Unit Conversion Exercises

To understand the effect that radiation has on biological systems, a number of different systems for measurement have arisen over the last 50 years. European scientists prefer to use Grays and Seiverts while American scientists still use Rads and Rems!

The chart to the left shows your typical radiation dosage on the ground and the factors that contribute to it.

<table>
<thead>
<tr>
<th>Basic Unit Conversions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Curie = 37 billion disintegrations/sec</td>
</tr>
<tr>
<td>1 Gray = 100 Rads</td>
</tr>
<tr>
<td>1 Rad = 0.01 Joules/kg</td>
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<tr>
<td>1 Seivert = 100 Rems</td>
</tr>
<tr>
<td>1 Roentgen = 0.000258 Charges/kg</td>
</tr>
<tr>
<td>1 microCoulomb/kg = 46 milliRem</td>
</tr>
<tr>
<td>1 Coulomb = 6.24 billion billion charges</td>
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<tr>
<td>0.001 milli</td>
</tr>
<tr>
<td>0.000001 micro</td>
</tr>
<tr>
<td>1 lifetime = 70 years</td>
</tr>
<tr>
<td>1 year = 8760 hours</td>
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</tbody>
</table>

Convert:

1. 360 milliRem per year to …………………………..microSeiverts per hour

2. 7.8 milliRem per day to …………………………..Rem per year

3. 1 Rad per day to …………………………………….Grays per year

4. 360 milliRem per year to ……………………………Rems per lifetime

5. 3.0 Roentgens to ………………………………… charges per gram

6. 5.6 Seiverts per year to …………………………….milliRem per day

7. 537.0 milliGrays per year to ………………………..milliRads per hour

Space Math http://spacemath.gsfc.nasa.gov
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Answer Key

1. 360 milliRem per year to \(0.41 \text{ microSeiverts per hour}\)
   \[
   360 \text{ milliRem/yr} \times 1 \text{ Rem/1000 milliRem} \times 1 \text{ year/8760 hours} = 0.000041 \text{ Rem/hour} \\
   0.000041 \text{ Rem/hour} \times 1.0 \text{ Seiverts/100 Rem} = 0.00000041 \text{ Seiverts/hour} \\
   0.00000041 \text{ Seiverts/hour} \times 1 \text{ microSeivert/0.000001Seivert} = 0.41 \text{ microSeiverts/hour}
   
   2. 7.8 milliRem per day to \(2.8 \text{ Rem per year}\)
   \[
   7.8 \text{ milliRem/day} \times 365 \text{ days/year} = 2847.0 \text{ milliRem/year} \\
   2847.0 \text{ milliRem/year} \times 1.0 \text{ Rem/1000milliRem} = 2.8 \text{ Rem/year}
   
   3. 1 Rad per day to \(3.65 \text{ Grays per year}\)
   \[
   1 \text{ Rad/day} \times 365 \text{ days/year} \times 1 \text{ Gray/100 Rads} = 3.65 \text{ Grays/year}
   
   4. 360 milliRem per year to \(25.2 \text{ Rems per lifetime}\)
   \[
   360 \text{ milliRem/year} \times 70 \text{ years/lifetime} \times 1 \text{ Rem/1000 milliRem} = 25.2 \text{ Rems/lifetime}
   
   5. 3.0 Roentgens to \(0.000000774 \text{ charges per gram}\)
   \[
   3.0 \text{ Roentgens} \times 0.000258 \text{ charges/kg per Roentgen} = 0.000774 \text{ charges/kg} \\
   0.000774 \text{ charges/kilogram} \times 1.0 \text{ kg/1000 gram} = 0.000000774 \text{ charges/gram}
   
   6. 5.6 Seiverts per year to \(1530 \text{ milliRem per day}\)
   \[
   5.6 \text{ Seiverts/year} \times 1.0 \text{ Year/365 days} \times 100 \text{ Rem/1.0 Seivert} = 1.53 \text{ Rem/day} \\
   1.53 \text{ Rem/day} \times 1000 \text{ milliRem/Rem} = 1530 \text{ milliRem/day}
   
   7. 537.0 milliGrays per year to \(6.13 \text{ milliRads per hour}\)
   \[
   537.0 \text{ milliGrays/year} \times 1.0 \text{ year/8760 hours} \times 100 \text{ Rads/1.0 Gray} = 6.13 \text{ milliRads/hour}
   
   Note: There are many different conversion 'chains' that the students can offer. The challenge is to set up each ratio correctly with the right number in the numerator and denominator!