ATAR Physics 12 Test 5 – Wave Particle Duality & Quantum Theory 2017

Name: TOTAL = / 50

**Answer all questions. Write your answer in the spaces provided. Show all working and express all final numerical answers to three (3) decimal places.**

Question 1

Mobile phones with Bluetooth technology use microwaves with a frequency of 2.40 GHz.

a) Calculate the wavelength of these microwaves.

**(2 marks)**

**b)** If the mobile phone emits $8.5 \times 10^{23}$ photons in 0.5 seconds, what is the power output (in watts) of the laser? **(3 marks)**

Question 2

A 2.0 mW light source emits a narrow beam that shines on a screen. The wavelength of the light is 633 nm.

(a) Calculate how many photons strike the screen per second.

**(3 marks)**

(b) If the power of the beam is doubled, which of the following statements is true?

**A.** The photons travel faster.
**B.** Each photon has more energy.
**C.** More photons hit the screen every second.
**D.** The frequency of the light is doubled.

**(1 mark)**

Question 3

The different colours seen in exploding fireworks are produced by using different elements.

| Element | Predominant Colour |
|---|---|
| Strontium | Red |
| **Barium** | **Green** |
| **Copper** | **Blue-green** |
| Sodium | Yellow**-orange** |

Given the information above, which of the elements emits **the lowest photon energy** of visible light?

_____

Briefly explain the reason for your answer.

_____

_____

_____

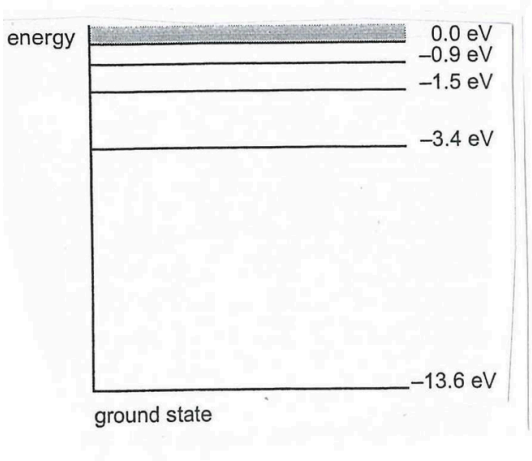
**(3 marks)**

Question 4

The energy level diagram for a certain element is shown below. The absorption spectrum for the element shows a dark line corresponding to a wavelength of 497 nm.

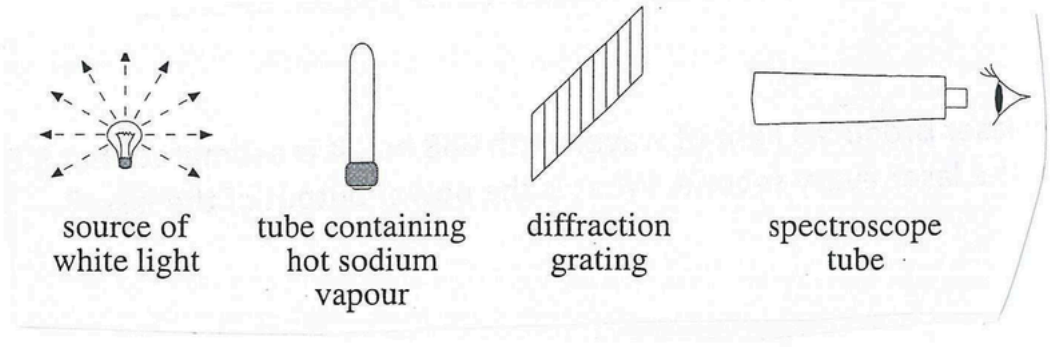
Which transition will produce this absorption line? **Show the transition on the diagram.**

Justify your answer with appropriate working. **(4 marks)**

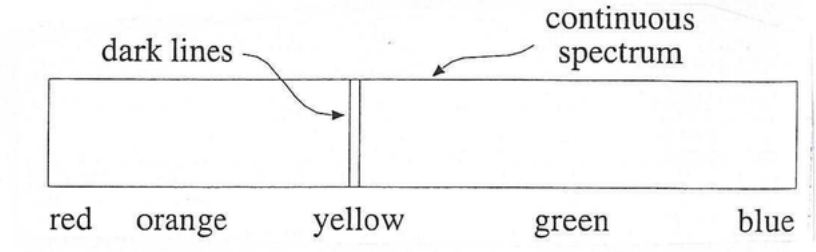


Question 5

White light is passed through a hot sodium vapour and then through a diffraction grating as shown in the diagram below.




The light is then viewed through a spectroscope. Two distinct dark parallel lines are seen in the otherwise continuous spectrum, as shown below.



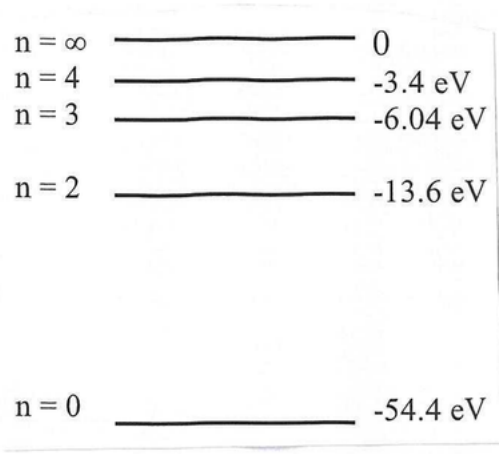

a) What type of spectrum has been observed? _____

**(1 mark)**

b) Explain how these dark lines are formed. **(3 marks)**

Question 6

The diagram below shows the energy levels for a helium atom.




a) What is the **ionisation energy** (in joules) of a helium atom?

**(2 marks)**

b) An electron jumps from the n = 4 level to the n= 2 level. Calculate the **wavelength** of the photon emitted?

**(3 marks)**

c) A dark line in the absorption spectrum of helium occurs at a wavelength of 471 nm. Between which two energy levels does a transition occur when this absorption line is formed?

**(3 marks)**

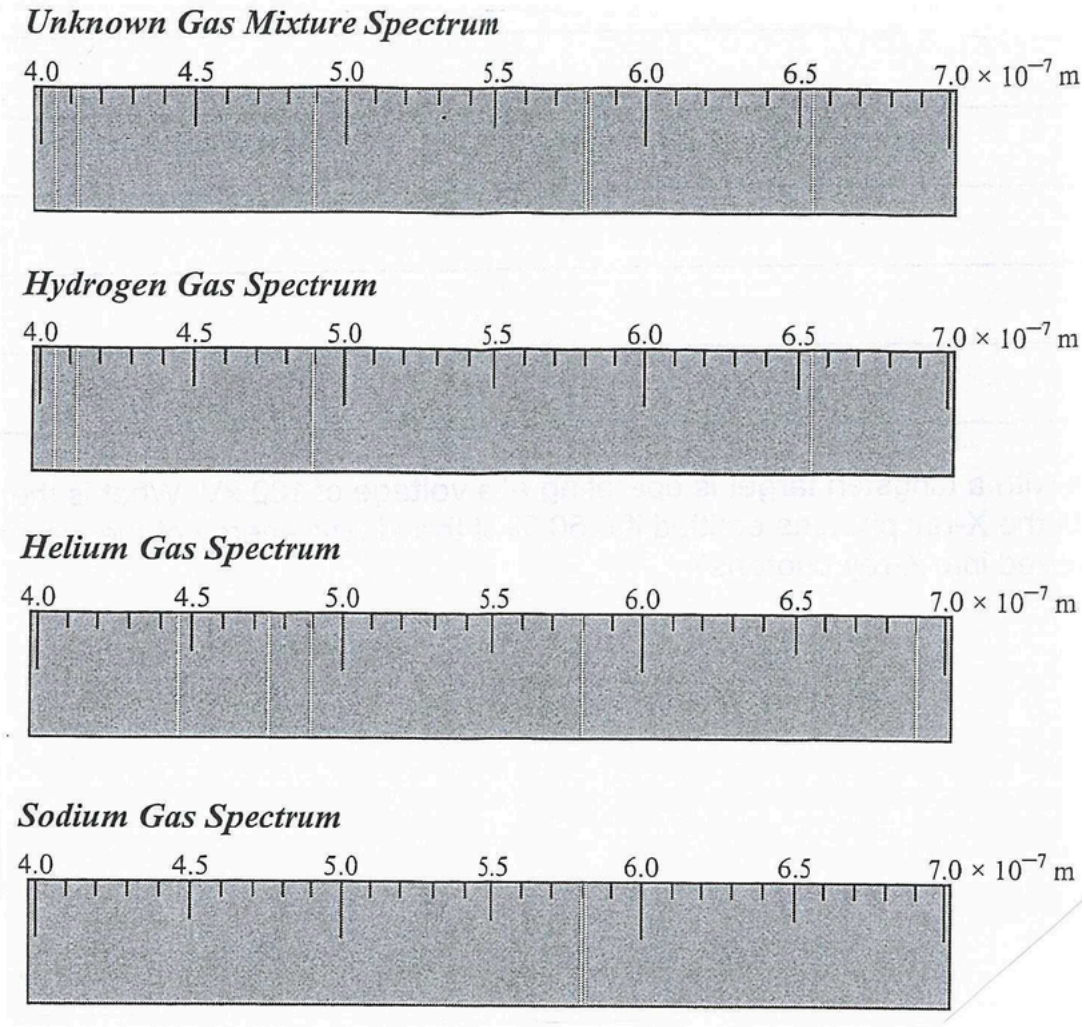
Question 7

Tara and Bronte are having an argument over the nature of light. Tara claims that light is a wave, whereas Bronte insists light behaves as a particle. Who is correct? Explain your answer.

**(6 marks)**

Question 8

The diagrams below show the bright line emission spectra for hydrogen gas, helium gas, sodium gas as an unknown gas mixture.




a) According to the spectra above, the gas mixture probably contains

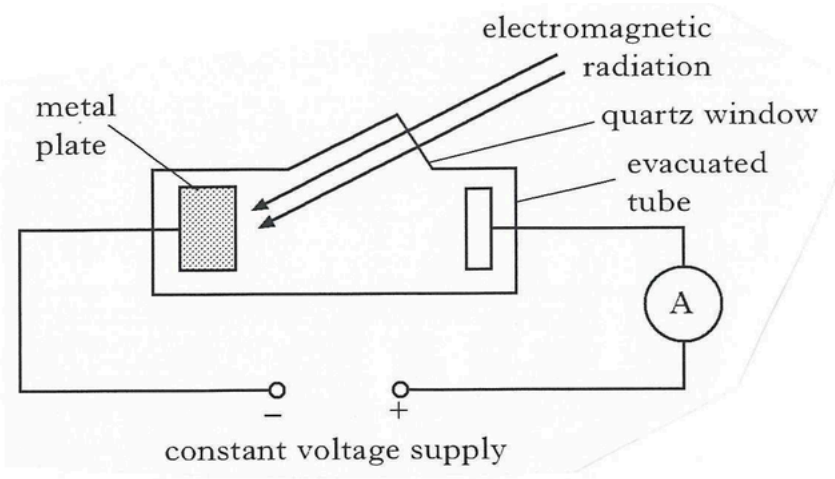
**A –** hydrogen, helium and sodium gases
**B –** hydrogen and sodium gases only
**C –** hydrogen and helium gases only
**D –** helium and sodium gases only

**(2 marks)**

b) Briefly explain the reasons for your answer. **(3 marks)**

Question 9

A metal plate emits electrons when certain wavelengths of electromagnetic radiation are incident on it.




When light of wavelength 605 nm is incident on the metal plate, electrons are just released from the surface of the metal. The corresponding amount of energy is called the **work function** of the metal.

a) Determine the size of the work function for the metal. Give the answer in units of **electron volts.** **(3 marks)**

b) Will light of frequency $3.50 \times 10^{14}$ Hz be able to release electrons from the surface of this metal? **(2 marks)**

c) The brightness (intensity) of the light used in b) is **increased.** Will this make any difference to your answer in b)? Explain. **(2 marks)**

Question 10

Describe two methods of producing electromagnetic radiation.

**(4 marks)**

**END OF TEST**