AH Exercise 1.1

Energy, Wavelength and Frequency

2016 AH MC1 (85%)

1. Which of the following lists electromagnetic radiation bands in order of increasing wavelength?

A X-ray, infrared, ultraviolet, radio

B Infrared, ultraviolet, X-ray, gamma

C Ultraviolet, visible, infrared, radio

D Radio, infrared, visible, gamma

2001 AH MC1 (67%)

1. If the wavelength of visible light from a tunable laser is increased

A the wavenumber increases

B the velocity increases

C the frequency increases

D the colour changes towards red.

2003 AH MC1

1. Which of the following is **not** a form of electromagnetic radiation?

A β-radiation

B γ-radiation

C UV-radiation

D IR-radiation

2007 AH MC3 (86%)

3. Which of the following is **not** a form of electromagnetic radiation?

A Beta radiation

B Gamma radiation

C Ultra-violet radiation

D Infra-red radiation

2012 AH MC1 (87%)

1. Which of the following is **not** a form of electromagnetic radiation?

A α radiation

B γ radiation

C UV radiation

D X-rays

2013 AH MC2 (77%) and 2013 revAH MC2 (75%)

2. Which of the following lists electromagnetic radiation bands in order of increasing frequency?

A Ultraviolet, visible, infra-red, radio

B Radio, infra-red, visible, ultraviolet

C Radio, microwave, ultraviolet, visible

D Visible, ultraviolet, X-ray, microwave

2001 AH MC22 (71%) and 2007 AH MC5 (70%)
2015 AH MC1 (80%) and 2015 revAH MC1 (95%)

22. Infra-red radiation can be used in the analysis and identification of organic compounds. Compared to visible radiation (light) infra-red radiation has a

A shorter wavelength and higher frequency

B longer wavelength and lower velocity

C longer wavelength and lower frequency

D shorter wavelength and higher velocity.

2014 AH MC1 (78%) and 2014 revAH MC6 (90%)

1. The energy associated with a photon of electromagnetic radiation is

A independent of the frequency

B proportional to the frequency

C inversely proportional to the frequency

D proportional to the square of the frequency.

2014 AH MC2 (76%)

2. The energy, in $kJ\,mol^{-1}$, corresponding to light of wavelength 501 nm is

A $1{\cdot}99 \times 10^{-7}$

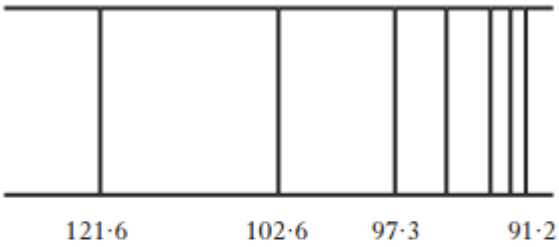
B 60·0

C 239

D $2{\cdot}39 \times 10^{5}$.

2009 AH MC1 (88%) and 2015 AH MC3 (91%) and 2015 revAH MC2 (94%)

3. The diagram shows one of the series of lines in the hydrogen emission spectrum.



Each line

A represents an energy level within a hydrogen atom

B results from an electron moving to a higher energy level

C lies within the visible part of the electromagnetic spectrum

D results from an excited electron dropping to a lower energy level.

2013 AH MC7 (60%) and 2013 revAH MC7 (65%)

7. Which of the following analytical techniques would be most suitable to determine quantitatively the concentration of sodium ions in a urine sample?

A Mass spectrometry

B Infra-red spectroscopy

C Atomic emission spectroscopy

D Proton nuclear magnetic resonance spectroscopy

2005 AH MC6 (76%)

6. In absorption spectroscopy, as the concentration of an ion in solution increases, there is an increase in the

A wavelength of radiation absorbed

B frequency of radiation absorbed

C intensity of radiation absorbed

D intensity of radiation emitted.

2005 AH MC4 (48%) and 2012 AH MC5 (69%)

4. Neon gas discharge lamps produce a red glow because electrons in neon atoms are

A absorbing radiation from the blue end of the visible spectrum

B emitting radiation from the red end of the visible spectrum

C emitting radiation from the blue end of the visible spectrum

D absorbing radiation from the red end of the visible spectrum.

2006 AH MC1 (77%)

1. Sodium vapour street lamps emit yellow light because

A sodium vapour is burning and giving out a yellow glow

B sodium vapour filters out all the light from the filament except yellow

C energy corresponding to yellow light is given out as electrons in sodium move to higher energies

D energy corresponding to yellow light is given out as electrons in sodium move to lower energies.

2010 AH MC5 (56%)

5. Which of the following statements about atomic emission spectroscopy is **incorrect**?

A Each element provides a characteristic spectrum.

B Visible light is used to promote electrons to higher energy levels.

C The lines arise from electron transitions between one energy level and another.

D The quantity of the element can be determined from the intensity of radiation transmitted.

2005 AH MC5 (67%)

5. In the emission line spectrum of hydrogen, there are many lines. How many of these lines are caused by all the possible electron transitions between the four lowest energy levels of the hydrogen atom?

A 3

B 4

C 6

D 10

2013 AH MC3 (74%) and 2013 revAH MC3 (75%)

3. Using information from the Data Booklet which one of the following metal salts will emit radiation of the highest frequency when placed in a Bunsen flame?

A Copper(II) sulphate

B Potassium chloride

C Barium chloride

D Lithium sulphate

2013 AH MC4 (62%) and 2013 revAH MC4 (69%)

4. Which of the following indicators transmits only the lower frequencies of the visible spectrum at low pH?

	Indicator	*Colour in acid*	*Colour in alkali*
A		Violet	Red
B		Green	Blue
C		Yellow	Violet
D		Red	Yellow

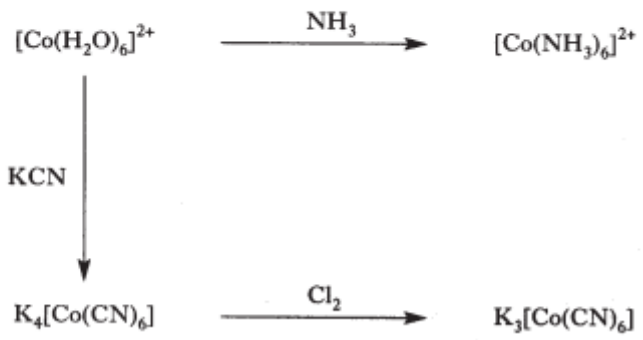
2002 AH L1d

1. At room temperature, titanium(III) chloride is a solid which dissolves in water to give a purple solution. However, titanium(IV) chloride is a liquid at room temperature which reacts vigorously with water giving off white fumes.

(*d*) A solution of titanium(III) chloride absorbs light at 500 nm.
Calculate the energy, in kJ mol^{-1}, associated with this wavelength. **2**

2004 AH L5e

5. Consider the following reactions.



(*e*) The $[Co(H_2O)_6]^{2+}$ ion absorbs at 550 nm.
Calculate the energy, in kJ mol^{-1}, corresponding to this absorption. **3**

2005 AH L13e

13. A soluble white solid, **X**, does **not** react with 2,4-dinitrophenylhydrazine (Brady's Reagent).

(*e*) Calculate the energy, in kJ mol^{-1}, corresponding to the absorption peak at **wavenumber** 1685 cm^{-1} in the infra red spectrum. **3**

2006 AH L4

4. In the stratosphere, oxygen molecules absorb ultraviolet radiation and break up to form oxygen atoms.

$$O=O \longrightarrow O + O$$

(*a*) The bond enthalpy of $O=O$ is 497 kJ mol^{-1}. Calculate the wavelength, in nm, of the ultraviolet radiation required to break up 1 mole of oxygen molecules into oxygen atoms. **3**

2008 AH L3c

3. Some metal salts emit light when heated in a Bunsen flame.

Lithium nitrate changes the flame colour to crimson.

Magnesium nitrate has no effect on the flame colour.

(*c*) Calculate the energy, in kJ mol^{-1}, associated with crimson light of wavelength 671 nm. **2**

2009 AH L1b

1. A detector in a Geiger counter contains argon which ionises when nuclear radiation passes through it.

(*b*) The first ionisation energy of argon is 1530 kJ mol^{-1}.

(i) Calculate the wavelength of the radiation, in nm, corresponding to this energy. **3**

(ii) Write the equation for the first ionisation of argon. **1**

2010 AH L1a

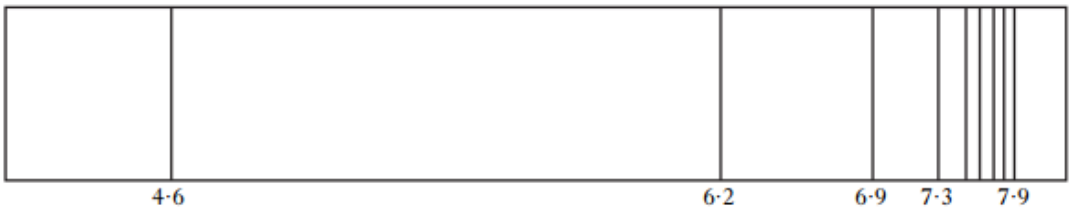
1. The first argon compound was prepared by shining light of wavelength 160 nm onto a mixture of argon and hydrogen fluoride at a temperature of 7·5 K. The hydrogen fluoride reacted with the argon to form HArF.

(*a*) Calculate the energy, in kJ mol^{-1}, associated with light of wavelength 160 nm. **2**

2011 AH L2

2. When hydrogen is subjected to a high voltage in a gas discharge tube and the emitted light is passed through a prism the atomic emission spectrum produced is as shown below.

hydrogen emission spectrum (visible region)



Frequency $\nu/10^{14}$ Hz

(*a*) Which line in the spectrum is red? **1**

(*b*) The ionisation energy of hydrogen has a value of 1311 kJ mol^{-1}.

(i) Write the equation for the ionisation energy of hydrogen. **1**

(ii) Calculate the wavelength of the light corresponding to this ionisation energy. **3**

2012 AH L1a(i)

1. Semiconductors are used in a wide variety of applications.

(*a*) In Blu-ray DVD players, light of wavelength 405 nm is produced from a gallium(III) nitride laser.

(i) Calculate the energy, in kJ mol^{-1}, corresponding to this wavelength. **2**

2013 AH L4d and 21013 revAH L4d

4. In a PPA the manganese content of a steel paper clip is determined by converting the manganese into purple permanganate ions, the concentration of which is measured using colorimetry.

(*d*) Colorimetry is not used to determine potassium content because potassium ions are not coloured. The concentration of potassium ions in a compound can be determined using atomic absorption spectroscopy at a wavelength of 405 nm.

Calculate the energy, in kJ mol^{-1}, of this radiation. **2**

2014 revAH L1a+d

1. Atomic spectroscopy is a useful analytical tool for identifying and quantifying the elements present in a sample. It also provides information about atomic structure.

(*a*) When a high voltage is applied to a lamp filled with helium gas, a line of red light, wavelength 706 nm, is observed through a spectroscope.

(i) Explain how the line of red light is produced. **2**

(ii) Calculate the energy, in kJ mol^{-1}, associated with this wavelength. **2**

(*d*) Mercury atoms are much larger than those of helium or phosphorus. A small section of the atomic emission spectrum for mercury is shown below.

Why does this spectrum have multiple lines? **1**

2015 AH L1b and 2015 revAH L1b

1.

(*b*) The first ionisation energy of sodium is 502 kJ mol^{-1}.

(i) Calculate the wavelength of light corresponding to this ionisation energy. **3**

(ii) Explain whether visible light would provide sufficient energy to ionise gaseous sodium atoms. **1**

2016 AH L6

6. Chlorine is a versatile element which forms a wide range of compounds.

(a) One example of a compound containing chlorine is vanadium(IV) chloride. It reacts vigorously with water forming a blue solution.

The blue solution absorbs light of wavelength 610 nm.

Calculate the energy, in kJ mol^{-1}, associated with this wavelength. **2**