Unit 4, Lesson 07: Half-life, Answers to Homework

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9. For a first order reaction: $t_{½} = \frac{0.693}{k}$ and $k = \frac{0.693}{t_{½}}$

a) $t_{½} = \frac{0.693}{k}$

$= \frac{0.693}{9.2\ s^{1-}}$

$= 0.075$ s

b) After 1 half life, 50 % of the cyclopropane will remain
- after 2 half lives, ½ x 50% or 25% will remain
- after 3 half-lives, ½ x 25% or 12.5% will remain
- after 4 half-lives, ½ x 12.5% or 6.25% will remain

10a) $k = \frac{0.693}{t_{½}}$

$= \frac{0.693}{32\ min}$

$= 0.022\ min^{1-}$

or $0.00036\ s^{1-}$

c) 128 minutes represents 4 half-lives, so after 4 half-lives there are 3.1×10^{13} molecules /L
- at 3 half-lives, there would have been 2 x (3.1×10^{13} molecules /L)
- at 2 half-lives there would have been 4 x (3.1×10^{13} molecules /L)
- at 1 half-life there would have been 8 x (3.1×10^{13} molecules /L)
- at time zero, there would have been 16 x (3.1×10^{13} molecules /L) or 5.0×10^{14} molecules /L

11. After 10 half- lives, a reaction is essentially over. This is shown:
- after 1 half life, 50 % of the reactants will remain
- after 2 half lives, ½ x 50% or 25% will remain
- after 3 half-lives, ½ x 25% or 12.5% will remain
- after 4 half-lives, ½ x 12.5% or 6.25% will remain
- after 5 half-lives, ½ x 6.25% or 3.125% will remain
- after 6 half-lives, ½ x 3.125% or 1.56% will remain
- after 7 half-lives, ½ x 1.56% or 0.78% will remain
- after 8 half-lives, ½ x 0.78% or 0.39% will remain
- after 9 half-lives, ½ x 0.39% or 0.195% will remain
- after 10 half-lives, ½ x 0.195% or 0.10% will remain

Because the reactant is essentially consumed by the end of the third half life, very little further reaction can occur.

12. Referring to the half-life calculations above, there is about 10% of the sample left after three half-lives. If the half-life for a reaction is 120 s, then three half-lives is 360 s. It will take slightly longer to consume an additional 2.5%, so it will take about 400 s until only 10% of the original reactant is left.

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7. $t_{½} = \frac{0.693}{k}$

$= \frac{0.693}{0.0234\ a^{1-}}$

$= 29.6$ a ("a" for annum or years)

Convert to seconds:

29.6 year x 365 days/year x 24 h/day x 3600 s/h

$= 9.34 \times 10^{8}$ s