



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
Group	1	2	3	4	5	6	7	0	Group

(1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18)

Group	1	2	3	4	5	6	7	0	Group
Group	1	2	3	4	5	6	7	0	Group
1	1	2	3	4	5	6	7	0	18
Hydrogen	H	He							Helium
2	1	2							
3	Li	Be							Neon
Lithium	2, 1	2, 2							2, 8
4									
5	Na	Mg							18
Sodium	2, 8, 1	2, 8, 2							Ar
6									2, 8, 8
7	K	Ca							Argon
Potassium	2, 8, 8, 1	2, 8, 8, 2							36
8									
9	Rb	Sr							Kr
Rubidium	2, 8, 18, 8, 1	2, 8, 18, 8, 2							2, 8, 18, 8
10									
11	Cs	Ba							86
Caesium	2, 8, 18, 8, 1	2, 8, 18, 8, 2							Rn
12									2, 8, 18, 32, 18, 8
13	Fr	Ra							Radon
Francium	2, 8, 18, 32, 18, 8, 1	2, 8, 18, 32, 18, 8, 2							

Atomic number	Symbol	Name
Electron arrangement		

## Transition Elements

Group	1	2	3	4	5	6	7	8	9	10	11	12
Group	1	2	3	4	5	6	7	8	9	10	11	12
13	21	22	23	24	25	26	27	28	29	30		
Scandium	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn		
2	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	2, 8, 18, 1	2, 8, 18, 2		
3	39	40	41	42	43	44	45	46	47	48		
Yttrium	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd		
4	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, 18, 0	2, 8, 18, 18, 1	2, 8, 18, 18, 2		
5	57	58	59	60	61	62	63	64	65	66		
Lanthanum	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy		
6	2, 8, 18, 18, 9, 2	2, 8, 18, 18, 8, 2	2, 8, 18, 20, 8, 2	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, 28, 8, 2		
7	89	90	91	92	93	94	95	96	97	98		
Actinium	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf		
8	2, 8, 18, 18, 9, 2	2, 8, 18, 18, 10, 2	2, 8, 18, 20, 8, 2	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, 28, 8, 2		

## Lanthanides

## Actinides

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Lanthanum	2, 8, 18, 18, 9, 2	2, 8, 18, 20, 8, 2	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, 28, 8, 2	2, 8, 18, 29, 8, 2	2, 8, 18, 30, 8, 2	2, 8, 18, 31, 8, 2	2, 8, 18, 32, 8, 2	2, 8, 18, 32, 9, 2
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
Actinium	2, 8, 18, 32, 18, 10, 2	2, 8, 18, 32, 18, 10, 2	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, 9, 2	2, 8, 18, 32, 27, 8, 2	2, 8, 18, 32, 28, 8, 2	2, 8, 18, 32, 29, 8, 2	2, 8, 18, 32, 30, 8, 2	2, 8, 18, 32, 31, 8, 2	2, 8, 18, 32, 32, 8, 2	2, 8, 18, 32, 32, 9, 2

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