



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

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

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

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

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

$$v = u + at$$

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

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

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

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

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

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

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

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

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

$$\omega = \omega_o + at$$

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

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

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

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

$$s = r\theta$$

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

$$a_t = r\alpha$$

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

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

$$E = hf$$

$$\omega = 2\pi f$$

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

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

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

$$I = \sum mr^2$$

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

$$\tau = Fr$$

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

$$\tau = I\alpha$$

$$F = qvB$$

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

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

$$L = I\omega$$

$$F = -ky$$

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

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

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

$$F = QE$$

$$V = Ed$$

$$W = QV$$

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

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

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

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

$$F = IlB \sin \theta$$

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

$$F = qvB$$

$$E = kA^2$$

$$\tau = RC$$

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

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

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

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

$$opd = n \times gpd$$

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

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

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

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

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

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

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

$$X_L = 2\pi f L$$

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

$$n = \tan i_P$$

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

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

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

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

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

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

$d = \bar{v}t$	$W = QV$	$V_{peak} = \sqrt{2}V_{rms}$
$s = \bar{v}t$	$E = mc^2$	$I_{peak} = \sqrt{2}I_{rms}$
$v = u + at$	$E = hf$	$Q = It$
$s = ut + \frac{1}{2}at^2$	$E_K = hf - hf_0$	$V = IR$
$v^2 = u^2 + 2as$	$E_2 - E_1 = hf$	$P = IV = I^2R = \frac{V^2}{R}$
$s = \frac{1}{2}(u+v)t$	$T = \frac{1}{f}$	$R_T = R_1 + R_2 + \dots$
$W = mg$	$v = f\lambda$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$F = ma$	$d \sin \theta = m\lambda$	$E = V + Ir$
$E_W = Fd$	$n = \frac{\sin \theta_1}{\sin \theta_2}$	$V_1 = \left(\frac{R_1}{R_1 + R_2} \right) V_S$
$E_P = mgh$	$\frac{\sin \theta_1}{\sin \theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$	$\frac{V_1}{V_2} = \frac{R_1}{R_2}$
$E_K = \frac{1}{2}mv^2$	$\sin \theta_c = \frac{1}{n}$	$C = \frac{Q}{V}$
$P = \frac{E}{t}$	$I = \frac{k}{d^2}$	$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$
$p = mv$	$I = \frac{P}{A}$	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

Key		Periodic Table of Elements																														
		Atomic number		Symbol		Electron arrangement																										
				Name																												
1		Hydrogen		(2)		Electron arrangement																										
3	1	4	He	Li	B	2,1	2,2	Symbol																								
11	1	12	Neon	Na	Mg	2,8,1	2,8,2	Name																								
Sodium		Magnesium		(3)		(4)		(5)		(6)		(7)		(8)		(9)		(10)		(11)		(12)										
19	20	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Ni	28	Cu	29	Zn	30	Sulfur	Chlorine	Argon									
K	Ca	Sc	2,8,9,2	Ti	2,8,10,2	V	2,8,11,2	Cr	2,8,13,1	Mn	2,8,13,2	Fe	2,8,14,2	Ni	2,8,16,2	Cu	2,8,18,1	Zn	Sulfur	Chlorine	Argon	Helium	2									
Potassium		Calcium		Scandium		Titanium		Vanadium		Chromium		Manganese		Iron		Cobalt		Nickel		Copper		Zinc										
37	38	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Pd	46	Ag	47	Cd	48	Indium	Gallium	Krypton									
Rb	Sr	Y	2,8,18,9,2	Zr	2,8,18,18,10,2	Nb	2,8,18,18,12,1	Mo	2,8,18,13,1	Tc	2,8,18,13,2	Ru	2,8,18,15,1	Pd	2,8,18,18,18,0	Ag	2,8,18,18,18,1	Cd	2,8,18,18,18,2	Indium	Gallium	Krypton	2									
Rubidium		Strontium		Yttrium		Zirconium		Niobium		Molybdenum		Technetium		Ruthenium		Rhodium		Palladium		Cadmium		Silver										
55	56	57	La	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	Thallium	Antimony	Xenon								
Cs	Ba	La	2,8,18,18,8,1	Hf	2,8,18,32,9,2	Ta	2,8,18,18,10,2	W	2,8,18,32,32,11,2	Re	2,8,18,32,12,2	Os	2,8,18,32,13,2	Ir	2,8,18,32,14,2	Pt	2,8,18,32,15,2	Au	2,8,18,32,17,1	Hg	Thallium	Antimony	Xenon	2								
Cs		Barium		Lanthanum		Hafnium		Tantalum		Tungsten		Rhenium		Osmium		Iridium		Platinum		Gold		Mercury										
87	88	89	Fr	104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt	110	Ds	111	Rg	112	Cn	Thallium	Lead	Radon								
Fr		Radium		Actinium		Rutherfordium		Dubnium		Seaborgium		Bohrium		Hasström		Meitnerium		Darmstadtium		Roentgenium		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	72
Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
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Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
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Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99	Es	100	Md	101	No	102	Lr	103	Lu	2
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Actinides		89	Th	90	Pa	91	U	92	Np	93	Pu	94	Am	95	Fm	96	Cm	97	Bk	98	Cf	99</td										

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