



National  
Qualifications  
2018

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X757/77/11

**Physics**  
**Relationships Sheet**

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TUESDAY, 8 MAY

9:00 AM – 11:30 AM

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# Relationships required for Physics Advanced Higher

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

$$L = I\omega$$

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

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

$$v = u + at$$

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

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

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

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

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

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

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

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

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

$$\omega = \omega_o + at$$

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

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

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

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

$$E = hf$$

$$s = r\theta$$

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

$$a_t = r\alpha$$

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

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

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

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

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

$$T = Fr$$

$$F = qvB$$

$$T = I\alpha$$

$$\omega = 2\pi f$$

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

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

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

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

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

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

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

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

$$t = RC$$

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

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

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

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

$$E = kA^2$$

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

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

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

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

$$\text{where } m = 0, 1, 2, \dots$$

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

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

$$X_L = 2\pi f L$$

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

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

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

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

$$n = \tan i_p$$

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

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

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

$$F = QE$$

$$V = Ed$$

$$F = IlB \sin \theta$$

$d = \bar{v}t$	$W = QV$	$V_{peak} = \sqrt{2}V_{rms}$
$s = \bar{v}t$	$E = mc^2$	$I_{peak} = \sqrt{2}I_{rms}$
$v = u + at$	$E = hf$	$Q = It$
$s = ut + \frac{1}{2}at^2$	$E_K = hf - hf_0$	$V = IR$
$v^2 = u^2 + 2as$	$E_2 - E_1 = hf$	$P = IV = I^2R = \frac{V^2}{R}$
$s = \frac{1}{2}(u+v)t$	$T = \frac{1}{f}$	$R_T = R_1 + R_2 + \dots$
$W = mg$	$v = f\lambda$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$F = ma$	$d \sin \theta = m\lambda$	$E = V + Ir$
$E_w = Fd$	$n = \frac{\sin \theta_1}{\sin \theta_2}$	$V_1 = \left( \frac{R_1}{R_1 + R_2} \right) V_s$
$E_p = mgh$	$\frac{\sin \theta_1}{\sin \theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$	$\frac{V_1}{V_2} = \frac{R_1}{R_2}$
$E_K = \frac{1}{2}mv^2$	$\sin \theta_c = \frac{1}{n}$	$C = \frac{Q}{V}$
$P = \frac{E}{t}$	$I = \frac{k}{d^2}$	$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$
$p = mv$	$I = \frac{P}{A}$	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	Transition Elements													
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)		
1	H	Hydrogen	1	2	3	4	5	6	7	8	9	10	11	He	
3	Li	Beryllium	2,1	Be	2,2		Boron	C	N	O	F	Ne	11	H	
11	Na	Sodium	2,8,1	Mg	2,8,2		Magnesium	Al	Si	P	S	Cl	Ar	13	
19	K	Calcium	2,8,8,1	Ca	2,8,8,2		Scandium	21	Ti	V	Mn	Fe	Co	Cr	5
21	Sc	Titanium	2,8,9,2	Ti	2,8,10,2		Vanadium	22	Cr	24	Mn	26	Ni	28	B
23		Chromium					Chromium	23	Fe	25	Fe	27	Cu	29	6
27	Potassium	Manganese					Manganese	24	Co	26	Co	28	Zn	30	C
37	Rb	Iron	2,8,8,1	Sr	2,8,8,2		Iron	25	Ni	27	Ni	29	Cu	30	N
39	Y	Nickel	2,8,18,9,2	Zr	2,8,18,10,2		Nickel	26	Cu	28	Cu	30	Zn	31	B
40		Cobalt					Cobalt	27	Zn	29	Zn	30	Al	14	5
41	Nb	Manganese					Manganese	28	As	31	As	33	Br	34	13
42	Mo	Titanium					Titanium	29	Ge	32	Ge	34	Kr	35	12
43	Tc	Vanadium					Vanadium	30	Se	33	Se	34		36	11
44	Ru	Chromium					Chromium	31	Br	34	Br	35		36	10
45	Rh	Manganese					Manganese	32	Ge	35	Ge	36		37	9
46	Pd	Iron					Iron	33	As	36	As	37		38	8
47	Ag	Nickel					Nickel	34	Se	37	Se	38		39	7
48	Cd	Cobalt					Cobalt	35	Br	38	Br	39		40	6
49	In	Manganese					Manganese	36	Kr	39	Kr	40		41	5
50	Sn	Titanium					Titanium	37		41		42		43	4
51	Sb	Vanadium					Vanadium	38	Gallium	42	Gallium	43		44	3
52	Te	Chromium					Chromium	39	Germanium	43	Germanium	44		45	2
53	I	Manganese					Manganese	40	Arsenic	44	Arsenic	45		46	1
54	Xe	Iron					Iron	41	Selenium	45	Selenium	46		47	0
55	La	Nickel					Nickel	42	Bromine	46	Bromine	47		48	-1
56	Ba	Cobalt					Cobalt	43	Bromine	47	Bromine	48		49	-2
57	Hf	Manganese					Manganese	44	Krypton	49	Krypton	50		51	-3
58	Ta	Titanium					Titanium	45		54		55		56	-4
59	W	Vanadium					Vanadium	46		54		55		56	-5
60	Re	Chromium					Chromium	47		54		55		56	-6
61	Os	Manganese					Manganese	48		54		55		56	-7
62	Ir	Titanium					Titanium	49		54		55		56	-8
63	Pt	Vanadium					Vanadium	50		54		55		56	-9
64	Dy	Chromium					Chromium	51		54		55		56	-10
65	Tb	Manganese					Manganese	52		54		55		56	-11
66	Ho	Titanium					Titanium	53		54		55		56	-12
67	Er	Vanadium					Vanadium	54		54		55		56	-13
68	Tm	Chromium					Chromium	55		54		55		56	-14
69	Yb	Manganese					Manganese	56		54		55		56	-15
70	Rn	Titanium					Titanium	57		54		55		56	-16
71	Lu	Vanadium					Vanadium	58		54		55		56	-17
72		Chromium					Chromium	59		54		55		56	-18
73		Manganese					Manganese	60		54		55		56	-19
74		Titanium					Titanium	61		54		55		56	-20
75		Vanadium					Vanadium	62		54		55		56	-21
76		Chromium					Chromium	63		54		55		56	-22
77		Manganese					Manganese	64		54		55		56	-23
78		Titanium					Titanium	65		54		55		56	-24
79		Vanadium					Vanadium	66		54		55		56	-25
80		Chromium					Chromium	67		54		55		56	-26
81		Manganese					Manganese	68		54		55		56	-27
82		Titanium					Titanium	69		54		55		56	-28
83		Vanadium					Vanadium	70		54		55		56	-29
84		Chromium					Chromium	71		54		55		56	-30
85		Manganese					Manganese	72		54		55		56	-31
86		Titanium					Titanium	73		54		55		56	-32
87		Vanadium					Vanadium	74		54		55		56	-33
88		Chromium					Chromium	75		54		55		56	-34
89		Manganese					Manganese	76		54		55		56	-35
90		Titanium					Titanium	77		54		55		56	-36
91		Vanadium					Vanadium	78		54		55		56	-37
92		Chromium					Chromium	79		54		55		56	-38
93		Manganese					Manganese	80		54		55		56	-39
94		Titanium					Titanium	81		54		55		56	-40
95		Vanadium					Vanadium	82		54		55		56	-41
96		Chromium					Chromium	83		54		55		56	-42
97		Manganese					Manganese	84		54		55		56	-43
98		Titanium					Titanium	85		54		55		56	-44
99		Vanadium					Vanadium	86		54		55		56	-45
100		Chromium					Chromium	87		54		55		56	-46
101		Manganese					Manganese	88		54		55		56	-47
102		Titanium					Titanium	89		54		55		56	-48
103		Vanadium					Vanadium	90		54		55		56	-49
104		Chromium					Chromium	91		54		55		56	-50
105		Manganese					Manganese	92		54		55		56	-51
106		Titanium					Titanium	93		54		55		56	-52
107		Vanadium					Vanadium	94		54		55		56	-53
108		Chromium					Chromium	95		54		55		56	-54
109		Manganese					Manganese	96		54		55		56	-55
110		Titanium					Titanium	97		54		55		56	-56
111		Vanadium					Vanadium	98		54		55		56	-57
112		Chromium					Chromium	99		54		55		56	-58
113		Manganese					Manganese	100		54		55		56	-59
114		Titanium					Titanium	101		54		55		56	-60
115		Vanadium					Vanadium	102		54		55		56	-61
116		Chromium					Chromium	103		54		55		56	-62
117		Manganese					Manganese	104		54		55		56	-63
118		Titanium					Titanium	105		54		55		56	-64
119		Vanadium					Vanadium	106		54		55		56	-65
120		Chromium					Chromium	107		54		55		56	-66
121		Manganese					Manganese	108		54		55		56	-67
122		Titanium					Titanium	109		54		55		56	-68
123		Vanadium					Vanadium	110		54		55		56	-69
124		Chromium					Chromium	111		54		55		56	-70
125		Manganese					Manganese	112		54		55		56	-71
126		Titanium					Titanium	113		54		55		56	-72
127		Vanadium					Vanadium	114		54		55		56	-73
128		Chromium					Chromium	115		54		55		56	-74
129		Manganese					Manganese	116		54		55		56	-75
130		Titanium					Titanium	117		54		55		56	-76
131		Vanadium					Vanadium	118		54		55		56	-77
132		Chromium					Chromium	119		54		55		56	-78
133		Manganese					Manganese	120		54		55		56	-79
134		Titanium					Titanium	121		54		55		56	-80
135		Vanadium					Vanadium	122		54		55		56	-81
136		Chromium					Chromium	123		54		55		56	-82
137		Manganese					Manganese	124		54		55		56	-83
138		Titanium					Titanium	125		54		55		56	-84
139		Vanadium					Vanadium	126		54		55		56	-85
140		Chromium					Chromium	127		54		55		56	-86
141		Manganese					Manganese	128		54		55		56	-87
142		Titanium					Titanium	129		54		55		56	-88
143		Vanadium					Vanadium	130		54		55		56	-89
144		Chromium					Chromium	131		54		55		56	-90
145		Manganese					Manganese	132		54		55		56	-91
146		Titanium					Titanium	133		54		55		56	-92
147		Vanadium					Vanadium	134		54		55		56	-93
148		Chromium					Chromium	135		54		55		56	-94
149		Manganese					Manganese	136		54		55		56	-95
150		Titanium					Titanium	137		54		55		56	-96
151		Vanadium					Vanadium	138		54		55		56	-97
152		Chromium					Chromium	139		54		55		56	-98
153		Manganese					Manganese	140		54	</td				

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