Principles of Energy Balance in Environmental Systems

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Lecture 1

1. Introduction: The magnitude of water use in agriculture
2. The challenge of measuring water use and evapotranspiration
3. Reference books on environmental physics
4. First law of thermodynamics: energy in equals energy out
5. The seven components of the energy balance equation
6. The magnitude of latent heat of evaporation
7. Understanding energy and power
8. Shortwave and longwave radiation
9. $E = mc^2$ homework

Environmental Plant Physiology

2016 Lecture and Exam Schedule

Plants, Soils and Climate 5270 / 6270

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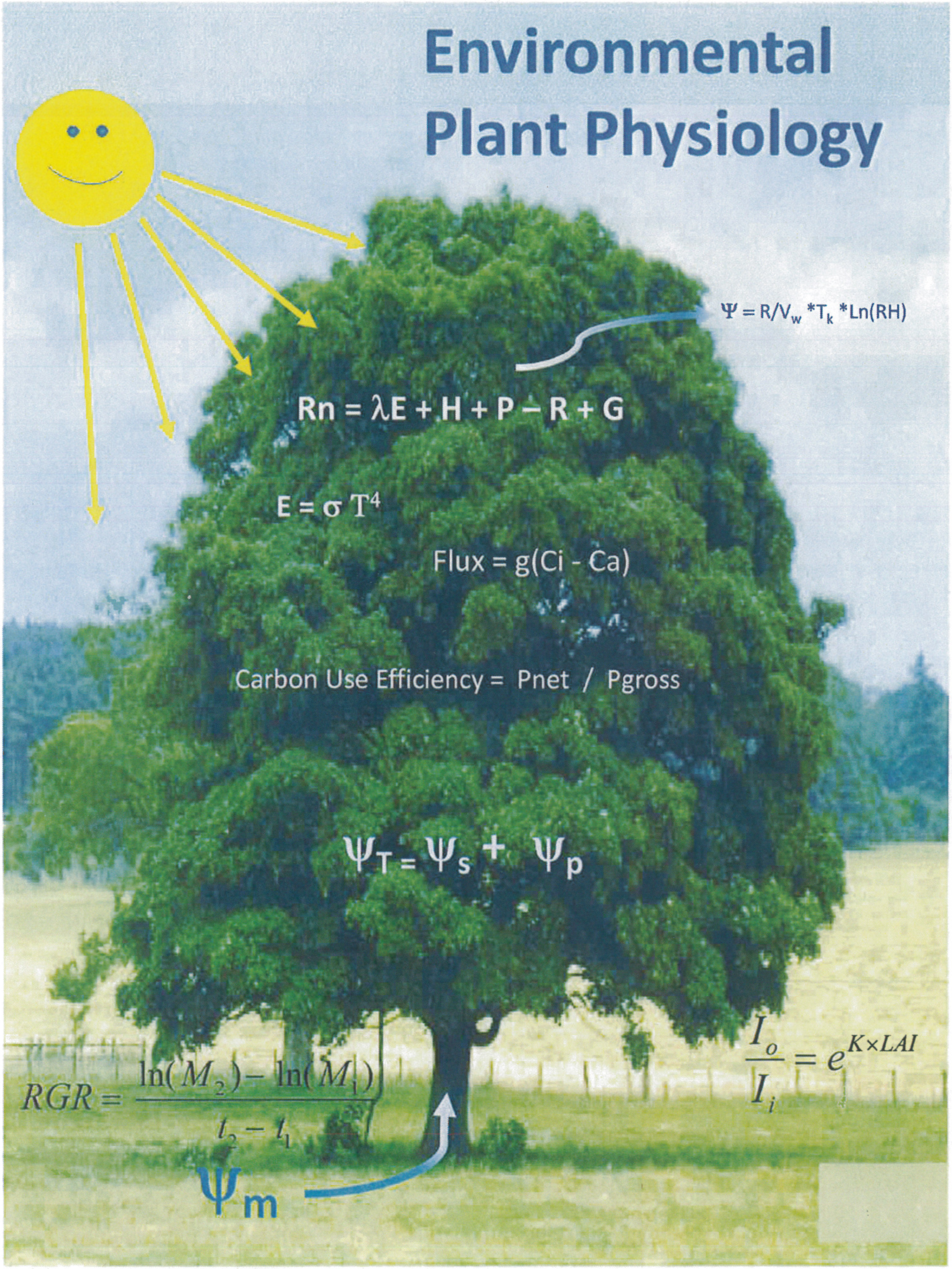
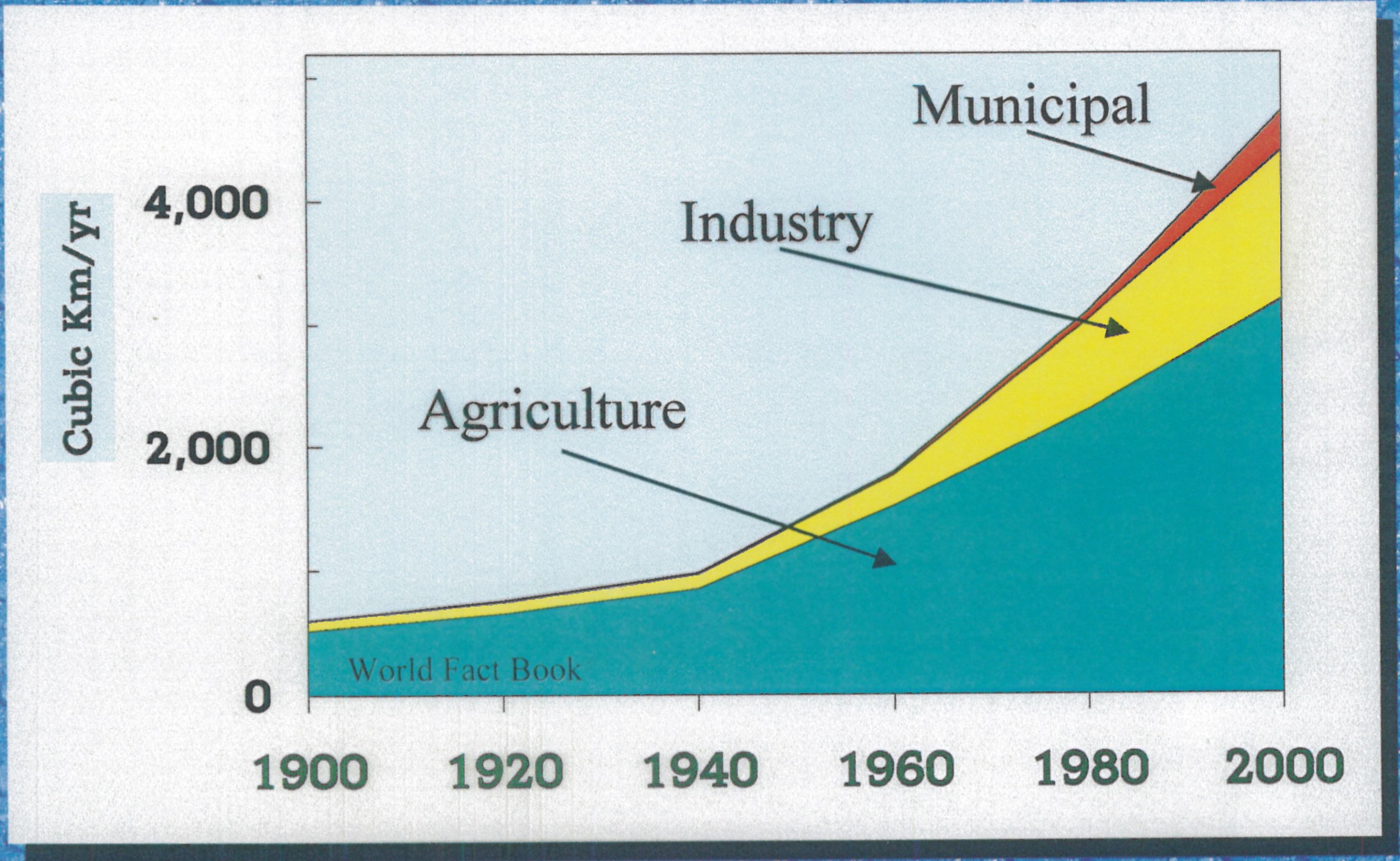
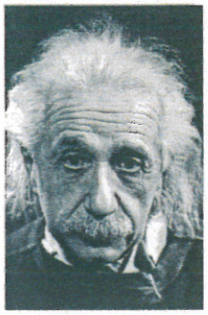
Date	Topic	Energy component
January 13	Course Overview: Introduction	
15	Leaf Energy Balance: Energy input	Energy into the
20	Leaf Energy Balance: Types of Radiation	Plant Community
22	Leaf Energy Balance: Longwave radiation	
27	Leaf Energy Balance: Radiation absorption.	
29	Leaf Energy Balance: Transpiration	
February 3	Leaf energy balance: Conduction & Convection	
5	Plant Growth Analysis: Relative Growth Rate	
10	Plant Growth Analysis: Leaf and Stem partitioning	
12	Plant Growth Analysis: Community growth rate	Energy Intercepted
17	Plant growth analysis: Leaf angles	by the Plant Community
19	**In class EXAM: Radiation & Growth analysis**	
24	Canopy Photosynthesis: Radiation absorption	
26	Canopy Photosynthesis: Radiation attenuation	
March 2	Canopy Photosynthesis: Radiation attenuation	
4	Photosynthetic efficiency	
7 – 11	Spring Break - no class	
16	Photosynthetic efficiency	Energy conversion
18	Photosynthetic efficiency	in photosynthesis
23	C_3/C_4/CAM Characteristics in Plants	
25	Water Use Efficiency: stomatal control	
30	Maintenance and Growth Respiration	Energy Conversion
	(Take home mid-term - 24 hours- due next day at noon)	in respiration
April 1	Maintenance and Growth Respiration	
6	Long distance Transport: Pressure gradients	
8	Phloem Transport: Driving gradients	Energy Partitioning
13	Assimilate Partitioning: Source-Sink Relationships	to seeds
15	Assimilate Partitioning: Source-Sink Relationships	
20	Absorption Capacity of Root Systems	
22	Nitrogen: uptake, translocation, assimilation	
27	Stress Physiology: Water	
29	Stress Physiology: Temperature	
May 4	**Wednesday - Comprehensive Final Exam: 11:30 – 1:20**	



Environmental
Plant Physiology
$\Psi = R/V_w * T_k * Ln(RH)$
$Rn = \lambda E + H + P - R + G$
$E = \sigma T^4$
Flux = g(Ci - Ca)
Carbon Use Efficiency = Pnet / Pgross
$\Psi_T = \Psi_s + \Psi_p$
$RGR = \frac{\ln(M_2) - \ln(M_1)}{t_2 - t_1}$
$\frac{I_o}{I_i} = e^{K \times LAI}$
Ψ_m

World Water Use





Environmental Plant Physiology 5270 / 6270
Modeling assignment number one

$E = mc^2$

5 points – show your work below

Make strict use of SI units

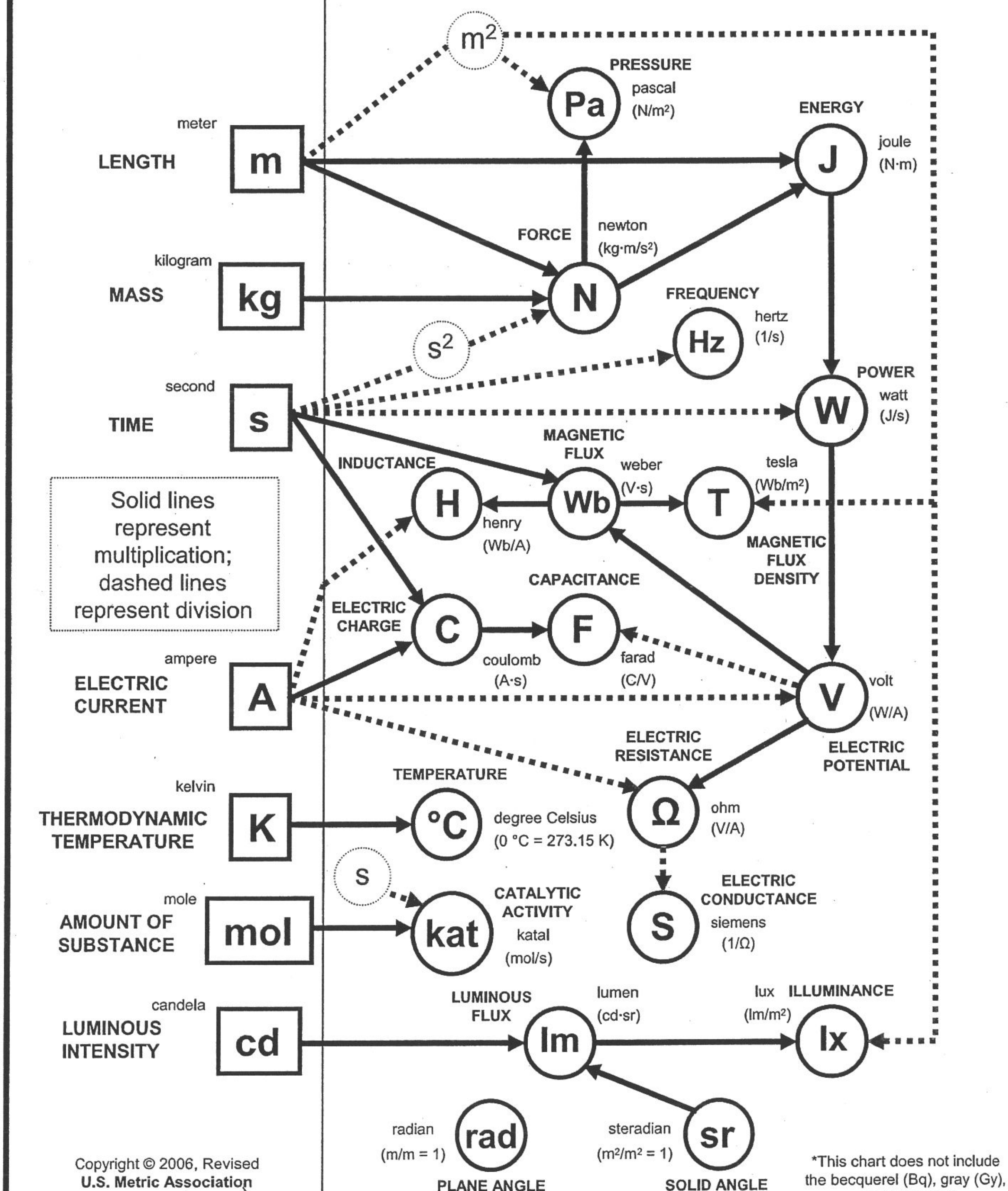
Name______________________________

1. Based on Einstein's famous equation, calculate how much energy is in a typical pea seed. If you could convert all of the dry mass in this pea seed to energy, how many years could you live after eating it?


m
kg
s
SI
cd
mol
K
A

SI UNITS

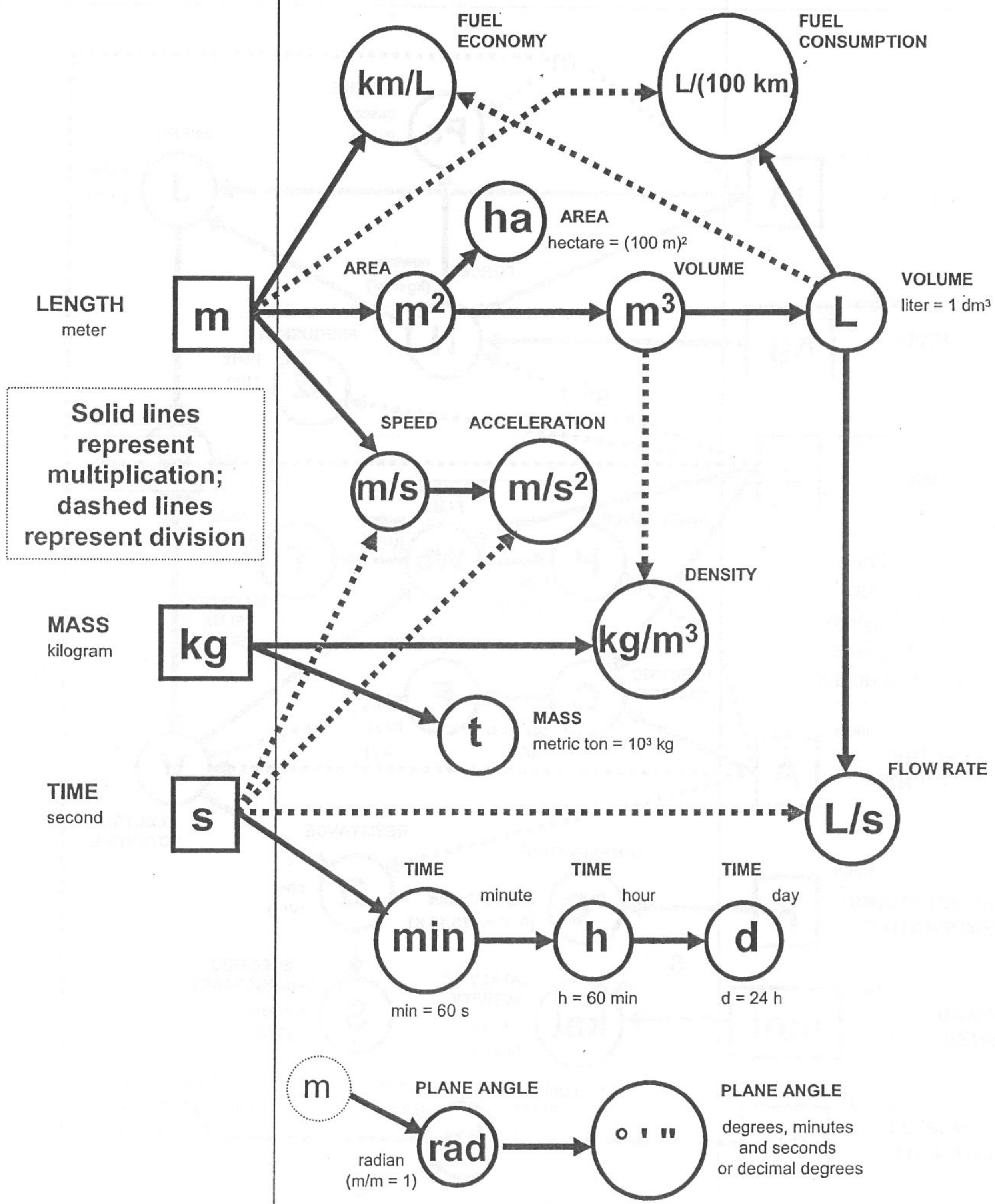
BASE UNITS | DERIVED UNITS WITH SPECIAL NAMES*



*This chart does not include the becquerel (Bq), gray (Gy), or sievert (Sv)

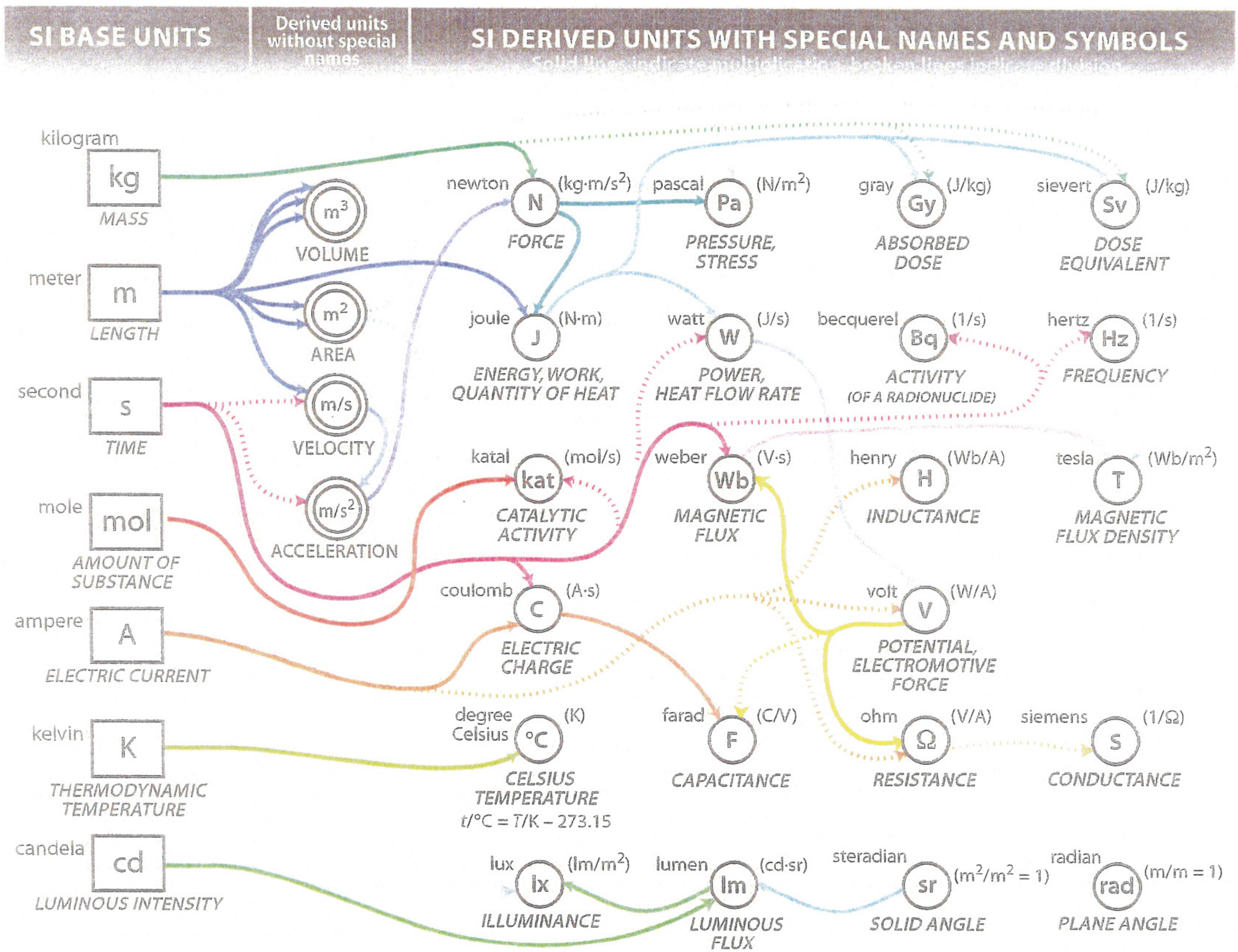
SI UNITS

BASE UNITS | EXAMPLES OF DERIVED UNITS*



1° = (π/180) rad
1' = (1/60)°
1" = (1/60)'

*The named units: hectare (ha), liter (L), metric ton (t), minute (min), hour (h), day (d), and degree, minute, and second of plane angle (° ' ") are approved for use with SI



SI BASE UNITS
Derived units without special names
SI DERIVED UNITS WITH SPECIAL NAMES AND SYMBOLS
Solid lines indicate multiplication, broken lines indicate division
kilogram
kg
MASS
meter
m
LENGTH
second
s
TIME
mole
mol
AMOUNT OF SUBSTANCE
ampere
A
ELECTRIC CURRENT
kelvin
K
THERMODYNAMIC TEMPERATURE
candela
cd
LUMINOUS INTENSITY
m³
VOLUME
m²
AREA
m/s
VELOCITY
m/s²
ACCELERATION
newton
N
(kg·m/s²)
FORCE
pascal
Pa
(N/m²)
PRESSURE, STRESS
gray
Gy
(J/kg)
ABSORBED DOSE
sievert
Sv
(J/kg)
DOSE EQUIVALENT
joule
J
(N·m)
ENERGY, WORK, QUANTITY OF HEAT
watt
W
(J/s)
POWER, HEAT FLOW RATE
becquerel
Bq
(1/s)
ACTIVITY (OF A RADIONUCLIDE)
hertz
Hz
(1/s)
FREQUENCY
katal
kat
(mol/s)
CATALYTIC ACTIVITY
weber
Wb
(V·s)
MAGNETIC FLUX
henry
H
(Wb/A)
INDUCTANCE
tesla
T
(Wb/m²)
MAGNETIC FLUX DENSITY
coulomb
C
(A·s)
ELECTRIC CHARGE
volt
V
(W/A)
POTENTIAL, ELECTROMOTIVE FORCE
degree Celsius
°C
(K)
CELSIUS TEMPERATURE
t/°C = T/K – 273.15
farad
F
(C/V)
CAPACITANCE
ohm
Ω
(V/A)
RESISTANCE
siemens
S
(1/Ω)
CONDUCTANCE
lux
lx
(lm/m²)
ILLUMINANCE
lumen
lm
(cd·sr)
LUMINOUS FLUX
steradian
sr
(m²/m² = 1)
SOLID ANGLE
radian
rad
(m/m = 1)
PLANE ANGLE