



National
Qualifications
2023

X857/77/11

**Physics
Relationships sheet**

WEDNESDAY, 17 MAY

9:00 AM – 12:00 NOON



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Relationships required for Physics Advanced Higher

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

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

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

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

$$v = u + at$$

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

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

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

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

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

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

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

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

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

$$\omega = \omega_o + at$$

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

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

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

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

$$s = r\theta$$

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

$$a_t = r\alpha$$

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

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

$$E = hf$$

$$\omega = 2\pi f$$

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

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

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

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

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

$$I = \sum mr^2$$

$$\tau = Fr$$

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

$$\tau = I\alpha$$

$$F = qvB$$

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

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

$$L = I\omega$$

$$F = -ky$$

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

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

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

$$F = QE$$

$$V = Ed$$

$$W = QV$$

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

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

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

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

$$F = IlB \sin \theta$$

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

$$F = qvB$$

$$E = kA^2$$

$$\tau = RC$$

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

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

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

$$X_C = \frac{1}{2\pi f C}$$

$$opd = n \times gpd$$

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

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

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

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

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

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

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

$$X_L = 2\pi f L$$

$$c = \frac{1}{\sqrt{\varepsilon_o \mu_o}}$$

$$n = \tan i_P$$

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

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

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

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

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

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

$d = \bar{v}t$	$W = QV$	$V_{peak} = \sqrt{2}V_{rms}$
$s = \bar{v}t$	$E = mc^2$	$I_{peak} = \sqrt{2}I_{rms}$
$v = u + at$	$E = hf$	$Q = It$
$s = ut + \frac{1}{2}at^2$	$E_K = hf - hf_0$	$V = IR$
$v^2 = u^2 + 2as$	$E_2 - E_1 = hf$	$P = IV = I^2R = \frac{V^2}{R}$
$s = \frac{1}{2}(u+v)t$	$T = \frac{1}{f}$	$R_T = R_1 + R_2 + \dots$
$W = mg$	$v = f\lambda$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$F = ma$	$d \sin \theta = m\lambda$	$E = V + Ir$
$E_W = Fd$	$n = \frac{\sin \theta_1}{\sin \theta_2}$	$V_1 = \left(\frac{R_1}{R_1 + R_2} \right) V_S$
$E_P = mgh$	$\frac{\sin \theta_1}{\sin \theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$	$\frac{V_1}{V_2} = \frac{R_1}{R_2}$
$E_K = \frac{1}{2}mv^2$	$\sin \theta_c = \frac{1}{n}$	$C = \frac{Q}{V}$
$P = \frac{E}{t}$	$I = \frac{k}{d^2}$	$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$
$p = mv$	$I = \frac{P}{A}$	path difference = $m\lambda$ or $\left(m + \frac{1}{2}\right)\lambda$ where $m = 0, 1, 2, \dots$
$Ft = mv - mu$	random uncertainty = $\frac{\text{max. value} - \text{min. value}}{\text{number of values}}$	
$F = G \frac{Mm}{r^2}$		
$t' = \frac{t}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}$		
$l' = l\sqrt{1 - \left(\frac{v}{c}\right)^2}$		
$f_o = f_s \left(\frac{v}{v \pm v_s} \right)$		
$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$		
$z = \frac{v}{c}$		
$v = H_0 d$		

Additional relationships

Circle

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

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

Sphere

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

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

Table of standard derivatives

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

Trigonometry

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

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

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

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

Table of standard integrals

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

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

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

Electron arrangements of elements

		Group 1		Group 2		Group 3		Group 4		Group 5		Group 6		Group 7		Group 0			
		(1)		(2)															
1 H	1 Hydrogen	3 Li	4 Be	2,1 Lithium	2,2 Beryllium	5 B	6 C	7 N	8 O	9 F	10 Ne	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
2,8,1 Sodium	2,8,2 Magnesium	2,8,9,1 Potassium	2,8,8,2 Calcium	2,8,9,2 Scandium	2,8,10,2 Titanium	2,8,11,2 Vanadium	2,8,13,1 Chromium	2,8,13,2 Manganese	2,8,14,2 Iron	2,8,15,2 Cobalt	2,8,16,2 Nickel	2,8,18,1 Copper	2,8,18,2 Zinc	2,8,18,3 Aluminium	2,8,18,4 Silicon	30 Phosphorus	31 Sulfur	32 Chlorine	33 Argon
2,8,8,1 Rubidium	2,8,18,8,2 Strontium	2,8,18,9,2 Yttrium	2,8,18,10,2 Zirconium	2,8,18,12,1 Niobium	2,8,18,13 Molybdenum	2,8,18,13 Technetium	2,8,18,15 Ruthenium	2,8,18,16 Rhodium	2,8,18,16 Palladium	2,8,18,18 Rhodium	2,8,18,18 Silver	2,8,18,18 Cadmium	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	
2,8,18,18,18, Cs 8,1 Caesium	2,8,18,18, Ba 8,2 Barium	2,8,18,18, La 9,2 Lanthanum	2,8,18,32, 10,2 Rutherfordium	2,8,18,12,2 Dubnium	2,8,18,32, 32,11,2 Seaborgium	2,8,18,32, 32,11,2 Bohrium	2,8,18,32, 32,12,2 Hassium	2,8,18,32, 32,14,2 Meitnerium	2,8,18,32, 32,15,2 Damstadtium	2,8,18,32, 32,17,1 Roentgenium	2,8,18,32, 32,18,1 Copernicium	2,8,18,32, 32,18,2 Rutherfordium	2,8,18,3 Aluminium	2,8,18,4 Silicon	2,8,18,5 Germanium	2,8,18,6 Arsenic	2,8,18,7 Selenium	2,8,18,8 Bromine	2,8,18,8 Krypton
2,8,18,32, 18,8,1 Francium	2,8,18,32, 18,8,2 Radium	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	2,8,18,22, 8,2 Promethium	2,8,18,23, 8,2 Samarium	2,8,18,24, 8,2 Europium	2,8,18,25, 8,2 Gadolinium	2,8,18,25, 8,2 Terbium	2,8,18,27, 8,2 Dysprosium	2,8,18,28, 8,2 Holmium	2,8,18,29, 8,2 Erbium	2,8,18,30, 8,2 Thulium	2,8,18,31, 8,2 Ytterbium	2,8,18,32, 8,2 Lutetium					
2,8,18,32, 18,9,2 Actinium	2,8,18,32, 18,10,2 Thorium	91 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	Proactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Rutherfordium	Lawrencium				

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