



National
Qualifications
2019

X757/77/11

Physics
Relationships sheet

WEDNESDAY, 15 MAY

9:00 AM – 11:30 AM



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Relationships required for Physics Advanced Higher

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

$$E_K = \frac{1}{2} I \omega^2$$

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

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

$$v = u + at$$

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

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

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

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

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

$$v = \sqrt{\frac{2GM}{r}}$$

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

$$\text{apparent brightness, } b = \frac{L}{4\pi r^2}$$

$$\omega = \omega_o + at$$

$$\text{Power per unit area} = \sigma T^4$$

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

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

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

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

$$s = r\theta$$

$$E = hf$$

$$v = r\omega$$

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

$$a_t = r\alpha$$

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

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

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

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

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

$$T = Fr$$

$$T = I\alpha$$

$$F = qvB$$

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

$$\omega = 2\pi f$$

$$L = I\omega$$

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

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

$$F = IlB \sin \theta$$

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

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

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

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

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

$$t = RC$$

$$y = A \sin 2\pi(f t - \frac{x}{\lambda})$$

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

$$E = kA^2$$

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

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

$$\mathcal{E} = -L \frac{dI}{dt}$$

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

$$E = \frac{1}{2} L I^2$$

where $m = 0, 1, 2, \dots$

$$\text{optical path difference} = n \times \text{geometrical path difference}$$

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

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

$$X_L = 2\pi f L$$

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

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

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

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

$$n = \tan i_p$$

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

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

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

$$F = QE$$

$$V = Ed$$

$d = \bar{v}t$	$W = QV$	$V_{peak} = \sqrt{2}V_{rms}$
$s = \bar{v}t$	$E = mc^2$	$I_{peak} = \sqrt{2}I_{rms}$
$v = u + at$	$E = hf$	$Q = It$
$s = ut + \frac{1}{2}at^2$	$E_K = hf - hf_0$	$V = IR$
$v^2 = u^2 + 2as$	$E_2 - E_1 = hf$	$P = IV = I^2R = \frac{V^2}{R}$
$s = \frac{1}{2}(u+v)t$	$T = \frac{1}{f}$	$R_T = R_1 + R_2 + \dots$
$W = mg$	$v = f\lambda$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$F = ma$	$d \sin \theta = m\lambda$	$E = V + Ir$
$E_w = Fd$	$n = \frac{\sin \theta_1}{\sin \theta_2}$	$V_1 = \left(\frac{R_1}{R_1 + R_2} \right) V_s$
$E_p = mgh$	$\frac{\sin \theta_1}{\sin \theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$	$\frac{V_1}{V_2} = \frac{R_1}{R_2}$
$E_K = \frac{1}{2}mv^2$	$\sin \theta_c = \frac{1}{n}$	$C = \frac{Q}{V}$
$P = \frac{E}{t}$	$I = \frac{k}{d^2}$	$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$
$p = mv$	$I = \frac{P}{A}$	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)				(13)		(14)		(15)		(16)		(17)		(18)		
1	H	1	Hydrogen	3	Li	4	Be	5	B	6	C	7	N	8	O	9	F	2	He	
1		2,1	Lithium	2,1		2,2	Beryllium	2,3		2,4		2,5		2,6		2,7		2	Helium	
11	Na	12	Mg	12		13		13	Al	14	Si	15	P	16	S	17	Cl	18	Ne	
2,8,1		2,8,2	Magnesium	2,8,2		2,8,3		2,8,3		2,8,4		2,8,5		2,8,6		2,8,7		2,8,8	Neon	
19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Ni	28	Zn	
2,8,8,1		2,8,8,2	Calcium	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	30	
37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	
2,8,18,8,1		2,8,18,8,2	Rubidium	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		2,8,18,16,2	48	
55	Cs	56	Ba	57	La	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Pt	78	Phosphorus	
2,8,18,18,8,1		2,8,18,18,8,2	Baesium	2,8,18,18,9,2		2,8,18,10,2		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		30	Zinc	
87	Fr	88	Ra	89	Ac	104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt	110	Rg	
2,8,18,32,18,8,1		2,8,18,32,18,8,2	Radium	2,8,18,32,18,9,2		2,8,18,32,20,10,2		2,8,18,32,21,11,2		2,8,18,32,22,12,2		2,8,18,32,23,13,2		2,8,18,32,24,14,2		2,8,18,32,25,15,2		2,8,18,32,26,17,1	111	
Transition Elements																				
57	La	58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	
2,8,18,18,9,2		2,8,18,18,9,2	Cerium	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		2,8,18,27,8,2		2,8,18,27,8,2		2,8,18,28,8,2	67	Ho
89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu	95	Am	96	Cm	97	Bk	98	Cf	
2,8,18,32,18,9,2		2,8,18,32,18,10,2	Thorium	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	69	Tm
99		100		101		102		103		104		105		106		107		108		
Lanthanides																				
13	Al	14	Si	15	P	16	S	17	Cl	18	Ar	19	Ne	20	F	21	He	22		
2,8,3		2,8,4		2,8,5		2,8,6		2,8,7		2,8,8		2,8,9		2,8,10		2,8,11		2,8,12	2,8,13	
31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr	37	Xe	38	At	39	Rn	40		
2,8,18,3		2,8,18,4		2,8,18,5		2,8,18,6		2,8,18,7		2,8,18,8		2,8,18,9		2,8,18,10		2,8,18,11		2,8,18,12	41	
49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe	55		56		57		58		
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	42	
81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn	87		88		89		90		
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	43	
81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn	87		88		89		90		
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	44	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	45	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	46	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	47	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	48	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	49	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	50	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	51	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	52	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	53	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	54	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	55	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	56	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	57	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	58	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	59	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	60	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	61	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	62	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	63	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	64	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	65	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	66	
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		2,8,18,18,9		2,8,18,18,10		2,8,18,18,11		2,8,18,18,12	67	
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		2,8,18,1										

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