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OCR GCSE (9-1) GATEWAY SCIENCE PHYSICS A J249

FOUNDATION + HIGHER

EQUATIONS, METHODS & PRACTICAL-MATHS HANDBOOK

Current equation-sheet regime + formula selection + units + PAG calculation toolkit

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Current equation-sheet regime

Do not revise as if this were 2019

OCR confirms that J249 students receive a revised equation sheet containing all Physics equations in 2027, and equation sheets continue from 2028 for the lifetime of the current specification. Students still need to recognise symbols, choose the correct relationship, rearrange, convert units and explain the physics.

The J249 specification distinguishes “recall and apply” and “select and apply” relationships, and marks Higher-only content in bold. OCR also marks some equations as separate-Physics-only relative to Combined Science.

Density - PM1.1i

Scope	Relationship / equation	Typical unit
Both	rho = m / V	kg/m^3

Selection/check: Convert volume units before substitution; rearrange only after identifying the target.

Original worked example: A sample has mass 0.72 kg and volume 3.0e-4 m^3. rho = 0.72 / 0.00030 = 2400 kg/m^3.

Distance, speed, time - PM2.1i

Scope	Relationship / equation	Typical unit
Both	s = v t	m, m/s, s

Selection/check: Match the distance and time interval; do not confuse displacement with distance.

Acceleration - PM2.1ii

Scope	Relationship / equation	Typical unit
Both	a = (v-u)/t	m/s^2

Selection/check: Velocity can be negative; keep direction/sign consistent.

Original worked example: Velocity changes from 4 m/s to 16 m/s in 3 s. a = (16-4)/3 = 4.0 m/s^2.

Kinetic energy - PM2.1iv

Scope	Relationship / equation	Typical unit
Both	E = 1/2 m v^2	J

Selection/check: Square the speed, not the mass; convert g to kg.

Original worked example: For m=1.5 kg and v=8 m/s: E = 0.5 x 1.5 x 8^2 = 48 J.

Newton II - PM2.2i

Scope	Relationship / equation	Typical unit
Both	F = m a	N

Selection/check: Use resultant force, not one individual force, when applying F=ma.

Original worked example: A 6 kg trolley accelerates at 2.5 m/s^2: resultant F = 6 x 2.5 = 15 N.

Momentum - PM2.2ii

Scope	Relationship / equation	Typical unit
Higher	p = m v	kg m/s

Selection/check: Choose a positive direction for collision problems.

Original worked example: A 0.20 kg ball moving at -12 m/s has p = -2.4 kg m/s relative to the chosen positive direction.

Work done - PM2.2iii

Scope	Relationship / equation	Typical unit
Both	W = F s	J

Selection/check: Distance must be along the force direction.

Power - PM2.2iv

Scope	Relationship / equation	Typical unit
Both	P = W/t	W

Selection/check: Power is rate, not total energy.

Hooke law - PM2.3i

Scope	Relationship / equation	Typical unit
Both	F = k x	N

Selection/check: x is extension, not total spring length.

Weight - PM2.3iii

Scope	Relationship / equation	Typical unit
Both	W = m g	N

Selection/check: Mass in kg; g in N/kg.

GPE - PM2.3iv

Scope	Relationship / equation	Typical unit
Both	E = m g h	J

Selection/check: Use change in vertical height.

Pressure - PM2.3v

Scope	Relationship / equation	Typical unit
Separate Physics	p = F/A	Pa

Selection/check: Use normal force and area in m^2.

Moment - PM2.3vi

Scope	Relationship / equation	Typical unit
Separate Physics	M = F d	N m

Selection/check: d is perpendicular distance from pivot to line of action.

Charge flow - PM3.1i

Scope	Relationship / equation	Typical unit
Both	Q = I t	C

Selection/check: Convert mA to A and minutes to seconds.

Original worked example: A current of 0.40 A flows for 150 s: Q = 0.40 x 150 = 60 C.

Ohm relationship - PM3.2i

Scope	Relationship / equation	Typical unit

Both	V = I R	V

Selection/check: Select the p.d. across the same component whose current is used.

Electrical energy - PM3.2ii

Scope	Relationship / equation	Typical unit
Both	E = Q V	J

Selection/check: Do not confuse energy with power.

Electrical power - PM3.2iii

Scope	Relationship / equation	Typical unit
Both	P = V I; P = I^2 R	W

Selection/check: Choose the form that matches known quantities.

Electrical energy - PM3.2iv

Scope	Relationship / equation	Typical unit
Both	E = P t	J

Selection/check: Use seconds when power is in watts.

Wave speed - PM5.1i

Scope	Relationship / equation	Typical unit
Both	v = f lambda	m/s

Selection/check: Frequency does not necessarily change at a boundary; units matter.

Original worked example: A 250 Hz wave has wavelength 1.36 m: v = 250 x 1.36 = 340 m/s.

Efficiency - PM7.2i

Scope	Relationship / equation	Typical unit
Both	efficiency = useful output / total input	unitless or %

Selection/check: Useful divided by total, not by wasted.

Thermal energy - PM1.2i

Scope	Relationship / equation	Typical unit
Both	Delta E = m c Delta theta	J

Selection/check: Use temperature change, not final temperature.

Original worked example: A 2.0 kg object with c=900 J/kg C warms by 15 C: DeltaE = 2.0 x 900 x 15 = 27000 J.

Latent heat - PM1.2ii

Scope	Relationship / equation	Typical unit
Both	E = m L	J

Selection/check: No temperature change during ideal state change.

Gas pressure-volume - PM1.3i

Scope	Relationship / equation	Typical unit
Separate Physics	pV = constant	Pa m^3

Selection/check: Same mass of gas, constant temperature.

Liquid pressure - PM1.3ii

Scope	Relationship / equation	Typical unit
Higher Separate Physics	p = h rho g	Pa

Selection/check: Use vertical depth, density and g.

SUVAT relation - PM2.1iii

Scope	Relationship / equation	Typical unit
Both	v^2-u^2 = 2 a s	SI

Selection/check: Keep signed acceleration/displacement consistent.

Elastic energy - PM2.3ii

Scope	Relationship / equation	Typical unit
Both	E = 1/2 k x^2	J

Selection/check: Square extension in metres.

Motor effect - PM4.2i

Scope	Relationship / equation	Typical unit
Higher	F = B I l	N

Selection/check: Applies when conductor is at right angles to magnetic field.

Original worked example: For B=0.25 T, I=3.0 A and l=0.40 m at right angles: F = 0.25 x 3.0 x 0.40 = 0.30 N.

Transformer turns - PM4.2ii

Scope	Relationship / equation	Typical unit
Higher Separate Physics	Vp/Vs = Np/Ns	ratio

Selection/check: Label primary/secondary before substitution.

Ideal transformer power - PM8.2i

Scope	Relationship / equation	Typical unit
Both	Vp Ip = Vs Is	W

Selection/check: Ideal model: input power = output power.

Unit and graph control

- Length: mm/cm -> m before SI substitution; area and volume factors must be squared/cubed.
- Mass: g -> kg. Time: min/h -> s when equations use SI.
- Prefixes: milli 10^-3, micro 10^-6, kilo 10^3, mega 10^6.
- Gradient units are y-unit divided by x-unit; use that to identify physical meaning.
- For significant figures, carry extra digits through intermediate steps and round only the final answer.

PAG calculation toolkit

PAG P1 Materials

Measure mass/volume appropriately; use displacement for irregular solids; calculate density; evaluate uncertainty.

PAG P2 Forces

Control mass or force as appropriate; measure extension or motion; plot/interpret graphs; identify proportional and non-linear regions.

PAG P3 Electric circuits

Correct ammeter/voltmeter placement; vary p.d.; collect paired V-I data; calculate resistance and interpret curves.

PAG P4 Waves

Measure wavelength/frequency or angles; use normal lines and repeat measurements; process graphical or calculated results.

PAG P5 Radioactivity

Measure count rate, correct for background where appropriate, control distance/time and apply safe handling principles.

PAG P6 Energy

Measure temperature/energy/time; control insulation or material variables; analyse rates/efficiency and losses.

PAG P7 Forces and pressure

Measure force/area/distance or pressure variables; use perpendicular distance and appropriate units.

PAG P8 Global challenges

Apply a suitable method to vehicle, energy or space-context data; evaluate evidence, risk and limitations.

Equation-selection drill

Prompt	Method choice
A spring is 0.12 m longer under a 6 N load. What relationship?	F = kx; extension is the measured change in length.
A pulse travels to a wall and back in 0.80 s at 340 m/s. What extra reasoning?	Use d=vt but halve the round-trip distance/time relationship to obtain one-way distance.
A gas changes pressure and volume at constant temperature.	pV = constant - this is a separate-Physics-only relationship in J249.
An ideal transformer question gives primary voltage/current and secondary voltage.	Use VpIp = VsIs if solving power/current; turns ratio is a Higher separate-Physics relationship.

References and evidence base

Accessed 12 November 2026. Specification mappings, boundaries, results statistics, equation-sheet policy and examiner-evidence labels were checked against the sources below. The diagnostic handbook does not invent error-frequency percentages where OCR has not published them.

[SPEC] OCR GCSE (9-1) Gateway Science Physics A J249 Specification, Version 4.2 (February 2024)
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https://www.ocr.org.uk/administration/support-and-tools/subject-updates/maths-science-ofqual-update-758751/

[MATH26] OCR mathematical skills handbook update for GCSE sciences
https://www.ocr.org.uk/administration/support-and-tools/subject-updates/gcse-sciences-maths-handbook-750981/