STUDY FORMULA BOOKLET

Edexcel IAL Physics Unit 1 (WPH11): mechanics and materials

The list printed in every Unit 1 paper covers suvat, F = ma, p = mv, moments, energy, power, density, Stokes' law and the Young modulus. Learn first: components, Pythagoras, upthrust, conservation of momentum, the principle of moments and area and volume formulae.

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

Built by CuratedPrep from 21 past question papers for Unit 1 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

Acceleration of free fall

Use with the equations of motion for anything falling or thrown. Used in: Oct 2025 Q19(b)(ii), vertical motion of a shot; Jun 2025 Q13, height of a basketball throw; Jan 2025 Q19(a)(ii), projectile from a mountain.

$$g = 9.81 \text{ m s}^{-2}$$

GIVEN

Gravitational field strength

Use with W = mg when the mass is in kg. Used in: Jan 2026 Q15(c), weight of a ball bearing; Oct 2025 (A) Q13(b), weight of a sphere; Oct 2025 Q15(a), weight of a 200 g mass.

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

GIVEN

Motion with constant acceleration

These four equations need constant acceleration, so they stop working once drag becomes significant.

Final velocity

a = (v - u)/t is the same equation rearranged. Used in: Jan 2026 (A) Q17(a)(iii), acceleration of a bumper car; Jan 2026 Q18(a)(ii), speed of a projectile above the Moon; Jan 2024 Q12(a), time for a dart to reach its highest point.

$$v = u + at$$

GIVEN

Displacement from average velocity

Average velocity (u + v)/2 multiplied by the time; with v = 0 it gives u = 2s/t. Used in: Jun 2021 Q12(b), time to slide down a ramp; Jan 2023 Q5, distance between two points; Jan 2020 Q16(a)(ii), initial speed of a popcorn kernel.

$$s = \frac{(u + v)t}{2}$$

GIVEN

Displacement with acceleration

With a = 0 it gives s = ut for constant velocity, and with u = 0 it gives a = 2s/t^2. Used in: Jan 2026 Q15(b), ball bearing at constant speed; Jan 2026 (A) Q6, acceleration from a fall time; Oct 2025 Q19(b), horizontal and vertical motion of a shot.

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

GIVEN

Velocity and displacement

Use it when the time is not given. Used in: Oct 2025 Q13(b)(ii), acceleration between two light gates; Jun 2025 Q13, height gained by a basketball; Jan 2025 Q12, speed after sliding down a slope.

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

GIVEN

Vectors and components

None of these is on the list, but projectile, slope and equilibrium questions all need them.

Components of a vector

Cos goes with the side next to the angle and sin with the side opposite. For a projectile use u cos(θ) horizontally and u sin(θ) vertically. Used in: Jan 2026 (A) Q18(a), launch velocity of a motorcyclist; Jun 2025 Q19(b)(i), forces on a bicycle rail; Jan 2025 Q19(a)(i), launch of a projectile.

$$F_x = F\cos\theta, \quad F_y = F\sin\theta$$

LEARN IT

Resultant of two perpendicular vectors

Pythagoras gives the size and the tangent gives the angle; it also combines horizontal and vertical velocities. Used in: Jan 2026 Q5, resultant of 20 N and 35 N; Jun 2025 Q7, resultant force on a helicopter; Oct 2025 Q19(b)(ii), launch velocity of a shot.

$$R = \sqrt{F_1^2 + F_2^2}, \quad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

LEARN IT

Components of weight on a slope

At constant speed the friction up the slope balances W sin(θ). Used in: Jan 2026 (A) Q11(a), acceleration of a trolley down a ramp; Oct 2025 (A) Q18(b), friction on a disc on a ramp; Jun 2025 Q8, box sliding at constant speed.

$$W_{\text{along slope}} = W\sin\theta, \quad W_{\text{into slope}} = W\cos\theta$$

LEARN IT

Forces and weight

Resultant force

The resultant force is the vector sum of all the forces, for example forward force minus resistive force. Used in: Jan 2026 (A) Q17(a)(iii), force on a bumper car; Oct 2025 Q11, acceleration of a lorry; Jan 2025 Q11, mass of people in a car.

$$\sum F = ma$$

GIVEN

Weight

Used in: Jun 2025 Q11, weight of a boat from its acceleration; Oct 2024 Q15(b)(i), mass of a high jumper; Jun 2023 Q20(b)(ii), tension in a cable lifting an actor.

$$W = mg$$

GIVEN

Gravitational field strength

Gravitational field strength is weight (or force) per unit mass. Used in: Jan 2023 Q2, which quantity is field strength; Jan 2020 Q2.

$$g = \frac{F}{m}$$

GIVEN

Momentum and moments

Momentum

Momentum is a vector, so give a direction. Used in: Jan 2026 Q13(b), momentum of a curling stone; Oct 2025 Q14(b), rocks in space; Jan 2025 Q14(b), air track gliders.

$$p = mv$$

GIVEN

Conservation of momentum

Total momentum before equals total momentum after when no external force acts. Choose one direction as positive. Used in: Jan 2026 (A) Q17(a)(i), bumper cars; Oct 2025 (A) Q18(a), mallet and disc; Oct 2025 Q14(b), rocks in space.

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

LEARN IT

Force as rate of change of momentum (impulse)

F = change in momentum / time gives the average force in a collision. It sits under Unit 4 on the list, which is printed in every unit paper. Used in: Jan 2026 (A) Q17(a)(iii), force on a bumper car; Jan 2021 Q14(a)(ii), rate of change of momentum of water; Jan 2026 Q13(a).

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

GIVEN

Moment of force

x is the perpendicular distance, so resolve the force or the distance first. Used in: Jan 2026 Q14(b), force from a screw on a bracket; Oct 2025 Q20(b)(iii), moment of a motor on a bridge; Oct 2024 Q13(a), moment of weight on a pedal.

$$\text{moment} = Fx$$

GIVEN

Principle of moments

In equilibrium the moments about any point balance; taking moments about the point where an unknown force acts removes that force. Used in: Oct 2025 (A) Q11(b), plank on a pivot; Jan 2025 Q16(b), balance beam; Jun 2024 Q18(a), forces on a bridge.

$$\sum \text{clockwise moments} = \sum \text{anticlockwise moments}$$

LEARN IT

Work, energy and power

Work done

Used in: Jan 2026 Q12, work to lift a load; Jan 2025 Q13(a), distance moved by a truck in an escape lane; Oct 2022 Q19(a), work done by a cyclist.

$$\Delta W = F\Delta s$$

GIVEN

Work done by a force at an angle

The list prints only F times s with s along the force; for a rope at an angle take the component of F along the motion. Used in: Oct 2023 Q10, box pulled by a rope at 40 degrees; Jun 2023 Q2, windsurfer; Oct 2019 Q11, work as the angle changes.

$$\Delta W = F\Delta s\cos\theta$$

LEARN IT

Kinetic energy

Equate it with the loss of gravitational energy to get v = sqrt(2gh) for a fall from rest. Used in: Jan 2026 Q13(b), speed of a curling stone; Oct 2025 Q14(b), speed of a rock; Oct 2024 Q15(b)(i), speed of a high jumper.

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

GIVEN

Change in gravitational potential energy

The height is vertical, so for a slope use the length along it times sin(θ). Used in: Jan 2026 Q19(b)(ii), launching a slice of bread; Jun 2025 Q14, braking on a hill; Jan 2025 Q15(a), hydroelectric power station.

$$\Delta E_\text{grav} = mg\Delta h$$

GIVEN

Power from energy transferred

Used in: Jan 2025 Q15(a), power of water in a pipe; Oct 2024 Q6, power input to a moving staircase; Jan 2023 Q8, time for a motor to lift a mass.

$$P = \frac{E}{t}$$

GIVEN

Power from work done

Used in: Jan 2026 Q12, time for a crane to lift a load; Jun 2024 Q11(b), work of a train engine; Oct 2023 Q14(b), power of a weight-lifting machine.

$$P = \frac{W}{t}$$

GIVEN

Power from force and speed

This combines P = W/t with W = Fs for a force acting at a steady speed. The mark scheme accepted it as an alternative route, and one question printed it. Used in: Oct 2023 Q14(b), weight machine; Oct 2022 Q11(c), engine power of a boat; Oct 2019 Q17(a)(iii), where it was printed.

$$P = Fv$$

LEARN IT

Efficiency from energy

Multiply by 100 for a percentage. Used in: Jan 2026 Q12, crane lifting a load; Jun 2025 Q14, braking energy stored in a battery; Jun 2020 Q6, energy supplied to a lamp.

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

GIVEN

Efficiency from power

Used in: Oct 2025 (A) Q12(b), power input to a walkway; Jan 2025 Q15(b), efficiency of a power station; Oct 2024 Q6, power input to a moving staircase.

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

GIVEN

Density, upthrust and viscous drag

Density

Used in: Oct 2025 (A) Q19(b)(ii), mass of a sphere in water; Jun 2025 Q18(a), mass of a steel sphere; Jan 2025 Q15(a), mass of water in a pipe.

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

GIVEN

Upthrust

V is the volume of the object that is under the surface, and a floating object has upthrust equal to its own weight. Used in: Jan 2026 Q15(c), ball bearing in paint; Oct 2025 Q17(a), lifting bags on the seabed; Jun 2025 Q1, upthrust on a cube.

$$U = W_{\text{fluid displaced}} = \rho_{\text{fluid}} V g$$

LEARN IT

Forces at terminal velocity

The resultant force is zero, so for a sinking sphere weight equals upthrust plus drag; for a rising bubble or balloon, upthrust equals weight plus drag. Used in: Jan 2026 Q15(c), ball bearing in a mixture; Oct 2025 Q17(b)(i), bubble of air in seawater; Jun 2024 Q14(b), grain of sand.

$$W = U + D \quad \text{so} \quad D = W - U$$

LEARN IT

Stokes' law

r is the radius, so halve a diameter. Used in: Jan 2026 Q15(b), drag on a ball bearing in paint; Jan 2026 (A) Q14(b), sphere in a viscous liquid; Oct 2025 (A) Q13(b), checking whether Stokes' law applies.

$$F = 6\pi\eta r v$$

GIVEN

Terminal velocity of a falling sphere

Not on the sheet. The question gave both equations (g is the glass sphere, s the liquid). Used in: Jun 2021 Q18(c), viscosity from a graph of v against d^2.

$$v = kd^2, \quad k = \frac{(\rho_g - \rho_s)g}{18\eta}$$

GIVEN

Drag at higher speed

Not on the sheet. The question gave the equation and the value of k. Used in: Jan 2023 Q18(a)(ii), terminal velocity of an object falling to the seabed.

$$D = kv^2$$

GIVEN

Areas, volumes and flow

These geometry formulae are not on the list but turn up in Young modulus, upthrust and flow questions.

Area of a circle

Use it for the cross-section of a wire or pipe, and halve a diameter to get r. Used in: Oct 2025 (A) Q15(b)(i), cross-section of a copper wire; Jun 2025 Q17(b), area of a violin string; Oct 2024 Q18(a), force on a spider silk thread.

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

LEARN IT

Volume of a sphere

Needed to find the weight and the upthrust of a sphere, or r from a given volume. Used in: Jan 2026 Q15(c), ball bearing; Oct 2025 Q17(a), lifting bags; Jun 2025 Q18(a), steel sphere.

$$V = \frac{4}{3}\pi r^3$$

LEARN IT

Volume of a cylinder

Used in: Oct 2024 Q16(b)(ii), volume of water displaced by a hydrometer; Jan 2022 Q15(b)(i), floating brass cylinder.

$$V = \pi r^2 l$$

LEARN IT

Volume flow rate

A is the cross-section of the pipe and v the speed of the fluid; divide mass per second by the density to get volume per second. Used in: Oct 2025 (A) Q16(a), speed of water from a fireboat pipe; Jan 2021 Q14(a)(i).

$$\frac{\Delta V}{\Delta t} = Av$$

LEARN IT

Hooke's law, stress and strain

Hooke's law

Δx is the extension, which is the new length minus the original length. Used in: Jan 2026 Q19(b)(i), spring in a toaster; Oct 2025 Q15(a), weight of a ball on a spring; Oct 2024 Q12, new length of a spring.

$$\Delta F = k\Delta x$$

GIVEN

Identical springs in series and parallel

For two identical springs of stiffness k: in series the same force gives double the extension, in parallel the extension is halved. Used in: Jan 2026 (A) Q8, energy stored in two arrangements; Jun 2023 Q10, stiffness of two springs in series; Jun 2020 Q16(c), why series halves the stiffness.

$$k_{\text{series}} = \frac{k}{2}, \quad k_{\text{parallel}} = 2k$$

LEARN IT

Stress

Used in: Jan 2026 (A) Q12(a), whether a constantan wire breaks; Oct 2025 Q16(b), breaking stress of a running blade; Jan 2025 Q17(b)(i), force on a rope.

$$\sigma = \frac{F}{A}$$

GIVEN

Strain

Used in: Jan 2026 Q16(c), strain in a tennis string; Jun 2025 Q17(b), strain in a violin string; Jan 2025 Q17(a), strain in a rope.

$$\varepsilon = \frac{\Delta x}{x}$$

GIVEN

Young modulus

E is the gradient of the straight part of a stress-strain graph. Used in: Oct 2025 Q16(a)(ii), new length of a running blade; Jun 2025 Q17(b), Young modulus of a string; Oct 2024 Q18(b), length of silk at its limit of proportionality.

$$E = \frac{\sigma}{\varepsilon}$$

GIVEN

Stiffness of a wire

Some questions printed it and some did not; it can also be built from the list's stress, strain, Young modulus and Hooke's law rows, and E = kx/A when k is the gradient of a force-extension graph. Used in: Jan 2026 (A) Q19(b)(i), stiffness of a nylon rope, not printed; Oct 2025 (A) Q15(b)(ii), Young modulus from a gradient, not printed; Jan 2026 (A) Q12(b)(ii), where it was printed.

$$k = \frac{EA}{x}$$

LEARN IT

Elastic strain energy

It is also the area under a force-extension graph; with ΔF = k Δx it gives (1/2)k(Δx)^2 or F^2/2k. Used in: Jan 2026 Q19(b)(ii), springs in a toaster; Oct 2025 Q15(b), why the energy is proportional to F^2; Jun 2025 Q15(a), compression of a brick.

$$\Delta E_{\text{el}} = \frac{1}{2} F \Delta x$$

GIVEN

Energy stored per unit volume

This is the area under a stress-strain graph, so multiply it by the volume Ax to get the energy stored. Used in: Jan 2025 Q17(b)(ii), energy stored in a rope; Jan 2021 Q16(b)(iii), showing the area is energy per unit volume, where part (iv) printed the statement; Oct 2024 Q18(c)(ii), silk against steel.

$$\frac{\Delta E_{\text{el}}}{V} = \frac{1}{2}\sigma\varepsilon$$

LEARN IT

Practical work and graphs

Percentage uncertainty

Measuring a longer length, with the same absolute uncertainty, gives a smaller percentage uncertainty. Used in: Jan 2026 Q16(b), length of a tennis string.

$$\%\ \text{uncertainty} = \frac{\Delta x}{x} \times 100$$

LEARN IT

Straight-line graph

Compare s = (1/2)gt^2 with y = mx + c: s against t^2 has gradient g/2, and 2s against t^2 has gradient g. Used in: Oct 2025 (A) Q4, choosing axes for g; Jan 2025 Q7, gradient of height against time squared; Oct 2024 Q14(b).

$$y = mx + c$$

LEARN IT

Also learn these

Vectors and scalars

Force, weight, velocity, acceleration, displacement and momentum are vectors; distance, speed, energy, work, power, mass and density are scalars. Used in: Jan 2026 Q1, Oct 2025 Q1, Jan 2025 Q3.

Graphs of motion

The gradient of a displacement-time graph is velocity, the gradient of a velocity-time graph is acceleration, the area under a velocity-time graph is displacement and the area under an acceleration-time graph is the change in velocity. Used in: Jan 2025 Q5, Jun 2025 Q12(b), Jan 2026 (A) Q16(c).

Average and instantaneous velocity

Average velocity is total displacement divided by total time, and instantaneous velocity is the gradient of a tangent. Used in: Oct 2024 Q3, Oct 2024 Q19(b)(ii).

Projectile motion

Horizontal velocity is constant and the vertical acceleration is g, so find the time from the vertical motion and use it for the horizontal distance. Used in: Oct 2025 Q19(b), Jan 2025 Q19(a), Jun 2025 Q3.

Scaled vector diagram

Draw the vectors tip to tail to scale, label two sides, then measure the resultant and its angle. Used in: Oct 2025 Q12, Jan 2025 Q18(a), Oct 2024 Q11.

Free-body diagram and equilibrium

Draw each force as an arrow from a dot, and for an object in equilibrium the vector sum of the forces is zero. Used in: Jan 2026 Q11, Oct 2025 Q6, Jun 2025 Q5.

Newton's laws

A third law pair has forces of equal size, opposite direction, the same type, acting on different bodies; the first law says no resultant force means constant velocity. Used in: Oct 2025 Q3, Oct 2025 (A) Q9, Jan 2026 (A) Q10.

Centre of gravity

It is the point where the weight may be considered to act, and for a uniform object it is at the centre. Used in: Jun 2024 Q7, Oct 2025 Q20(b)(iii), Jun 2024 Q18.

Conditions for equilibrium

An object is in equilibrium when the resultant force is zero and the resultant moment about any point is zero. Used in: Jan 2025 Q16(a), Jun 2025 Q2, Jun 2024 Q18(a).

Conservation of energy

Total energy is conserved, so gravitational, kinetic and elastic energy can be equated, and any difference is work done against resistive forces. Used in: Oct 2025 (A) Q18(b), Jan 2026 Q19(b)(ii), Jun 2025 Q20(c).

Elastic and inelastic collisions

Momentum is conserved in every collision with no external force, but kinetic energy is conserved only in an elastic collision. Used in: Jan 2026 Q3, Jun 2024 Q15(b), Jun 2021 Q11(c).

Stokes' law conditions

The object must be a small sphere moving at low speed with laminar flow and no turbulence. Used in: Jan 2026 Q15(a), Jan 2026 (A) Q14(a), Oct 2024 Q19(a)(i).

Viscosity and temperature

The viscosity of a liquid falls as its temperature rises, so the terminal velocity of a sphere rises and its fall time falls. Used in: Oct 2025 Q4, Jun 2025 Q16(c), Jun 2024 Q14(c).

Terminal velocity

Drag grows with speed until the resultant force is zero, and then the acceleration is zero and the speed is constant. Used in: Jan 2025 Q20(a), Jun 2025 Q20(d), Oct 2025 (A) Q14.

Force-extension graphs

The area under a force-extension graph is the work done or elastic strain energy, and for a loading and unloading loop the area between the lines is energy transferred to heat. Used in: Jan 2026 (A) Q9, Jan 2024 Q11(b), Oct 2025 (A) Q7.

Terms for materials

Limit of proportionality, elastic limit and yield point are different points on a graph; elastic deformation recovers when the force is removed and plastic deformation does not. Used in: Jan 2026 (A) Q3, Jun 2025 Q15(b), Jan 2025 Q4.

Young modulus and stiffness

The Young modulus belongs to the material and does not change with the length of the wire, but the extension for a given force grows with length and falls with cross-sectional area. Used in: Oct 2025 (A) Q15(b)(iii), Jan 2026 Q8, Jun 2024 Q9.

Core practical: acceleration of free fall

Time a fall from rest over a measured distance and plot s against t^2; a hand-held stopwatch gives a large random error from reaction time. Used in: Oct 2025 Q13, Oct 2024 Q14, Jun 2024 Q8.

Core practical: Young modulus

Measure the original length from clamp to marker, the diameter with a micrometer at several places and orientations, and the extension for each mass. Used in: Jun 2024 Q16(a), Oct 2025 (A) Q15(b)(i), Jan 2026 Q16(a).

Core practical: viscosity by falling ball

Time a ball over a measured distance at terminal velocity, and measure its diameter and mass and the density of the liquid. Used in: Jun 2025 Q16(a), Jun 2020 Q15(a), Jan 2025 Q20(b).

Units and prefixes

W = J s^{-1}, N = kg m s^{-2}, Pa = N m^{-2} and N kg^{-1} = m s^{-2}, with GPa = 10^9 Pa and MPa = 10^6 Pa. Used in: Oct 2024 Q1, Jan 2022 Q10, Jan 2024 Q1.

Using the booklet in the exam

- The data and formulae list is printed in every Unit 1 paper. Look under Unit 1: Mechanics and Unit 1: Materials, but impulse (force equals change in momentum over time) sits under Unit 4 and a mark scheme used it in Jan 2026 (A) Q17.
- The list prints work done as F times s along the force. When the force is at an angle you supply the cos(θ) yourself, as in Oct 2023 Q10 and Jun 2023 Q2.
- Upthrust is not on the list. For a falling or rising sphere find the volume with 4/3 pi r^3, the upthrust from the weight of fluid displaced, then drag = weight - upthrust, and use F = 6 pi eta r v with r the radius (halve a diameter).
- Check the question before you worry about a formula: k = EA/x was printed in Oct 2022 Q12 and Jan 2026 (A) Q12 but not in Jan 2026 (A) Q19, and D = kv^2 was printed in Jan 2023 Q18.
- A question can change g, such as 1.63 m s^{-2} for the Moon in Jan 2026 Q18, so use the value in the question first and 9.81 otherwise.

- Write the equation, substitute with units, then compare with the figure in the question; for 'show that' give one more significant figure than the printed value.

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