Higher Spectra Questions

1. a) What is meant by the term '**Emission Spectra**'?

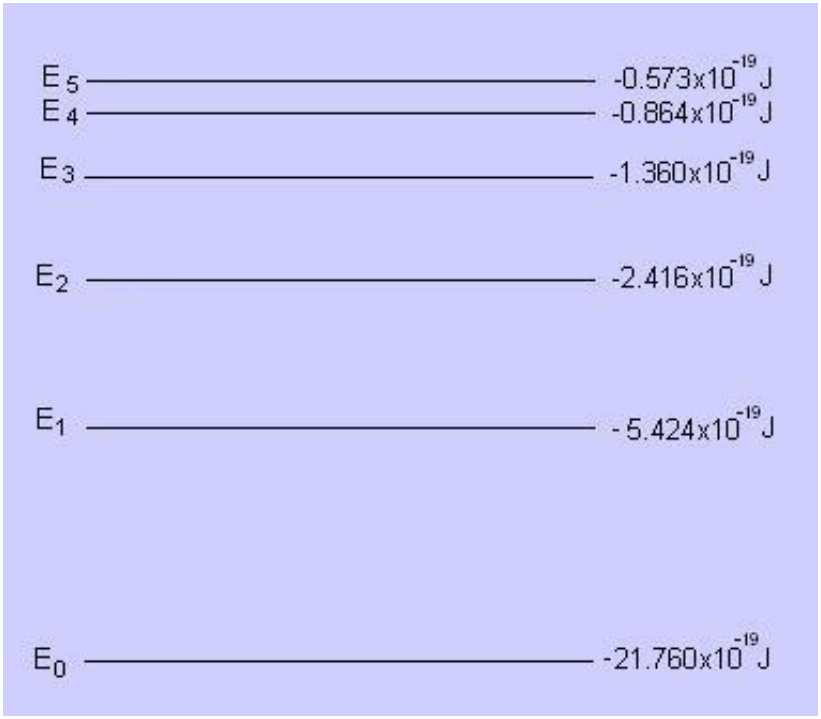
b) State the names of the **two forms** of emission spectra.

c) Emission Spectra is described by the **Bohr Model** of the atom.

Describe the Bohr Model of the atom using the following terms:

Orbits, **energies**, **levels**, **electrons, ground state** and the **nucleus**.

2.



a) **State the number of transition lines** possible for the Hydrogen atom in the energy level diagram above.

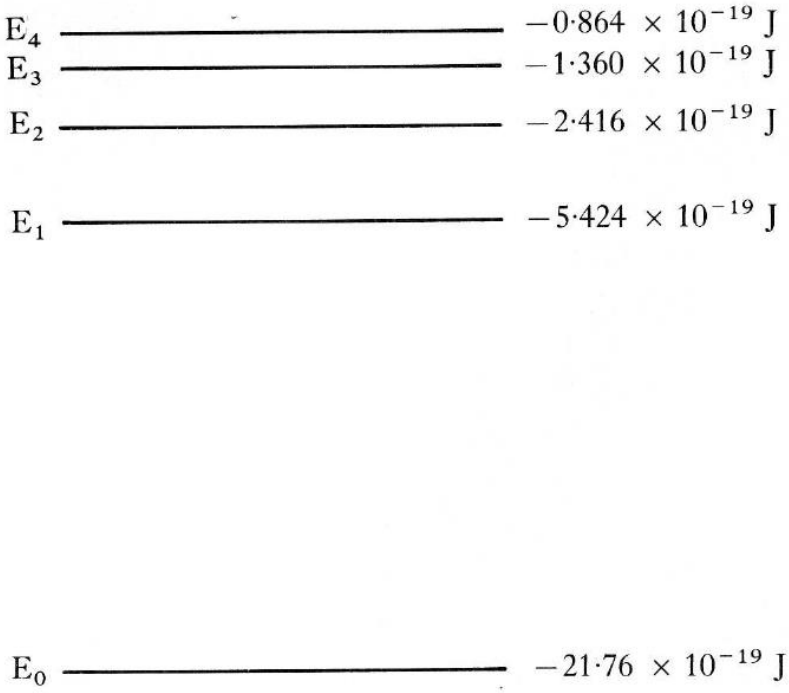
b) What is the energy level $\mathbf{E_o}$ known as?

c) **Which transition** in the Hydrogen atom gives rise to the line of:
i) **Longest wavelength**.
ii) **Highest frequency**.

d) **Show by calculation the two energy levels involved** in the emission of radiation of frequency **6.88×10^{14}Hz**.

3.

The diagram below shows the energy levels for the hydrogen atom.



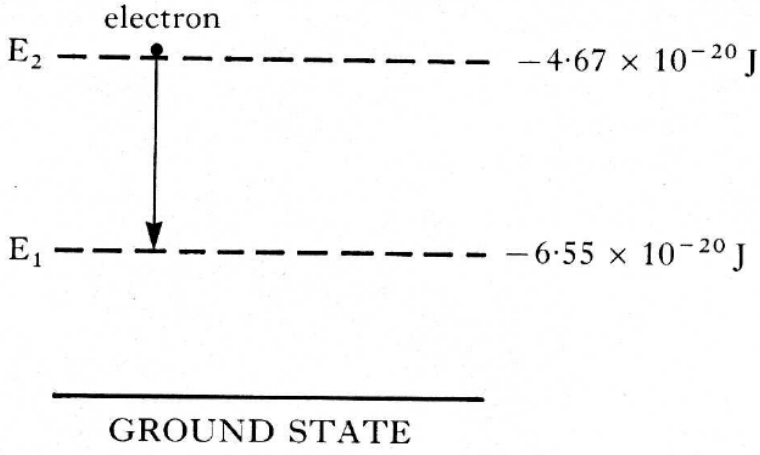
(*a*) Between which two energy levels would an electron transition lead to the emission of radiation of **highest** frequency?

(*b*) Calculate the frequency of the radiation in part (*a*).
(You may have to refer to the Science Data Booklet.)

4.

(*a*) Laser light is *monochromatic* and *coherent*.
Briefly explain the meaning of the terms *monochromatic* and *coherent*.

(*b*) A laser radiates energy when electrons are stimulated to fall from energy level E_2 to energy level E_1 as shown in the diagram.



(i) What are the frequency and wavelength of the radiation emitted?

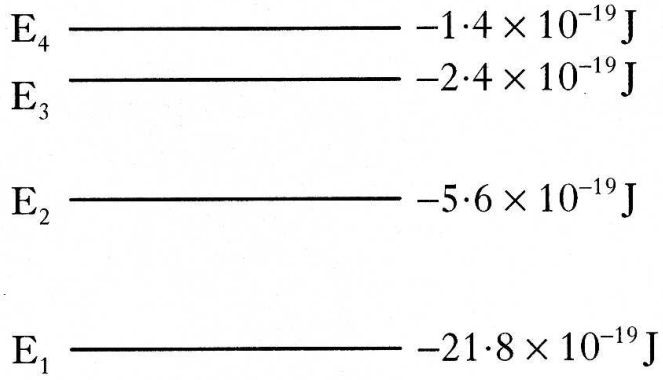
(ii) Name the section of the electromagnetic spectrum in which the radiation occurs.

(*c*) The beam of light from a laser is very intense.
Give **two** reasons for this.

5.

(*a*) Electrons which orbit the nucleus of an atom can be considered as occupying discrete energy levels.

The following diagram shows some of the energy levels for a particular atom.

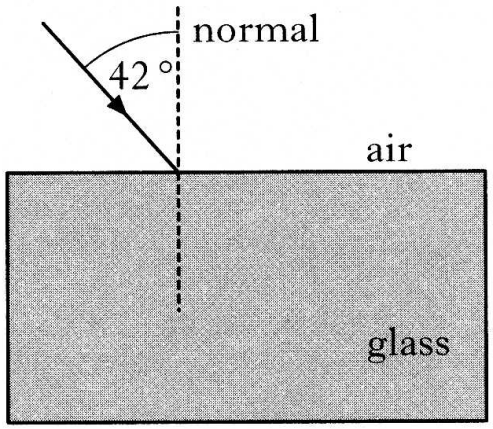


(i) The transition between which two of these energy levels produces radiation with the longest wavelength? You must justify your answer.

(ii) Calculate the frequency of the photon produced when an electron falls from E_3 to E_2.

(*b*) A laser produces light of frequency $4{\cdot}74 \times 10^{14}$ Hz in air.

A ray of light from this laser is directed into a block of glass as shown below.



The refractive index of the glass for this light is 1·60.

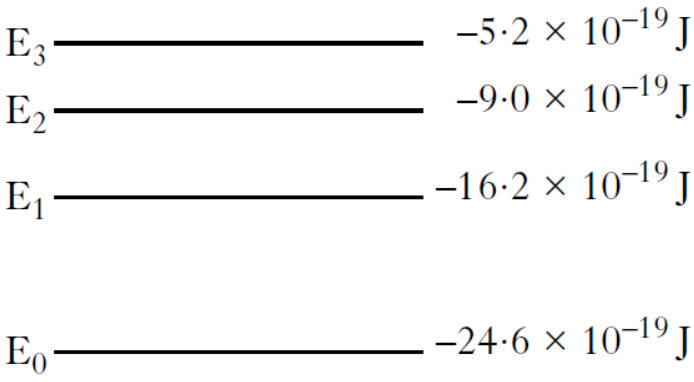
(i) What is the value of the frequency of the light in the block of glass?

(ii) Calculate the wavelength of the light in the glass.

6.

(*a*) Electrons which orbit the nucleus of an atom can be considered as occupying discrete energy levels.

The following diagram shows some of the energy levels for a particular atom.



(i) Radiation is produced when electrons make transitions from a higher to a lower energy level.

Which transition, between these energy levels, produces radiation with the shortest wavelength?

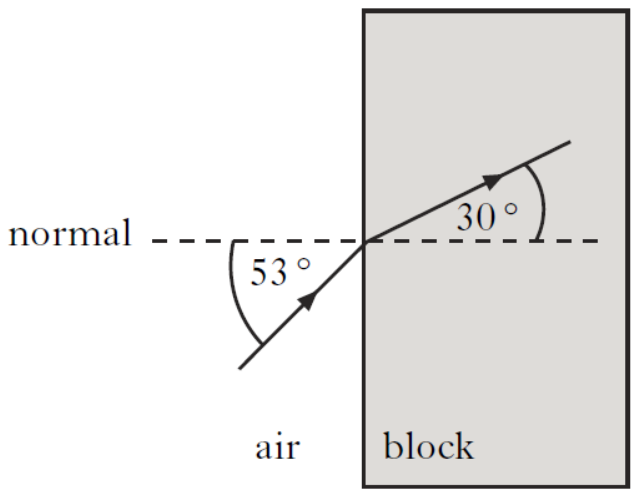
Justify your answer.

(ii) An electron is excited from energy level E_2 to E_3 by absorbing light energy.

What frequency of light is used to excite this electron?

(*b*) Another source of light has a frequency of $4{\cdot}6 \times 10^{14}$ Hz in air.

A ray of this light is directed into a block of transparent material as shown.



Calculate the wavelength of the light in the block.

7.

(*a*) The Sun is the source of most of the energy on Earth. This energy is produced by nuclear reactions which take place in the interior of the Sun.

One such reaction can be described by the following statement.

$$^{3}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$$

The masses of the particles involved in this reaction are shown in the table.

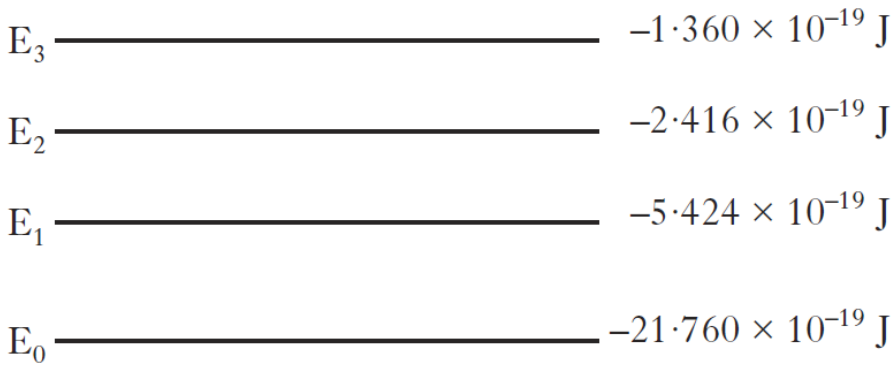
Particle	*Mass*/kg
$^{3}_{1}\mathrm{H}$	$5{\cdot}005 \times 10^{-27}$
$^{2}_{1}\mathrm{H}$	$3{\cdot}342 \times 10^{-27}$
$^{4}_{2}\mathrm{He}$	$6{\cdot}642 \times 10^{-27}$
$^{1}_{0}\mathrm{n}$	$1{\cdot}675 \times 10^{-27}$

(i) Name this type of nuclear reaction.

(ii) Calculate the energy released in this reaction.

(*b*) The Sun emits a continuous spectrum of visible light. When this light passes through hydrogen atoms in the Sun's outer atmosphere, certain wavelengths are absorbed.

The diagram shows some of the energy levels for the hydrogen atom.



(i) One of the wavelengths absorbed by the hydrogen atoms results in an electron transition from energy level E_1 to E_3.

Calculate this wavelength.

(ii) The absorption of this wavelength produces a faint dark line in the continuous spectrum from the Sun.

In which colour of the spectrum is this dark line observed?

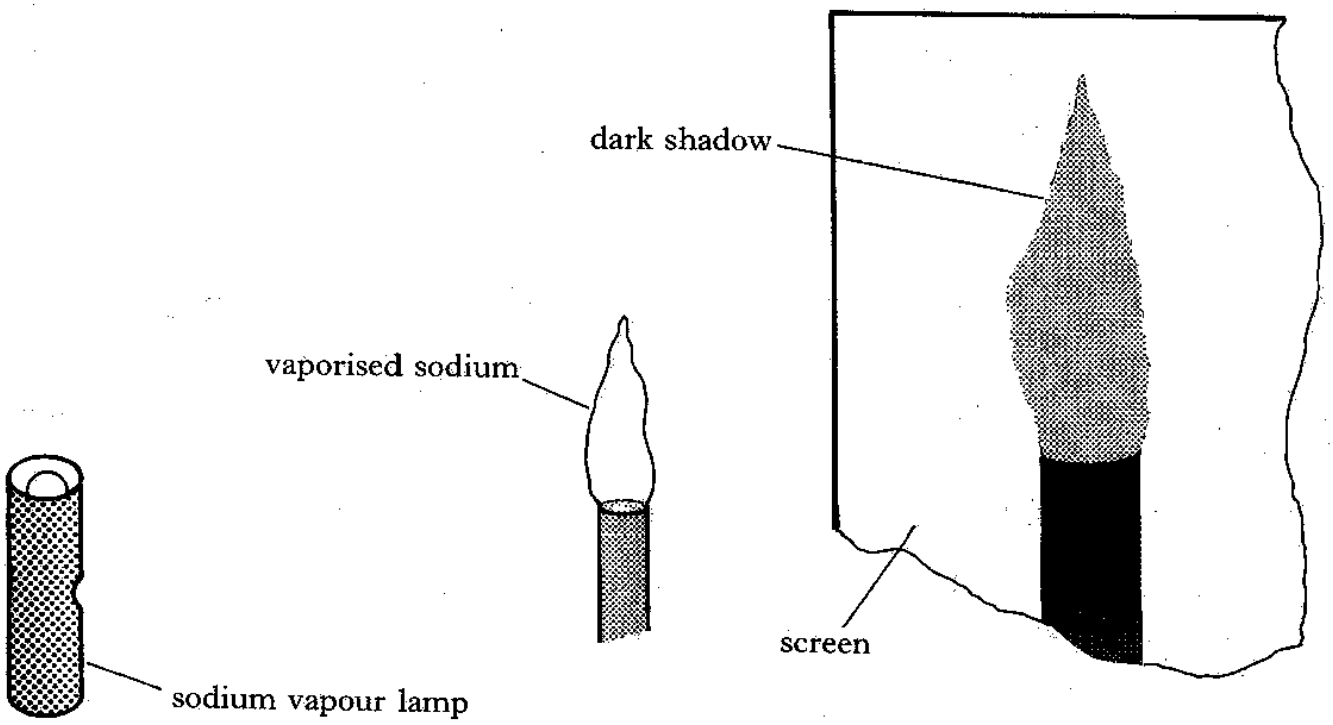
8.

(*a*) A sodium vapour lamp emits bright yellow light when electrons make transitions from one energy level to another within the sodium atoms.

(i) State whether electrons are moving to higher or lower energy levels when the light is emitted.

(ii) Using information provided in the data sheet, calculate the energy difference between these two electron energy levels in the sodium atom.

(*b*) A Bunsen flame containing vaporised sodium is placed between a sodium vapour lamp and a screen as shown.



(i) Explain why a dark shadow of the flame is seen on the screen.

(ii) The sodium vapour lamp is replaced with a cadmium vapour lamp.
Explain why there is now no dark shadow of the flame on the screen.