Pages 52–56 Exam practice questions

1 Answer C

2 Answer B

3 Answer D

4 Answer C

5 Answer B

6 Answer C

7 Answer B

8 Answer C

9 Answer D

10 Answer A

11 a) The electron must absorb exactly 10.2 eV from a colliding electron or photon to move to energy level $n = 2$

b) The frequency is calculated using $f = E/h = (10.2 \times 1.6 \times 10^{-19})$ J / 6.63×10^{-34} J s

$= 2.46 \times 10^{15}$ Hz;

A photon of this frequency is in the UV part of the specification.

12 a) The ground state is when all electrons are in the lowest possible energy level. (1)

b) The electrons absorb exactly the right amount of energy (1) to move between quantised energy levels in the atom (1) by collisions with free electrons. (1)

c) The cathode provide free electrons (1) by thermionic emission. (1)

d) Wavelengths correspond to allowed energy levels in the mercury atom; as electrons fall back to the ground state from an excited state they release photons

13 a) $\lambda = hc/E = 6.63 \times 10^{-34}$ J s $\times 3 \times 10^{8}$ ms^{-1}/((11.4 – 1.8) $\times 10^{3} \times 1.6 \times 10^{-19}$) J $= 1.3 \times 10^{-10}$ m

b) Ionisation frequency is calculated using f = ionisation energy / h

$= (69.6 \times 10^{3} \times 1.6 \times 10^{-19})$ J /6.63×10^{-34} J s $= 1.6 \times 10^{19}$ Hz

c) Any transition with an energy difference greater than 1.2 keV

e.g. between energy levels 4–2; 4–1; 3–1; 3–2

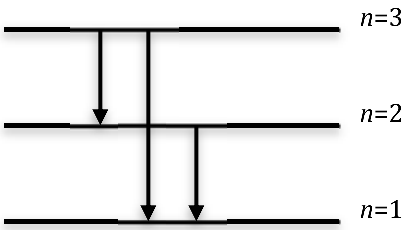
d) i) KE of electron after the collision = its original KE – energy transferred during the collision

$= 3.2 \times 10^{-15}$ J – $(11.4 \times 10^{3} \times 1.6 \times 10^{-19}$ J) $= 1.376 \times 10^{-15}$ J

ii) The ionisation energy is greater than the energy of the incident electron so it cannot ionise the atom.

e) Ionisation energy $= (69.6 \times 10^{3} \times 1.6 \times 10^{-19})$ J $= 1.11 \times 10^{-14}$ J

14 a) Each arrow represents a possible energy level transition and hence photon frequency



b) 3 frequencies are possible.

15 6 marks out of:

A glass tube is filled with mercury vapour and coated inside with fluorescent materials. (1)

A cathode releases free electrons with a range of kinetic energies. (1)

Electrodes accelerate free electrons through the mercury vapour. (1)

Collisions between free electrons and mercury atoms (1) leave mercury atoms ionised or excited. (1)

When the electrons in the excited mercury atoms return to their ground state, (1) photons of ultraviolet radiation are released. (1)

UV photons collide with the phospors in the coating, (1) and are reemitted as visible light. (1)

16 a) 5.1 eV

b) Orange – these lines fall into the orange part of the visible spectrum.

(400 nm = violet; 700 nm = red)

c) 4s → 3p: transition energy is 1.1ev (approx.);
wavelength = hc/E = $(3 \times 10^{8}\ \text{m s}^{-1} \times 6.63 \times 10^{-34}\ \text{J s}) / (1.6 \times 10^{-19} \times 1.1)\ \text{J} = 1.13 \times 10^{-6}\ \text{m}$

3c → 3p: transition energy is 1.6 eV ; wavelength = hc/E

$= (3 \times 10^{8}\ \text{m s}^{-1} \times 6.63 \times 10^{-34}\ \text{J s}) /(1.6 \times 10^{-19} \times 1.6)\ \text{J} = 7.8 \times 10^{-7}\ \text{m}$

3p → 3s: transition energy is 2.1 eV; wavelength = hc/E

$= (3 \times 10^{8}\ \text{m s}^{-1} \times 6.63 \times 10^{-34}\ \text{J s}) / (1.6 \times 10^{-19} \times 2.1)\ \text{J} = 5.9 \times 10^{-7}\ \text{m}$

d) $E = hc/\lambda = 3 \times 10^{8}\ \text{m s}^{-1} \times 6.63 \times 10^{-34}\ \text{J s} / 620 \times 10^{-9}\ \text{m} = 3.2 \times 10^{-19}$ J or 2eV; these correspond to the lines 3p → 3s and 5s → 3p

Page 56 Stretch and challenge questions

17 a) Hard X-rays are more penetrating than soft X-rays and are therefore more suitable than soft X-rays for medical diagnosis. Soft X-rays cannot penetrate through a patient's body.

Because they are absorbed more readily by body tissues than hard X-rays, soft X-rays would potentially cause more damage to the patient's body. They are usually filtered out when a scan is carried out for this reason.

18 a) 24 keV = 24 000 × 1.6 × 10^{-19} J

$E = \frac{hc}{\lambda}$ so $\lambda = \frac{hc}{E} = \frac{6.63\times 10^{-34}\times 3\times 10^{8}}{24\,000\times 1.6\times 10^{-19}}$ = 518 × 10^{-9} m = 518 nm

b) Absorption of X-rays increases with density. Soft tissue is less dense than bone so has a lower attenuation (i.e. ability to absorb X-rays) than bone. X-ray photons with lower energy are absorbed more readily than those with higher energy. To be able to see detail in soft tissue, different layers need to absorb X-rays by different amounts and this is increased if the X-ray has a low energy. This means that X-rays used for mammograms should have a higher wavelength than those used for bone X-rays.