## Question 1

(*f*) What are the charge carriers in (*i*) semiconductors and (*ii*) metals?

## Question 2

(*h*) The work function of tungsten is 4.50 eV. Calculate the maximum kinetic energy of an electron ejected from a tungsten surface when electromagnetic radiation whose photon energy is 5.85 eV shines on the surface.

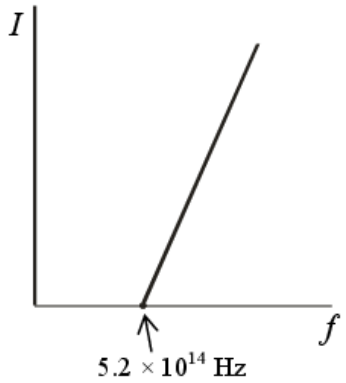
## Question 3

(*i*) How are X-rays produced? (7)

## Question 4

**8.** What is a photon? (6)

An investigation was carried out to establish the relationship between the current flowing in a photocell and the frequency of the light incident on it. The graph illustrates the relationship.




Draw a labelled diagram of the structure of a photocell. (12)

Using the graph, calculate the work function of the metal.

What is the maximum speed of an emitted electron when light of wavelength 550 nm is incident on the photocell?

Explain why a current does not flow in the photocell when the frequency of the light is less than $5.2 \times 10^{14}$ Hz. (21)

The relationship between the current flowing in a photocell and the intensity of the light incident on the photocell was then investigated. Readings were taken and a graph was drawn to show the relationship.

Draw a sketch of the graph obtained. How was the intensity of the light varied?

What conclusion about the nature of light can be drawn from these investigations? (17)

(Planck constant = $6.6 \times 10^{-34}$ J s; speed of light = $3.0 \times 10^{8}$ m $s^{-1}$; charge on electron = $1.6 \times 10^{-19}$ C; mass of electron = $9.1 \times 10^{-31}$ kg)

## Question 5

(*h*) Give two ways of deflecting a beam of electrons. (7)

## Question 6

(*f*) What is the force exerted on an electron when it is in an electric field of strength 5 N $C^{-1}$? (7)

## Question 7

*(i)* How are electrons accelerated in a cathode ray tube? (7)

## Question 8

*(d)* The first Nobel Prize in Physics was awarded in 1901 for the discovery of X-rays. What are X-rays? Who discovered them? (9)

In an X-ray tube electrons are emitted from a metal cathode and accelerated across the tube to hit a metal anode.

How are the electrons

(i) emitted from the cathode;

(ii) accelerated? (6)

Calculate the kinetic energy gained by an electron when it is accelerated through a potential difference of 50 kV in an X-ray tube.

Calculate the minimum wavelength of an X-ray emitted from the anode. (13)

(Planck constant = $6.6 \times 10^{-34}$ J s; speed of light = $3.0 \times 10^{8}$ m $s^{-1}$;
charge on electron = $1.6 \times 10^{-19}$ C )

## Question 9

*(i)* How are electrons produced in an X-ray tube? (7)

## Question 10

*(d)* One hundred years ago, Albert Einstein explained the photoelectric effect.

What is the photoelectric effect? (6)

Write down an expression for Einstein's photoelectric law. (9)

Summarise Einstein's explanation of the photoelectric effect (9)

Give one application of the photoelectric effect. (4)