

# International System of Units (SI Units)

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Système International d'Unités, or SI units, are an extension of the meter, kilogram, second, ampere (MKSA) system proposed in 1950. In 1966, the International Federation of Clinical Chemistry (IFCC) recommended the use of selected, or favored, SI units for the clinical laboratory: whenever possible, use *mole* and *liter* units to express concentration, and express whole-unit multiples of three as powers of ten (eg, millimole =  $10^{-3}$  moles, micromole =  $10^{-6}$  moles, nanomole =  $10^{-9}$  moles, picomole =  $10^{-12}$  moles). This approach was designed to provide clearer quantitative relationships among molecular species and some standardization of databases.

This partial application of SI units to laboratory data has been accepted by many scientific journals and is used increasingly in day-to-day clinical medicine. The operative words are "whenever possible." In many instances the molecular weight or the homogeneity of the measured analyte is not clear, and gravimetric units rather than molar units are preferred.

With regard to laboratory reports, we remain in a transition state between conventional (gravimetric) units and SI units. Quest Diagnostics is moving to SI units but continues to use selected conventional units during what has become a prolonged transition period. For your convenience, we have included a guide for interconversion of conventional and SI units, along with definitions of abbreviations used. The following table lists gravimetric and possible international unitage for a variety of laboratory tests. The conversion factor (CF) is used as follows:

$$\text{gravimetric} \times \text{CF} = \text{international unit}$$
$$\text{international} \div \text{CF} = \text{gravimetric unit}$$

Abbreviation	Definition
BCE	bone collagen equivalent
creat	creatinine
d	day
dL	deciliter
g	gram
h	hour
IU	international units
kat	katal (mol/s)
L	liter
mg	milligram
min	minute
mL	milliliter
mL/h	milliliter/hour
mol	mole
mmol	millimole
mIU	milli international units
ng	nanogram
pg	picogram
pmol	picomole
s	second
U	units
µg	microgram
µmol	micromole
µU	microunits
y	year

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Name of Analyte	Gravimetric Units	Conversion Factor	International Units
ACTH	pg/mL	0.22	pmol/L
Aldosterone, S	ng/dL	0.0277	nmol/L
Aldosterone, U	µg/24 h	2.77	nmol/d
Alkaline Phosphatase, Bone Specific	µg/L	1.0	µg/L
Alpha Subunit	ng/mL	1.0	µg/L
3α-Androstanediol Glucuronide	ng/dL	0.0213	nmol/L
Androstenedione	ng/dL	0.0349	nmol/L
Angiotensin Converting Enzyme	U/L	0.017	µKat/L
Angiotensin II	ng/L	1.0	ng/L
Apolipoprotein A1	mg/dL	0.01	g/L
Apolipoprotein B	mg/dL	0.01	g/L
Arginine Vasopressin	pg/mL	0.926	pmol/L
Atrial Natriuretic Hormone	pg/mL	1.0	ng/L
B-Type Natriuretic Peptide	pg/mL	1.0	ng/L
C-peptide, 24-h U	µg/g creat	0.0377	nmol/mmol creat
C-Peptide, S	ng/mL	0.333	nmol/L
Calcitonin	pg/mL	1.0	ng/L
Calcium, Ionized	mg/dL	0.25	mmol/L
Calcium, Total	mg/dL	0.25	mmol/L
Calcium, U	mg/24 h	0.025	mmol/d
Catecholamines, P			
Epinephrine	pg/mL	5.454	pmol/L
Norepinephrine	pg/mL	5.914	pmol/L
Dopamine	pg/mL	6.524	pmol/L
Catecholamines, U			
Epinephrine	µg/24 h	5.454	nmol/d
Norepinephrine	µg/24 h	5.914	nmol/d
Dopamine	µg/24 h	6.524	nmol/d
Epinephrine	µg/g creat	0.617	µmol/mol creat
Norepinephrine	µg/g creat	0.669	µmol/mol creat
Dopamine	µg/g creat	0.738	µmol/mol creat
Cholesterol, HDL	mg/dL	0.0259	mmol/L
Cholesterol, HDL Subclasses	mg/dL	0.0259	mmol/L
Cholesterol, LDL, Direct	mg/dL	0.0259	mmol/L
Cholesterol, Total	mg/dL	0.0259	mmol/L
Chromogranin A	ng/mL	1.0	µg/L

S, serum; U, urine; P, plasma.

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Name of Analyte	Gravimetric Units	Conversion Factor	International Units
Collagen Cross-Linked N-Telopeptide (NTx)	nmol BCE/ mmol creat	1.0	nmol BCE/ mmol creat
Collagen Type I C-Telopeptide (CTx)	pg/mL	1.0	ng/L
Corticosterone	ng/dL	0.0289	nmol/L
Corticotropin Releasing Hormone	pg/mL	1.0	ng/L
Cortisol Binding Globulin	mg/L	17.18	nmol/L
Cortisol, Free, S	µg/dL	27.6	nmol/L
Cortisol, Free, U	µg/24 h	2.76	nmol/d
Cortisol, S	µg/dL	27.6	nmol/L
Cortisone, S	µg/dL	0.0277	µmol/L
Cortisone, U	µg/24 h	2.774	mmol/d
Creatinine	mg/dL	88.4	µmol/L
	g/24 h	8.84	mmol/d
Cyclic AMP, Nephrogenous	nmol/dL	10.0	nmol/L
Cyclic AMP, P	nmol/L	1.0	nmol/L
Cyclic AMP, U	µmol/L	1.0	µmol/L
Cystatin C	mg/L	1.0	mg/L
Deoxycorticosterone	ng/dL	0.0303	nmol/L
11-Deoxycortisol	ng/dL	0.0289	nmol/L
Deoxypridinoline, Free	nmol/mg creat	113	nmol/mmol creat
Dexamethasone	ng/dL	25.48	pmol/L
DHEA	ng/dL	0.0347	nmol/L
DHEA Sulfate	µg/dL	0.0271	µmol/L
Dihydrotestosterone	ng/dL	0.0344	nmol/L
Dihydrotestosterone, Free	pg/mL	3.440	pmol/L
Estradiol, Bioavailable	pg/mL	3.67	pmol/L
Estradiol (E <sub>2</sub> ), Free	pg/mL	3.67	pmol/L
Estradiol (E <sub>2</sub> ), S	pg/mL	3.67	pmol/L
Estradiol (E <sub>2</sub> ), U	µg/g creat	0.415	nmol/mmol creat
Estrogen, Total, S	pg/mL	1.0	ng/L
Estrogen, Total, U	µg/g creat	0.113	µg/mmol creat
Estrogens, Fractionated, S			
Estrone	pg/mL	3.699	pmol/L
Estradiol	pg/mL	3.67	pmol/L
Estril	ng/mL	3.47	nmol/L

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Name of Analyte	Gravimetric Units	Conversion Factor	International Units
Estrogens, Fractionated, U			
Estrone	µg/g creat	0.418	nmol/mmol creat
Estradiol	µg/g creat	0.415	nmol/mmol creat
Estriol	µg/g creat	0.3925	nmol/mmol creat
Total	µg/g creat	0.113	µg/mmol
Estrone (E <sub>1</sub> ), S	pg/mL	3.699	pmol/L
Estrone Sulfate	pg/mL	2.730	pmol/L
Estrone (E <sub>1</sub> ), U	µg/g creat	0.418	nmol/mmol creat
Fructosamine	µmol/L	1.0	µmol/L
FSH	mIU/mL	1.0	IU/L
GAD-65 Antibodies	U/mL	1.0	kU/L
Gastrin	pg/mL	1.0	ng/L
Glucagon	pg/mL	1.0	ng/L
Glucose, S	mg/dL	0.0555	mmol/L
Growth Hormone	ng/mL	1.0	µg/L
Growth Hormone Binding Protein	pmol/L	1.0	pmol/L
Growth Hormone Releasing Hormone	pg/mL	1.0	ng/L
hCG, Beta Subunit	mIU/mL	1.0	IU/L
hCG, Total	mIU/mL	1.0	IU/L
5-HIAA	mg/24 h	5.23	µmol/d
	mg/g creat	0.592	µmol/mmol
Histamine			
Plasma or whole blood	ng/mL	8.997	nmol/L
Urine	µg/g creat	1.018	nmol/mmol creat
Homovanillic Acid	mg/24 h	5.49	µmol/d
	mg/g creat	0.621	µmol/mmol creat
17-Hydroxycorticosteroids	mg/24 h	2.76	µmol/d
	mg/g creat	0.312	nmol/mol creat
18-Hydroxycorticosterone	ng/dL	0.0276	nmol/L
6β-Hydroxycortisol	µg/24 h	2.642	nmol/d
18-Hydroxycortisol	µg/24 h	2.642	nmol/d
21-Hydroxylase Antibody	U/mL	1.0	kU/L
17-Hydroxypregnenolone	ng/dL	0.0301	nmol/L

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Name of Analyte	Gravimetric Units	Conversion Factor	International Units
17-Hydroxyprogesterone	ng/dL	0.0303	nmol/L
Hydroxyproline, Free	mg/24 h	7.63	μmol/d
	mg/dL	76.3	μmol/L
Hydroxyproline, Total	mg/24 h	0.0076	mmol/d
	mg/g creat	0.863	μmol/mmol creat
IA-2 Antibody	U/mL	1.0	kU/L
IGFBP-1	ng/mL	1.0	μg/L
IGFBP-2	ng/mL	1.0	μg/L
IGFBP-3	mg/L	1.0	mg/L
IGF-I	ng/mL	1.0	μg/L
IGF-II	ng/mL	1.0	μg/L
Inhibin A	pg/mL	1.0	ng/L
Inhibin B	pg/mL	1.0	ng/L
Insulin Antibodies	U/mL	1.0	kU/L
Insulin, Free	μU/mL	7.175	pmol/L
Insulin, Total	μU/mL	7.175	pmol/L
Invasive Trophoblast Antigen (ITA, hyperglycosylated hCG)	μg/L	1.0	μg/L
17-Ketosteroids	mg/24 h	3.47	μmol/d
	mg/g creat	0.392	μmol/mmol creat
Leptin	ng/mL	1.0	μg/L
LH (Luteinizing Hormone)	mIU/mL	1.0	IU/L
Lipoprotein (a)	mg/dL	0.01	g/L
Macroprolactin	ng/mL	1.0	μg/L
Magnesium, S	mg/dL	0.4114	mmol/L
Metanephrines, P			
Metanephrine	pg/mL	5.07	pmol/L
Normetanephrine	pg/mL	5.46	pmol/L
Total	pg/mL	5.26	pmol/L
Metanephrines, U			
Metanephrine	μg/24 h	5.07	nmol/d
Normetanephrine	μg/24 h	5.46	nmol/d
Total	μg/24 h	5.26	nmol/d
Metanephrine	μg/g creat	0.574	nmol/mmol creat
Normetanephrine	μg/g creat	0.617	nmol/mmol creat
Total	μg/g creat	0.595	nmol/mmol creat

S, serum; U, urine; P, plasma; IGFBP, IGF binding protein; IGF, insulin-like growth factor.

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Name of Analyte	Gravimetric Units	Conversion Factor	International Units
Microalbumin, U	mg/24 h mg/g creat	1.0 0.113	mg/d mg/mmol creat
Osmolality, S	mOsm/kg	1.0	mmol osmotically active particles/ kg H <sub>2</sub> O
Osmolality, U	mOsm/kg	1.0	mmol osmotically active particles/ kg H <sub>2</sub> O
Osteocalcin	ng/mL	1.0	µg/L
Pancreatic Polypeptide	pg/mL	1.0	ng/L
Pepsinogen I	ng/mL	1.0	µg/L
Plasma Renin Activity (PRA)	ng/mL/h ng/mL/h	1.0 0.2778	µg/L/h ng/L·s
Pregnanetriol	µg/24 h µg/g creat	2.97 0.336	nmol/d µmol/mol creat
Pregnenolone	ng/dL	0.0316	nmol/L
Progesterone	ng/mL	3.18	nmol/L
Proinsulin	pg/mL	0.1134	pmol/L
Prolactin	ng/mL	0.04348	nmol/L
PTH, Biointact (amino acids 1-84)	pg/mL	0.1053	pmol/L
PTH, Intact	pg/mL	0.1061	pmol/L
PTH-Related Protein (PTH-RP)	pmol/L	1.0	pmol/L
Pyridinium Collagen Cross-Links (DPYD, PYD)	nmol/mmol creat	1.0	nmol/mmol creat
Renin, Direct	µU/mL	1.0	mU/L
Serotonin	ng/mL	5.675	nmol/L
Sex Hormone Binding Globulin	nmol/L	1.0	nmol/L
Somatostatin	pg/mL	0.611	pmol/L
T3, Free	pg/dL	0.0154	pmol/L
T3, Reverse	ng/mL	1.54	nmol/L
T3, Total	ng/dL	0.0154	nmol/L
T4, Free	ng/dL	12.87	pmol/L
T4, Total	µg/dL	12.87	nmol/L
Tartrate Resistant Acid Phosphatase (TRAP)	U/L	1.0	U/L

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TBG	µg/mL	18.5	nmol/L
Testosterone, Bioavailable	ng/dL	0.0347	nmol/L
Testosterone, Free	pg/mL	3.47	pmol/L
Testosterone, Total	ng/dL	0.0347	nmol/L
Testosterone, Urine	µg/24 h	3.47	nmol/d
Tetrahydroaldosterone	µg/24 h	1.0	µg/d
	µg/g creat	0.113	µg/mmol creat
Thyroglobulin	ng/mL	1.0	µg/L
Thyroglobulin Antibody	IU/mL	1.0	kIU/L
Thyroid Peroxidase Antibody (Anti-TPO)	IU/mL	1.0	kIU/L
Thyroid Stimulating Hormone (TSH)	mU/L	1.0	mU/L
Thyrotropin Releasing Hormone	pg/mL	2.759	pmol/L
Triglycerides	mg/dL	0.0113	mmol/L
Vasoactive Intestinal Polypeptide	pg/mL	1.0	ng/L
Vitamin D, 1,25-Dihydroxy	pg/mL	2.400	pmol/L
Vitamin D, 25-Hydroxy	ng/mL	2.496	nmol/L
Vitamin D <sub>2</sub> , 25-Hydroxy	ng/mL	2.42	nmol/L
Vitamin D <sub>3</sub> , 25-Hydroxy	ng/mL	2.50	nmol/L
VMA, Urine	mg/24 h	5.05	µmol/d
	mg/g creat	0.571	mmol/mol creat

S, serum; U, urine; P, plasma; TBG, thyroxine binding globulin; VMA, vanillyl-mandelic acid.