



National
Qualifications
2022

X857/77/11

**Physics
Relationships sheet**

FRIDAY, 13 MAY

9:00 AM – 12:00 NOON



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Relationships required for Physics Advanced Higher

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

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

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

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

$$v = u + at$$

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

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

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

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

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

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

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

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

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

$$\omega = \omega_o + at$$

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

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

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

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

$$s = r\theta$$

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

$$a_t = r\alpha$$

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

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

$$E = hf$$

$$\omega = 2\pi f$$

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

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

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

$$I = \sum mr^2$$

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

$$\tau = Fr$$

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

$$\tau = I\alpha$$

$$F = qvB$$

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

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

$$L = I\omega$$

$$F = -ky$$

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

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

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

$$F = QE$$

$$V = Ed$$

$$W = QV$$

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

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

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

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

$$F = IlB \sin \theta$$

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

$$F = qvB$$

$$E = kA^2$$

$$\tau = RC$$

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

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

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

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

$$opd = n \times gpd$$

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

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

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

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

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

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

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

$$X_L = 2\pi f L$$

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

$$n = \tan i_P$$

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

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

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

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

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

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

$d = \bar{v}t$	$W = QV$	$V_{peak} = \sqrt{2}V_{rms}$
$s = \bar{v}t$	$E = mc^2$	$I_{peak} = \sqrt{2}I_{rms}$
$v = u + at$	$E = hf$	$Q = It$
$s = ut + \frac{1}{2}at^2$	$E_K = hf - hf_0$	$V = IR$
$v^2 = u^2 + 2as$	$E_2 - E_1 = hf$	$P = IV = I^2R = \frac{V^2}{R}$
$s = \frac{1}{2}(u+v)t$	$T = \frac{1}{f}$	$R_T = R_1 + R_2 + \dots$
$W = mg$	$v = f\lambda$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$F = ma$	$d \sin \theta = m\lambda$	$E = V + Ir$
$E_W = Fd$	$n = \frac{\sin \theta_1}{\sin \theta_2}$	$V_1 = \left(\frac{R_1}{R_1 + R_2} \right) V_S$
$E_P = mgh$	$\frac{\sin \theta_1}{\sin \theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$	$\frac{V_1}{V_2} = \frac{R_1}{R_2}$
$E_K = \frac{1}{2}mv^2$	$\sin \theta_c = \frac{1}{n}$	$C = \frac{Q}{V}$
$P = \frac{E}{t}$	$I = \frac{k}{d^2}$	$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$
$p = mv$	$I = \frac{P}{A}$	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	2,2	Lithium	2,8,1	Beryllium	2,8,2	Magnesium	2,8,1	Sodium	2,8,1	Hydrogen		
19	K	20	Ca	2,8,9,1	Sc	21	Ti	2,8,8,2	22	V	23	Cr	24	Mn	25	Fe	26	C		
Potassium	Calcium	Scandium	Titanium	Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Iron	2,8,11,2	2,8,13,1	2,8,13,2	2,8,14,2	2,8,15,2	2,8,16,2	2,8,17,1	2,8,18,2		
37	Rb	38	Sr	2,8,18,8,1	Y	39	Zr	2,8,18,8,2	40	Nb	41	Mo	42	Tc	43	Ru	44	Rh		
Rubidium	Strontium	Yttrium	Zirconium	Niobium	Molybdenum	Tantalum	Hafnium	Tungsten	Rhenium	Ruthenium	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	2,8,18,15,1	2,8,18,16,1	2,8,18,17,1	2,8,18,18,2	
55	Cs	56	Ba	2,8,18,18,8,1	La	57	Hf	2,8,18,18,8,2	72	Ta	73	W	74	Re	75	Os	76	Pt		
Caesium	Barium	Lanthanum	Hafnium	Tantalum	Tungsten	Rhenium	Osmium	Ruthenium	Rhenium	Tantalum	2,8,18,18,9,2	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
87	Fr	88	Ra	2,8,18,32,18,8,1	Ac	89	Rf	2,8,18,32,18,8,2	104	Db	105	Sg	106	Bh	107	Hs	108	Mt		
Francium	Radium	Actinium	Rutherfordium	Dubnium	Seaborgium	Bertrandium	Hassium	Metternium	Darmstadtium	Roentgenium	2,8,18,32,18,9,2	2,8,18,32,32,10,2	2,8,18,32,32,11,2	2,8,18,32,32,12,2	2,8,18,32,32,13,2	2,8,18,32,32,14,2	2,8,18,32,32,15,2	2,8,18,32,32,17,1	2,8,18,32,32,18,1	2,8,18,32,32,18,2
Key		Atomic number		Symbol		Electron arrangement		Name												
Transition elements																				
Lanthanides																				
Actinides																				
5	B	6	C	7	N	8	O	9	F	10	He	11	Ne	12	Ar	13	Kr			
13	Al	14	Si	15	P	16	S	17	Cl	18	He	19	Ne	20	Ar	21	Ar			
2,3	Carbon	2,4	2,5	2,6	2,7	2,6	2,7	2,7	2,8	2,8	Helium	10	Neon	2,8	Neon	2,8,8,8	Argon			
31	Ga	32	Ge	33	As	34	Se	35	Br	36	He	37	Ne	38	Ar	39	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
49	In	50	Sn	51	Sb	52	Te	53	I	54	He	55	Ne	56	Ar	57	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
81	Tl	82	Pb	83	Bi	84	Po	85	Rn	86	He	87	Ne	88	Ar	89	Radon			
2,8,18,32,18,3	Thallium	2,8,18,32,18,4	Bismuth	2,8,18,32,18,5	Polonium	2,8,18,32,18,6	Astatine	2,8,18,32,18,7	Radon	2,8,18,32,18,8	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Radon			
13	(13)	14	(14)	15	(15)	16	(16)	17	(17)	18	(18)	19	(19)	20	(20)	21	(21)			
13	Al	14	Si	15	P	16	S	17	Cl	18	He	19	Ne	20	Ar	21	Ar			
2,8,3	Aluminium	2,8,4	Silicon	2,8,5	Sulfur	2,8,6	Chlorine	2,8,7	Fluorine	2,8,8	Helium	10	Neon	2,8,8,8	Argon	2,8,8,8	Xenon			
31	Ga	32	Ge	33	As	34	Se	35	Br	36	He	37	Ne	38	Ar	39	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
49	In	50	Sn	51	Sb	52	Te	53	I	54	He	55	Ne	56	Ar	57	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
81	Tl	82	Pb	83	Bi	84	Po	85	Rn	86	He	87	Ne	88	Ar	89	Radon			
2,8,18,32,18,3	Thallium	2,8,18,32,18,4	Bismuth	2,8,18,32,18,5	Polonium	2,8,18,32,18,6	Astatine	2,8,18,32,18,7	Radon	2,8,18,32,18,8	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
13	(13)	14	(14)	15	(15)	16	(16)	17	(17)	18	(18)	19	(19)	20	(20)	21	(21)			
13	Al	14	Si	15	P	16	S	17	Cl	18	He	19	Ne	20	Ar	21	Ar			
2,3	Boron	2,4	Carbon	2,5	Nitrogen	2,6	Oxygen	2,7	Fluorine	2,8	Helium	10	Neon	2,8,8,8	Argon	2,8,8,8	Xenon			
31	Ga	32	Ge	33	As	34	Se	35	Br	36	He	37	Ne	38	Ar	39	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
49	In	50	Sn	51	Sb	52	Te	53	I	54	He	55	Ne	56	Ar	57	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
81	Tl	82	Pb	83	Bi	84	Po	85	Rn	86	He	87	Ne	88	Ar	89	Radon			
2,8,18,32,18,3	Thallium	2,8,18,32,18,4	Bismuth	2,8,18,32,18,5	Polonium	2,8,18,32,18,6	Astatine	2,8,18,32,18,7	Radon	2,8,18,32,18,8	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
13	(13)	14	(14)	15	(15)	16	(16)	17	(17)	18	(18)	19	(19)	20	(20)	21	(21)			
13	Al	14	Si	15	P	16	S	17	Cl	18	He	19	Ne	20	Ar	21	Ar			
2,3	Boron	2,4	Carbon	2,5	Nitrogen	2,6	Oxygen	2,7	Fluorine	2,8	Helium	10	Neon	2,8,8,8	Argon	2,8,8,8	Xenon			
31	Ga	32	Ge	33	As	34	Se	35	Br	36	He	37	Ne	38	Ar	39	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
49	In	50	Sn	51	Sb	52	Te	53	I	54	He	55	Ne	56	Ar	57	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
81	Tl	82	Pb	83	Bi	84	Po	85	Rn	86	He	87	Ne	88	Ar	89	Radon			
2,8,18,32,18,3	Thallium	2,8,18,32,18,4	Bismuth	2,8,18,32,18,5	Polonium	2,8,18,32,18,6	Astatine	2,8,18,32,18,7	Radon	2,8,18,32,18,8	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
13	(13)	14	(14)	15	(15)	16	(16)	17	(17)	18	(18)	19	(19)	20	(20)	21	(21)			
13	Al	14	Si	15	P	16	S	17	Cl	18	He	19	Ne	20	Ar	21	Ar			
2,3	Boron	2,4	Carbon	2,5	Nitrogen	2,6	Oxygen	2,7	Fluorine	2,8	Helium	10	Neon	2,8,8,8	Argon	2,8,8,8	Xenon			
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49	In	50	Sn	51	Sb	52	Te	53	I	54	He	55	Ne	56	Ar	57	Krypton			
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	Helium	18,8,8	Neon	2,8,18,8	Neon	2,8,18,8	Xenon			
81	Tl	82	Pb	83	Bi	84	Po	85	Rn	86	He	87	Ne	88	Ar	89	Radon			
2,8,18,32,18,3	Thallium	2,8,18,32,18,4	Bismuth	2,8,18,32,1																

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