

Exam-style questions and sample answers have been written by the authors. In examinations, the way marks are awarded may be different.

Coursebook answers

Chapter 28

Science in context guidance

- Students should already be familiar with a number of wave behaviours such as reflection, refraction and diffraction. These are all phenomena that occur with light, but also with other waves such as water waves.
- Waves can also be transmitted and absorbed. It is worth asking students if they can explain wave phenomena using particles instead of waves. They may come up with some interesting ideas!

Self-assessment questions

1 energy $E = hf = 6.63 \times 10^{-34} \times 1.0 \times 10^{16}$
 $= 6.63 \times 10^{-18} \text{ J} \approx 6.6 \times 10^{-18} \text{ J}$

2 energy $E = \frac{hc}{\lambda}$
 For red light, $E = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{700 \times 10^{-9}}$
 $= 2.8 \times 10^{-19} \text{ J}$

For violet light, $E = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{400 \times 10^{-9}}$
 $= 5.0 \times 10^{-19} \text{ J}$

3 Rearrange energy $E = \frac{hc}{\lambda}$ to give wavelength $\lambda = \frac{hc}{E}$

a $\lambda = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{10^{-12}} = 2.0 \times 10^{-13} \text{ m}$,
 γ -ray

b $\lambda = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{10^{-11}} = 2.0 \times 10^{-14} \text{ m}$,
 X-ray

c $\lambda = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{10^{-10}} = 2.0 \times 10^{-15} \text{ m}$,
 ultraviolet

d $\lambda = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{10^{-9}} = 2.0 \times 10^{-16} \text{ m}$,
 infrared

e $\lambda = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{10^{-17}} = 2.0 \text{ m}$, radio
 wave

4 energy of one photon, $E = \frac{hc}{\lambda}$
 $= \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{6.48 \times 10^{-7}} = 3.07 \times 10^{-19} \text{ J}$

number of photons per second =
 $\frac{\text{power of laser}}{\text{energy per photon}} = \frac{0.0010}{3.07 \times 10^{-19}} = 3.26 \times 10^{15} \text{ s}^{-1} \approx 3.3 \times 10^{15} \text{ s}^{-1}$

5 energy change, $W = 1.2 \text{ eV} = QV$
 $= 1.6 \times 10^{-19} \times 1.2 = 1.92 \times 10^{-19} \text{ J} \approx 1.9 \times 10^{-19} \text{ J}$
 energy in eV = 1.2 eV

6 energy in joules, $E = hf$
 $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$
 $E = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{15}}{1.60 \times 10^{-19}} = 12\,400 \text{ eV} \approx 12 \text{ keV}$

7 Rearrange energy $E = \frac{hc}{\lambda}$ to give wavelength λ
 $= \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^8}{10 \times 1.6 \times 10^{-19}} \approx 1.24 \times 10^{-7} \text{ m}$,
 ultraviolet

8 a energy gained = work done on proton by potential difference
 energy gained = $QV = 1.60 \times 10^{-19} \times 1500$
 $= 2.4 \times 10^{-16} \text{ J}$

b kinetic energy $E_k = \frac{1}{2}mv^2$ so speed $v = \sqrt{\frac{2E_k}{m}}$
 $= \sqrt{\frac{2 \times 2.4 \times 10^{-16}}{1.67 \times 10^{-27}}} = 5.3 \times 10^5 \text{ m s}^{-1}$

9 Rearrange $eV = \frac{hc}{\lambda}$ to give Planck's constant,
 $h = \frac{e\lambda c}{f}$

For infrared LED, $h = \frac{1.6 \times 10^{-19} \times 1.35 \times 910 \times 10^{-9}}{3.0 \times 10^8} = 6.55 \times 10^{-34} \text{ J s}$

Chapter 28 D Reading Answers

AN Whitehead



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