

PHYSICAL SCIENCES (PSC315109)

2011 External Examination Formula Sheet



CONSTANTS

Acceleration due to gravity: $g = 9.80 \text{ m s}^{-2}$ down

Charge on an electron: $e = -1.6 \times 10^{-19} \text{ C}$

EQUATIONS OF MOTION

$$v_{\text{av}} = \frac{s}{t} \qquad v = u + at \qquad v^2 = u^2 + 2as \qquad s = ut + \frac{1}{2}at^2$$

MOMENTUM, ENERGY & POWER	PHYSICAL QUANTITY SYMBOLS (SI UNITS)
$p = mv$	$s =$ displacement (m)
$F_{\text{net}} = \frac{\Delta p}{t} = \frac{m(v - u)}{t}$	$u =$ initial velocity (m s^{-1})
$F_{\text{net}} = ma$	$v =$ final velocity (m s^{-1})
$F_w = mg$	$a =$ acceleration (m s^{-2})
$E_k = \frac{1}{2}mv^2$	$t =$ time (s)
$E_p = mgh$	$p =$ momentum (kg m s^{-1})
$P = \frac{W}{t}$	$\Delta p =$ change in momentum (kg m s^{-1})
$P = \frac{\Delta E}{t}$	$m =$ mass (kg)
$W = Fs$	$F =$ force (N)
$W = \Delta E$	$E_k =$ kinetic energy (J)
	$E_p =$ potential energy (J)
	$\Delta E =$ change in energy (J)
	$g =$ acceleration due to gravity (m s^{-2})
	$h =$ change in vertical height (m)
	$P =$ power (W)
	$W =$ work done (J)
ELECTRICITY	
$I = \frac{Q}{t}$	$Q =$ charge (C)
$V = \frac{W}{Q}$	$I =$ current (A)
$V = \frac{\Delta E}{Q}$	$V =$ potential difference (V)
$V = IR$	$R =$ resistance (Ω)
$P = VI = I^2R = \frac{V^2}{R}$	

PREFIXES

T	—	tera	10^{12}
G	—	giga	10^9
M	—	mega	10^6
k	—	kilo	10^3
c	—	centi	10^{-2}
m	—	milli	10^{-3}
μ	—	micro	10^{-6}
n	—	nano	10^{-9}

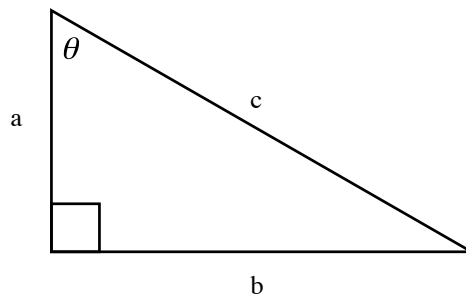
VECTORS AT RIGHT ANGLES

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

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

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

$$c^2 = a^2 + b^2$$



IONISING RADIATION

	α (alpha)	β (beta)	γ (gamma)	Neutron	Proton
Nature of radiation	helium nucleus ${}^4_2\text{He}$	electron ${}^0_{-1}\text{e}$	electromagnetic waves	neutron ${}^1_0\text{n}$	proton ${}^1_1\text{H}$
Electrical charge	+2	-1	no charge	no charge	+1
Mass (amu)	4	negligible	none	1	1
Distance travelled in air	a few cm	20 – 30 cm	long distances	very long distances	20 – 30 cm
Stopped by	paper, skin	~1 mm of aluminium	several cm of lead	thick layer of concrete	~1 mm of aluminium

ORGANIC CHEMISTRY

Alkanes: C_nH_{2n+2}	Alkynes: C_nH_{2n-2}
Alkenes: C_nH_{2n}	Cyclic Alkanes: C_nH_{2n}

ORGANIC STEM NAMES

Carbon Atoms in Chain	1	2	3	4	5	6	7	8	9	10
Stem Name	meth-	eth-	prop-	but-	pent-	hex-	hept-	oct-	non-	dec-

SIDE CHAINS AND SUBSTITUTES

methyl	$-CH_3$	bromo	$-Br$
ethyl	$-C_2H_5$	chloro	$-Cl$
propyl	$-C_3H_7$	fluoro	$-F$
		iodo	$-I$

PREFIXES

Atoms in molecule	1	2	3	4	5	6	7	8	9	10
prefix	mono-	di-	tri-	tetra-	penta-	hexa-	hepta-	octa-	nona-	deca-

GENERAL CHARACTERISTICS OF DIFFERENT STRUCTURES

Structure	Melting/boiling point	Electrical conductivity			Further physical properties	Particles present	Charge carriers
		Solid	Molten	Aqueous			
Metallic	high	conducts	conducts	insoluble	dense, malleable, ductile, lustrous	+ ions & electrons	electrons
Ionic	high	non-conducting	conducts	conducts if soluble	hard, brittle	+ & - ions	ions
Covalent molecular	low	non-conducting	non-conducting	non-conducting if soluble	soft solids, liquids or gases	molecules	none
Covalent network	very high	non-conducting	non-conducting	insoluble	hard, brittle	atoms	none

COMMON POSITIVE IONS (CATIONS)

1+	2+	3+	4+
ammonium NH_4^+ hydrogen H^+ lithium Li^+ potassium K^+ silver Ag^+ sodium Na^+	barium Ba^{2+} calcium Ca^{2+} copper (II) Cu^{2+} iron (II) Fe^{2+} lead (II) Pb^{2+} magnesium Mg^{2+} mercury (II) Hg^{2+} nickel (II) Ni^{2+} strontium Sr^{2+} tin (II) Sn^{2+} zinc Zn^{2+}	aluminium Al^{3+} chromium (III) Cr^{3+} iron (III) Fe^{3+}	lead (IV) Pb^{4+} tin (IV) Sn^{4+}

NAMES AND FORMULAE OF SOME COMMON NEGATIVE IONS (ANIONS)

-1	-2	-3
bromide Br^- chloride Cl^- ethanoate (acetate) CH_3COO^- fluoride F^- hydrogen carbonate HCO_3^- hydrogen sulfate HSO_4^- hydrogen sulfite HSO_3^- hydroxide OH^- iodide I^- nitrate NO_3^- nitrite NO_2^- permanganate MnO_4^-	carbonate CO_3^{2-} chromate CrO_4^{2-} dichromate $\text{Cr}_2\text{O}_7^{2-}$ oxide O^{2-} sulfate SO_4^{2-} sulfide S^{2-} sulfite SO_3^{2-} thiosulfate $\text{S}_2\text{O}_3^{2-}$	nitride N^{3-} phosphate PO_4^{3-}

IMPORTANT REACTIONS OF ACIDS

acid + base [hydroxide/ metal oxide] \longrightarrow salt + water

acid + reactive metal \longrightarrow salt + hydrogen

acid + carbonate \longrightarrow salt + water + carbon dioxide

acid + hydrogen carbonate \longrightarrow salt + water + carbon dioxide

SOLUBILITY TABLE FOR COMMON IONIC COMPOUNDS

Negative Ions (anions)	Solubility of Compounds
ethanoates (acetates) (CH ₃ COO ⁻)	All soluble
nitrates (NO ₃ ⁻)	All soluble
chlorides (Cl ⁻)	All soluble except AgCl, PbCl ₂ , HgCl ₂
bromides (Br ⁻)	All soluble except AgBr, PbBr ₂ , HgBr ₂
iodides (I ⁻)	All soluble except AgI, PbI ₂ , HgI ₂
sulfates (SO ₄ ²⁻)	All soluble except BaSO ₄ , CaSO ₄ , SrSO ₄ , PbSO ₄ , Ag ₂ SO ₄ , SnSO ₄
hydroxides (OH ⁻)	Insoluble except LiOH, NaOH, KOH, RbOH, NH ₄ OH, Sr(OH) ₂ , Ba(OH) ₂
sulfides (S ²⁻)	Insoluble except Li ₂ S, Na ₂ S, K ₂ S, Rb ₂ S, (NH ₄) ₂ S, MgS, CaS, SrS, BaS
carbonates (CO ₃ ²⁻)	Insoluble except Li ₂ CO ₃ , Na ₂ CO ₃ , K ₂ CO ₃ , Rb ₂ CO ₃ , (NH ₄) ₂ CO ₃
phosphates (PO ₄ ³⁻)	Insoluble except Li ₃ PO ₄ , Na ₃ PO ₄ , K ₃ PO ₄ , Rb ₃ PO ₄ , (NH ₄) ₃ PO ₄
sulfites (SO ₃ ²⁻)	Insoluble except Li ₂ SO ₃ , Na ₂ SO ₃ , K ₂ SO ₃ , Rb ₂ SO ₃

QUANTITATIVE CHEMISTRY

Avogadro's Number: $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

$$N = n \times N_A$$

$$c = \frac{n}{V}$$

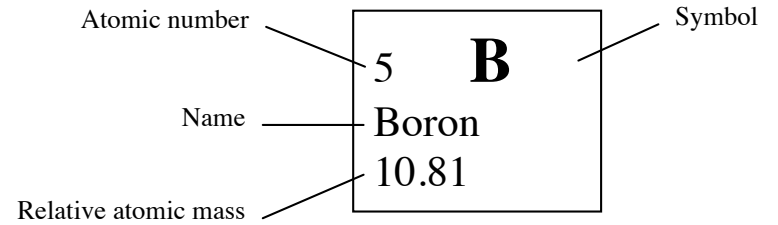
$$n = \frac{m}{M}$$

N = number of particles, etc
 n = amount of substance (mol)
 m = mass (g)
 M = molar mass (g mol⁻¹)
 c = concentration (mol L⁻¹)
 V = volume (L)

TABLE OF RELATIVE ATOMIC MASSES (BASED ON $^{12}\text{C} = 12.00$)

Name	Symbol	Atomic Number	Relative Atomic Mass	Name	Symbol	Atomic Number	Relative Atomic Mass
actinium	Ac	89	-	mercury	Hg	80	200.6
aluminium	Al	13	26.98	molybdenum	Mo	42	95.94
americium	Am	95	-	neodymium	Nd	60	144.2
antimony	Sb	51	121.8	neon	Ne	10	20.18
argon	Ar	18	39.95	neptunium	Np	93	-
arsenic	As	33	74.92	nickel	Ni	28	58.71
astatine	At	85	-	niobium	Nb	41	92.91
barium	Ba	56	137.3	nitrogen	N	7	14.01
berkelium	Bk	97	-	nobelium	No	102	-
beryllium	Be	4	9.012	osmium	Os	76	190.2
bismuth	Bi	83	209.0	oxygen	O	8	16.00
boron	B	5	10.81	palladium	Pd	46	106.4
bromine	Br	35	79.90	phosphorus	P	15	30.97
cadmium	Cd	48	112.4	platinum	Pt	78	195.1
caesium	Cs	55	132.9	plutonium	Pu	94	-
calcium	Ca	20	40.08	polonium	Po	84	-
californium	Cf	98	-	potassium	K	19	39.10
carbon	C	6	12.01	praseodymium	Pr	59	140.9
cerium	Ce	58	140.1	promethium	Pm	61	-
chlorine	Cl	17	35.45	protactinium	Pa	91	-
chromium	Cr	24	52.00	radium	Ra	88	-
cobalt	Co	27	58.93	radon	Rn	86	-
copper	Cu	29	63.54	rhenium	Re	75	186.2
curium	Cm	96	-	rhodium	Rh	45	102.9
dysprosium	Dy	66	162.5	rubidium	Rb	37	85.47
einsteinium	Es	99	-	ruthenium	Ru	44	101.1
erbium	Er	68	167.3	samarium	Sm	62	150.4
europium	Eu	63	152.0	scandium	Sc	21	44.96
fermium	Fm	100	-	selenium	Se	34	78.96
fluorine	F	9	19.00	silicon	Si	14	28.09
francium	Fr	87	-	silver	Ag	47	107.9
gadolinium	Gd	64	157.3	sodium	Na	11	22.99
gallium	Ga	31	69.72	strontium	Sr	38	87.62
germanium	Ge	32	72.59	sulfur	S	16	32.06
gold	Au	79	197.0	tantalum	Ta	73	180.9
hafnium	Hf	72	178.5	technetium	Tc	43	-
helium	He	2	4.002	tellurium	Te	52	127.6
holmium	Ho	67	164.9	terbium	Tb	65	158.9
hydrogen	H	1	1.008	thallium	Tl	81	204.4
indium	In	49	114.8	thorium	Th	90	232.0
iodine	I	53	126.9	thulium	Tm	69	168.9
iridium	Ir	77	192.2	tin	Sn	50	118.7
iron	Fe	26	55.85	titanium	Ti	22	47.90
krypton	Kr	36	83.80	tungsten	W	74	183.9
lanthanum	La	57	138.9	uranium	U	92	238.0
lawrencium	Lr	103	-	vanadium	V	23	50.94
lead	Pb	82	207.2	xenon	Xe	54	131.3
lithium	Li	3	6.941	ytterbium	Yb	70	173.0
lutetium	Lu	71	175.0	yttrium	Y	39	88.91
magnesium	Mg	12	24.31	zinc	Zn	30	65.37
manganese	Mn	25	54.94	zirconium	Zr	40	91.22
mendelevium	Md	101	-				

PERIODIC TABLE OF ELEMENTS



I		II												III	IV	V	VI	VII	VIII
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18		
1 H Hydrogen 1.008																	2 He Helium 4.002		
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18		
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminium 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.95		
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.90	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.71	29 Cu Copper 63.54	30 Zn Zinc 65.37	31 Ga Gallium 69.72	32 Ge Germanium 72.59	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80		
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium	44 Ru Ruthenium 101.1	45 Rh Rhodium 102.9	46 Pd Palladium 106.4	47 Ag Silver 107.9	48 Cd Cadmium 112.4	49 In Indium 114.8	50 Sn Tin 118.7	51 Sb Antimony 121.8	52 Te Tellurium 127.6	53 I Iodine 126.9	54 Xe Xenon 131.3		
55 Cs Caesium 132.9	56 Ba Barium 137.3	57 La Lanthanum 138.9	72 Hf Hafnium 178.5	73 Ta Tantalum 180.9	74 W Tungsten 183.9	75 Re Rhenium 186.2	76 Os Osmium 190.2	77 Ir Iridium 192.2	78 Pt Platinum 195.1	79 Au Gold 197.0	80 Hg Mercury 200.6	81 Tl Thallium 204.4	82 Pb Lead 207.2	83 Bi Bismuth 209.0	84 Po Polonium	85 At Astatine	86 Rn Radon		
87 Fr Francium	88 Ra Radium	89 Ac Actinium	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uun	112 Uub	113	114	115	116	117	118		

58-71 Lanthanide Series	58 Ce Cerium 140.1	59 Pr Praseodymium 140.9	60 Nd Neodymium 144.2	61 Pm Promethium	62 Sm Samarium 150.4	63 Eu Europium 152.0	64 Gd Gadolinium 157.3	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
90-103 Actinide Series	90 Th Thorium 232.0	91 Pa Protactinium	92 U Uranium 238.0	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium