→ *The model was an important step towards understanding and accepting the quantum view of the atom and introduced the idea of energy levels (shells) to describe the electronic configuration of atoms.*

→ *The Bohr model could not be applied to atoms other than hydrogen and did not provide any explanation for the quantisation.*

→ *These restrictions and limitations of the model were recognised by Bohr and the model was not meant to be used beyond the hydrogen atom, but the attractiveness of the simplicity of the model has ensured continued use and propagates the incorrect concept of electrons as particles orbiting a nucleus.*

PALS

Purpose	To address the NESA verb "Evaluate" in an exam question
Audience	HSC marker Your teacher Stage 6 Chemistry students
Language	Tier 3 language Tier 2 language
Structure	BREAKDOWN: Responding to the VERB: definition positives negatives Judgement Succinct demonstration of content knowledge Note that it is acceptable to use dotpoint form to prevent you from wasting both time and writing space.