Course notes

AQA · GCSE · Physics

AQA GCSE · Physics: teaching notes

Version: 8463; Version 1.1 (30 September 2019); exams 2018 onwards

These notes cover selected topics of the course; they are not the whole specification.

Assessment and course boundaries

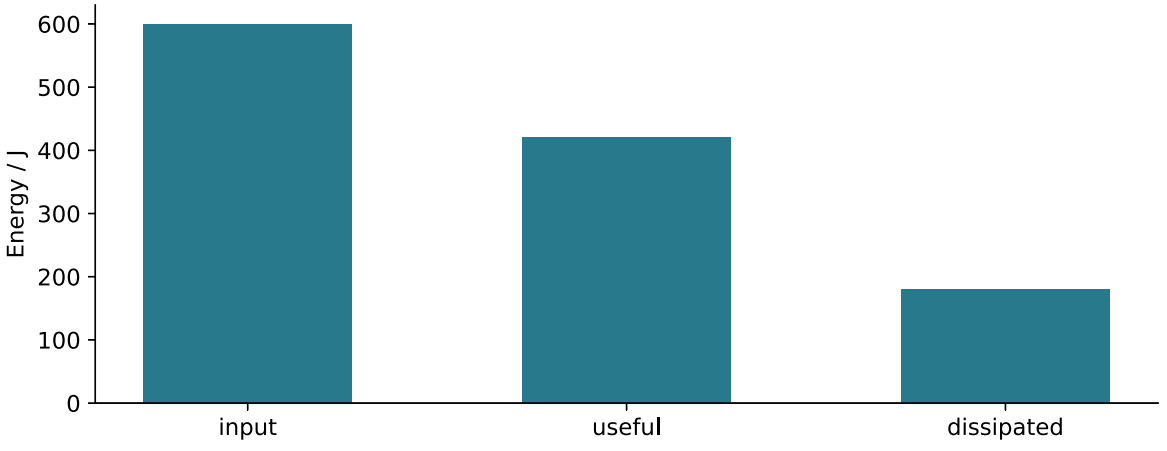
- Foundation and Higher route, with physics-only and HT statements retained.
- Paper 1: 4.1–4.4; Paper 2: 4.5–4.8. Each is 100 marks, 1 h 45 min, 50%.
- Use the equation sheet for the actual examination year; do not infer a 2026 aid from a 2024 copy.
- The equations insert is explicitly FOR USE IN JUNE 2027 ONLY. AQA confirms its content is unchanged from 2026, but examinations must use their own dated clean insert, supplied with both papers. Preserve the insert's HT labels; do not infer future assessment conditions from this copy.

Energy stores, work and efficiency

Official-unit focus: 4.1 Energy

A motor can transfer some input energy to lifting and the rest to heating. Useful output is part of the total energy transfer.

Work done by a constant force parallel to displacement is force multiplied by distance. Kinetic energy depends on speed squared. Energy is conserved when all transfers and stores are included.



Define the system and useful output before calculating efficiency. Doubling speed quadruples kinetic energy at constant mass. Power describes transfer per time, not

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total energy.

Measure a lifting height and load, time the lift, and record electrical input with suitable instruments. Repeat trials and account for heating or friction as transfers, not missing energy.

■ Checked worked case

Known: a device receives 600 J and transfers 420 J usefully. Efficiency = useful output / total input. Efficiency = 420/600 = 0.70 = 70%. Over 3 s, useful power = useful energy/time = 420/3 = 140 W.

■ Common error

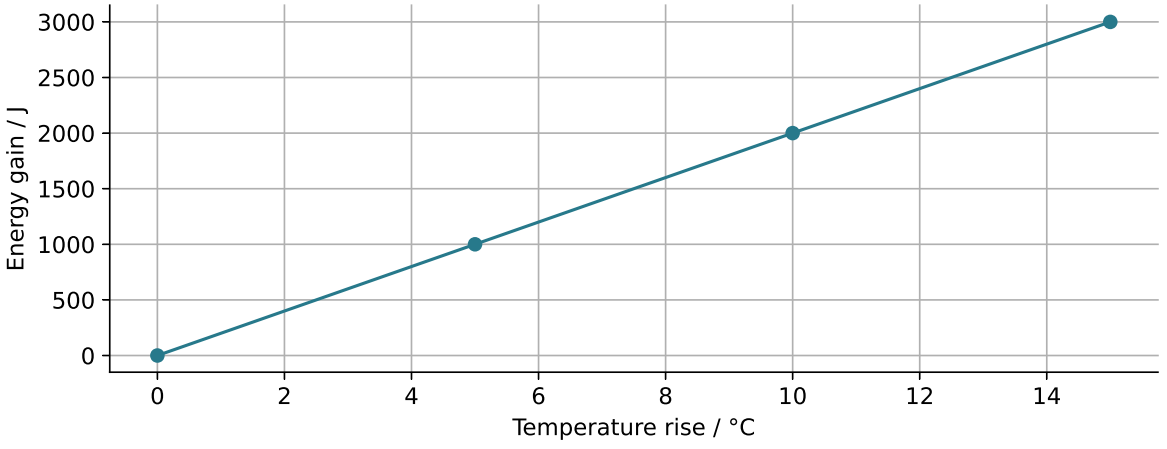
Efficiency cannot exceed 100% for a properly defined energy balance. Energy dissipated by heating is still conserved.

Thermal measurements and particle models

Official-unit focus: 4.1 Energy; 4.3 Particle model of matter

Two equal masses receive the same energy but show different temperature rises. Material properties determine how energy transfer changes temperature.

Specific heat capacity is energy needed to raise the temperature of unit mass by one degree. Specific latent heat relates energy to change of state without temperature change for the idealized process.



Temperature relates to particle motion in a model; internal energy includes kinetic and potential contributions. During a change of state, energy can change particle arrangements rather than temperature.

Measure mass, electrical input and temperature change for an insulated block. Ensure the temperature sensor has good contact, allow time for equilibration, and consider energy transferred to the surroundings.

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■ Checked worked case

Known: a 0.50 kg block gains 2,000 J and rises 10 °C. Use $E = mc\Delta T$. Rearranging gives $c = E/(m\Delta T)$. $c = 2{,}000/(0.50\times10) = 400$ J per kilogram per degree. Heat loss would make the value inferred from electrical input too large.

■ Common error

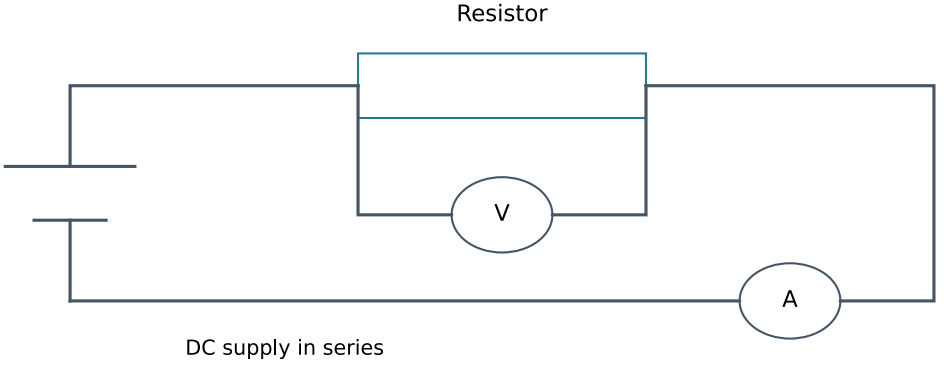
A flat section of a heating curve can show a phase change, not absence of energy transfer. Do not substitute temperature for a temperature difference in $E = mc\Delta T$.

Current, potential difference and resistance

Official-unit focus: 4.2 Electricity

A lamp becomes dimmer when another is added in series. Current and energy transfer depend on the whole circuit, not only one lamp.

Current is charge passing per time. Potential difference is energy transferred per charge. Resistance is potential difference divided by current for a stated operating point.



Ammeter in series; voltmeter across resistor

Current is the same through components in series. Potential differences add around the series path. In parallel, branches share the same potential difference, while branch currents sum at a junction.

Place an ammeter in series and a voltmeter in parallel. For an I-V investigation, change voltage in steps, reverse polarity when appropriate and limit current to reduce heating.

■ Checked worked case

Known: a resistor has 6.0 V across it and carries 0.30 A. Use $R = V/I$. $R = 6.0/0.30 = 20$ ohms. Power $= VI$. Power $= 6.0\times0.30 = 1.8$ W. These quantities describe the same operating point.

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■ Common error

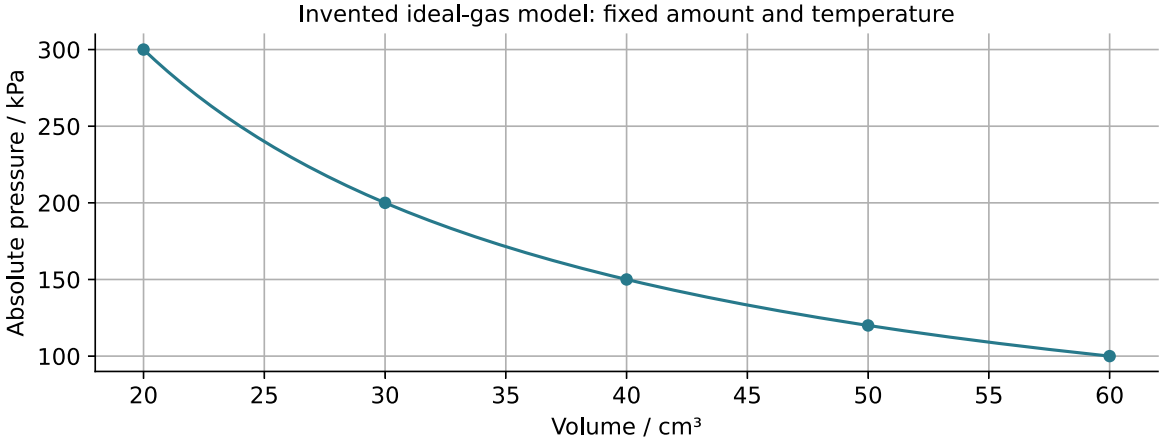
Current is not used up by a lamp. A filament heats up, so its resistance need not remain constant as voltage changes.

Gas models and absolute temperature

Official-unit focus: 4.3 Particle model of matter

A sealed gas container changes pressure when heated. Celsius ratios cannot predict the pressure change because the gas model uses absolute temperature.

Gas particles move randomly and collide with container walls. Pressure depends on collisions with the walls. At fixed temperature, compression reduces volume and increases pressure for a fixed amount of gas.



State which quantities stay fixed. A pressure-volume relation requires consistent units and a fixed temperature. The kelvin-based temperature ratio is an extension only where the course explicitly specifies it.

Use approved apparatus with a temperature range and pressure limit set by the teacher. Allow thermal equilibrium and record pressure against kelvin temperature. Never heat an improvised sealed vessel.

■ Checked worked case

Known: gas pressure is 100 kPa at volume 60 cubic centimetres, at fixed temperature. p1V1=p2V2. At volume 30 cubic centimetres, p2=p1V1/V2=100×60/30=200 kPa.

■ Common error

An ideal gas is a model with conditions of validity. Celsius zero is not zero molecular motion, and internal energy is not determined by pressure alone.

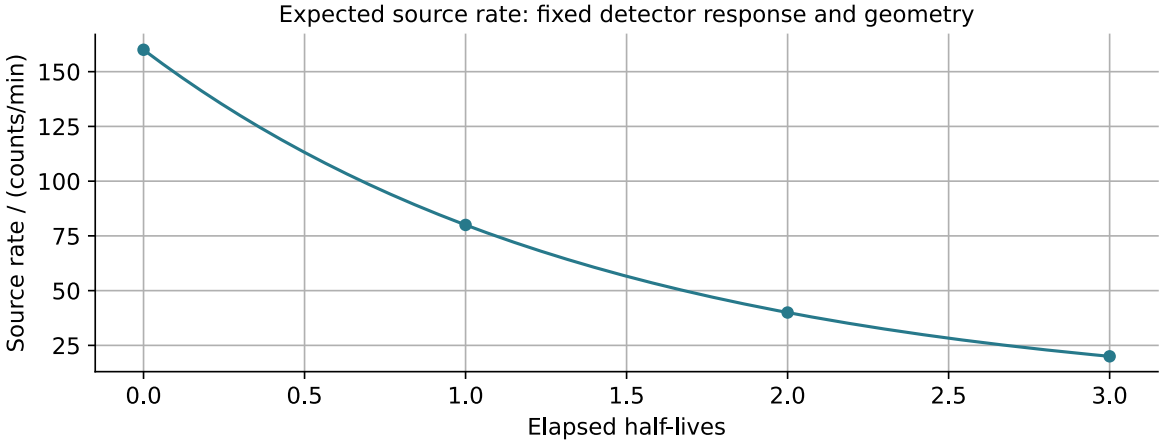
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Nuclear changes and radiation evidence

Official-unit focus: 4.4 Atomic structure

A detector records counts even when the classroom source is removed. Background must be considered before attributing every count to the source.

Radioactive decay is spontaneous and random for an individual nucleus. Half-life describes the time for half the undecayed nuclei in a large population to decay, or for background-corrected activity to halve.



Subtract background counts measured over the same time interval. Distinguish irradiation from contamination. Shielding, distance and reduced exposure time can reduce risk under a school-controlled procedure.

Use teacher-managed sources and the school radiation rules. Record count duration and repeat background measurements. Do not extrapolate a half-life from one nucleus or from uncorrected readings.

■ Checked worked case

Known: measured count rate falls from 100 to 55 counts per minute; background is 10. Source rates are 90 and 45, so one half-life has elapsed. Without subtraction, 55/100 would obscure the exact half in this example.

■ Common error

An irradiated object is not automatically radioactive. A half-life does not predict the exact decay time of one nucleus.

Forces, momentum and safe stopping

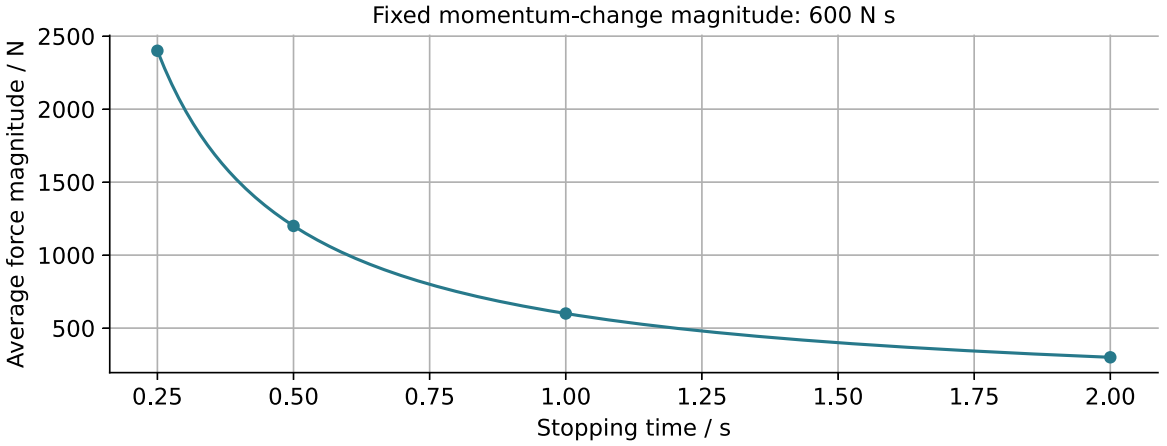
Official-unit focus: 4.5 Forces

A passenger continues moving when a vehicle brakes. The seat belt provides the force needed to change the passenger momentum.

Resultant force causes acceleration, not motion itself. Momentum is mass multiplied

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by velocity. For an isolated system, total momentum is conserved even when kinetic energy is not.



Impulse equals momentum change. Increasing stopping time for the same momentum change reduces average force. Identify external forces before applying momentum conservation.

Draw a free-body diagram containing only forces on the selected object. For spring measurements, add loads in steps within the elastic range and measure extension from the unloaded position.

■ Checked worked case

Known: a 60 kg passenger slows from 10 to 0 metres per second in 0.50 s. $\Delta p = m(v-u) = 60(0-10) = -600$ kg metres per second. Average $F = \Delta p/\Delta t = -600/0.50 = -1{,}200$ N. The sign shows the force opposes the initial motion.

■ Common error

Balanced forces do not require the object to be at rest. Mass and weight have different units and meanings.

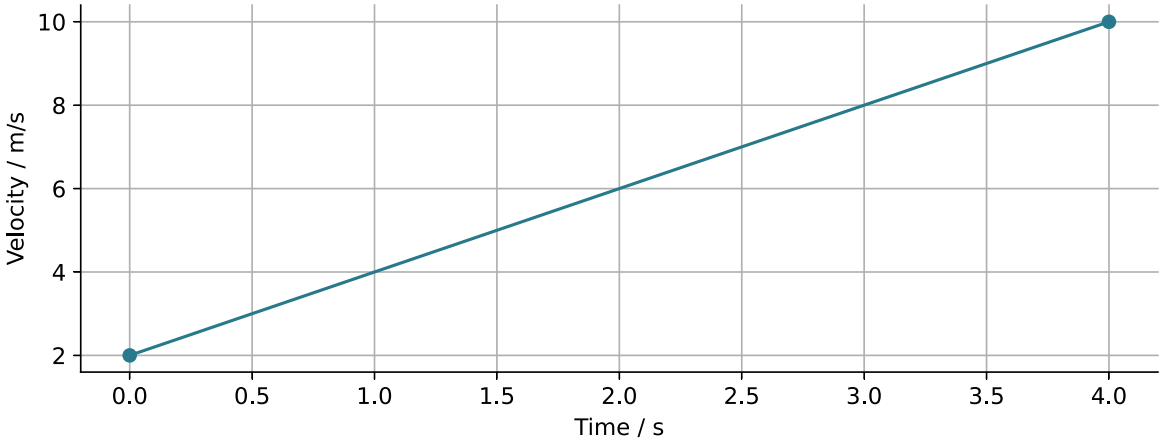
Motion graphs and acceleration

Official-unit focus: 4.5 Forces

A speedometer gives a reading at one moment. A journey average can hide stops and rapid changes in speed.

Displacement includes direction; distance counts total path length. Velocity is change in displacement per time. Acceleration is change in velocity per time.

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The gradient of a displacement-time graph is velocity. The area under a velocity-time graph gives displacement. A constant-acceleration formula is valid only when its assumption is justified.

Choose a positive direction and state it. Use a light gate or video with a known scale and frame interval for repeatable motion measurements. Avoid assuming hand timing is exact over very short intervals.

■ Checked worked case

Known: velocity rises uniformly from 2 to 10 metres per second in 4 s. a = (v-u)/t. a = (10-2)/4 = 2 metres per second squared. Displacement is trapezium area: s = (u+v)t/2 = (2+10)×4/2 = 24 m.

■ Common error

Negative velocity indicates direction under the chosen sign convention; it does not necessarily mean slowing down.

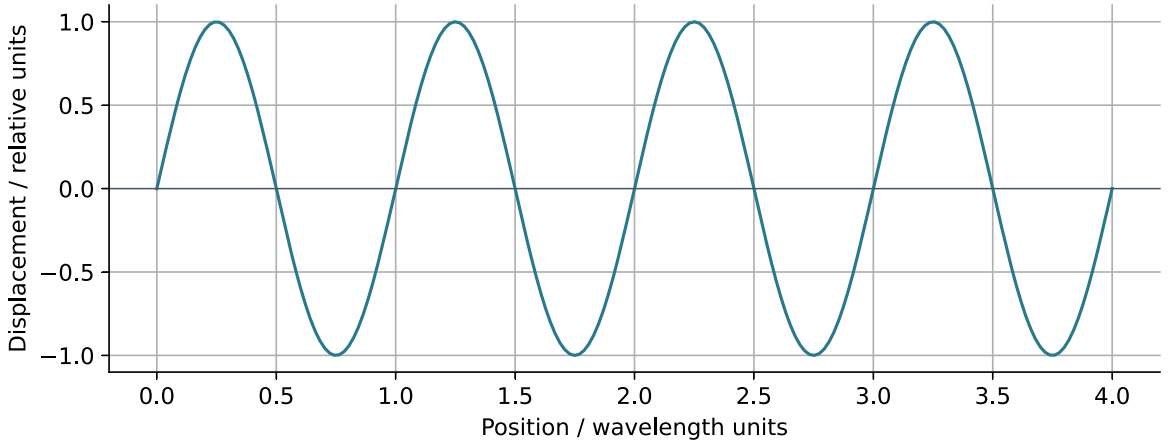
Waves, measurement and refraction

Official-unit focus: 4.6 Waves

A wave can carry energy across water while a floating marker mainly oscillates. Energy transfer and bulk transfer of matter are different.

Frequency is oscillations per time; wavelength is distance between successive points in phase. Wave speed equals frequency multiplied by wavelength. Transverse oscillations are perpendicular to propagation.

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At a boundary, frequency stays fixed by the source. A change of speed changes wavelength. Refraction follows from speed differences; angles are measured from the normal.

Measure several wavelengths and divide to reduce fractional reading uncertainty. Use a ray box with a normal drawn at the boundary. Keep the beam away from eyes and record incident and refracted angles clearly.

■ Checked worked case

Known: frequency 5 Hz and wavelength 0.40 m. Use $v = f\lambda$. $v = 5 \times 0.40 = 2.0$ metres per second. If speed falls to 1.5 metres per second at the same frequency, wavelength $= v/f = 1.5/5 = 0.30$ m.

■ Common error

The wave frequency does not change simply because the medium changes. A longitudinal wave has oscillations parallel to propagation.

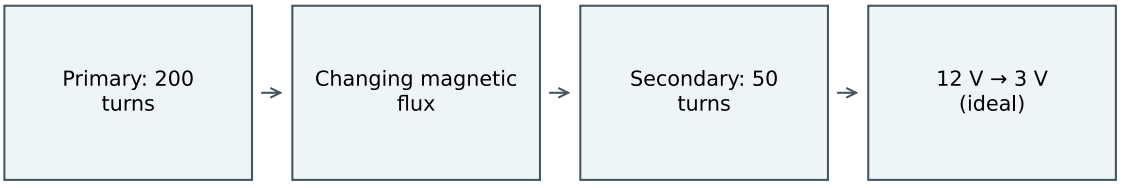
Fields, motors and induction

Official-unit focus: 4.7 Magnetism and electromagnetism

A magnet beside a wire does not always produce a current. An induced electromotive force depends on changing magnetic flux linkage.

A field describes a force effect at positions in space. A current-carrying conductor in a magnetic field can experience a force. Electromagnetic induction occurs when magnetic flux linkage changes.

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Changing field strength, coil area, orientation or relative motion can change flux linkage. Lenz law describes an induced effect opposing the change producing it, consistent with energy conservation.

Use a coil and sensitive meter to compare magnet motion in each direction. Record that a stationary arrangement gives no induced signal. Use approved low-voltage supplies for motor demonstrations.

■ Checked worked case

Known: a transformer has 200 primary turns, 50 secondary turns and 12 V primary voltage. For an ideal transformer, Vs/Vp = Ns/Np. Vs = Vp Ns/Np = 12×50/200 = 3.0 V. Real transformers also dissipate energy.

■ Common error

A transformer needs changing magnetic flux; a steady DC input does not provide continuous transformer action. Magnetic field direction is not automatically the direction of force.

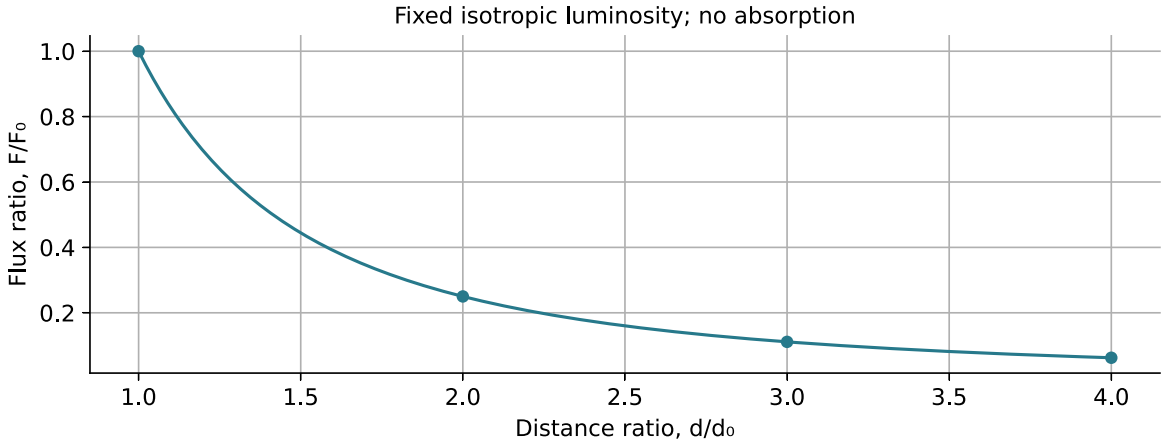
Stars, radiation and scale

Official-unit focus: 4.8 Space physics (physics only)

Two stars can have the same apparent brightness while having different luminosities. Distance changes the flux reaching an observer.

Stars transfer energy through nuclear fusion. A star life cycle depends on its initial mass. Light spectra and redshift provide evidence used in models of the universe.

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For isotropic emission without absorption, flux follows an inverse-square relationship with distance. Observed brightness alone therefore cannot establish luminosity.

Compare source observations with the life-cycle model and identify the relevant initial mass. State limitations of evidence rather than treating a model diagram as a direct observation of one star whole lifetime.

■ Checked worked case

Known: distance doubles while luminosity remains fixed. Use F proportional to $1/d^2$. Flux ratio $= 1/2^2 = 1/4$. A flux of 12 units becomes 3 units. This assumes no change in absorption or source output.

■ Common error

The Sun is not expected to become a supernova. Redshift can support cosmological expansion; it does not mean every nearby object must move away from every observer.

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