



National
Qualifications
2021 ASSESSMENT RESOURCE

X857/77/11

**Physics
Relationships sheet**

Duration — 3 hours



Relationships required for Physics Advanced Higher

$$v = \frac{ds}{dt}$$

$$a = \frac{dv}{dt} = \frac{d^2s}{dt^2}$$

$$v = u + at$$

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

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

$$\omega = \frac{d\theta}{dt}$$

$$\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}$$

$$\omega = \omega_o + \alpha t$$

$$\omega^2 = \omega_o^2 + 2\alpha\theta$$

$$\theta = \omega_o t + \frac{1}{2}\alpha t^2$$

$$s = r\theta$$

$$v = r\omega$$

$$a_t = r\alpha$$

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

$$\omega = 2\pi f$$

$$a_r = \frac{v^2}{r} = r\omega^2$$

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

$$I = \sum mr^2$$

$$\tau = Fr$$

$$\tau = I\alpha$$

$$L = mvr = mr^2\omega$$

$$L = I\omega$$

$$E_{k(\text{rotational})} = \frac{1}{2}I\omega^2$$

$$E_P = E_{k(\text{translational})} + E_{k(\text{rotational})}$$

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

$$F = \frac{GMm}{r^2} = \frac{mv^2}{r} = mr\omega^2 = mr\left(\frac{2\pi}{T}\right)^2$$

$$V = -\frac{GM}{r}$$

$$E_P = Vm = -\frac{GMm}{r}$$

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

$$r_{\text{Schwarzschild}} = \frac{2GM}{c^2}$$

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

$$\frac{P}{A} = \sigma T^4$$

$$L = 4\pi r^2 \sigma T^4$$

$$E = hf$$

$$mvr = \frac{nh}{2\pi}$$

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

$$\Delta x \Delta p_x \geq \frac{h}{4\pi}$$

$$\Delta E \Delta t \geq \frac{h}{4\pi}$$

$$F = qvB$$

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

$$F = -ky$$

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

$$a = \frac{d^2 y}{dt^2} = -\omega^2 y$$

$$y = A \cos \omega t \quad \text{or} \quad y = A \sin \omega t$$

$$v = \pm \omega \sqrt{(A^2 - y^2)}$$

$$E_k = \frac{1}{2} m \omega^2 (A^2 - y^2)$$

$$E_p = \frac{1}{2} m \omega^2 y^2$$

$$E = kA^2$$

$$y = A \sin 2\pi \left(ft - \frac{x}{\lambda} \right)$$

$$\phi = \frac{2\pi x}{\lambda}$$

$$opd = n \times gpd$$

$$opd = m\lambda \quad \text{or} \quad \left(m + \frac{1}{2} \right) \lambda \quad \text{where } m = 0, 1, 2, \dots$$

$$\Delta x = \frac{\lambda l}{2d}$$

$$d = \frac{\lambda}{4n}$$

$$\Delta x = \frac{\lambda D}{d}$$

$$n = \tan i_p$$

$$F = \frac{Q_1 Q_2}{4\pi \epsilon_0 r^2}$$

$$V = \frac{Q}{4\pi \epsilon_0 r}$$

$$E = \frac{Q}{4\pi \epsilon_0 r^2}$$

$$F = QE$$

$$V = Ed$$

$$W = QV$$

$$E_k = \frac{1}{2} mv^2$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$F = IlB \sin \theta$$

$$F = qvB$$

$$\tau = RC$$

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

$$X_C = \frac{1}{2\pi fC}$$

$$\varepsilon = -L \frac{dI}{dt}$$

$$E = \frac{1}{2} LI^2$$

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

$$X_L = 2\pi fL$$

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

$$\Delta W = \sqrt{\Delta X^2 + \Delta Y^2 + \Delta Z^2}$$

$$\frac{\Delta W}{W} = \sqrt{\left(\frac{\Delta X}{X} \right)^2 + \left(\frac{\Delta Y}{Y} \right)^2 + \left(\frac{\Delta Z}{Z} \right)^2}$$

$$\left(\frac{\Delta W^n}{W^n} \right) = n \left(\frac{\Delta W}{W} \right)$$

$$d = \bar{v}t$$

$$s = \bar{v}t$$

$$v = u + at$$

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

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

$$s = \frac{1}{2}(u + v)t$$

$$W = mg$$

$$F = ma$$

$$E_W = Fd$$

$$E_P = mgh$$

$$E_K = \frac{1}{2}mv^2$$

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

$$p = mv$$

$$Ft = mv - mu$$

$$F = G \frac{Mm}{r^2}$$

$$t' = \frac{t}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}$$

$$l' = l\sqrt{1 - \left(\frac{v}{c}\right)^2}$$

$$f_o = f_s \left(\frac{v}{v \pm v_s} \right)$$

$$z = \frac{\lambda_{\text{observed}} - \lambda_{\text{rest}}}{\lambda_{\text{rest}}}$$

$$z = \frac{v}{c}$$

$$v = H_0 d$$

$$W = QV$$

$$E = mc^2$$

$$E = hf$$

$$E_K = hf - hf_0$$

$$E_2 - E_1 = hf$$

$$T = \frac{1}{f}$$

$$v = f\lambda$$

$$d \sin \theta = m\lambda$$

$$n = \frac{\sin \theta_1}{\sin \theta_2}$$

$$\frac{\sin \theta_1}{\sin \theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$$

$$\sin \theta_c = \frac{1}{n}$$

$$I = \frac{k}{d^2}$$

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

$$V_{\text{peak}} = \sqrt{2}V_{\text{rms}}$$

$$I_{\text{peak}} = \sqrt{2}I_{\text{rms}}$$

$$Q = It$$

$$V = IR$$

$$P = IV = I^2 R = \frac{V^2}{R}$$

$$R_T = R_1 + R_2 + \dots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$E = V + Ir$$

$$V_1 = \left(\frac{R_1}{R_1 + R_2} \right) V_S$$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

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

$$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2} \frac{Q^2}{C}$$

$$\text{path difference} = m\lambda \quad \text{or} \quad \left(m + \frac{1}{2}\right)\lambda \quad \text{where } m = 0, 1, 2, \dots$$

$$\text{random uncertainty} = \frac{\text{max. value} - \text{min. value}}{\text{number of values}}$$

Additional relationships

Circle

$$\text{circumference} = 2\pi r$$

$$\text{area} = \pi r^2$$

Sphere

$$\text{area} = 4\pi r^2$$

$$\text{volume} = \frac{4}{3}\pi r^3$$

Trigonometry

$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\sin^2 \theta + \cos^2 \theta = 1$$

Moment of inertia

point mass

$$I = mr^2$$

rod about centre

$$I = \frac{1}{12}ml^2$$

rod about end

$$I = \frac{1}{3}ml^2$$

disc about centre

$$I = \frac{1}{2}mr^2$$

sphere about centre

$$I = \frac{2}{5}mr^2$$

Table of standard derivatives

$f(x)$	$f'(x)$
$\sin ax$	$a \cos ax$
$\cos ax$	$-a \sin ax$

Table of standard integrals

$f(x)$	$\int f(x)dx$
$\sin ax$	$-\frac{1}{a}\cos ax + C$
$\cos ax$	$\frac{1}{a}\sin ax + C$

Electron arrangements of elements

Group 1 Group 2

(1)

1 H 1	4 He 2
Hydrogen	(2)
3 Li 2, 1	4 Be 2, 2
Lithium	Beryllium
11 Na 2, 8, 1	12 Mg 2, 8, 2
Sodium	Magnesium
19 K 2, 8, 8, 1	20 Ca 2, 8, 8, 2
Potassium	Calcium
37 Rb 2, 8, 18, 8, 1	38 Sr 2, 8, 18, 8, 2
Rubidium	Strontium
55 Cs 2, 8, 18, 18, 8, 1	56 Ba 2, 8, 18, 18, 8, 2
Caesium	Barium
87 Fr 2, 8, 18, 32, 18, 8, 1	88 Ra 2, 8, 18, 32, 18, 8, 2
Francium	Radium

Key

Atomic number
Symbol
Electron arrangement
Name

Transition elements

(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
21 Sc 2, 8, 9, 2	22 Ti 2, 8, 10, 2	23 V 2, 8, 11, 2	24 Cr 2, 8, 13, 1	25 Mn 2, 8, 13, 2	26 Fe 2, 8, 14, 2	27 Co 2, 8, 15, 2	28 Ni 2, 8, 16, 2	29 Cu 2, 8, 18, 1	30 Zn 2, 8, 18, 2
Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc
39 Y 2, 8, 18, 9, 2	40 Zr 2, 8, 18, 10, 2	41 Nb 2, 8, 18, 12, 1	42 Mo 2, 8, 18, 13, 1	43 Tc 2, 8, 18, 13, 2	44 Ru 2, 8, 18, 15, 1	45 Rh 2, 8, 18, 16, 1	46 Pd 2, 8, 18, 18, 0	47 Ag 2, 8, 18, 18, 1	48 Cd 2, 8, 18, 18, 2
Yttrium	Zirconium	Niobium	Molybdenum	Technetium	Ruthenium	Rhodium	Palladium	Silver	Cadmium
57 La 2, 8, 18, 18, 9, 2	72 Hf 2, 8, 18, 32, 10, 2	73 Ta 2, 8, 18, 32, 11, 2	74 W 2, 8, 18, 32, 12, 2	75 Re 2, 8, 18, 32, 13, 2	76 Os 2, 8, 18, 32, 14, 2	77 Ir 2, 8, 18, 32, 15, 2	78 Pt 2, 8, 18, 32, 17, 1	79 Au 2, 8, 18, 32, 18, 1	80 Hg 2, 8, 18, 32, 18, 2
Lanthanum	Hafnium	Tantalum	Tungsten	Rhenium	Osmium	Iridium	Platinum	Gold	Mercury
89 Ac 2, 8, 18, 32, 18, 9, 2	104 Rf 2, 8, 18, 32, 10, 2	105 Db 2, 8, 18, 32, 11, 2	106 Sg 2, 8, 18, 32, 12, 2	107 Bh 2, 8, 18, 32, 13, 2	108 Has 2, 8, 18, 32, 14, 2	109 Mt 2, 8, 18, 32, 15, 2	110 Ds 2, 8, 18, 32, 17, 1	111 Rg 2, 8, 18, 32, 18, 1	112 Cn 2, 8, 18, 32, 18, 2
Actinium	Rutherfordium	Dubnium	Seaborgium	Bohrium	Hassium	Meitnerium	Darmstadtium	Roentgenium	Copernicium

5 B 2, 3	6 C 2, 4	7 N 2, 5	8 O 2, 6	9 F 2, 7	10 Ne 2, 8
Boron	Carbon	Nitrogen	Oxygen	Fluorine	Neon
13 Al 2, 8, 3	14 Si 2, 8, 4	15 P 2, 8, 5	16 S 2, 8, 6	17 Cl 2, 8, 7	18 Ar 2, 8, 8
Aluminium	Silicon	Phosphorus	Sulfur	Chlorine	Argon
31 Ga 2, 8, 18, 3	32 Ge 2, 8, 18, 4	33 As 2, 8, 18, 5	34 Se 2, 8, 18, 6	35 Br 2, 8, 18, 7	36 Kr 2, 8, 18, 8
Gallium	Germanium	Arsenic	Selenium	Bromine	Krypton
49 In 2, 8, 18, 18, 3	50 Sn 2, 8, 18, 18, 4	51 Sb 2, 8, 18, 18, 5	52 Te 2, 8, 18, 18, 6	53 I 2, 8, 18, 18, 7	54 Xe 2, 8, 18, 18, 8
Indium	Tin	Antimony	Tellurium	Iodine	Xenon
81 Tl 2, 8, 18, 32, 18, 3	82 Pb 2, 8, 18, 32, 18, 4	83 Bi 2, 8, 18, 32, 18, 5	84 Po 2, 8, 18, 32, 18, 6	85 At 2, 8, 18, 32, 18, 7	86 Rn 2, 8, 18, 32, 18, 8
Thallium	Lead	Bismuth	Polonium	Astatine	Radon

Lanthanides

57 La 2, 8, 18, 18, 9, 2	58 Ce 2, 8, 18, 20, 8, 2	59 Pr 2, 8, 18, 21, 8, 2	60 Nd 2, 8, 18, 22, 8, 2	61 Pm 2, 8, 18, 23, 8, 2	62 Sm 2, 8, 18, 24, 8, 2	63 Eu 2, 8, 18, 25, 8, 2	64 Gd 2, 8, 18, 25, 9, 2	65 Tb 2, 8, 18, 27, 8, 2	66 Dy 2, 8, 18, 28, 8, 2	67 Ho 2, 8, 18, 29, 8, 2	68 Er 2, 8, 18, 30, 8, 2	69 Tm 2, 8, 18, 31, 8, 2	70 Yb 2, 8, 18, 32, 8, 2	71 Lu 2, 8, 18, 32, 9, 2
Lanthanum	Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium

Actinides

89 Ac 2, 8, 18, 32, 18, 9, 2	90 Th 2, 8, 18, 32, 18, 10, 2	91 Pa 2, 8, 18, 32, 20, 9, 2	92 U 2, 8, 18, 32, 21, 9, 2	93 Np 2, 8, 18, 32, 22, 9, 2	94 Pu 2, 8, 18, 32, 24, 8, 2	95 Am 2, 8, 18, 32, 25, 9, 2	96 Cm 2, 8, 18, 32, 25, 9, 2	97 Bk 2, 8, 18, 32, 27, 8, 2	98 Cf 2, 8, 18, 32, 28, 8, 2	99 Es 2, 8, 18, 32, 29, 8, 2	100 Fm 2, 8, 18, 32, 30, 8, 2	101 Md 2, 8, 18, 32, 31, 8, 2	102 No 2, 8, 18, 32, 32, 8, 2	103 Lr 2, 8, 18, 32, 32, 9, 2
Actinium	Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium

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