



National  
Qualifications  
2016

**X757/77/11**

**Physics  
Relationships Sheet**

TUESDAY, 24 MAY  
9:00 AM – 11:30 AM

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## Relationships required for Physics Advanced Higher

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

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

$$v = u + at$$

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

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

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

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

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

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

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

$$s = r\theta$$

$$v = r\omega$$

$$a_t = r\alpha$$

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

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

$$T = Fr$$

$$T = I\alpha$$

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

$$L = I\omega$$

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

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

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

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

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

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

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

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

$$E = hf$$

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

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

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

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

$$F = qvB$$

$$\omega = 2\pi f$$

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

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

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

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

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

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

$$E = kA^2$$

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

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

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

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

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

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

$$n = \tan i_p$$

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

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

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

$$F = QE$$

$$V = Ed$$

$$F = IlB \sin \theta$$

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

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

$$t = RC$$

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

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

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

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

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

$$X_L = 2\pi fL$$

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

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

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

$$E_W = QV$$

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

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

$$E = mc^2$$

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

$$v = u + at$$

$$E = hf$$

$$Q = It$$

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

$$E_K = hf - hf_0$$

$$V = IR$$

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

$$E_2 - E_1 = hf$$

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

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

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

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

$$W = mg$$

$$v = f\lambda$$

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

$$F = ma$$

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

$$E = V + Ir$$

$$E_W = Fd$$

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

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

$$E_P = mgh$$

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

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

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

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

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

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

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

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

$$p = mv$$

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

$$Ft = mv - mu$$

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

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

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

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

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

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

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

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

$$v = H_0 d$$

## Additional Relationships

### Circle

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

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

### Sphere

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

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

### 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	2	3	4	5	6	7	0	Group
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Key

(18)

Atomic number	Symbol	Electron arrangement	Name
1	H	1	Hydrogen
2	He	2	Helium
3	Li	2, 1	Lithium
4	Be	2, 2	Beryllium
5	B	2, 2, 1	Boron
6	C	2, 2, 2	Carbon
7	N	2, 2, 2, 1	Nitrogen
8	O	2, 2, 2, 2	Oxygen
9	F	2, 2, 2, 2, 1	Fluorine
10	Ne	2, 2, 2, 2, 2	Neon
11	Na	2, 8, 1	Sodium
12	Mg	2, 8, 2	Magnesium
13	Al	2, 8, 3	Aluminium
14	Si	2, 8, 4	Silicon
15	P	2, 8, 5	Phosphorus
16	S	2, 8, 6	Sulphur
17	Cl	2, 8, 7	Chlorine
18	Ar	2, 8, 8	Argon
19	K	2, 8, 8, 1	Potassium
20	Ca	2, 8, 8, 2	Calcium
21	Sc	2, 8, 9, 2	Scandium
22	Ti	2, 8, 10, 2	Titanium
23	V	2, 8, 11, 2	Vanadium
24	Cr	2, 8, 13, 1	Chromium
25	Mn	2, 8, 13, 2	Manganese
26	Fe	2, 8, 14, 2	Iron
27	Co	2, 8, 15, 2	Cobalt
28	Ni	2, 8, 16, 2	Nickel
29	Cu	2, 8, 18, 1	Copper
30	Zn	2, 8, 18, 2	Zinc
31	Ga	2, 8, 18, 3	Gallium
32	Ge	2, 8, 18, 4	Germanium
33	As	2, 8, 18, 5	Arsenic
34	Se	2, 8, 18, 6	Selenium
35	Br	2, 8, 18, 7	Bromine
36	Kr	2, 8, 18, 8	Krypton
37	Rb	2, 8, 18, 8, 1	Rubidium
38	Sr	2, 8, 18, 8, 2	Strontium
39	Y	2, 8, 18, 9, 2	Yttrium
40	Zr	2, 8, 18, 10, 2	Zirconium
41	Nb	2, 8, 18, 12, 1	Niobium
42	Mo	2, 8, 18, 13, 1	Molybdenum
43	Tc	2, 8, 18, 13, 2	Technetium
44	Ru	2, 8, 18, 15, 1	Ruthenium
45	Rh	2, 8, 18, 16, 1	Rhodium
46	Pd	2, 8, 18, 18, 0	Palladium
47	Ag	2, 8, 18, 18, 1	Silver
48	Cd	2, 8, 18, 18, 2	Cadmium
49	In	2, 8, 18, 18, 3	Indium
50	Sn	2, 8, 18, 18, 4	Tin
51	Sb	2, 8, 18, 18, 5	Antimony
52	Te	2, 8, 18, 18, 6	Tellurium
53	I	2, 8, 18, 18, 7	Iodine
54	Xe	2, 8, 18, 18, 8	Xenon
55	Cs	2, 8, 18, 18, 8, 1	Caesium
56	Ba	2, 8, 18, 18, 8, 2	Barium
57	La	2, 8, 18, 18, 9, 2	Lanthanum
58	Ce	2, 8, 18, 18, 9, 2	Cerium
59	Pr	2, 8, 18, 18, 9, 2	Praseodymium
60	Nd	2, 8, 18, 18, 9, 2	Neodymium
61	Pm	2, 8, 18, 18, 9, 2	Promethium
62	Sm	2, 8, 18, 18, 9, 2	Samarium
63	Eu	2, 8, 18, 18, 9, 2	Europium
64	Gd	2, 8, 18, 18, 9, 2	Gadolinium
65	Tb	2, 8, 18, 18, 9, 2	Terbium
66	Dy	2, 8, 18, 18, 9, 2	Dysprosium
67	Ho	2, 8, 18, 18, 9, 2	Holmium
68	Er	2, 8, 18, 18, 9, 2	Erbium
69	Tm	2, 8, 18, 18, 9, 2	Thulium
70	Yb	2, 8, 18, 18, 9, 2	Ytterbium
71	Lu	2, 8, 18, 18, 9, 2	Lutetium
72	Hf	2, 8, 18, 18, 10, 2	Hafnium
73	Ta	2, 8, 18, 18, 10, 2	Tantalum
74	W	2, 8, 18, 18, 10, 2	Tungsten
75	Re	2, 8, 18, 18, 10, 2	Rhenium
76	Os	2, 8, 18, 18, 10, 2	Osmium
77	Ir	2, 8, 18, 18, 10, 2	Iridium
78	Pt	2, 8, 18, 18, 10, 2	Platinum
79	Au	2, 8, 18, 18, 10, 2	Gold
80	Hg	2, 8, 18, 18, 10, 2	Mercury
81	Tl	2, 8, 18, 18, 10, 2	Thallium
82	Pb	2, 8, 18, 18, 10, 2	Lead
83	Bi	2, 8, 18, 18, 10, 2	Bismuth
84	Po	2, 8, 18, 18, 10, 2	Polonium
85	At	2, 8, 18, 18, 10, 2	Astatine
86	Rn	2, 8, 18, 18, 10, 2	Radon
87	Fr	2, 8, 18, 18, 10, 2	Francium
88	Ra	2, 8, 18, 18, 10, 2	Radium

## Transition Elements

Atomic number	Symbol	Electron arrangement	Name
21	Sc	2, 8, 9, 2	Scandium
22	Ti	2, 8, 10, 2	Titanium
23	V	2, 8, 11, 2	Vanadium
24	Cr	2, 8, 13, 1	Chromium
25	Mn	2, 8, 13, 2	Manganese
26	Fe	2, 8, 14, 2	Iron
27	Co	2, 8, 15, 2	Cobalt
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29	Cu	2, 8, 18, 1	Copper
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43	Tc	2, 8, 18, 13, 2	Technetium
44	Ru	2, 8, 18, 15, 1	Ruthenium
45	Rh	2, 8, 18, 16, 1	Rhodium
46	Pd	2, 8, 18, 18, 0	Palladium
47	Ag	2, 8, 18, 18, 1	Silver
48	Cd	2, 8, 18, 18, 2	Cadmium
57	La	2, 8, 18, 18, 9, 2	Lanthanum
58	Ce	2, 8, 18, 18, 9, 2	Cerium
59	Pr	2, 8, 18, 18, 9, 2	Praseodymium
60	Nd	2, 8, 18, 18, 9, 2	Neodymium
61	Pm	2, 8, 18, 18, 9, 2	Promethium
62	Sm	2, 8, 18, 18, 9, 2	Samarium
63	Eu	2, 8, 18, 18, 9, 2	Europium
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81	Tl	2, 8, 18, 18, 10, 2	Thallium
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83	Bi	2, 8, 18, 18, 10, 2	Bismuth
84	Po	2, 8, 18, 18, 10, 2	Polonium
85	At	2, 8, 18, 18, 10, 2	Astatine
86	Rn	2, 8, 18, 18, 10, 2	Radon
87	Fr	2, 8, 18, 18, 10, 2	Francium
88	Ra	2, 8, 18, 18, 10, 2	Radium

## Lanthanides

## Actinides

57	La	2, 8, 18, 18, 9, 2	Lanthanum
58	Ce	2, 8, 18, 18, 9, 2	Cerium
59	Pr	2, 8, 18, 18, 9, 2	Praseodymium
60	Nd	2, 8, 18, 18, 9, 2	Neodymium
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66	Dy	2, 8, 18, 18, 9, 2	Dysprosium
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68	Er	2, 8, 18, 18, 9, 2	Erbium
69	Tm	2, 8, 18, 18, 9, 2	Thulium
70	Yb	2, 8, 18, 18, 9, 2	Ytterbium
71	Lu	2, 8, 18, 18, 9, 2	Lutetium
89	Ac	2, 8, 18, 18, 10, 2	Actinium
90	Th	2, 8, 18, 18, 10, 2	Thorium
91	Pa	2, 8, 18, 18, 10, 2	Protactinium
92	U	2, 8, 18, 18, 10, 2	Uranium
93	Np	2, 8, 18, 18, 10, 2	Neptunium
94	Pu	2, 8, 18, 18, 10, 2	Plutonium
95	Am	2, 8, 18, 18, 10, 2	Americium
96	Cm	2, 8, 18, 18, 10, 2	Curium
97	Bk	2, 8, 18, 18, 10, 2	Berkelium
98	Cf	2, 8, 18, 18, 10, 2	Californium
99	Es	2, 8, 18, 18, 10, 2	Einsteinium
100	Fm	2, 8, 18, 18, 10, 2	Fermium
101	Md	2, 8, 18, 18, 10, 2	Mendelevium
102	No	2, 8, 18, 18, 10, 2	Nobelium
103	Lr	2, 8, 18, 18, 10, 2	Lawrencium

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