STUDY FORMULA BOOKLET

Edexcel IAL Physics Unit 4 (WPH14): further mechanics, fields and particles

The list printed in every Unit 4 paper covers impulse, circular motion, fields, capacitor discharge, Bqv, Faraday's law, r = p/BQ and delta E = c^2 delta m. Learn first: two-dimensional momentum, banking, φ = BA, e.m.f. = Blv, the charging equation and quark charges.

GIVEN printed on the formula list in the paper LEARN IT not on the list: learn it

Built by CuratedPrep from 22 past question papers for Unit 4 in our question bank, June 2019 to January 2026. Given means it is in the list of data, formulae and relationships printed at the back of every unit paper. Learn it means a past question needed it and the exam did not print it.

Data and constants

Electron charge

e is the charge of a proton and the size of an electron's charge; an alpha particle has charge 2e and a nucleus has Ze. Used in: Jan 2026 Q11, flux density from the force on an alpha particle; Oct 2025 Q21(b)(ii), force on an electron between plates; Jun 2024 Q17(b)(i), energy for an electron between two charged bodies.

$$e = -1.60 \times 10^{-19}\ \text{C}$$

GIVEN

Electron mass

Use it for the mass of an electron or a positron. Used in: Jan 2026 Q19(b)(i), kinetic energy of the electron in the Bohr model; Oct 2025 Q21(b)(ii), acceleration of an electron in a field; Jun 2024 Q16(a), speed of 60 GeV electrons.

$$m_\text{e} = 9.11 \times 10^{-31}\ \text{kg}$$

GIVEN

Electronvolt

Use it to change MeV and GeV to joules, remembering 1 MeV = 10^6 eV. Used in: Jan 2026 Q16(b), photon energy of 1.2 MeV; Oct 2025 Q13, ions of energy 1.25 MeV; Jun 2024 Q14(b)(ii), collision energy of 6800 GeV.

$$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$$

GIVEN

Permittivity of free space

Use it in Coulomb's law and in the field and potential of a point charge. Used in: Jan 2026 (A) Q17(b)(ii), potential of a gold nucleus; Oct 2025 Q11, field of a zinc nucleus; Jan 2026 Q19(b)(i), force on the Bohr electron.

$$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$$

GIVEN

Coulomb law constant

k = 1/(4 pi eps0), so you can use either constant and the schemes accepted both. Used in: Jan 2026 (A) Q13(a), force between two point charges; Jan 2022 Q13(a)(ii), charge on a balloon; Jun 2023 Q17(b)(i), charge on a sphere.

$$k = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$$

GIVEN

Speed of light in a vacuum

Use it with delta E = c^2 delta m and with c = f λ for photons. Used in: Jan 2026 Q16(b), energy to create an electron-positron pair; Oct 2025 Q15(c), mass of a tetraquark; Jun 2024 Q14(b)(ii), mass from a collision energy.

$$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$$

GIVEN

Planck constant

Use it in E = hf and in the de Broglie wavelength. Used in: Jan 2026 (A) Q18(d), frequency of a gamma ray; Jan 2025 Q14(b), pd for a given de Broglie wavelength; Jan 2024 Q19(a), speed of electrons that cause green light.

$$h = 6.63 \times 10^{-34}\ \text{J s}$$

GIVEN

Gravitational field strength

Use it for weight, W = mg. Used in: Jan 2026 (A) Q16(b)(ii), banked go-kart track; Jun 2024 Q13(a), weight of a coin on a tilted disk; Jan 2022 Q13(a)(i), weight of a balloon.

$$g = 9.81\ \text{N kg}^{-1}$$

GIVEN

Momentum, impulse and collisions

Conservation of momentum in two dimensions and the elastic test are not on the list, so learn them.

Impulse

F = delta p / delta t gives the average force in a collision, and the area under a force-time graph is the impulse. Used in: Jan 2026 Q18(b)(ii), impulse on an ink droplet; Oct 2025 Q9, mean force of a rebounding ball; Oct 2024 Q17(a)(iii), force from a toy propeller.

$$F\Delta t = \Delta p$$

GIVEN

Density

For a moving fluid find the volume first (area times distance), then the mass m = ρ V, and then the momentum or the force. It sits under Unit 1 on the list. Used in: Oct 2024 Q17(a)(i), mass of air pushed by a propeller.

$$\rho = \frac{m}{V}$$

GIVEN

Conservation of momentum

Total momentum before equals total momentum after when no external force acts. It holds along each of two perpendicular axes separately, or you can draw a closed triangle of momenta. Used in: Jan 2026 (A) Q12(a), DART and an asteroid; Oct 2025 Q17(a), two snow tubes; Jun 2024 Q15(b)(i), air-table pucks.

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

LEARN IT

Momentum

Momentum is a vector, so give a direction or resolve it. Used in: Jan 2026 (A) Q12(a), momentum of a spacecraft; Oct 2025 Q17(a), momentum of a child on a snow tube; Jun 2024 Q15(b)(i), momentum components of a puck.

$$p = mv$$

GIVEN

Components of a vector

Cos goes with the side next to the angle and sin with the side opposite; the same resolving works for forces and for field components. Used in: Oct 2025 Q17(a), momentum after a collision; Oct 2025 Q14(a)(i), vertical component of the Earth's field; Jun 2024 Q13(a), component of weight down a tilted disk.

$$p_x = p\cos\theta, \quad p_y = p\sin\theta$$

LEARN IT

Elastic collision

A collision is elastic if the total kinetic energy is unchanged and inelastic if it falls. Used in: Jan 2026 Q14(b)(i), speed of the incoming sphere; Oct 2025 Q17(b), whether snow tubes collided elastically; Jun 2024 Q15(b)(ii), whether pucks collided elastically.

$$\sum E_{\text{k,before}} = \sum E_{\text{k,after}}$$

LEARN IT

Kinetic energy of a non-relativistic particle

Use it when you know the momentum, or with p = mv to compare two particles. Used in: Jan 2026 (A) Q5, kinetic energy of a particle with half the mass and twice the momentum; Oct 2025 Q3, alpha particle that loses half its momentum; Jun 2024 Q15(b)(ii), kinetic energy of a puck.

$$E_{\mathrm{k}} = \frac{p^2}{2m}$$

GIVEN

Kinetic energy

Equate it with the work done on a charge to find a speed; a speed above c means the particle is relativistic. It sits under Unit 1 on the list. Used in: Jan 2026 (A) Q18(c)(i), a 23 MeV positron; Jun 2024 Q16(a), 60 GeV electrons; Oct 2025 Q13, which heavy ion.

$$E_{\mathrm{k}} = \frac{1}{2}mv^2$$

GIVEN

Circular motion

Angular velocity

Change revolutions per minute to rad s^{-1} by multiplying by 2 pi/60, and degrees to radians by multiplying by 2 pi/360. Used in: Jan 2026 Q12(b), time between two riders passing a point; Oct 2025 (A) Q2, angular velocity from 7.5 revolutions in 9.0 s; Jan 2025 Q1, 40 degrees in radians.

$$\omega = \frac{\Delta\theta}{\Delta t}, \quad 2\pi \text{ rad} = 360^\circ$$

LEARN IT

Frequency and period

It sits under Unit 5 on the list. Use it to turn a frequency into a period or a period into a frequency. Used in: Jan 2025 Q17(b), time a proton spends in one dee; Jan 2024 Q19(b), frequency of an electron circling in a field; Jan 2021 Q12, period of a washing machine drum.

$$T = \frac{1}{f} = \frac{2\pi}{\omega}$$

GIVEN

Linear and angular speed

The speed of a point on a rotating object grows with its distance from the axis. Used in: Jan 2023 Q13(a)(ii), time for an aeroplane to turn through 90 degrees; Jun 2024 Q13(b)(ii), coin on a turntable; Oct 2024 Q17(b)(iii), toy aeroplane on a thread.

$$v = \omega r$$

GIVEN

Period of circular motion

ω = 2 pi f is on the list too, under Unit 5. Used in: Jan 2026 Q12(a), carousel; Jun 2024 Q13(b)(i), disk turning at 45 rpm; Jan 2026 (A) Q11(a), wire in Faraday's electric motor.

$$T = \frac{2\pi}{\omega}$$

GIVEN

Centripetal acceleration (speed)

Use it when you know the speed. Used in: Jan 2026 Q19(a), deriving it from a vector diagram; Jan 2022 Q15(b), acceleration of a poi ball; Jun 2022 Q17(a)(iii), acceleration of a hammer.

$$a = \frac{v^2}{r}$$

GIVEN

Centripetal acceleration (angular speed)

Use it when you know the angular speed or the frequency. Used in: Jan 2025 Q15(a)(ii), point on a washing machine drum; Jan 2022 Q15(b), poi ball turning 1.3 times each second; Jun 2022 Q17(a)(iii), hammer turning 2.8 times each second.

$$a = r\omega^2$$

GIVEN

Centripetal force

The centripetal force is the resultant force towards the centre, not an extra force. Used in: Jan 2026 (A) Q16(a), go-kart on a bend; Oct 2022 Q17(b)(ii), radius of an aeroplane's banked turn; Oct 2025 Q16(b), minimum speed for water in a bucket.

$$F = ma = \frac{mv^2}{r}$$

GIVEN

Centripetal force (angular speed)

Use it when you know the angular speed. Used in: Jun 2024 Q13(b)(ii), how close to the edge a coin can sit; Jan 2021 Q12, force on a coin in a washing machine drum.

$$F = mr\omega^2$$

GIVEN

Weight

Use it with g = 9.81 N kg^{-1}. Used in: Jan 2023 Q13(a)(i), weight of an aeroplane; Jun 2023 Q17(b)(iii), weight of a charged sphere; Jun 2024 Q13(a), weight of a coin.

$$W = mg$$

GIVEN

Resultant force in a vertical circle

The weight adds to the tension at the top and subtracts at the bottom. At the minimum speed at the top the tension or contact force is zero, so mg = mv^2/r. Used in: Jan 2026 Q10, ball on a string at the bottom; Oct 2025 Q16(b), bucket of water at the top; Jan 2022 Q15(c), force on a child's hand.

$$T - mg = \frac{mv^2}{r}\ (\text{bottom}), \quad T + mg = \frac{mv^2}{r}\ (\text{top})$$

LEARN IT

Banked turn or conical pendulum

Resolve the lift or the tension: the vertical part balances the weight (L cos(θ) = mg) and the horizontal part is the centripetal force (L sin(θ) = mv^2/r). Used in: Oct 2024 Q17(b)(ii), toy aeroplane, where the result was printed in a show-that part; Jan 2023 Q13(a)(i), banking aeroplane, not printed; Oct 2022 Q17(b)(ii), radius of a banked turn, not printed.

$$\tan\theta = \frac{v^2}{rg}$$

LEARN IT

Electric fields and potential

Electric field

Field strength is the force per unit charge, so F = EQ. Used in: Jan 2026 Q18(b)(i), force on an ink droplet; Oct 2025 Q21(b)(ii), force on an electron; Oct 2023 Q20(a), force on a charged sphere.

$$E = \frac{F}{Q}$$

GIVEN

Coulomb's law

The force acts along the line joining the two charges. Used in: Jan 2026 (A) Q13(a), force between two point charges; Oct 2025 Q19(b)(ii), force on an alpha particle at closest approach; Jun 2024 Q17(b)(ii), force between a satellite and a spacecraft.

$$F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$$

GIVEN

Electric field of a point charge

The field points away from a positive charge, and fields from several charges add as vectors. Used in: Oct 2025 Q11, field of a zinc nucleus; Jan 2026 Q5, field at a point between two protons; Jan 2025 Q12(b), field near a Van de Graaff sphere.

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}$$

GIVEN

Electric field between parallel plates

Use it between parallel plates, with d in metres. Used in: Jan 2026 Q18(b)(i), field between printer plates; Oct 2025 Q21(b)(i), distance between plates; Jun 2024 Q18(b), field in a spark plug gap.

$$E = \frac{V}{d}$$

GIVEN

Electric potential

Potential is a scalar, so potentials from several charges add as numbers. For a closest approach set the kinetic energy equal to QV. Used in: Jan 2026 Q19(b)(ii), potential energy of the Bohr electron; Jan 2026 (A) Q17(b)(ii), potential of a gold nucleus; Jun 2024 Q17(b)(i), potential of a charged sphere.

$$V = \frac{Q}{4\pi\varepsilon_0 r}$$

GIVEN

Charge of a nucleus

Z is the proton number, so a gold nucleus has charge 79e and an alpha particle has 2e. Used in: Jan 2026 (A) Q17(b)(ii), potential of a gold nucleus; Oct 2025 Q19(b)(i), closest approach of an alpha particle; Jun 2022 Q16, closest approach to a gold nucleus.

$$Q = Ze$$

LEARN IT

Charged particles in electric fields

Potential difference

W = QV is the energy gained by a charge Q moving through a pd V, so an electron accelerated from rest through V gains eV of kinetic energy. It sits under Unit 2 on the list. Used in: Oct 2023 Q22(b)(i), speed of electrons after 850 V; Jan 2025 Q14(b), pd for a given de Broglie wavelength; Jan 2024 Q15, pd for a beam of electrons.

$$V = \frac{W}{Q}$$

GIVEN

Resultant force

Find the force from F = EQ, then the acceleration. It sits under Unit 1 on the list. Used in: Jan 2026 Q18(b)(i), droplet between plates; Oct 2025 Q21(b)(ii), electron between plates; Oct 2025 Q22(b), acceleration of a rod in a field.

$$\sum F = ma$$

GIVEN

Final velocity

It sits under Unit 1 on the list. Used in: Jan 2026 Q18(b)(i), vertical velocity of an ink droplet; Jun 2022 Q17(b), time of flight of a hammer.

$$v = u + at$$

GIVEN

Displacement with acceleration

Use it for the vertical motion of a particle that crosses a field. It sits under Unit 1 on the list. Used in: Oct 2025 Q21(b)(iii), electron displacement on a screen; Oct 2023 Q22(b)(ii), deflection of an electron beam; Jun 2024 Q17(b)(ii), time to move a satellite 300 km.

$$s = ut + \frac{1}{2}at^2$$

GIVEN

Velocity and displacement

It sits under Unit 1 on the list. Used in: Oct 2025 Q22(b), acceleration of a rod from its speed and distance; Jun 2022 Q17(b), height reached by a hammer.

$$v^2 = u^2 + 2as$$

GIVEN

Distance at constant speed Use it for the horizontal motion of a particle crossing plates or for a particle moving at constant speed; it is the a = 0 case of the list's s = ut + 1/2 at^2. Used in: Oct 2025 Q21(b)(iii), electron after leaving the plates; Oct 2024 Q17(a)(i), air pushed by a propeller; Jan 2026 (A) Q15, distance travelled by a muon.	$s = vt$	LEARN IT

Capacitors and exponential decay

Capacitance Used in: Oct 2025 Q20(a)(i), charge on a touchscreen capacitor; Jun 2024 Q12(b)(ii), charge on a fully charged capacitor; Jan 2026 Q15(b)(ii), charge left on a defibrillator capacitor.	$C = \frac{Q}{V}$	GIVEN
Energy stored in a capacitor (charge and pd) It is the area under a graph of pd against charge. Used in: Jun 2024 Q12(b)(iii), energy of a fully charged capacitor; Jan 2022 Q14(e), maximum energy stored; Jan 2021 Q11(b), energy stored by two capacitors.	$W = \frac{1}{2}QV$	GIVEN
Energy stored in a capacitor (capacitance and pd) Used in: Jan 2026 Q15(a), whether a defibrillator stores 150 J; Oct 2025 Q12, energy at the largest possible capacitance; Jan 2024 Q11, maximum energy of a capacitor with a tolerance.	$W = \frac{1}{2}CV^2$	GIVEN
Energy stored in a capacitor (charge and capacitance) Use it when you know the charge and the capacitance. Used in: Jan 2026 (A) Q19(b)(ii), energy stored in a coulombmeter; Jan 2022 Q14(e), energy from Q and C.	$W = \frac{1}{2}\frac{Q^2}{C}$	GIVEN
Capacitor discharge Used in: Oct 2025 Q20(a)(ii), whether a touchscreen capacitor discharges in 50 ms; Jan 2026 (A) Q19(b)(i), capacitance from a graph; Oct 2023 Q9, time for the charge to halve.	$Q = Q_0e^{-t/RC}$	GIVEN
Resistor-capacitor discharge: current Used in: Jan 2026 Q15(b)(i), time for a defibrillator current to fall to 8.0 A; Jun 2024 Q12(b)(i), capacitance from a current-time graph; Jan 2020 Q17(a), capacitor for a night light.	$I = I_0e^{-t/RC}$	GIVEN
Resistor-capacitor discharge: pd Used in: Jun 2024 Q6, time constant from two pd readings; Oct 2021 Q14, time for the pd across a capacitor to fall to 4.0 V; Jan 2025 Q20(b)(ii), pd remaining after 3 minutes.	$V = V_0e^{-t/RC}$	GIVEN

Log of current

A graph of ln I against t has gradient -1/RC and intercept ln I_0. Used in: Jan 2026 (A) Q7, capacitance from the gradient; Jun 2023 Q18(a), capacitance from a ln I graph; Jan 2022 Q14(c), capacitance from two readings.

$$\ln I = \ln I_0 - \frac{t}{RC}$$

GIVEN

Log of pd

Used in: Jun 2025 Q17(b)(i), resistance in a smoothing circuit; Oct 2023 Q18(a), capacitance from a pd-time graph.

$$\ln V = \ln V_0 - \frac{t}{RC}$$

GIVEN

Time constant

After one time constant the charge, current or pd has fallen to 1/e (about 37%) of its starting value, and the tangent at t = 0 meets the time axis at tau. Used in: Jan 2026 (A) Q19(b)(i), capacitance from the time for the charge to fall by 1/e; Jun 2024 Q12(b)(i), time constant from a current graph; Jan 2025 Q20(b)(i), time constant of a discharge circuit.

$$\tau = RC$$

LEARN IT

Charging a capacitor

The pd across the capacitor follows the same form, while the current still falls as I_0 e^{-t/RC}. Used in: Jan 2026 Q15(c), resistor in a charging circuit, where the question printed it; Jan 2024 Q18(a)(i), capacitance from a charging graph, not printed.

$$Q = Q_0\left(1 - e^{-t/RC}\right)$$

LEARN IT

Maximum value with a tolerance

Use 1 - tolerance/100 for the minimum, and the same idea for a resistor. Used in: Oct 2025 Q12, a 47 uF capacitor with 20%; Jan 2024 Q11, a capacitor with 20%; Jun 2025 Q17(b), a 6.8 kohm resistor with 5%.

$$C_{\max} = C\left(1 + \frac{\text{tolerance}}{100}\right)$$

LEARN IT

Resistance

It gives the starting current of a charging or discharging circuit as I_0 = V/R. It sits under Unit 2 on the list. Used in: Oct 2025 Q20(b), maximum current of a touchscreen circuit; Jan 2024 Q18(a)(ii), maximum charging current; Jan 2022 Q14(a), initial current on a graph.

$$R = \frac{V}{I}$$

GIVEN

Magnetic fields and electromagnetic induction

Force on a moving charge

q is the charge of the particle, and the force is zero if the velocity is parallel to the field. Used in: Jan 2026 Q11, flux density from the force on an alpha particle; Oct 2023 Q22(b)(iii), specific charge of an electron; Jan 2023 Q17(a)(i), speed of electrons in Thomson's apparatus.

$$F = Bqv\sin\theta$$

GIVEN

Force on a current-carrying conductor

l is the length of wire in the field and θ the angle between the wire and the field. Used in: Jan 2026 Q4, force on a wire at 40 degrees; Jan 2026 (A) Q11(b), force on Faraday's wire; Oct 2025 Q22(b), flux density from an accelerating rod.

$$F = BIl\sin\theta$$

GIVEN

Moment of the magnetic forces on a coil

For a coil of N turns each side has force F = NBIl, and the two forces form a couple. It sits under Unit 1 on the list. Used in: Oct 2024 Q15(a)(ii), moment on a motor coil; Jun 2020 Q11, moment on a model motor coil.

$$\text{moment} = Fx$$

GIVEN

Area of a circle

Halve a diameter to get r. Use it for the area of a coil or of the circle swept out by a propeller. Used in: Jun 2024 Q18(b), area of a spark plug coil; Jan 2022 Q18(b), coil of radius 3.0 mm; Oct 2024 Q17(a)(i), circle swept by a propeller.

$$A = \pi r^2 = \frac{\pi d^2}{4}$$

LEARN IT

Magnetic flux

A is the area at right angles to the field, so for a tilted coil use B sin(θ) or A cos(θ); flux linkage is N φ. Used in: Jan 2026 Q17(b), flux through a rotating coil; Jun 2024 Q18(b), flux in a spark plug coil; Jun 2023 Q16(b), flux through a search coil.

$$\phi = BA$$

LEARN IT

Faraday's and Lenz's laws

Use the gradient of a flux linkage against time graph for the e.m.f.; the minus sign is Lenz's law. Used in: Oct 2025 Q14(a)(ii), e.m.f. across the wing tips; Jun 2024 Q18(b), pd across a secondary coil; Jan 2022 Q18(b), maximum e.m.f. from a graph of B.

$$\varepsilon = -\frac{\mathrm{d}(N\phi)}{\mathrm{d}t}$$

GIVEN

E.m.f. across a moving conductor

It follows from Faraday's law, because a conductor of length l moving at speed v sweeps an area lv each second. Used in: Oct 2025 Q14(a)(ii), wing tips, where the scheme allowed it; Jan 2024 Q16, speed of an aeroplane from the e.m.f. across its wing tips; Oct 2023 Q17(a), rod moving along rails.

$$\varepsilon = Blv$$

LEARN IT

Charged particle in a magnetic field

With p = mv it gives r = mv/(BQ), and so the specific charge Q/m = v/(Br). Used in: Jan 2026 Q9, ratio of the radii for an alpha particle and a proton; Oct 2023 Q22(b)(iii), specific charge of an electron; Jan 2022 Q17(d)(ii), muon storage ring.

$$r = \frac{p}{BQ}$$

GIVEN

Period of a particle in a magnetic field

It does not depend on speed or radius, so a cyclotron's alternating pd has a fixed frequency f = Bq/(2 pi m). Used in: Jan 2025 Q17(b), time a proton spends in a dee, where the question printed f; Jan 2020 Q19(b), time to accelerate a proton, where the question printed it; Jan 2024 Q19(b), frequency of an electron circling in a field, not printed.

$$T = \frac{2\pi m}{Bq}$$

LEARN IT

Particles, energy and mass

Mass-energy

m = E/c^2, so change MeV/c^2 to kg by changing MeV to joules and dividing by c^2. Used in: Jan 2026 Q16(b), electron-positron pair; Oct 2025 Q15(c), mass of a tetraquark; Jun 2024 Q14(b)(ii), maximum mass from a collision.

$$\Delta E = c^2 \Delta m$$

GIVEN

Energy prefixes

With 1 eV = 1.60 × 10^{-19} J this gives 1 MeV = 1.60 × 10^{-13} J. Used in: Jan 2026 (A) Q6, mass of a particle in GeV/c^2; Oct 2025 Q13, ion energy of 1.25 MeV; Jun 2024 Q16(a), electron energy of 60 GeV.

$$1\ \text{MeV} = 10^6\ \text{eV}, \quad 1\ \text{GeV} = 10^9\ \text{eV}$$

LEARN IT

Pair production and annihilation

A photon needs at least 2mc^2 to make a particle and its antiparticle, and an electron and a positron at rest annihilate into photons with a total energy 2mc^2. Used in: Jan 2026 Q16(b), 1.2 MeV photon; Jan 2025 Q7, photon energy for an electron-positron pair; Jun 2025 Q7, energy of a photon from annihilation.

$$E_{\text{photon}} \geq 2mc^2$$

LEARN IT

Energy and momentum of a relativistic particle

Not on the sheet: the question printed it. Both questions printed it as a relationship for relativistic particles, and you then use r = p/BQ with p = E/c. Used in: Jan 2026 (A) Q18(c)(ii), flux density for a 23 MeV positron; Jun 2021 Q18(c)(ii), flux density for a 23 MeV positron.

$$E = pc$$

GIVEN

Quark charges

Antiquarks have the opposite charge, and a baryon or meson must have a whole-number charge. Used in: Oct 2025 Q15(b), tetraquark of charge +2e, with the charges printed; Oct 2023 Q21(a), quark structure of a pion, not printed; Oct 2021 Q9, quark structure of a pion, not printed.

$$\text{up} = +\tfrac{2}{3}e, \quad \text{down} = -\tfrac{1}{3}e$$

LEARN IT

Wave speed

Use it for photons, with c = 3.00 × 10^8 m s^{-1}. It sits under Unit 2 on the list. Used in: Jan 2024 Q19(a), wavelength of green light; Jun 2020 Q12(b), wavelength of annihilation photons.

$$v = f\lambda$$

GIVEN

Photon energy

It sits under Unit 2 on the list. Used in: Jan 2026 (A) Q18(d), frequency of gamma radiation from annihilation; Jun 2020 Q12(b), wavelength of gamma photons in a PET scan; Jun 2019 Q13(b), frequency of photons from a Higgs boson decay.

$$E = hf$$

GIVEN

de Broglie wavelength

It sits under Unit 2 on the list. Used in: Jan 2025 Q14(b), pd for a de Broglie wavelength of 2.65 × 10^{-11} m; Jan 2024 Q15, pd for a beam of electrons; Oct 2023 Q12, wavelength of an electron.

$$\lambda = \frac{h}{p}$$

GIVEN

Also learn these

Scalars and vectors

Impulse, momentum, force, centripetal acceleration, electric field strength and magnetic flux density are vectors; electric potential, capacitance and energy are scalars. Used in: Jan 2026 Q2, Oct 2025 Q4, Jan 2021 Q1.

Areas and gradients on graphs

The area under a force-time graph is the impulse, the area under a current-time graph is charge and the area under a pd-charge graph is energy; the gradient of ln I against t is -1/RC. Used in: Jun 2024 Q8, Jan 2022 Q14(d), Jun 2025 Q2.

Centripetal force

A resultant force towards the centre is needed for circular motion, it is perpendicular to the velocity and does no work, and there is no outward centrifugal force. Used in: Jun 2022 Q17(a)(ii), Oct 2023 Q14, Oct 2025 Q16(b).

Electric field lines

Field lines around a point charge are radial and point away from a positive charge, they are parallel and equally spaced between plates, and equipotentials cross them at right angles. Used in: Jan 2026 Q18(a), Jan 2022 Q11, Jun 2024 Q17(a)(i).

Charge and discharge of a capacitor

The current is a maximum at the start and falls to zero as the capacitor charges; the pd across it rises until it equals the supply pd. A larger R or C gives a longer time constant. Used in: Oct 2025 (A) Q15(a), Jan 2025 Q20(a)(i), Jan 2024 Q18(b).

Faraday's law and Lenz's law

The induced e.m.f. equals the rate of change of flux linkage, and its direction opposes the change that causes it, so there is a force opposing the motion. Used in: Jan 2026 Q17(c), Jun 2024 Q18(c), Oct 2025 Q22(c).

Fleming's left-hand rule

Use it for the direction of the force on a current in a field or on a moving charge, remembering that the current direction is that of positive charge. Used in: Oct 2025 Q22(a), Jun 2024 Q3, Oct 2024 Q15(a)(i).

Linac and cyclotron

In a linac the drift tubes get longer and the alternating pd reverses while the particles are inside the tubes; in a cyclotron the magnetic field curves the path and a constant frequency accelerates the particles in the gap. Used in: Jan 2026 Q8, Oct 2025 Q8, Jun 2024 Q16(b).

Alpha scattering

Most alpha particles pass straight through, so the atom is mostly empty space; a few deflect by more than 90 degrees, so there is a small, charged, massive nucleus. The experiment did not show neutrons. Used in: Oct 2025 Q19(a), Jan 2026 (A) Q17(a), Jan 2026 Q7.

Classifying particles

Baryons are three quarks, mesons are a quark and an antiquark, and leptons and quarks are fundamental; every particle has an antiparticle with opposite charge and lepton or baryon number. Used in: Jan 2026 Q13(a), Jun 2024 Q14(a), Oct 2025 Q15(a).

Conservation laws for particles

Charge, baryon number, lepton number, energy and momentum are conserved in an interaction, and you check each side of the equation. Used in: Jan 2026 Q13(b), Oct 2025 Q18(b), Oct 2023 Q21(b).

Why high energies are needed

High-energy particles have a short de Broglie wavelength to probe the structure of nucleons, and kinetic energy can be converted into the mass of new particles. Used in: Jan 2026 Q3, Jan 2026 (A) Q10, Oct 2025 Q15(d).

Relativistic effects

Particles at speeds close to c have a longer lifetime as observed, a lower rate of decay and never reach c. Used in: Oct 2025 Q5, Jan 2022 Q17(d)(iii), Jan 2026 (A) Q8.

Particle tracks

Neutral particles leave no track, opposite charges curve in opposite directions, and a larger radius means a larger momentum. Used in: Jan 2026 Q16(c), Oct 2025 Q18(a), Jan 2022 Q16(a).

Using the booklet in the exam

- The list is printed in every Unit 4 paper, and many formulae you need sit under other units: F = ma and the suvat equations under Unit 1, de Broglie, E = hf, V = W/Q and R = V/I under Unit 2, and T = 1/f and ω = 2 pi f under Unit 5.
- For a two-dimensional collision resolve the momentum along two perpendicular axes, as in Oct 2025 Q17 and Jun 2024 Q15, then compare the kinetic energy before and after to decide whether it was elastic.
- A banked turn or a conical pendulum is not on the list. Resolve the force: the vertical part balances the weight and the horizontal part is mv^2/r, as in Oct 2022 Q17(b) and Jan 2023 Q13(a).
- Read the question for the charging equation: Jan 2026 Q15(c) printed Q = Q_0 - Q_0 e^(-t/RC) but Jan 2024 Q18(a)(i) did not, although the scheme accepted a time-constant route.
- Change MeV and GeV to joules before using delta E = c^2 delta m (Jan 2026 Q16(b), Jun 2024 Q14(b)(ii)), write each charge in terms of e (2e for an alpha particle, 79e for gold), and for a relativistic particle find p = E/c before using r = p/BQ (Jan 2026 (A) Q18(c)(ii)).

Built by CuratedPrep from the Edexcel International A Level Physics Unit 4 (WPH14) papers June 2019 to January 2026 in our question bank (22 question papers). Given rows are copied from our checked copy of the Edexcel IAL Physics list of data, formulae and relationships. Updated 17 November 2026. Always practise with the version of the official booklet your exam uses. More free sheets and topic worksheets at curatedprep.com.