Worksheet 01: Electromagnetic Radiation and Atomic Spectra

Focus: colour, wavelength, frequency, energy, continuous spectra, line spectra | Suggested time: 50 minutes | Total: 40 marks

Student name	_____	Class	_____
Instructions	Answer all questions. Show working for calculations. Use the data booklet values where needed.	Calculator	Permitted where appropriate

Section A: Multiple choice

Choose the best answer for each question. Each question is worth 1 mark.

1. Which statement correctly compares red visible light with blue visible light?

A. Red light has a shorter wavelength and higher frequency.	B. Red light has a longer wavelength and lower frequency.
C. Red light has a higher frequency and higher photon energy.	D. Red light travels faster than blue light in a vacuum.

2. A continuous spectrum is best described as:

A. only a few separated frequencies of light	B. an unbroken range of wavelengths
C. light produced only by hydrogen atoms	D. a pattern formed only by absorbed infrared radiation

3. The equation c = f lambda shows that, for electromagnetic waves in a vacuum:

A. frequency is directly proportional to wavelength	B. frequency is inversely proportional to wavelength
C. energy is independent of frequency	D. wavelength is independent of speed

4. A line emission spectrum is strong evidence that electrons in atoms:

A. have no charge	B. can occupy only certain energy states
C. are found only in the nucleus	D. move at the speed of light

5. Which region has photons of higher energy than visible violet light?

A. infrared	B. microwave
C. ultraviolet	D. radio

6. A flame test can help identify a metal ion because different elements:

A. all emit the same white light	B. have characteristic emission lines or colours
C. absorb only radio waves	D. contain the same number of electrons

Section B: Short-answer questions

1. State the meaning of wavelength and frequency for electromagnetic radiation. [2 marks]

Answer: _____

_____

_____

2. Calculate the frequency of light with wavelength 500 nm. Use c = 3.00 x 10^8 m s^-1. [3 marks]

Answer: _____

_____

_____

_____

3. Distinguish between a continuous spectrum and a line emission spectrum. [3 marks]

Answer: _____

4. Explain why a line emission spectrum can act like a barcode for an element. [4 marks]

Answer: _____

Section C: Data response / case study

A technician tests four chloride salts using a flame test and a simple spectroscope. The observed flame colours and approximate strongest visible lines are shown below.

Sample	Observed flame colour	Strong visible lines / nm
Reference Li+	crimson red	671
Reference Na+	yellow-orange	589
Reference K+	lilac	404, 766
Reference Cu2+	blue-green	510, 578
Unknown A	yellow-orange	589
Unknown B	green with weak yellow	510, 578, 589

1. Identify Unknown A and justify your answer. [2 marks]

2. Suggest the ions present in Unknown B. [3 marks]

3. State one qualitative and one quantitative observation collected in this investigation. [2 marks]

4. Explain one limitation of using only flame colour instead of a spectroscope. [3 marks]

Section D: Extended response

Discuss how electromagnetic spectra provide evidence for discrete electron energy levels and can be used to identify elements. [8 marks]

Write a structured response. Use relevant scientific terminology and support your points with examples where possible.

Answer key and marking guidance

Award marks for scientifically correct alternative wording. Penalize only once for the same repeated error unless it causes a new error in reasoning.

Section A: Multiple choice

Q	Answer	Brief marking guidance
1	B	In visible light, red has a longer wavelength, so it has lower frequency and lower photon energy than blue.
2	B	A continuous spectrum contains a smooth, unbroken range of wavelengths or colours.
3	B	Since c is constant, increasing wavelength lowers frequency.
4	B	Only certain photon energies are emitted, so electron energy changes are discrete.
5	C	Ultraviolet has shorter wavelength and higher frequency than visible violet light.
6	B	Different electron energy gaps produce characteristic emitted colours or line spectra.

Section B: Short-answer mark scheme

Q	Marks	Expected answer / marking points
1	2	1 mark for wavelength as distance between successive crests/troughs; 1 mark for frequency as number of waves passing a point per second.
2	3	Convert 500 nm to 5.00 x 10^-7 m (1); use f = c/lambda (1); f = 6.00 x 10^14 s^-1 (1).
3	3	Continuous spectrum is an unbroken range of wavelengths/colours (1); line spectrum contains separated/discrete lines (1); link to atoms emitting specific photon energies/electron transitions (1).
4	4	Each element has a unique set of electron energy levels (1); transitions release photons of specific energies/frequencies/wavelengths (1); the pattern of lines is characteristic (1); unknown samples can be compared with reference spectra (1).

Section C: Data response / case study mark scheme

Q	Marks	Expected answer / marking points
1	2	Unknown A is Na+ (1); matching yellow-orange flame and 589 nm line (1).
2	3	Cu2+ present because 510 and 578 nm lines match (1); Na+ present because 589 nm line/yellow component matches (1); answer recognizes mixture rather than pure sample (1).
3	2	Qualitative: flame colour or line colour (1); quantitative: wavelength in nm or number/intensity of lines if measured numerically (1).
4	3	Colours can be subjective or masked by contaminants (1); sodium can dominate weak colours (1); a spectroscope separates wavelengths/lines and improves identification (1).

Section D: Extended response mark scheme

Award up to 8 marks: describes excitation of electrons to higher levels (1); electrons return to lower levels (1); photons are emitted with energy equal to the energy difference (1); E = hf or shorter wavelength/higher frequency means higher energy (1); line spectra show only specific energies rather than continuous emission (1); therefore electron energies are quantized/discrete (1); different elements have different energy level spacings and line patterns (1); applications such as flame tests, discharge tubes, star spectra, or sample identification (1).