Appendix B — Supplement

Problem B.4

Calculate the magnitude of the physical quantities in the indicated units. Show all of your work. [Do not just look up one single unit conversion factor in a table.] If it is impossible to make the conversions indicated, please state the reasons why you believe this to be the case.

a) Dynamic Viscosity:
\[
15 \text{ kg/(m} \cdot \text{s)} = \underline{\underline{\text{________}}\text{ Pa} \cdot \text{s}} = \underline{\underline{\text{________}}\text{ slug/ft} \cdot \text{s}}
\]
b) Pressure
\[
100 \text{ lbf/in}^2 = \underline{\underline{\text{________}}\text{ lbf/ft}^2} = \underline{\underline{\text{________}}\text{ bar}}
\]
c) Energy per unit mass
\[
2000 \text{ ft} \cdot \text{lbf/slug} = \underline{\underline{\text{________}}\text{ ft}^2/\text{s}^2} = \underline{\underline{\text{________}}\text{ kJ/kg}}
\]
d) Product of pressure and specific volume
\[
3000 \text{ bar} \cdot \text{m}^3/\text{kg} = \underline{\underline{\text{________}}\text{ kJ/kg}} = \underline{\underline{\text{________}}\text{Btu/s}}
\]

Problem B.5

The following unit equivalence factors for moment of inertia were copied from a standard controls textbook:

\[
1 \text{ lb} \cdot \text{in} \cdot \text{s}^2 = 386 \text{ lb} \cdot \text{in}^2 \quad \text{and} \quad 1 \text{ g} \cdot \text{cm} \cdot \text{s}^2 = 980 \text{ g} \cdot \text{cm}^2
\]

A quick examination seems to indicate some strange results that are dimensionally inconsistent, e.g. \(1 \text{ in}^2 = 386 \text{ in}^2\) and \(1 \text{ cm} \cdot \text{s}^2 = 980 \text{ cm}^2\). How can this be? What if the author had distinguished between lbf (pound-force) and lbm (pound-mass) and between g\(_f\) (gram-force) and g\(_m\) (gram-mass)? Would make the expressions above dimensionally correct? Please explain.

Problem B.6

A moon landing craft has a mass of 5000 lbm on the surface of the earth.

(a) Determine the following information when the object is on the surface of the earth:

.....weight of the object in lbf
.....mass of the object mass in slugs

(b) Determine the following information for the object when it sits on the surface of the moon if the strength of gravity on the moon is 1/6 of the value on earth:

..... weight of the object in lbf, and
..... mass of the object in lbm and slugs.

(c) An infrequently used unit of force the poundal is defined by the following expression:

\[1 \text{ poundal} = 1 \text{ lbm-ft/s}^2\]

Determine the weight of the object in poundals when it is on the surface of the earth and the surface of the moon.
Problem B.7
A moon landing craft has a mass of 5000 kg on the surface of the earth.
(a) Determine the following information when the object is on the surface of the earth:
.....weight of the object in newtons
.....mass of the object mass in kilograms.
(b) Determine the following information for the object when it sits on the surface of the moon if
the strength of gravity on the moon is 1/6 of the value on earth:
..... weight of the object in newtons, and
..... mass of the object in kilograms.
(c) Although it is not a standard unit of measure, you will sometimes find forces expressed in
terms of kilogram-force, e.g. 1 kgf = 9.81 kg-m/s². Determine the weight of the object in kgf when it is on the surface of the earth and the surface of the moon.

Problem B.8
Engineers often define units which make their life easier and simplify calculations. Calculate the
magnitude of the physical quantities in the indicated units. Consult a good engineering hand-
book to find the units of terms with which you are unfamiliar. Show all of your work. [Do not
just look up one single unit conversion factor in a table.] If it is impossible to make the conver-
sions indicated, please state the reasons why you believe this to be the case.
(a) Unit of mass:  1 blob = 1 lbf/(in/s²)
100 blobs = _____________ lbm = _____________ kg
(b) Units of volume: Acre-foot
10 acre-foot = _____________ ft³ = _____________ gal
(c) Unit of area: circular mils
1000 circular mils = _____________ in² = _____________ mm²
(d) Unit of electrical resistivity: microhms-cm
1000 microhms-cm = _____________ ohms-in = _____________ volt-cm/amp
(e) Unit of electrical inductance: 1 henry = 1 volt-s/amp
100 henrys = _____________ joule/amp² = _____________ hp-s³/coulomb²

Problem B.9
Units of energy and power frequently occur in many different forms. Calculate the magnitude of
the physical quantities in the indicated units. Show all of your work. [Do not just look up one
single unit conversion factor in a table.] If it is impossible to make the conversions indicated,
please state the reasons why you believe this to be the case.
(a) 100 hp = _____________ kW = _____________ J/s
(b) 100 kW-h = _____________ hp-s = _____________ J
(c) 1000 lbf-in³ = _____________ bar-cm² = _____________ ft-lbf
(d) 1000 J = _____________ N-m = _____________ Btu-h
(e) 1000 Btu = _____________ J-ft = _____________ hp-h