



National
Qualifications
2024

X857/77/11

**Physics
Relationships sheet**

THURSDAY, 25 APRIL
9:00 AM – 12:00 NOON



* X 8 5 7 7 7 1 1 *

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

Key

Atomic number
Symbol
Electron arrangement
Name

Transition elements

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

Group 3 Group 4 Group 5 Group 6 Group 7 Group 0

(18)

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

Lanthanides

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

Actinides

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

[BLANK PAGE]

DO NOT WRITE ON THIS PAGE

[BLANK PAGE]

DO NOT WRITE ON THIS PAGE