

**Level 3 Alternative Academic Qualification Cambridge
Advanced Nationals in Applied Science**

H051/H151 Unit F180: Fundamentals of science

Sample Assessment Material (SAM)

Data, Formulae and Relationships Booklet

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(0)
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
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17	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0
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24	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0
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30	0	0	0	0	0	0	0	0
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37	0	0	0	0	0	0	0	0
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41	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0
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45	0	0	0	0	0	0	0	0
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49	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0
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54	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0
57	0	0	0	0	0			

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57	La	lanthanum	138.9
58	Ce	cerium	140.1
59	Pr	praseodymium	140.9
60	Nd	neodymium	144.2
61	Pm	promethium	144.9
62	Sm	samarium	150.4
63	Eu	euroium	152.0
64	Gd	gadolinium	157.2
65	Tb	terbium	158.9
66	Dy	dysprosium	162.5
67	Ho	holmium	164.9
68	Er	erbium	167.3
69	Tm	thulium	168.9
70	Yb	ytterbium	173.0
71	Lu	lutetium	175.0
72	Hf	hafnium	178.5
73	Ta	tantalum	180.9
74	W	wolframium	183.8
75	Re	rhenium	186.2
76	Os	osmium	190.2
77	Ir	iridium	192.2
78	Pt	platinum	195.1
79	Au	aurum	197.0
80	Hg	hydrargyrum	200.6
81	Tl	thallium	204.4
82	Pb	plumbum	207.2
83	Bi	bismuth	209.0
84	Po	polonium	209.0
85	At	astatine	210.0
86	Rn	radon	222.0
87	Fr	francium	223.0
88	Ra	radium	226.0
89	Ac	actinium	227.0
90	Th	thorium	232.0
91	Pa	protactinium	231.0
92	U	uranium	238.1
93	Np	neptunium	237.0
94	Pu	plutonium	244.1
95	Am	americium	243.1
96	Cm	curium	247.1
97	Bk	berkelium	247.1
98	Cf	californium	251.1
99	Es	einsteinium	252.1
100	Fm	fermium	257.1
101	Md	mendelevium	258.1
102	No	nobelium	259.1
103	Lr	lawrencium	262.1
104	Rf	rutherfordium	261.1
105	Db	nielsbohrium	262.1
106	Sg	seaborgium	266.1
107	Bh	bohrium	264.1
108	Hs	hassium	277.1
109	Mt	meitnerium	268.1
110	Ds	darmstadtium	271.1
111	Rg	roentgenium	272.1
112	Cn	coppernium	285.1
113	Nh	nihonium	284.1
114	Fl	flerovium	289.1
115	Mc	moscovium	288.1
116	Lv	livermorium	293.1
117	Ts	tennessine	289.1
118	Og	oganesson	294.1

General information

Physical constant	Symbol	Value and units
Acceleration of free fall	g	9.81 m s^{-2}
Avogadro constant	N_A	$6.02 \times 10^{23} \text{ mol}^{-1}$
Elementary charge	e	$1.60 \times 10^{-19} \text{ C}$
Electron rest mass	m_e	$9.11 \times 10^{-31} \text{ kg}$
Neutron rest mass	m_n	$1.675 \times 10^{-27} \text{ kg}$
Planck constant	h	$6.63 \times 10^{-34} \text{ J s}$
Proton rest mass	m_p	$1.673 \times 10^{-27} \text{ kg}$
Specific heat capacity of water	c	$4180 \text{ J kg}^{-1} \text{ }^\circ\text{C}^{-1}$
Speed of light in a vacuum	c	$3.00 \times 10^8 \text{ m s}^{-1}$
Molar gas volume (at room temperature and pressure, RTP)	V_m	$24.0 \text{ dm}^3 \text{ mol}^{-1}$
Euler's number	e	2.718

Conversion factors: $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$

Mathematical Equations

Circumference of circle = $2\pi r$

Area of circle = πr^2

Curved surface area of cylinder = $2\pi rh$

Surface area of sphere = $4\pi r^2$

Area of trapezium = $\frac{1}{2} (a + b)h$

Volume of cylinder = $\pi r^2 h$

Volume of sphere = $\frac{4}{3} \pi r^3$

Formulae and relationships for Unit F180

B1 Cell structure and microscopy	
Total magnification = magnification of objective lens $\times$ magnification of eyepiece lens	$M_T = M_O \times M_E$
Magnification = $\frac{\text{observed size}}{\text{actual size}}$	

B4 Biodiversity and ecosystems	
Percentage efficiency = $\frac{\text{useful energy transferred}}{\text{total energy transferred}} \times 100\%$	

C1 Atomic Structure and the Periodic Table	
Relative atomic mass = $\sum \frac{(\text{isotope mass} \times \text{isotope abundance})}{100}$	

C2 Amount of substance	
Amount of substance = $\frac{\text{mass of substance}}{\text{molar mass}}$	$n = \frac{m}{M}$
Concentration = $\frac{\text{amount of solute}}{\text{volume}}$	$c = \frac{n}{V}$
Concentration = $\frac{\text{mass of solute}}{\text{volume}}$	$c = \frac{m}{V}$
Amount of gas = $\frac{\text{volume of gas}}{24}$	$n = \frac{V}{24}$

C4 Rates of Reaction and Enthalpy Changes	
Thermal energy = mass × specific heat capacity × change in temperature	$Q = mc\Delta\theta$

P1 Electricity	
Charge = current × time	$Q = It$
Potential difference = current × resistance	$V = IR$
Power = current × potential difference	$P = IV$
Power = (current) ² × resistance	$P = I^2R$
Power = $\frac{(\text{potential difference})^2}{\text{resistance}}$	$P = \frac{V^2}{R}$
Work done = potential difference × current × time	$W = VIt$
Work done = potential difference × charge	$W = VQ$
Total resistance in series = resistance of resistor 1 + resistance of resistor 2 + ...	$R_T = R_1 + R_2 + \dots$
$\frac{1}{\text{Total resistance in parallel}} = \frac{1}{\text{Resistance of resistor 1}} + \frac{1}{\text{Resistance of resistor 2}} + \dots$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

P2 Forces & Motion	
Work done = force × displacement	$W = Fs$
Work done = force × displacement × $\cos\theta$	$W = Fs \cos\theta$
Kinetic energy = $\frac{1}{2} \times \text{mass} \times (\text{velocity})^2$	$E = \frac{1}{2}mv^2$
Gravitational potential energy = mass × acceleration of free fall × height	$E = mg\Delta h$
Elastic potential energy = $\frac{1}{2} \times \text{force} \times \text{extension} = \frac{1}{2} \times \text{spring constant} \times (\text{extension})^2$	$E = \frac{1}{2}Fx$ $= \frac{1}{2}kx^2$
Power = $\frac{\text{work done}}{\text{time}}$	$P = \frac{W}{t}$
Efficiency = $\frac{\text{useful energy transferred}}{\text{total energy transferred}}$	
Net force = mass × acceleration	$F = ma$
Average velocity = $\frac{\text{displacement}}{\text{time taken}}$	$v = \frac{s}{t}$
Acceleration = $\frac{\text{final velocity} - \text{initial velocity}}{\text{time taken}}$	$a = \frac{v - u}{t}$
Final velocity = initial velocity + (acceleration × time taken)	$v = u + at$
Displacement = $\frac{1}{2}(\text{initial velocity} + \text{final velocity}) \times \text{time taken}$	$s = \frac{1}{2}(u + v)t$
Displacement = (initial velocity × time taken) + ($\frac{1}{2} \times \text{acceleration} \times \text{time taken}^2$)	$s = ut + \frac{1}{2}at^2$
Final velocity ² = initial velocity ² + 2 × acceleration × displacement	$v^2 = u^2 + 2as$

P3.1 Medical Physics	
Energy of a photon = Planck constant × frequency	$E = hf$
Energy of a photon = $\frac{\text{Planck constant} \times \text{speed of light in a vacuum}}{\text{wavelength}}$	$E = \frac{hc}{\lambda}$
Intensity of emergent beam = intensity of incident beam × $e^{-\text{linear attenuation coefficient} \times \text{distance travelled through the medium}}$	$I = I_0 e^{-\mu x}$
Mass attenuation coefficient = $\frac{\text{linear attenuation coefficient}}{\text{density of medium}}$	$\mu_m = \frac{\mu}{\rho}$
Density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$

Frequency = $\frac{1}{\text{time period}}$	$f = \frac{1}{T}$
Wave speed = frequency $\times$ wavelength	$v = f\lambda$
Intensity = $\frac{\text{power}}{\text{area}}$	$I = \frac{P}{A}$
Acoustic impedance = density of medium $\times$ speed of sound in the medium	$Z = \rho c$
Intensity reflection coefficient = $\frac{\text{intensity of reflected wave}}{\text{intensity of incident wave}}$ Intensity reflection coefficient = $(\text{acoustic impedance of second medium} - \frac{\text{acoustic impedance of initial medium}}{\text{acoustic impedance of second medium}} + \text{acoustic impedance of initial medium})^2$	$\alpha = \frac{I_r}{I_0}$ $\alpha = \left(\frac{Z_2 - Z_1}{Z_2 + Z_1}\right)^2$

P3.2 Radioactivity	
Physical half-life = $\frac{0.693}{\text{radioactive decay constant}}$	$t_{\frac{1}{2}} = \frac{0.693}{\lambda}$
$\frac{1}{\text{effective half-life}} = \frac{1}{\text{physical half-life}} + \frac{1}{\text{biological half-life}}$	$\frac{1}{t_E} = \frac{1}{t_{\frac{1}{2}}} + \frac{1}{t_B}$
Activity = radioactive decay constant $\times$ number of undecayed nuclei	$A = \lambda N$
Number of undecayed nuclei = initial number of undecayed nuclei $\times e^{-\text{radioactive decay constant} \times \text{time}}$	$N = N_0 e^{-\lambda t}$
Activity = initial activity $\times e^{-\text{radioactive decay constant} \times \text{time}}$	$A = A_0 e^{-\lambda t}$