AH

National
Qualifications
2021 ASSESSMENT RESOURCE

X857/77/11

**Physics
Relationships sheet**

Duration — 3 hours

Relationships required for Physics Advanced Higher

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

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

$$v = u + at$$

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

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

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

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

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

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

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

$$s = r\theta$$

$$v = r\omega$$

$$a_t = r\alpha$$

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

$$\omega = 2\pi f$$

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

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

$$I = \sum mr^2$$

$$\tau = Fr$$

$$\tau = I\alpha$$

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

$$L = I\omega$$

$$E_{k(rotational)} = \frac{1}{2}I\omega^2$$

$$E_P = E_{k(translational)} + E_{k(rotational)}$$

$$F = \frac{GMm}{r^2}$$

$$F = \frac{GMm}{r^2} = \frac{mv^2}{r} = mr\omega^2 = mr\left(\frac{2\pi}{T}\right)^2$$

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

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

$$v_{esc} = \sqrt{\frac{2GM}{r}}$$

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

$$b = \frac{L}{4\pi d^2}$$

$$\frac{P}{A} = \sigma T^4$$

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

$$E = hf$$

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

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

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

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

$$F = qvB$$

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

$$F = -ky$$

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

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

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

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

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

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

$$E = kA^2$$

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

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

$$opd = n \times gpd$$

$$opd = m\lambda \text{ or } \left(m + \frac{1}{2}\right)\lambda \text{ where } m = 0,1,2\ldots$$

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

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

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

$$n = \tan i_P$$

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

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

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

$$F = QE$$

$$V = Ed$$

$$W = QV$$

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

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

$$F = IlB\sin\theta$$

$$F = qvB$$

$$\tau = RC$$

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

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

$$\varepsilon = -L\frac{dI}{dt}$$

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

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

$$X_L = 2\pi fL$$

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

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

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

$$\left(\frac{\Delta W^n}{W^n}\right) = n\left(\frac{\Delta W}{W}\right)$$

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

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

$$v = u + at$$

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

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

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

$$W = mg$$

$$F = ma$$

$$E_W = Fd$$

$$E_P = mgh$$

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

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

$$p = mv$$

$$Ft = mv - mu$$

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

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

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

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

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

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

$$v = H_0 d$$

$$W = QV$$

$$E = mc^2$$

$$E = hf$$

$$E_K = hf - hf_0$$

$$E_2 - E_1 = hf$$

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

$$v = f\lambda$$

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

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

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

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

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

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

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

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

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

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

$$Q = It$$

$$V = IR$$

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

$$R_T = R_1 + R_2 + \ldots$$

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

$$E = V + Ir$$

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

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

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

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

Additional relationships

Circle

circumference $= 2\pi r$

area $= \pi r^2$

Sphere

area $= 4\pi r^2$

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

Trigonometry

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

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

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

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

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

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

Electron arrangements of elements

Key

Atomic number
Symbol
Electron arrangement
Name

Group 1 (1)

Atomic number	Symbol	Electron arrangement	Name
1	H	1	Hydrogen
3	Li	2,1	Lithium
11	Na	2,8,1	Sodium
19	K	2,8,8,1	Potassium
37	Rb	2,8,18,8,1	Rubidium
55	Cs	2,8,18,18,8,1	Caesium
87	Fr	2,8,18,32,18,8,1	Francium

Group 2 (2)

Atomic number	Symbol	Electron arrangement	Name
4	Be	2,2	Beryllium
12	Mg	2,8,2	Magnesium
20	Ca	2,8,8,2	Calcium
38	Sr	2,8,18,8,2	Strontium
56	Ba	2,8,18,18,8,2	Barium
88	Ra	2,8,18,32,18,8,2	Radium

Transition elements

Atomic number	Symbol	Electron arrangement	Name	Group
21	Sc	2,8,9,2	Scandium	(3)
39	Y	2,8,18,9,2	Yttrium	(3)
57	La	2,8,18,18,9,2	Lanthanum	(3)
89	Ac	2,8,18,32,18,9,2	Actinium	(3)
22	Ti	2,8,10,2	Titanium	(4)
40	Zr	2,8,18,10,2	Zirconium	(4)
72	Hf	2,8,18,32,10,2	Hafnium	(4)
104	Rf	2,8,18,32,32,10,2	Rutherfordium	(4)
23	V	2,8,11,2	Vanadium	(5)
41	Nb	2,8,18,12,1	Niobium	(5)
73	Ta	2,8,18,32,11,2	Tantalum	(5)
105	Db	2,8,18,32,32,11,2	Dubnium	(5)
24	Cr	2,8,13,1	Chromium	(6)
42	Mo	2,8,18,13,1	Molybdenum	(6)
74	W	2,8,18,32,12,2	Tungsten	(6)
106	Sg	2,8,18,32,32,12,2	Seaborgium	(6)
25	Mn	2,8,13,2	Manganese	(7)
43	Tc	2,8,18,13,2	Technetium	(7)
75	Re	2,8,18,32,13,2	Rhenium	(7)
107	Bh	2,8,18,32,32,13,2	Bohrium	(7)
26	Fe	2,8,14,2	Iron	(8)
44	Ru	2,8,18,15,1	Ruthenium	(8)
76	Os	2,8,18,32,14,2	Osmium	(8)
108	Hs	2,8,18,32,32,14,2	Hassium	(8)
27	Co	2,8,15,2	Cobalt	(9)
45	Rh	2,8,18,16,1	Rhodium	(9)
77	Ir	2,8,18,32,15,2	Iridium	(9)
109	Mt	2,8,18,32,32,15,2	Meitnerium	(9)
28	Ni	2,8,16,2	Nickel	(10)
46	Pd	2,8,18,18,0	Palladium	(10)
78	Pt	2,8,18,32,17,1	Platinum	(10)
110	Ds	2,8,18,32,32,17,1	Darmstadtium	(10)
29	Cu	2,8,18,1	Copper	(11)
47	Ag	2,8,18,18,1	Silver	(11)
79	Au	2,8,18,32,18,1	Gold	(11)
111	Rg	2,8,18,32,32,18,1	Roentgenium	(11)
30	Zn	2,8,18,2	Zinc	(12)
48	Cd	2,8,18,18,2	Cadmium	(12)
80	Hg	2,8,18,32,18,2	Mercury	(12)
112	Cn	2,8,18,32,32,18,2	Copernicium	(12)

Group 3 (13)

Atomic number	Symbol	Electron arrangement	Name
5	B	2,3	Boron
13	Al	2,8,3	Aluminium
31	Ga	2,8,18,3	Gallium
49	In	2,8,18,18,3	Indium
81	Tl	2,8,18,32,18,3	Thallium

Group 4 (14)

Atomic number	Symbol	Electron arrangement	Name
6	C	2,4	Carbon
14	Si	2,8,4	Silicon
32	Ge	2,8,18,4	Germanium
50	Sn	2,8,18,18,4	Tin
82	Pb	2,8,18,32,18,4	Lead

Group 5 (15)

Atomic number	Symbol	Electron arrangement	Name
7	N	2,5	Nitrogen
15	P	2,8,5	Phosphorus
33	As	2,8,18,5	Arsenic
51	Sb	2,8,18,18,5	Antimony
83	Bi	2,8,18,32,18,5	Bismuth

Group 6 (16)

Atomic number	Symbol	Electron arrangement	Name
8	O	2,6	Oxygen
16	S	2,8,6	Sulfur
34	Se	2,8,18,6	Selenium
52	Te	2,8,18,18,6	Tellurium
84	Po	2,8,18,32,18,6	Polonium

Group 7 (17)

Atomic number	Symbol	Electron arrangement	Name
9	F	2,7	Fluorine
17	Cl	2,8,7	Chlorine
35	Br	2,8,18,7	Bromine
53	I	2,8,18,18,7	Iodine
85	At	2,8,18,32,18,7	Astatine

Group 0 (18)

Atomic number	Symbol	Electron arrangement	Name
2	He	2	Helium
10	Ne	2,8	Neon
18	Ar	2,8,8	Argon
36	Kr	2,8,18,8	Krypton
54	Xe	2,8,18,18,8	Xenon
86	Rn	2,8,18,32,18,8	Radon

Lanthanides

Atomic number	Symbol	Electron arrangement	Name
57	La	2,8,18,18,9,2	Lanthanum
58	Ce	2,8,18,20,8,2	Cerium
59	Pr	2,8,18,21,8,2	Praseodymium
60	Nd	2,8,18,22,8,2	Neodymium
61	Pm	2,8,18,23,8,2	Promethium
62	Sm	2,8,18,24,8,2	Samarium
63	Eu	2,8,18,25,8,2	Europium
64	Gd	2,8,18,25,9,2	Gadolinium
65	Tb	2,8,18,27,8,2	Terbium
66	Dy	2,8,18,28,8,2	Dysprosium
67	Ho	2,8,18,29,8,2	Holmium
68	Er	2,8,18,30,8,2	Erbium
69	Tm	2,8,18,31,8,2	Thulium
70	Yb	2,8,18,32,8,2	Ytterbium
71	Lu	2,8,18,32,9,2	Lutetium

Actinides

Atomic number	Symbol	Electron arrangement	Name
89	Ac	2,8,18,32,18,9,2	Actinium
90	Th	2,8,18,32,18,10,2	Thorium
91	Pa	2,8,18,32,20,9,2	Protactinium
92	U	2,8,18,32,21,9,2	Uranium
93	Np	2,8,18,32,22,9,2	Neptunium
94	Pu	2,8,18,32,24,8,2	Plutonium
95	Am	2,8,18,32,25,8,2	Americium
96	Cm	2,8,18,32,25,9,2	Curium
97	Bk	2,8,18,32,27,8,2	Berkelium
98	Cf	2,8,18,32,28,8,2	Californium
99	Es	2,8,18,32,29,8,2	Einsteinium
100	Fm	2,8,18,32,30,8,2	Fermium
101	Md	2,8,18,32,31,8,2	Mendelevium
102	No	2,8,18,32,32,8,2	Nobelium
103	Lr	2,8,18,32,32,9,2	Lawrencium

[BLANK PAGE]

DO NOT WRITE ON THIS PAGE

[BLANK PAGE]

DO NOT WRITE ON THIS PAGE