STUDY FORMULA BOOKLET

Edexcel IAL Physics Unit 5 (WPH15): thermodynamics, radiation, oscillations and cosmology

The list supplied in each Unit 5 paper covers heating, gases, decay, simple harmonic motion, gravity, stars and redshift. Learn first: kelvin conversion, binding energy, the orbit equation, change in gravitational potential energy, the age of the universe and sphere 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 5 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

Use a value printed in the question before the one on the list.

Gravitational constant

Use it in g = Gm/r^2, F = Gm1m2/r^2, V = -Gm/r and the orbit equation; masses and radii come from the question. Used in: Jan 2026 Q20(a)(i), mass of Mars from a potential graph; Oct 2025 Q11, field strength on Proxima Centauri b; Jun 2024 Q12, weight of a vehicle on Titania.

$$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$$

GIVEN

Boltzmann constant

k goes in pV = NkT and in the mean kinetic energy 3kT/2, with T in kelvin. Used in: Jan 2026 Q13, volume of a car airbag; Jan 2026 Q18(b)(ii), mean kinetic energy of molecules on an exoplanet; Jun 2024 Q13(b), mass of helium in an airship.

$$k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$$

GIVEN

Speed of light in a vacuum

It is used in c^2 for mass and energy, in z = v/c for redshift and as c = f λ for light. Used in: Jan 2026 Q11, speed of a nearby galaxy; Jan 2026 Q19(a)(i), energy released when polonium-214 decays; Oct 2025 Q13(b), maximum radius of a black hole.

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

GIVEN

Stefan-Boltzmann constant

It goes with L = sigma A T^4 and A = 4 pi r^2 to find a star's radius, temperature or luminosity. Used in: Jan 2026 Q18(a)(i), radius of Trappist-1; Oct 2025 Q18(b)(i), radius of Arcturus; Oct 2024 Q15(a), luminosity of Sirius.

$$\sigma = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$$

GIVEN

Unified atomic mass unit

Convert a mass difference from u to kg before using c^2 times the mass. Use 1.66 × 10^{-27} kg: the Jan 2026 scheme did not accept the proton mass 1.67 × 10^{-27} kg for this step, although the Oct 2025 scheme allowed it. Used in: Jan 2026 Q19(a)(i), energy released by polonium-214; Oct 2025 Q20(b)(i), binding energy of iron-56; Jun 2024 Q19(a)(i), energy released when four protons form helium.

$$u = 1.66 \times 10^{-27}\ \text{kg}$$

GIVEN

Electronvolt

Use 1 eV = 1.60 × 10^{-19} J to change joules to eV, so 1 MeV = 1.60 × 10^{-13} J, or a mass given in GeV/c^2 into kg. Used in: Jan 2026 Q19(a)(i), energy in MeV; Oct 2025 Q20(b)(i), binding energy in MeV; Jun 2024 Q17(b)(i), mass of an iodine-131 atom given in GeV/c^2.

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

GIVEN

Proton mass

The proton mass in kg is used for a mass defect when the nucleus mass is given in u and the neutron mass is given separately. Used in: Jan 2025 Q21(b), binding energy per nucleon of promethium-145; Oct 2024 Q21(a)(ii), binding energy of uranium-241.

$$m_\text{p} = 1.67 \times 10^{-27}\ \text{kg}$$

GIVEN

Gravitational field strength

Use g = 9.81 N kg^{-1} for W = mg and for the pendulum period; a question may give another value for another planet. Used in: Jan 2026 Q15(a), period of a pendulum; Jan 2024 Q12, pendulum on Earth and on Venus; Oct 2024 Q19(a)(i), stiffness of a spring balance.

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

GIVEN

Acceleration of free fall

The same value in m s^{-2}, for the equations of motion. Used in: Jun 2022 Q20(a)(i), time for a lead sphere to fall 41.5 m.

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

GIVEN

Seconds in a year

Not on the sheet: the question printed it. Some papers give 3.16 × 10^7 s, so use the value in the question. It converts a half-life in years to seconds for λ, and an age in seconds to years. Used in: Oct 2025 Q17(b)(ii), time for caesium-137 to fall to the activity of strontium-90; Jan 2024 Q18(c), age of the universe in years; Jun 2024 Q19(a)(ii), time to fuse hydrogen in the Sun.

$$1\ \text{year} = 3.15 \times 10^7\ \text{s}$$

GIVEN

Megaparsec

Not on the sheet: the question printed it. Jun 2025 gave 3.1 × 10^{22} m. Convert km to m as well, so 72 km s^{-1} Mpc^{-1} is 72 × 10^3 m s^{-1} per 3.09 × 10^{22} m. Used in: Jun 2025 Q4, age of the universe in seconds from H0; Jun 2022 Q12(a)(i), H0 in s^{-1}.

$$1\ \text{Mpc} = 3.09 \times 10^{22}\ \text{m}$$

GIVEN

Heating, melting and boiling

Energy for a temperature change, a change of state and the power or efficiency of a heater.

Heating: specific heat capacity

Δtheta is a temperature difference, so no kelvin conversion is needed (the scheme of Jan 2026 Q12 ignored one). When a hot body and a cold body mix, energy lost equals energy gained. Used in: Jan 2026 Q12, energy change when acid and alkali mix; Oct 2025 Q16(a), cooling a mug of water; Oct 2024 Q12, final temperature when tin melts in molten copper.

$$\Delta E = mc\Delta\theta$$

GIVEN

Heating: specific latent heat

Use it for melting or boiling at constant temperature, and add mc delta θ for any warming or cooling as well (ice cooled below 0 °C needs both). Used in: Jan 2026 Q16, coal needed to evaporate salt water; Jun 2024 Q15(a), energy to melt an ice floe; Oct 2023 Q16(b), time to boil away 75% of the water in a kettle.

$$\Delta E = L\Delta m$$

GIVEN

Power from energy transferred

The power of a heater is the energy it transfers divided by the time. Used in: Jan 2026 (A) Q17(a), power of a drinks dispenser heater; Oct 2023 Q16(a), power of a kettle; Jan 2021 Q12(a), time for a heater to boil water.

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

GIVEN

Electrical power (current and pd)

Electrical power of a heater from its pd and current; energy is then power times time. Used in: Jan 2025 Q20(a), time to heat water in a tank with a 230 V, 12.6 A heater.

$$P = VI$$

GIVEN

Efficiency from power

The useful power is the energy to boil the water divided by the time, and the total power is the power of the hot-plate. Used in: Jan 2025 Q13(a), efficiency of boiling water on a hot-plate.

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

GIVEN

Density

Mass of water or ice from its volume; for a tray or pan the volume is length x width x depth. Used in: Jun 2025 Q16(a), mass of an ice block; Jun 2023 Q14(a), mass of water in an ice cube compartment; Oct 2023 Q16(a), mass of water in a kettle.

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

GIVEN

Intensity of radiation

Power received equals intensity times area, so the energy for a given time is I x A x t. Used in: Jun 2024 Q15(b), time for sunlight to melt an ice floe.

$$I = \frac{P}{A}$$

GIVEN

Ideal gases and kinetic theory

Ideal gas equation

N is the number of molecules, not moles, and T is in kelvin. For a fixed mass of gas pV/T is constant, so p1V1/T1 = p2V2/T2 is this equation; at constant temperature pV is constant (Boyle's law) and at constant volume p/T is constant. Used in: Jan 2026 Q13, volume of a car airbag; Oct 2025 Q14, temperature of an expanding balloon; Jun 2024 Q13(b), mass of helium in an airship.

$$pV = NkT$$

GIVEN

Molecular kinetic theory

The mean kinetic energy of a molecule, 3kT/2, depends only on T, so two gases at the same temperature have the same mean kinetic energy and the r.m.s. speed falls as the molecular mass rises. The internal energy of N molecules of an ideal gas is N x 3kT/2. Used in: Jan 2026 Q18(b)(ii), mean kinetic energy of molecules at 235 K; Oct 2025 Q10, ratio of r.m.s. speeds of xenon and argon; Oct 2024 Q11, internal energy of helium.

$$\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$$

GIVEN

Temperature in kelvin

Convert whenever T appears by itself, as in pV = NkT, kT, Wien's law and T^4. The Jan 2026 scheme accepted 273.15. Used in: Jan 2026 Q13, airbag at 22 °C; Oct 2025 Q14, balloon at 22 °C and 95 °C; Jan 2026 (A) Q15, balloon rising to -48.0 °C.

$$T/\mathrm{K} = \theta/^\circ\mathrm{C} + 273$$

LEARN IT

Number and mass of molecules

M is the mass of the gas and m the mass of one molecule, which the questions gave. Used in: Jan 2026 Q13, number of nitrogen molecules in 0.0875 kg; Jun 2025 Q17(a), mass of nitrogen in a globe; Oct 2022 Q12, density of oxygen in a cylinder.

$$N = \frac{M}{m}, \quad M = Nm$$

LEARN IT

Mass, energy and binding energy

Mass-energy

Δm is the mass before minus the mass after, or the mass defect, in kg, so change u to kg first. The same equation gives the mass the Sun loses from the energy it radiates. Used in: Jan 2026 Q19(a)(i), energy released by polonium-214; Oct 2025 Q20(b)(i), binding energy of iron-56; Jun 2020 Q14(b), mass lost by the Sun in a year.

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

GIVEN

Binding energy per nucleon

Z is the proton number and A the nucleon number. Find the mass defect in kg, then the energy in J, divide by A and change to MeV. From a binding energy graph, energy released equals the rise in binding energy per nucleon times the number of nucleons. Used in: Oct 2025 Q20(b)(i), iron-56; Jan 2025 Q21(b), promethium-145; Oct 2024 Q21(a)(ii), uranium-241.

$$\Delta m = Z m_\mathrm{p} + (A - Z) m_\mathrm{n} - m_\mathrm{nucleus}, \quad \frac{E_\mathrm{B}}{A} = \frac{c^2 \Delta m}{A}$$

LEARN IT

Radioactive decay and absorption

Activity

N is the number of undecayed nuclei and A is in Bq, so λ must be in s^{-1}. Used in: Oct 2025 Q17(b)(i), number of caesium-137 atoms; Jan 2026 (A) Q18(c)(i), activity of a tritium sample; Oct 2022 Q20(c)(i), activity of 24 kg of caesium-137.

$$A = \lambda N$$

GIVEN

Rate of decay

The same relationship as A = λ N: the activity is the rate of decay, and the minus sign shows N falls. Used in: Oct 2023 Q19(a)(ii), mass of caesium in a capsule; Jan 2023 Q15(b), mass of a 7400 Bq caesium sample; Oct 2021 Q6, expression for the activity of polonium-218.

$$\frac{\mathrm{d}N}{\mathrm{d}t} = -\lambda N$$

GIVEN

Decay constant and half-life

Keep the half-life and λ in the same time unit, years or seconds. Used in: Jan 2026 Q19(b)(ii), lead-210 in river mud; Oct 2025 Q17(b)(i), caesium-137 with the half-life in seconds; Jun 2024 Q17(b)(i), iodine-131 with the half-life in days.

$$\lambda = \frac{\ln 2}{t_{1/2}}$$

GIVEN

Number of undecayed nuclei

N is the number of undecayed nuclei, so it also gives the original number from what is left, or the ratio for two isotopes. Used in: Oct 2024 Q21(b), uranium-241 against uranium-242; Jun 2023 Q16(b), time for 90% of thorium-230 to decay; Jun 2020 Q18(c), original number of oganesson-294 atoms.

$$N = N_0 e^{-\lambda t}$$

GIVEN

Activity over time

Write a percentage as a fraction of the initial activity, so 2.5% is A/A0 = 0.025. Used in: Jan 2026 Q19(b)(ii), age of river mud; Oct 2025 Q17(b)(ii), time for caesium-137 to reach the activity of strontium-90; Jun 2024 Q17(b)(ii), activity of iodine-131 a day earlier.

$$A = A_0 e^{-\lambda t}$$

GIVEN

Absorption of gamma radiation

Not on the sheet: the question printed it. R is the count rate behind a thickness x of absorber, R0 the count rate with none and μ the absorption coefficient. Taking logs gives ln R = ln R0 - μ x, a straight line with gradient -μ and intercept ln R0. Used in: Jun 2024 Q14(c), μ for lead from a graph; Jan 2024 Q20(b), μ from a graph of ln R against x; Jan 2021 Q15, half-value thickness of iron.

$$R = R_0 e^{-\mu x}$$

GIVEN

Half-value thickness

Each half-value thickness halves the count rate, so a count rate of one quarter needs two. Used in: Jan 2026 Q8, count rate behind 4.0 mm of lead; Jan 2026 (A) Q8, thickness of lead for half the intensity; Jan 2021 Q15, finding it from a graph.

$$x_{1/2} = \frac{\ln 2}{\mu}$$

LEARN IT

Corrected count rate

Subtract the background count rate, not the background count, which covers a different time. Used in: Jan 2026 Q1, absorption of gamma radiation by lead; Jun 2024 Q14(b), improving the measured count rate.

$$R_{\text{corrected}} = R_{\text{measured}} - R_{\text{background}}$$

LEARN IT

Power from nuclear events

Activity is decays per second, so multiply by the energy per decay in joules (1 MeV = 1.60 × 10^{-13} J). The same idea gives the power of the Sun from the energy per fusion times the rate of fusions. Used in: Jan 2024 Q19(c)(ii), heat output of strontium-90 canisters; Jun 2025 Q20(b)(ii), power of plutonium-238 on a space probe; Oct 2023 Q19(b), energy released by a caesium capsule in 14 days.

$$P = A \times E_{\text{per}}\ \text{decay}$$

LEARN IT

Mass of a sample of nuclei

m_atom is the mass of one atom, about the nucleon number times 1 u (1.66 × 10^{-27} kg), or the value the question gives. Used in: Oct 2023 Q19(a)(ii), mass of caesium in a capsule; Jan 2023 Q15(b), mass of a caesium-137 sample; Oct 2022 Q20(c)(i), activity of 24 kg of caesium-137 using a given atom mass in u.

$$M = N \times m_{\text{atom}}$$

LEARN IT

Simple harmonic motion

Simple harmonic motion: force

The minus sign means the force is always opposite to the displacement x, which is measured from the equilibrium position. Used in: Oct 2025 Q15(a), meaning of x and of the minus sign for a floating test tube; Jun 2025 Q15(a), conditions for SHM of a racing car; Jun 2024 Q20(a), meaning of SHM.

$$F = -kx$$

GIVEN

Simple harmonic motion: acceleration

A straight line through the origin on a graph of a against x has gradient -ω^2. Used in: Jan 2025 Q17(b)(i), ω from an acceleration graph; Jan 2022 Q11, period from an acceleration graph; Jan 2021 Q18(b)(ii), acceleration of a bee's wing tip.

$$a = -\omega^2 x$$

GIVEN

Simple harmonic motion: velocity

The maximum speed is v = ω A, reached at the equilibrium position where sin ω t = 1. Used in: Jan 2026 Q15(b), maximum speed of a pendulum bob; Oct 2025 Q15(a)(iii), maximum speed of a test tube; Jun 2025 Q15(b), maximum speed of a racing car body.

$$v = -A\omega \sin \omega t$$

GIVEN

Simple harmonic motion: acceleration against time

The maximum acceleration is ω^2 A. Used in: Oct 2019 Q16(b), maximum acceleration of a steel strip in a musical box; Oct 2022 Q19(b)(ii), maximum acceleration of a paint shaker bracket.

$$a = -A\omega^2 \cos \omega t$$

GIVEN

Period, frequency and angular frequency

The list also gives ω = 2 pi f. Turn beats per minute or oscillations in a time into a frequency first. Used in: Jan 2026 Q15(b), ω from the period; Jun 2023 Q15(a), displacement of a baby's heart wall; Oct 2019 Q16(b), 1600 oscillations in 5.0 s.

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

GIVEN

Mass on a spring

m is the total mass on the spring, so add the passengers to the empty car. Rearranged, k = 4 pi^2 m/T^2 and f = (1/2 pi) sqrt(k/m), so a graph of f^2 against 1/m has gradient k/4 pi^2. Used in: Jan 2025 Q11, added mass from two periods; Jun 2024 Q20(b)(ii), stiffness of a damper spring; Jan 2024 Q17(b), mass of an astronaut on a spring chair.

$$T = 2\pi\sqrt{\frac{m}{k}}$$

GIVEN

Simple pendulum

T depends on l and g, not on the mass or the amplitude; on another planet use g = GM/r^2. Used in: Jan 2026 Q15(a), period of a 0.65 m pendulum; Jan 2024 Q12, period on Venus; Oct 2024 Q13, pendulums of length L and L/2.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

GIVEN

Hooke's law

To find the stiffness of a hanging spring, divide the weight mg by the extension. Used in: Oct 2024 Q19(a)(i), stiffness of a spring balance; Oct 2023 Q20(b), maximum speed of a hanging mass; Jun 2022 Q17(b)(i), stiffness of a diving board.

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

GIVEN

Weight

W in newtons, m in kg. Used in: Jun 2024 Q12, weight of a vehicle on Titania; Oct 2024 Q19(a)(i), weight of a mass on a spring balance; Jan 2023 Q19(b), weight of a person stepping into a car.

$$W = mg$$

GIVEN

Kinetic energy

The kinetic energy is greatest at the equilibrium position, where v = ω A. Used in: Jan 2026 Q15(b), maximum kinetic energy of a pendulum bob; Oct 2025 Q15(a)(iii), maximum kinetic energy of a test tube; Jan 2025 Q17(b)(i), maximum kinetic energy of an oscillating object.

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

GIVEN

Elastic strain energy

A second route to the maximum kinetic energy: with F = kA, the energy stored at the amplitude, (1/2)FA, equals the maximum kinetic energy. Used in: Oct 2023 Q20(b), maximum speed through elastic energy; Jan 2025 Q17(b)(i), alternative solution from an a against x graph; Jun 2020 Q20(b), maximum kinetic energy of a mass on a spring.

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

GIVEN

Maximum kinetic energy of an oscillator

It follows from v = ω A with E_k = (1/2)mv^2, and no question printed it. Doubling the amplitude gives four times the energy, and total energy stays constant, so E_k = total energy - elastic energy at a given displacement. Used in: Jun 2024 Q3, effect of doubling the amplitude; Oct 2024 Q13, two pendulums of different length; Jan 2023 Q14(b), speed at 1.0 cm from a graph of energy.

$$E_{\mathrm{k,max}} = \frac{1}{2}m(\omega A)^2 = \frac{1}{2}kA^2$$

LEARN IT

Driving frequency from speed bumps

v is the speed of the car and d the spacing of the bumps, so the time between bumps is d/v; resonance occurs when this matches the natural period of the car on its springs. Used in: Jan 2026 (A) Q20(b)(ii), deciding whether resonance occurs; Jan 2023 Q19(b), speed of a car at resonance.

$$f_{\mathrm{driving}} = \frac{v}{d}$$

LEARN IT

Gravitational fields and orbits

Gravitational force

r is the distance between centres, so add the height or the other radius. Used in: Oct 2023 Q18(a), force between an asteroid and the Earth; Oct 2022 Q17(a)(i), force of the Sun on Ceres; Jan 2023 Q20(a), force between two lead spheres.

$$F = \frac{Gm_1m_2}{r^2}$$

GIVEN

Gravitational field of a point mass

When a question gives ratios, use g proportional to M/r^2. Used in: Jan 2026 Q18(b)(i), field strength at the surface of an exoplanet; Oct 2025 Q11, field strength on Proxima Centauri b; Jan 2026 (A) Q11, mean radius of the Moon.

$$g = \frac{Gm}{r^2}$$

GIVEN

Gravitational potential

The potential is negative and rises to zero at infinity; read r and V from a graph to find the mass, since Vr = -GM. Used in: Jan 2026 Q20(a)(i), mass of Mars from a potential graph; Jan 2025 Q12, mass of the Earth from a graph; Jun 2024 Q11, spacing of equipotential surfaces.

$$V_{\text{grav}} = \frac{-Gm}{r}$$

GIVEN

Change in gravitational potential energy

Find V at the start and the end with V = -GM/r, or read it from a graph, and multiply the difference by m. Do not use mg delta h, because g is not constant over these heights: the Jun 2025 scheme did not credit it. Used in: Jan 2026 Q20(a)(ii), landing a probe on Mars; Jun 2025 Q13(a), launching a satellite; Oct 2023 Q18(b), asteroid falling to the Earth.

$$\Delta E_{\text{grav}} = m\Delta V$$

LEARN IT

Gravitational force as the centripetal force

The list prints the gravitational force and the centripetal force separately but not that they are equal for an orbit. Cancel m, then use ω = 2 pi/T or v = 2 pi r/T; r is the distance from the centre, and the orbits in a day are 86 400 s divided by T. Used in: Jan 2026 Q17(b), orbits of the ISS in a day; Oct 2025 Q21(c)(i), height of a geostationary satellite; Jan 2025 Q14(a), mass of the Sun.

$$\frac{GMm}{r^2} = mr\omega^2 = \frac{mv^2}{r}$$

LEARN IT

Period of circular motion

T = 2 pi/ω turns an orbital period into the angular speed used in the orbit equation. Used in: Jan 2026 Q17(b), orbital period of the ISS; Jan 2025 Q14(a), angular speed of the Earth round the Sun; Oct 2024 Q18(a), orbit time of Ganymede.

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

GIVEN

Kepler's third law

It comes from equating gravitational and centripetal force, so T^2 is proportional to r^3 for bodies orbiting the same mass. Derive it when the question says show that; the Jun 2023 and Jan 2026 schemes credited a memorised version only when the final answer was correct. Jun 2024 Q18(a) printed it as the result to show. Used in: Jun 2024 Q18(b)(i), orbital period of a star in the galaxy; Jun 2022 Q16(a)(i), T^2 proportional to r^3; Jan 2022 Q18(b), Kepler's constant from Newton's law.

$$T^2 = \frac{4\pi^2}{GM}r^3$$

LEARN IT

Orbital speed

Not on the sheet: the question printed it. Both questions printed it, once as a result to show and once as a fact; M is the mass inside radius r. A star's speed falls with r when M stays constant. Used in: Jan 2026 (A) Q22(a), speed of a star orbiting a larger mass; Jan 2022 Q16(a), speed of stars in a galaxy.

$$v = \sqrt{\frac{GM}{r}}$$

GIVEN

Escape velocity

Not on the sheet. The question gave the equation or asked you to show it by equating the kinetic energy with GMm/R. Setting v = c gives the largest radius of a black hole. Used in: Oct 2025 Q13(b), maximum radius of Sagittarius A*; Jan 2023 Q12(b)(i), escape velocity of the Earth.

$$v_{\text{esc}} = \sqrt{\frac{2GM}{R}}$$

GIVEN

Stars, distances and the expanding universe

Stefan-Boltzmann law

For a sphere A = 4 pi r^2 and T is in kelvin; compare two stars with ratios. Used in: Jan 2026 Q18(a)(i), radius of Trappist-1; Oct 2025 Q18(b)(i), radius of Arcturus; Oct 2024 Q15(a), luminosity of Sirius.

$$L = \sigma A T^4$$

GIVEN

Surface area of a sphere

r is the radius, so halve a diameter. Used in: Jan 2026 Q18(a)(i), area of Trappist-1; Jun 2024 Q16(a), area of epsilon Eridani; Oct 2024 Q15(a), area of Sirius.

$$A = 4\pi r^2$$

LEARN IT

Wien's law

T is the surface temperature in kelvin, so a longer peak wavelength means a cooler star. For a peak frequency find the wavelength with c = f λ first. Used in: Jan 2026 Q18(a)(ii), peak wavelength of Trappist-1; Oct 2025 Q18(b)(i), temperature of Arcturus; Jan 2026 (A) Q21(a)(iv), surface temperature of the Sun from a curve.

$$\lambda_{\text{max}} T = 2.898 \times 10^{-3}\ \text{m K}$$

GIVEN

Wave speed (c = f λ for light)

For light v = c. It turns a peak frequency into the wavelength Wien's law needs. Used in: Jun 2025 Q19(a)(i), temperature of Tau Ceti from a peak at 5.50 × 10^{14} Hz; Oct 2024 Q20(a)(i), temperature of the Sun from a peak frequency.

$$v = f\lambda$$

GIVEN

Intensity of radiation

Intensity falls as 1/d^2 for the same luminosity; for a standard candle L is known, I is measured and d is found. Used in: Jun 2024 Q16(a), luminosity of epsilon Eridani from its intensity at Earth; Oct 2024 Q15(b), comparing the brightness of Sirius and Canopus; Oct 2025 Q6, distance ratio from an intensity ratio.

$$I = \frac{L}{4\pi d^2}$$

GIVEN

Trigonometric parallax

p is the parallax angle in radians, r the Earth to Sun distance and d the distance to the star, so a star with twice the parallax angle is half as far away. The two calculation questions printed the Earth to Sun distance. Used in: Jan 2026 Q4, ratio of distances from a ratio of angles; Jun 2022 Q18(a)(i), distance to Wolf 359; Jan 2022 Q19(a), whether parallax can measure a distance.

$$\tan p = \frac{r}{d} \approx p$$

LEARN IT

Redshift of electromagnetic radiation

Use the laboratory or emitted wavelength (or frequency) in the denominator, and give only the magnitude of the velocity when asked. A longer wavelength means the source is moving away. Used in: Jan 2026 Q11, speed of a nearby galaxy; Oct 2025 Q12, speed of the Andromeda galaxy; Jun 2024 Q16(b), whether a shift in 480 nm light can be detected.

$$z = \frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$$

GIVEN

Cosmological expansion

H0 is in s^{-1} when v is in m s^{-1} and d is in m. A graph of v against d has gradient H0, and a graph of z against d has gradient H0/c. Used in: Jan 2024 Q18(c), H0 from a galaxy's speed and distance; Jan 2023 Q13, distance to M87; Jan 2021 Q16(a)(ii), distance of NGC 6052.

$$v = H_0 d$$

GIVEN

Age of the universe

t is in seconds when H0 is in s^{-1}; divide by the seconds in a year for years. A larger H0 means a younger universe. Used in: Oct 2025 Q4, expression for H0 from the age; Jan 2025 Q7, age for a new value of H0; Jun 2022 Q12(a)(ii), age in years.

$$t = \frac{1}{H_0}$$

LEARN IT

Linear and angular speed

For a rotating star, v = ω r links a Doppler speed to the rotation period. Used in: Jan 2026 (A) Q12, angular velocity of the Sun; Jan 2025 Q18(b), rotation period of the Sun; Oct 2021 Q16(c), period of the Sun's rotation.

$$v = \omega r$$

GIVEN

Geometry and earlier units

These are not Unit 5 content but past Unit 5 questions needed them.

Volume of a sphere

r is the radius, so halve a diameter; for a balloon, V is proportional to r^3. Used in: Oct 2025 Q14, balloon of diameter 11.5 cm; Jun 2025 Q17(a), volume of the Gaia globe; Oct 2024 Q14, methane bubble.

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

LEARN IT

Displacement with acceleration

Free fall from rest has u = 0. Used in: Jun 2022 Q20(a)(i), time for a lead sphere to fall 41.5 m.

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

GIVEN

Change in gravitational potential energy

Used in: Jun 2022 Q20(b)(i), why the temperature rise of falling lead shot does not depend on the mass.

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

GIVEN

Also learn these

Random and spontaneous decay

Decay is random (you cannot predict which nucleus decays or when) and spontaneous (you cannot influence it), but the fraction that decays in a given time can be predicted from the half-life. Used in: Jan 2026 Q6, Jan 2026 (A) Q5, Jun 2024 Q5.

Alpha, beta and gamma radiation

Alpha is the most ionising and the least penetrating and does not pass through paper, beta does not pass through a 0.5 cm aluminium sheet, and gamma is weakly ionising and the most penetrating (it passes through aluminium and is reduced by lead). Used in: Oct 2025 Q2, Jan 2024 Q20(a), Jun 2024 Q14(a).

Nuclear equations

Nucleon number (top line) and charge (bottom line) are both conserved, and beta minus decay emits an electron and an antineutrino. Used in: Jan 2026 Q19(b)(i), Oct 2025 Q17(a), Jun 2024 Q17(a).

Energy sharing in decay

Momentum is conserved, so the recoiling nucleus takes some kinetic energy and an alpha particle has less than the energy released; in beta decay the energy is shared between the beta particle and the antineutrino, so beta energies form a range. Used in: Jan 2026 Q19(a)(ii), Oct 2022 Q20(b)(ii), Jan 2022 Q20(c).

Binding energy curve, fission and fusion

Fission of a large nucleus and fusion of small nuclei both raise the binding energy per nucleon, so energy is released, equal to the rise times the number of nucleons. Used in: Jan 2026 Q14(a), Oct 2025 Q20(a), Jan 2024 Q19(a).

Conditions for fusion

A very high temperature gives nuclei enough kinetic energy to overcome their electrostatic repulsion and get close enough to fuse, and a very high density gives a high collision rate to keep fusion going. Used in: Jan 2026 Q14(b), Jan 2024 Q21(a), Jun 2023 Q17(b).

Core practical: absorption of gamma radiation by lead

Measure the count rate for several thicknesses of lead with the source and GM tube a fixed distance apart, subtract the background count rate, count for longer or repeat to reduce random variation, and plot ln R against x. Used in: Jun 2024 Q14(b), Jan 2026 Q8, Jan 2021 Q15.

Internal energy and change of state

Internal energy is the random kinetic and potential energy of the molecules; during melting or boiling at constant temperature the potential energy rises while the mean kinetic energy stays the same. Used in: Jan 2026 (A) Q6, Jun 2023 Q18, Oct 2019 Q12(a).

Core practical: specific latent heat

Energy lost to the surroundings makes the measured latent heat too large, and energy gained from the surroundings makes it too small. Used in: Jan 2026 Q10, Jan 2022 Q2.

Pressure of a gas from molecules

Molecules collide with the walls and each collision changes their momentum; pressure is the rate of change of momentum, or force, per unit area, so more frequent or faster collisions raise it. Used in: Oct 2025 Q19(b), Jan 2026 (A) Q16, Jun 2021 Q11(a).

Core practical: pressure and volume of a gas (Boyle's law)

At constant temperature and mass, p is inversely proportional to V, so pV is constant; test it by calculating pV for several readings from the graph. Used in: Oct 2023 Q12, Jun 2022 Q8.

Core practical: thermistor calibration

Put the thermistor in a stirred water bath, take the temperature from 0 to 100 °C with a thermometer beside it and the resistance from an ohmmeter, then plot resistance against temperature. Used in: Oct 2024 Q16, Oct 2023 Q15.

Conditions for SHM

The resultant force or acceleration is proportional to the displacement from the equilibrium position and always acts towards it. Used in: Jun 2025 Q15(a), Oct 2025 Q15(a), Jun 2024 Q20(a).

Graphs of SHM

Velocity is the gradient of the displacement-time graph and acceleration is the gradient of the velocity-time graph; velocity leads displacement by a quarter of a cycle and acceleration is in antiphase with displacement. Used in: Oct 2025 Q15(b), Jun 2024 Q9, Jan 2026 (A) Q9.

Free, forced and damped oscillations, resonance

A forced oscillation has the frequency of the driver, and the amplitude and the energy transfer are greatest when the driving frequency equals the natural frequency (resonance). Damping transfers energy from the oscillator to the surroundings, so the amplitude falls. Used in: Jun 2024 Q4, Jan 2023 Q19(a), Jan 2023 Q19(c).

Weightlessness in orbit

Astronauts in orbit do have weight because a gravitational force acts on them; they feel weightless because they are in free fall with no contact force. Used in: Jan 2026 Q17(c), Jan 2024 Q17(a).

Black body radiation curves

A hotter star has its peak intensity at a shorter wavelength and the peak is higher; a cooler star peaks at a longer wavelength. Used in: Oct 2025 Q7, Jan 2026 (A) Q21(a)(iii), Jan 2024 Q18(a).

Hertzsprung-Russell diagram and stellar life cycle

Luminosity is plotted against surface temperature on a reversed temperature axis with hot stars on the left; the main sequence runs from top left to bottom right, red giants are at the top right and white dwarfs at the bottom left, and a main sequence star becomes a red giant and then a white dwarf. Used in: Oct 2025 Q18(a), Jun 2025 Q18, Jan 2026 Q9.

Standard candles and parallax

A standard candle is an object of known luminosity: measure its intensity at the Earth and use the inverse square law to find the distance. Parallax measures a star's shift against distant stars over six months and works only for nearby stars. Used in: Oct 2025 Q21(a), Jun 2025 Q14, Jan 2025 Q16(a).

Redshift and the expanding universe

Light from a receding source is shifted to longer wavelengths (the Doppler effect), and the light from distant galaxies is red shifted, which shows the universe is expanding. Used in: Oct 2023 Q14(a), Oct 2024 Q17(a)(i), Jan 2021 Q16(a)(i).

Dark matter and the fate of the universe

Dark matter has mass and exerts a gravitational force but emits no electromagnetic radiation. The fate depends on the average density compared with the critical density: less is an open universe, equal is flat, and more means the universe eventually contracts. Used in: Jan 2026 Q17(a), Jan 2026 Q5, Oct 2024 Q7.

Masses in MeV/c^2 or GeV/c^2

Subtract the masses in those units to get the energy in MeV or GeV, then use 1 eV = 1.60×10^{-19} J; to change a mass in GeV/c^2 to kg, convert the energy to joules and divide by c^2. Used in: Jan 2023 Q16(b), Jan 2024 Q21(b)(i), Oct 2022 Q18(a)(ii).

Units in astronomy

Intensity is in W m^{-2}, luminosity in W and H0 in s^{-1}, so a value in km s^{-1} Mpc^{-1} must be converted. Used in: Jan 2026 Q3, Oct 2025 Q4, Jun 2022 Q12(a)(i).

Proportionality arguments

When a question gives ratios, use proportionality: I proportional to $1/d^2$, g to M/r^2, T to the square root of m for a spring and the r.m.s. speed to 1/sqrt(m). Used in: Oct 2025 Q6, Oct 2025 Q9, Oct 2025 Q10.

Using the booklet in the exam

- The list of data, formulae and relationships is supplied in each Unit 5 paper, but questions also use rows from other units: F = mr ω^2 and T = 2 pi/ω sit under Unit 4 and orbit questions need them (Jan 2026 Q17(b)), while I = P/A and ρ = m/V sit under Units 2 and 1 (Jun 2024 Q15(b) and Q20(b)(ii)).
- Convert to kelvin for pV = NkT, kT, Wien's law and T^4, but not for mc delta θ, where a difference in °C equals a difference in kelvin.
- For orbits, equate the gravitational force with the centripetal force yourself and take r from the centre of the planet; schemes such as Jun 2023 Q21 and Jan 2026 Q17 credited a memorised Kepler equation only when the final answer was right.
- Check whether the question printed the equation: R = R0 e^{-μ x} was printed in Jan 2021 Q15, Jan 2024 Q20 and Jun 2024 Q14, and v = sqrt(2GM/R) in Oct 2025 Q13 and Jan 2023 Q12.
- For decay, keep the half-life, λ and time in one unit, and write a percentage as a fraction of the starting value, as in Jan 2026 Q19(b)(ii) where 2.5% became A/A0 = 0.025.
- On show that questions the schemes asked for at least 3 significant figures, as in Jan 2026 Q15(a) and Jan 2026 Q18(a)(ii), so do not round early.

Built by CuratedPrep from the Edexcel International A Level Physics Unit 5 (WPH15) papers June 2019 to January 2026 in our question bank (21 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.