



National
Qualifications
2021 ASSESSMENT RESOURCE

X857/77/11

**Physics
Relationships sheet**

Duration — 3 hours



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Relationships required for Physics Advanced Higher

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

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

$$v = u + at$$

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

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

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

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

$$\omega = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha\theta$$

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$s = r\theta$$

$$v = r\omega$$

$$a_t = r\alpha$$

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

$$\omega = 2\pi f$$

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

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

$$I = \sum mr^2$$

$$\tau = Fr$$

$$\tau = I\alpha$$

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

$$L = I\omega$$

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

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

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

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

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

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

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

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

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

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

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

$$E = hf$$

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

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

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

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

$$F = qvB$$

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

$$F = -ky$$

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

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

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

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

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

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

$$E = kA^2$$

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

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

$$opd = n \times gpd$$

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

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

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

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

$$n = \tan i_p$$

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

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

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

$$F = QE$$

$$V = Ed$$

$$W = QV$$

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

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

$$F = IlB \sin \theta$$

$$F = qvB$$

$$\tau = RC$$

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

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

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

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

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

$$X_L = 2\pi fL$$

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

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

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

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

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

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

$$v = u + at$$

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

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

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

$$W = mg$$

$$F = ma$$

$$E_W = Fd$$

$$E_P = mgh$$

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

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

$$p = mv$$

$$Ft = mv - mu$$

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

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

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

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

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

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

$$v = H_0 d$$

$$W = QV$$

$$E = mc^2$$

$$E = hf$$

$$E_K = hf - hf_0$$

$$E_2 - E_1 = hf$$

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

$$v = f\lambda$$

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

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

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

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

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

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

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

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

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

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

$$Q = It$$

$$V = IR$$

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

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

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

$$E = V + Ir$$

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

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

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

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

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

Key

Atomic number
Symbol
Electron arrangement
Name

Transition elements

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

Lanthanides

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

Actinides

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

Group 3 Group 4 Group 5 Group 6 Group 7 Group 8 Group 9 Group 10
(18)

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

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