

- 9 (a)** For a particular metal surface, it is observed that there is a minimum frequency of light below which photoelectric emission does not occur. This observation provides evidence for a particulate nature of electromagnetic radiation.

- (i) State two further observations from photoelectric emission that provide evidence for a particulate nature of electromagnetic radiation.

1.

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2.

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[2]

- (ii) When electromagnetic radiation of wavelength λ is incident on a metal surface, electrons of maximum kinetic energy E_{MAX} are emitted.

1. On Fig. 9.1, sketch the variation with $1/\lambda$ of E_{MAX} .

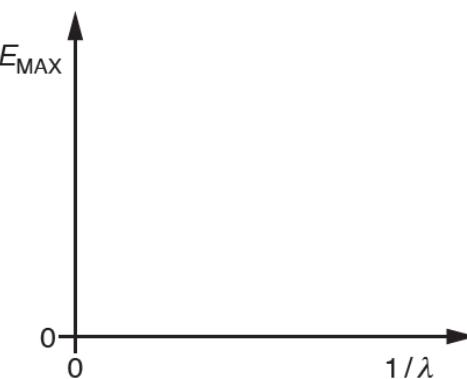


Fig. 9.1

[2]

2. State an equation relating the gradient of the graph drawn on Fig. 9.1 to the Planck constant h .
Explain any symbols you use.

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[1]

3. Light of a particular wavelength is incident on a metal surface and gives rise to a photoelectric current.

The wavelength is reduced. The intensity of the light is kept constant.

State and explain the effect, if any, on the photoelectric current.

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[3]

- (b) Fig. 9.2 shows the visible part of the emission spectrum from hydrogen gas in a laboratory on the Earth. The numbers indicate the wavelength, in nm, represented by each line.

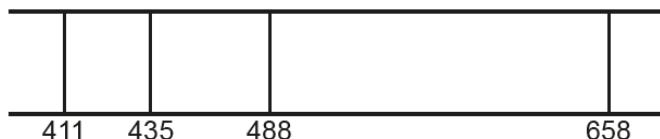


Fig. 9.2

- (i) Explain how the emission spectrum provides evidence for the existence of discrete energy levels for the electron in a hydrogen atom.

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[3]

- (ii) Fig. 9.3 shows five of the energy levels in the hydrogen atom. The wavelengths of radiation shown in Fig. 9.2 relate to transitions to the -3.400 eV level in Fig. 9.3.

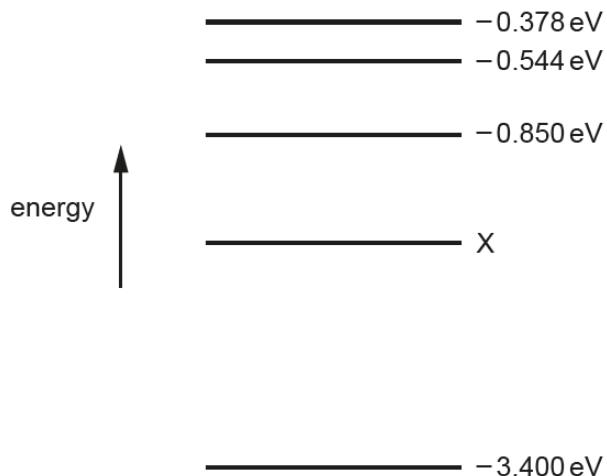


Fig. 9.3 (not to scale)

Show that the energy level X is -1.51 eV .

[3]

- (c) Electrons are accelerated through a potential difference of 15 kV . The electrons collide with a metal target and a spectrum of X-rays is produced.
- (i) Calculate the wavelength of the highest energy X-ray photon produced.

$$\text{wavelength} = \dots \text{m} [2]$$

- (ii) Describe and explain the changes, if any, in the x-ray spectrum if the accelerating potential is increased.
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[4]