

Exercise walk-through

3.12

Properties of Photons

AP Chemistry

The ladder of intermolecular forces

London dispersion

present in **all** molecules – Coulombic attraction between **temporary, fluctuating dipoles**. Stronger with more electrons and a larger, more polarisable cloud

dipole–dipole

–

between polar molecules; strength depends on the size of the dipoles **and their relative orientation**

hydrogen bonding

the strongest of these – H bonded to N, O or F

ion–dipole

an ion beside a polar molecule – what dissolves a salt in water

how to reason

the whole ladder is judged **qualitatively** from the **sign and size of the partial charges**, and how well they can align

Bigger or better-aligned partial charges, or a more polarisable electron cloud, means a stronger force – and a higher boiling point.

Types of solids

A solid's properties follow from its particles and the force holding them:

Ionic : high melt, brittle,
conducts molten

Covalent network :
very high melt, hard (diamond)

Metallic : conducts, mal-
leable

Molecular : low melt,
soft (ice)

Network solids melt highest – you must break **covalent bonds**, not just weak IMFs.

Drawing a particulate diagram of a solution

what it shows

the **solute** and **solvent** particles, at the particle level

an ionic solute

show it fully **dissociated** into **separate ions**, each surrounded by solvent molecules

the orientation

water's δ^- oxygen faces the cations, its δ^+ hydrogens face the anions

a molecular solute

show whole molecules, not fragments – sugar does not dissociate

a strong acid

fully ionised: no intact HCl molecules should appear

the marks

come from correct **ratio**, **dissociation and orientation**, not from artistic quality

Count the particles you draw. A diagram showing the wrong stoichiometric ratio loses the mark however neat it is.

Exercises 2.1-2.3

2.1 Write the equation linking a photon's energy and frequency.

[1]

2.2 Find the frequency of light with $\lambda = 6.00 \times 10^{-7}$ m.

[2]

2.3 Find the energy of a photon of frequency 5.0×10^{14} Hz.

[2]

Exercises 2.1-2.3

2.1 Write the equation linking a photon's energy and frequency.

[1]

2.1

- $E = h\nu$

2.2 Find the frequency of light with $\lambda = 6.00 \times 10^{-7}$ m.

[2]

2.2

- $\nu = \frac{3.00 \times 10^8}{6.00 \times 10^{-7}} = 5.00 \times 10^{14} \text{ Hz}$

2.3 Find the energy of a photon of frequency 5.0×10^{14} Hz.

[2]

2.3

- $E = (6.63 \times 10^{-34})(5.0 \times 10^{14}) = 3.3 \times 10^{-19} \text{ J}$

Exercise 3.1

3.1 The energy of a photon is

[1]

☐

A inversely proportional to frequency

B proportional to frequency

C independent of frequency

D proportional to wavelength

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3.1 B

- $E = h\nu$, proportional to frequency

Exercise 3.2 (a)

3.2 A laser emits light of wavelength 650 nm.

(a) Convert to metres and find the frequency.

[3]

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(a) Convert to metres and find the frequency.

[3]

(a)

- $650 \text{ nm} = 6.50 \times 10^{-7} \text{ m}; \nu = \frac{3.00 \times 10^8}{6.50 \times 10^{-7}} = 4.62 \times 10^{14} \text{ Hz}$

Exercise 3.2 (b)

3.2 A laser emits light of wavelength 650 nm.

(b) Find the energy of one photon.

[2]

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3.2 A laser emits light of wavelength 650 nm.

(b) Find the energy of one photon.

[2]

(b)

- $E = h\nu = (6.63 \times 10^{-34})(4.62 \times 10^{14}) = 3.06 \times 10^{-19} \text{ J}$

Exercise 3.3

3.3 Explain why UV photons are more damaging to skin than visible photons, in terms of photon energy. [2]

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3.3

- UV light has a shorter wavelength and higher frequency, so by $E = h\nu$ each UV photon carries more energy – enough to break bonds/damage molecules that visible photons cannot