



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

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

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

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

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

$$v = u + at$$

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

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

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

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

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

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

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

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

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

$$\omega = \omega_o + \alpha t$$

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

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

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

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

$$E = hf$$

$$s = r\theta$$

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

$$v = r\omega$$

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

$$a_t = r\alpha$$

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

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

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

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

$$T = Fr$$

$$F = qvB$$

$$T = I\alpha$$

$$\omega = 2\pi f$$

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

$$L = I\omega$$

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

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

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

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

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

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

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

$$E = kA^2$$

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

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

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

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

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

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

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

$$n = \tan i_p$$

$$F = \frac{Q_1 Q_2}{4\pi \epsilon_0 r^2}$$

$$E = \frac{Q}{4\pi \epsilon_0 r^2}$$

$$V = \frac{Q}{4\pi \epsilon_0 r}$$

$$F = QE$$

$$V = Ed$$

$$F = IlB \sin \theta$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

$$t = RC$$

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

$$X_C = \frac{1}{2\pi fC}$$

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

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

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

$$X_L = 2\pi fL$$

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

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

$$d = \bar{v}t$$

$$s = \bar{v}t$$

$$v = u + at$$

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

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

$$s = \frac{1}{2}(u+v)t$$

$$W = mg$$

$$F = ma$$

$$E_w = Fd$$

$$E_p = mgh$$

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

$$P = \frac{E}{t}$$

$$p = mv$$

$$Ft = mv - mu$$

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

$$t' = \frac{t}{\sqrt{1 - (v/c)^2}}$$

$$l' = l\sqrt{1 - (v/c)^2}$$

$$f_o = f_s \left(\frac{v}{v \pm v_s} \right)$$

$$z = \frac{\lambda_{\text{observed}} - \lambda_{\text{rest}}}{\lambda_{\text{rest}}}$$

$$z = \frac{v}{c}$$

$$v = H_0d$$

$$W = QV$$

$$E = mc^2$$

$$E = hf$$

$$E_k = hf - hf_0$$

$$E_2 - E_1 = hf$$

$$T = \frac{1}{f}$$

$$v = f\lambda$$

$$d \sin \theta = m\lambda$$

$$n = \frac{\sin \theta_1}{\sin \theta_2}$$

$$\frac{\sin \theta_1}{\sin \theta_2} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$$

$$\sin \theta_c = \frac{1}{n}$$

$$I = \frac{k}{d^2}$$

$$I = \frac{P}{A}$$

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

$$\text{random uncertainty} = \frac{\text{max. value} - \text{min. value}}{\text{number of values}}$$

$$V_{\text{peak}} = \sqrt{2}V_{\text{rms}}$$

$$I_{\text{peak}} = \sqrt{2}I_{\text{rms}}$$

$$Q = It$$

$$V = IR$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$R_T = R_1 + R_2 + \dots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$E = V + Ir$$

$$V_1 = \left(\frac{R_1}{R_1 + R_2} \right) V_s$$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

$$C = \frac{Q}{V}$$

$$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2} \frac{Q^2}{C}$$

Additional Relationships

Circle

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

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

Sphere

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

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

Trigonometry

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

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

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

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

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

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

Table of standard derivatives

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

Table of standard integrals

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

Electron Arrangements of Elements

Group 1 Group 2
(1)

1	H	4	Be
Hydrogen	1	(2)	
3	Li	2,1	Be
Lithium	2,1	2,2	Beryllium
11	Na	12	Mg
2,8,1	2,8,1	2,8,2	
Sodium		Magnessium	
19	K	20	Ca
2,8,8,1	2,8,8,1	2,8,8,2	Calcium
Potassium			
37	Rb	38	Sr
2,8,18,8,1	2,8,18,8,1	2,8,18,8,2	Strontium
Rubidium			
55	Cs	56	Ba
2,8,18,18,8,1	2,8,18,18,8,1	2,8,18,18,8,2	Barium
Caesium			
87	Fr	88	Ra
2,8,18,32,18,8,1	2,8,18,32,18,8,1	2,8,18,32,18,8,2	Radium
Francium			

Key

Atomic number
Symbol
Electron arrangement
Name

Transition Elements

21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn
Scandium	2,8,9,2	Titanium	2,8,10,2	Vanadium	2,8,11,2	Chromium	2,8,13,1	Manganese	2,8,13,2	Iron	2,8,14,2	Cobalt	2,8,15,2	Nickel	2,8,16,2	Copper	2,8,18,1	Zinc	2,8,18,2
39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd
Yttrium	2,8,18,9,2	Zirconium	2,8,18,10,2	Niobium	2,8,18,12,1	Molybdenum	2,8,18,13,1	Technetium	2,8,18,13,2	Ruthenium	2,8,18,15,1	Rhodium	2,8,18,16,1	Palladium	2,8,18,18,0	Silver	2,8,18,18,1	Cadmium	2,8,18,18,2
57	La	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg
Lanthanum	2,8,18,18,9,2	Hafnium	2,8,18,32,10,2	Tantalum	2,8,18,32,11,2	Tungsten	2,8,18,32,12,2	Rhenium	2,8,18,32,13,2	Osmium	2,8,18,32,14,2	Iridium	2,8,18,32,15,2	Platinum	2,8,18,32,17,1	Gold	2,8,18,32,18,1	Mercury	2,8,18,32,18,2
89	Ac	104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt	110	Ds	111	Rg	112	Cn
Actinium	2,8,18,32,18,9,2	Rutherfordium	2,8,18,32,32,10,2	Dubnium	2,8,18,32,32,11,2	Seaborgium	2,8,18,32,32,12,2	Bohrium	2,8,18,32,32,13,2	Hassium	2,8,18,32,32,14,2	Meitnerium	2,8,18,32,32,15,2	Darmstadtium	2,8,18,32,32,17,1	Roentgenium	2,8,18,32,32,18,1	Copernicium	2,8,18,32,32,18,2

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
Lanthanum	2,8,18,18,9,2	Cerium	2,8,18,20,8,2	Praseodymium	2,8,18,21,8,2	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	2,8,18,25,9,2	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	2,8,18,32,9,2

Actinides

89	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
Actinium	2,8,18,32,18,9,2	Thorium	2,8,18,32,18,10,2	Protactinium	2,8,18,32,20,9,2	Uranium	2,8,18,32,21,9,2	Neptunium	2,8,18,32,22,9,2	Plutonium	2,8,18,32,24,8,2	Americium	2,8,18,32,25,8,2	Curium	2,8,18,32,25,9,2	Berkelium	2,8,18,32,27,8,2	Californium	2,8,18,32,28,8,2	Einsteinium	2,8,18,32,29,8,2	Fermium	2,8,18,32,30,8,2	Mendelevium	2,8,18,32,31,8,2	Nobelium	2,8,18,32,32,8,2	Lawrencium	2,8,18,32,32,9,2

Group 3 Group 4 Group 5 Group 6 Group 7 Group 8 Group 9 Group 10
(18)

5	B	6	C	7	N	8	O	9	F	10	Ne
2,3	Boron	2,4	Carbon	2,5	Nitrogen	2,6	Oxygen	2,7	Fluorine	2,8	Neon
13	Al	14	Si	15	P	16	S	17	Cl	18	Ar
2,8,3	Aluminium	2,8,4	Silicon	2,8,5	Phosphorus	2,8,6	Sulfur	2,8,7	Chlorine	2,8,8	Argon
31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr
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
49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe
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	Xenon
81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn
2,8,18,32,18,3	Thallium	2,8,18,32,18,4	Lead	2,8,18,32,18,5	Bismuth	2,8,18,32,18,6	Polonium	2,8,18,32,18,7	Astatine	2,8,18,32,18,8	Radon

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