12.1 Electrons in Atoms

Question Paper

Course	DP IB Chemistry
Section	12. Atomic Structure (HL only)
Topic	12.1 Electrons in Atoms
Difficulty	Medium

Time allowed: 60

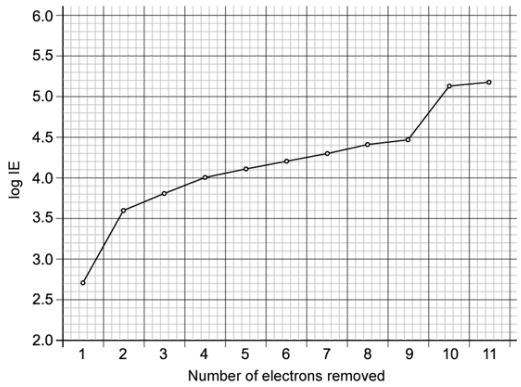
Score: /49

Percentage: /100

Question 1a

a)

The successive ionisation energies of an element, X, are shown below. The vertical axis plots log (ionisation energy) instead of ionisation energy to represent the data without an unreasonably long vertical axis.



Identify element X and give its full electron configuration.

[2 marks]

Question 1b

b)

Explain how the successive ionisation energy data for the element X are related to its electron configuration.

[3 marks]

Question 1c

c)

Explain why the first ionisation energy of aluminium is lower than the first ionisation energy of magnesium.

[2 marks]

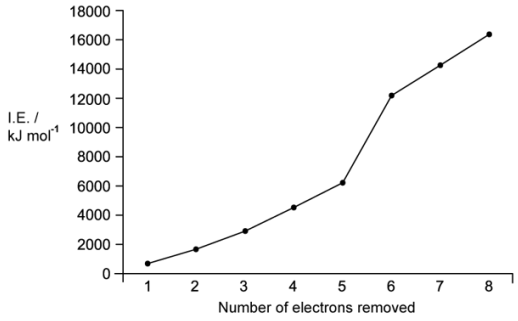
Question 1d

d)
Explain why the first ionisation energy of sulfur is lower than the first ionisation energy of phosphorus.

[2 marks]

Question 2a

a)
The successive ionisation energies of vanadium are shown.



State the sub-levels from which each of the first four electrons are lost

[2 marks]

Question 2b

b)
Outline why there is an increase in ionisation energy from electron 3 to electron 5.

[2 marks]

Question 2c

c)
Explain why there is a large increase in the ionisation energy between electrons 5 and 6.

[3 marks]

Question 2d

d)
The first six ionisation energies, in kJ mol^{-1}, of an element are shown below

IE_1	IE_2	IE_3	IE_4	IE_5	IE_6
578	1816	2744	11576	14829	18375

Explain the large increase in ionisation energy from IE_3 to IE_4

[2 marks]

Question 3a

a)
Emission spectra provide experimental evidence for the existence of atomic energy levels.

i)
Explain the convergence of lines in a hydrogen emission spectrum.

ii)
State what can be determined from the frequency of the convergence limit.

[2 marks]

Question 3b

b)
Determine the energy, in J, of a photon of red light, correct to two significant figures, given that the wavelength is 650.0 nm using Sections 1 and 2 of the Data Booklet.

[2 marks]

Question 3c

c)
Calculate the first ionisation energy, in kJ mol^{-1}, for hydrogen given that its shortest wavelength in the Lyman series is 91.16 nm using Sections 1 and 2 of the Data Booklet.

[3 marks]

Question 3d

d)

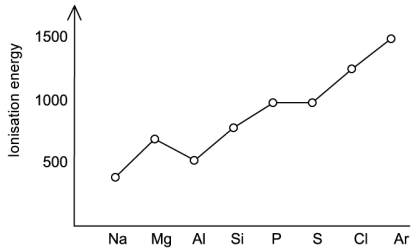
Describe why the energy required to reach the convergence limit on an emission spectrum is considered the ionisation energy for an atom. You should refer to the appearance of the spectrum, frequency, and energy in your answer.

[3 marks]

Question 4a

a)

The first ionisation energies of the elements in period 3 are shown below.



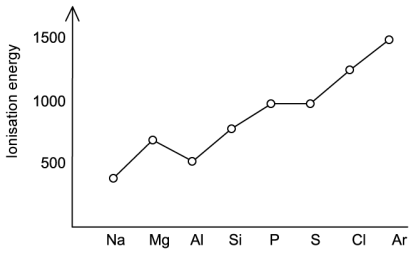
Explain the general trend seen in ionisation energy across period 3.

[3 marks]

Question 4b

b)

On the diagram below, sketch the line for the first ionisation energies of period 2 elements

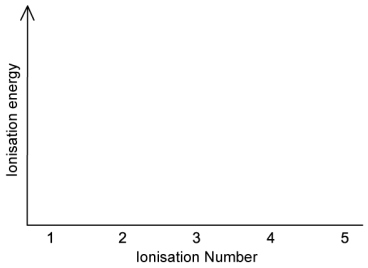


[2 marks]

Question 4c

c)

Sketch a graph of ionisation energy versus the number of electrons removed for five ionisations of silicon. Explain the shape of the trend you have drawn.



[5 marks]

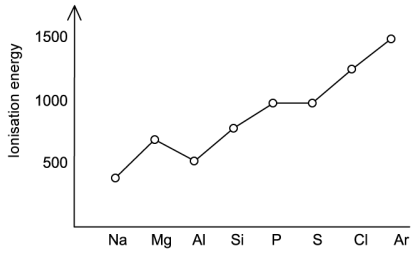
Question 4d

d)
The wavelength of a line in the Balmer series of hydrogen is 726.2 m. Calculate the energy of photons emitted, in kJ, using Sections 1 and 2 of the Data Booklet.

[2 marks]

Question 5a

a)
The first ionisation energies of the elements in period 3 are shown.



Draw a graph on the diagram to to show the second ionisation energies of the period 3 elements

[2 marks]

Question 5b

b)
Explain the differences seen in first and second ionisation energies of the elements in period 3.

[3 marks]

Question 5c

c)
Hydrogen spectral data give the frequency of 3.28×10^{15} s^{-1} for its convergence limit.

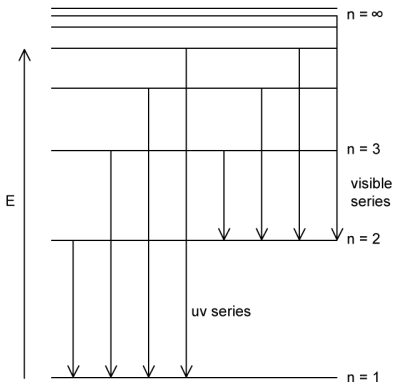
i)
Calculate the ionisation energy, in J, for a single atom of hydrogen using Sections 1 and 2 of the Data Booklet.

ii)
Calculate the wavelength, in nm, for the electron transition corresponding to the frequency in part (i) using Section 1 of the Data Booklet.

[2 marks]

Question 5d

d)
On the diagram below, draw a line that corresponds to the first ionisation energy of hydrogen and explain your reasoning.



[2 marks]