Wave Particle Duality

Have a go at the following exam questions.

OCR, G482, JANUARY 2011

6 **(a)** In atomic physics electron energies are often stated in *electronvolts* (eV).

Define the *electronvolt*. State its value in joule.

.....

.....

..... **[2]**

(b) An electron is accelerated from rest through a potential difference of 300 V.

(i) Calculate the final kinetic energy of the electron

1 in eV

kinetic energy = ... eV **[1]**

2 in J.

kinetic energy = ... J **[1]**

(ii) Show that the final speed of the electron is about $1 \times 10^7\,m\,s^{-1}$.

[2]

(c) **(i)** Explain what is meant by the *de Broglie wavelength* of an electron.

.....

.....

..... **[2]**

(ii) Calculate the de Broglie wavelength of the electron in **(b)**.

wavelength = ... m **[2]**

[Total: 10]

OCR, G482, JUNE 2012

5 This question is about electrons and photons.

(a) Both electrons and photons can be considered as particles. State **two** differences between their properties.

.....

.....

..... **[2]**

(b) An electron is accelerated from rest through a p.d. of 5000 V.

(i) Show that the energy gained by the electron is 8.0×10^{-16} J.

[2]

(ii) Show that the speed of the electron is about $4 \times 10^{7}\,m\,s^{-1}$.

[3]

(c) **(i)** Explain what is meant by the de Broglie wavelength of an electron.

.....

.....

..... **[1]**

(ii) Calculate the de Broglie wavelength of the electron in **(b)**.

wavelength = ... m **[3]**

(d) Calculate the wavelength of a photon of energy 8.0×10^{-16} J.

wavelength = ... m **[3]**

(e) Photons of energy 9.0×10^{-19} J are incident on a clean tungsten surface causing electrons to be emitted.

(i) State the name of this process.

..... **[1]**

(ii) Calculate the maximum kinetic energy of the emitted electrons. Tungsten has a work function of 7.2×10^{-19} J.

maximum kinetic energy = ... J **[2]**

(iii) Explain why your answer to **(ii)** is a maximum value.

.....

.....

.....

.....

..... **[2]**

[Total: 19]

EDEXCEL, 6PH02/01, JANUARY 2010

***16** In 1921, Albert Einstein won the Nobel Prize for his work on the photoelectric effect.

The results of experiments on the photoelectric effect show that:

- photoelectrons are not released when the incident radiation is below a certain threshold frequency;
- the kinetic energy of the photoelectrons released depends on the frequency of the incident light and not its intensity.

Explain how these results support a particle theory, but not a wave theory of light.

EDEXCEL, 6PH02/01, JUNE 2010

8 The behaviour of light can be described in terms of waves or particles. The particle nature of light can be demonstrated by

☒ **A** light being diffracted as it passes through a narrow slit.

☒ **B** the speed of light reducing when it is refracted by glass.

☒ **C** light causing electrons to be emitted from a metal surface.

☒ **D** light being polarised.

(Total for Question 8 = 1 mark)

4. *(a)* Einstein's *photoelectric equation* may be written

$$E_{\text{k max}} = hf - \phi .$$

(i) What quantity of energy does hf represent? [1]

.....

(ii) A student mistakenly thinks that the 'minus' sign should be a 'plus' sign. Explain, in terms of electrons and photons, why the equation must be correct as written above. [3]

.....

.....

.....

.....

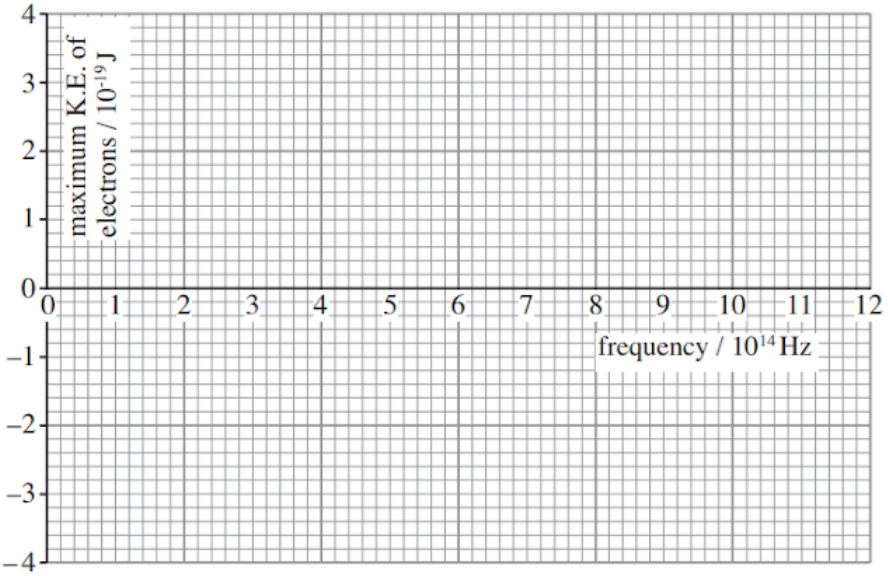
.....

.....

(b) In an experiment in which a sodium surface is exposed to electromagnetic radiation, these results are obtained.

$f / 10^{14}$ Hz	6.9	9.6	11.8
$E_{\text{k max}} / 10^{-19}$ J	0.79	2.58	4.04

(i) Plot these data points on the grid, and hence draw the graph line. [2]



(ii) Use the data, or your graph, to determine values for

(I) the *work function* of sodium, [1]

.....

.....

.....

(II) the *Planck constant*. Show your working. [2]

.....

.....

.....

.....

.....

(iii) Draw on the grid a line, labelled (iii), which might be obtained if a metal with a **lower** work function were used in the experiment. [2]