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Beach Volleyball – Nuclear and Organic Chemistry

Nuclear Decay and Equations

1. Write the nuclear equation for the alpha decay of $^{238}_{92}U$

$$^{238}_{92}U \rightarrow {}^{4}_{2}He + {}^{234}_{90}Th$$

2. Write the nuclear equation for the positron emission of $^{8}_{5}B$

$$^{8}_{5}B \rightarrow {}^{8}_{4}Be + {}^{0}_{1}e$$

3. Write the nuclear equation for the beta decay of $^{14}_{6}C$

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$$

4. Write the nuclear equation for the electron capture of $^{18}_{9}F$

$${}^{0}_{-1}e + {}^{18}_{9}F \rightarrow {}^{18}_{10}Ne$$

5. A $^{214}_{84}Po$ nuclide emits two alpha particles and two beta particles. What is the resulting nuclide?

$$^{214}_{84}Po \rightarrow {}^{4}_{2}He + {}^{4}_{2}He + {}^{206}_{80}Hg \rightarrow {}^{206}_{81}Tl$$

Half-Lives

6. Strontium-90 decays through the emission of beta particles. It has a half life of 29 years. How long does it take for 80% of a sample of strontium-90 to decay?

$t_{1/2} = 29\ yr$ $\quad k = \frac{0.693}{29} = 0.0239\ yr^{-1}$

$\ln(0.2) = -(0.0239)t + \ln(1)$

$\boxed{67.3\ yr = t}$

7. After 44 minutes, a sample of $^{44}_{19}K$ is found to have decayed to 25% of the original amount present. What is the half-life of $^{44}_{19}K$?

$\ln(0.25) = -(k)(44) + \ln(1)$

$0.0315\ min^{-1} = k$

$t_{1/2} = \frac{0.693}{0.0315} = \boxed{22\ min}$

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8. Neon-23 is an unstable nuclide with a half-life of 38 second. (a) What form of decay would neon-23 be expected to undergo? Write the balanced nuclear reaction for this process. (b) If you had 52 g of Neon-23, then how much would remain after 4 minutes?

(a) 10 p^+ to 13 n^0 ∴ likely beta decay

$^{23}_{10}Ne \rightarrow {}^{23}_{11}Na + {}^{0}_{-1}e$

(b) $k = \frac{0.693}{38} = 0.0182\ s^{-1}$

$\ln[A]_t = -(0.0182)(240) + \ln(52)$

$\ln[A]_t = -0.417$

$[A]_t = 0.659\ g$

Einstein's Equation

9. The following alpha decay is observed: $^{238}_{92}U \rightarrow {}^{4}_{2}He + {}^{234}_{90}Th$

The masses of the nuclei are uranium = 238.0003 amu, Th = 233.9942 amu, and He = 4.0015 amu. Calculate the amount of energy released in this reaction.

$\Delta m = 233.9942 + 4.0015 - 238.0003 = -0.0046\ g$

$E = (3\times10^8)^2 (-0.0046\ g \times \frac{1\ kg}{1000\ g})$

$E = -4.1\times10^{11}\ J$

10. You know that: mass of proton (mp) = 1.007276 amu, mass of neutron (mn) = 1.008665 amu, and mass of electron (me) = 5.485799×10^{-4} amu. Calculate the mass defect (in amu) and nuclear binding energy (in J/nucleon) for Carbon-12 (nuclear mass: 11.996708 amu)

$6(1.007276) + 6(1.008665) + 12(5.485799\times10^{-4}) = 12.102228\ 96$

$12.10222896 - 11.996708 = 0.10552$ amu

$0.10552\ amu \left(\frac{1\ g}{6\times10^{23}\ amu}\right)\left(\frac{1\ kg}{1000}\right) = 1.7\times10^{-28}$

$E = (3\times10^8)^2 (1.7\times10^{-28}) = 1.53\times10^{-11}\ J$

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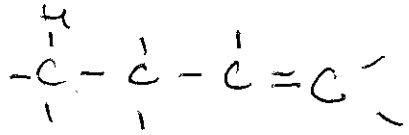
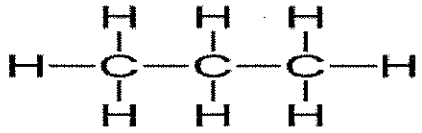
Naming Hydrocarbons

11. Name the following hydrocarbons:

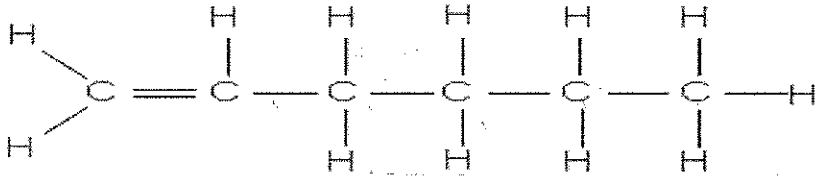
a. C_2H_6: ethane

b. $CH_3CH_2CHCH_2$: butene

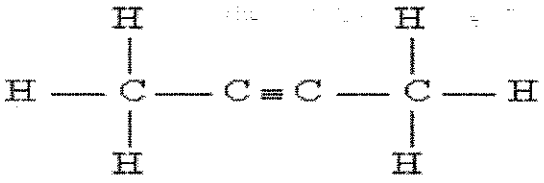


c.  : Propane

d.

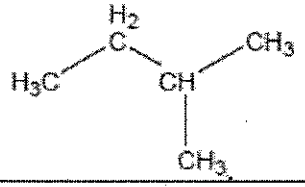
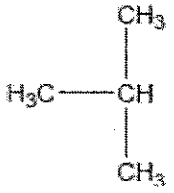
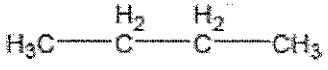


: hexene

e.  : butyne

Isomers

12. What is the relationship between each of the following pairs of structures? Are they totally *different* molecules (i.e., which do not have the same molecular formula), are they *isomers*, or are two drawings of the *same* compound?

5. C_4H_{10} Different molecules	
6. 	

Isomers

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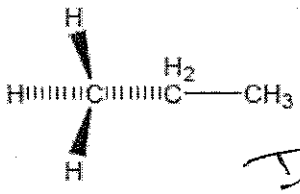
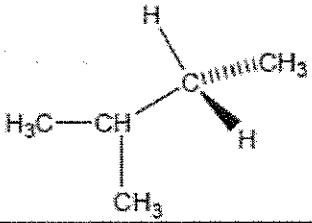
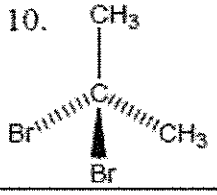
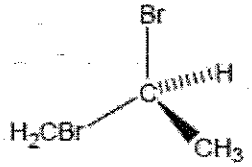
9.  Different molecules	
10.  Isomers	

Functional Groups

16. Circle and label 12 functional groups among the following molecules (no alkanes):