Ch 25

Q1 :

Write a nuclear equation to represent β^--particle emission by ${}^{241}_{94}$Pu.

(E) A β^- has a mass number of zero and an "atomic number" of -1. Emission of this electron has the effect of transforming a neutron into a proton. ${}^{241}_{94}\text{Pu} \rightarrow {}^{241}_{95}\text{Am} + {}^{0}_{-1}\beta$

Q2 :

^{131}I is a β^- emitter used as a tracer for radioimmunoassays in biological systems. Use information in Table 25.1 to determine (a) the decay constant in s^{-1}; (b) the activity of a 2.05 mg sample of ^{131}I; (c) the percentage of ^{131}I remaining after 16 days; and (d) the rate of β^- emission after 16 days.

(M) (a) The decay constant is found from the 8.040-day half-life.

$$\lambda = \frac{0.693}{8.040\ \text{d}} = 0.0862\ \text{d}^{-1} \times \frac{1\ \text{d}}{24\ \text{h}} \times \frac{1\ \text{h}}{60\,\text{min}} \times \frac{1\,\text{min}}{60\ \text{s}} = 9.98 \times 10^{-7}\ \text{s}^{-1}$$

(b) The number of ^{131}I atoms is used to find the activity.

$$\text{no.}^{131}\text{I atoms} = 2.05\ \text{mg} \times \frac{1\ \text{g}}{1000\ \text{mg}} \times \frac{1\ \text{mol}\ ^{131}\text{I}}{131\ \text{g}\ ^{131}\text{I}} \times \frac{6.022 \times 10^{23}\ \text{atoms}}{1\ \text{mol}\ ^{131}\text{I}}$$

$$= 9.42 \times 10^{18}\ \text{atoms}\ ^{131}\text{I}$$

$$\text{activity} = \lambda N = 9.98 \times 10^{-7}\ \text{s}^{-1} \times 9.42 \times 10^{18}\ \text{atoms} = 9.40 \times 10^{12}\ \text{disintegrations / second}$$

(c) We now determine the number of atoms remaining after 16 days. Because two half-lives elapse in 16 days, the number of atoms has been halved twice, to one-fourth (25%) the original number of atoms.

$$N_t = 0.25 \times N_0 = 0.25 \times 9.42 \times 10^{18}\ \text{atoms} = 2.36 \times 10^{18}\ \text{atoms}$$

(d) The rate after 14 days is determined by the number of atoms present on day 14.

$$\text{rate} = \lambda N_t = 9.98 \times 10^{-7}\ \text{s}^{-1} \times 2.36 \times 10^{18}\ \text{atoms} = 2.36 \times 10^{12}\ \text{dis/s}$$

Q3 :

^{223}Ra has a half-life of 11.4 days. How would it take for the activity associated with a sample of ^{223}Ra to decrease to 1.0% of its current value?

(M) First we determine the value of λ: $\lambda = \frac{0.693}{t_{1/2}} = \frac{0.693}{11.4\ \text{d}} = 0.0608\ \text{d}^{-1}$

Then we set $N_t = 1\% N_0 = 0.010 N_0$ in equation (25.12).

$$\ln \frac{N_t}{N_0} = -\lambda t = \ln \frac{0.010 N_0}{N_0} = \ln\left(0.010\right) = -4.61 = -\left(0.0608\ \text{d}^{-1}\right)t$$

$$t = \frac{-4.61}{-0.0608\ \text{d}^{-1}} = 75.8\ \text{d}$$

Q4 :

What is the age of a mummy, given a ^{14}C activity of 8.5 dis min^{-1}g^{-1}?

(M) The half-life of $^{14}\mathrm{C}$ is 5730 y and $\lambda = 1.21\times10^{-4}\ \mathrm{y}^{-1}$. The activity of $^{14}\mathrm{C}$ when the object supposedly stopped growing was 15 dis/min per g C. We use equation (25.12) with activities (λN) in place of numbers of atoms (N).

$$\ln\frac{A_t}{A_0} = -\lambda t = \ln\frac{8.5\ \text{dis/min}}{15\ \text{dis/min}} = -\left(1.21\times10^{-4}\ \mathrm{y}^{-1}\right)t = -0.56_8\,;t = \frac{0.57}{1.21\times10^{-4}\ \mathrm{y}^{-1}} = 4.7\times10^{3}\ \mathrm{y}$$

Q5 :

What is the energy associated with the a decay of ^{145}Sm(145.913053 u) to ^{142}Nd(141.907719 u)?Use 4.002603 u as the mass of ^{4}He.

(M)

$$\text{mass defect.} = 145.913053\ \mathrm{u}\left(^{146}\mathrm{Sm}\right) - 141.907719\ \mathrm{u}\left(^{142}\mathrm{Nd}\right) - 4.002603\ \mathrm{u}\left(^{4}\mathrm{He}\right) = 0.002731\ \mathrm{u}$$

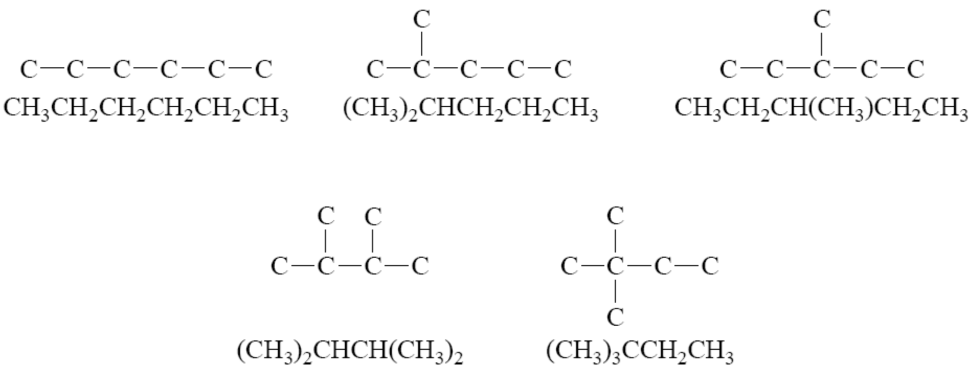
Then, from the text, we have $931.5\ \mathrm{MeV} = 1\ \mathrm{u}$ $E = 0.002731\ \mathrm{u}\times\dfrac{931.5\ \mathrm{MeV}}{1\ \mathrm{u}} = 2.544\ \mathrm{MeV}$

Ch26

Q1 :

Write condensed structural formulas for the five constitutional isomers with the formula C_6H_{14}.

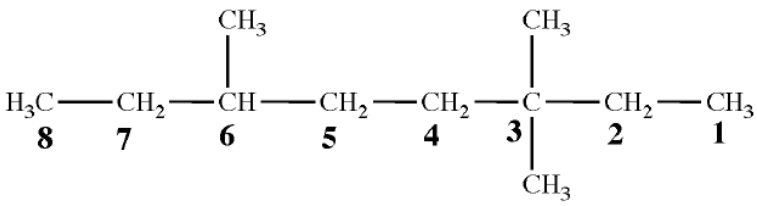
(E) We have shown only the C atoms and the bonds between them. Remember that there are four bonds to each C atom; the remaining bonds not shown are to H atoms. First we realize there is only one isomer with all six C atoms in one line. Then we draw the isomers with one 1-C branch. The isomers with two 1-C branches can have them both on the same atom or on different atoms. This accounts for all five isomers.



Q2 :

Give an IUPAC name for $CH_3CH_2CH(CH_3)CH_2CH_2C(CH_3)_2CH_2CH_3$.(Hint: Any CH_3 group enclosed in parentheses is bonded only to the C atom preceding it.)

(M)



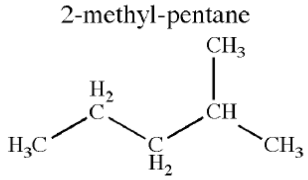
3,3,6-trimethyloctane

Numbering starts from the right and goes left so that the substituents appear with the lowest numbers possible. This is 3,6,6-trimethyloctane.

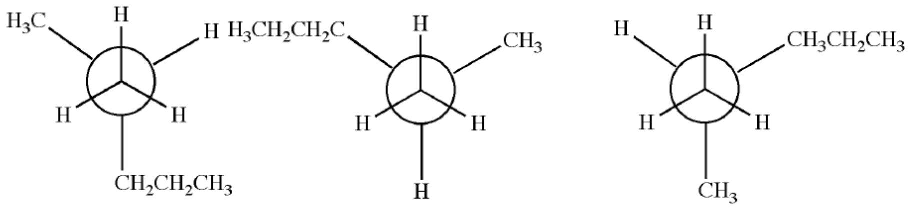
Q3 :

Draw Newman projections for the staggered conformations of 2-methylpentane when the molecule is viewed along the C1---C2 bond. Rank the conformations in order of increasing energy (from lowest to highest).

(M) The structural diagram for 2-methyl-pentane is given below:



When the molecule is viewed along C1-C2 bond there are several possible staggered conformations:

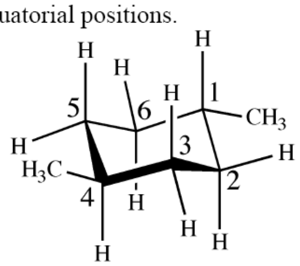


There are no gauche interactions in this molecule. Therefore, conformations (a), (b) and (c) all have the same energy.

Q4 :

Draw the lower energy conformation of *trans*-1,4-dimethylcyclohexane.

(M) We are dealing with a trans isomer, and so both methyl groups are adjacent to opposite face of the ring. The conformation of the lowest energy will be the one that has the methyl groups in the equatorial positions.

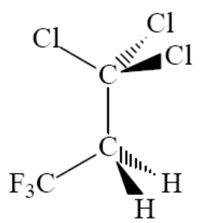


Q5 :

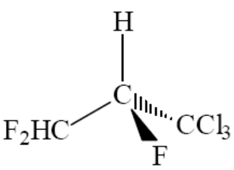
Which of the following chlorofluorohydrocarbons is chiral:

(a)$CF_3CH_2Cl_3$; (b) $CF_2HCHFCCl_3$; (c) $CClFHCHHCCl_2F$?

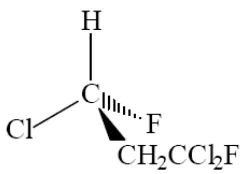
(M)



All three carbon atoms in this molecule are attached to at least two groups of the same type; thus, the molecule is achiral



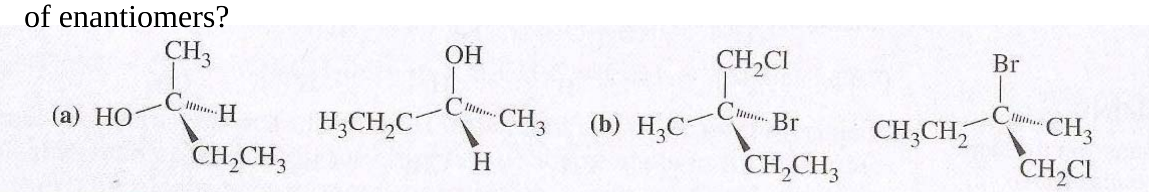
This molecule contains a carbon atom that is bonded to four different groups; consequently, the molecule is chiral.



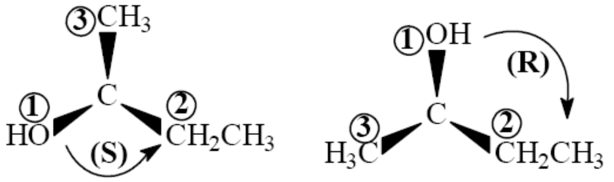
This molecule contains a carbon atom that is attached to four different groups; consequently, the molecule is chiral.

Q6 :

Do the structures in each of the following pairs represent identical molecules or pairs of enantiomers?

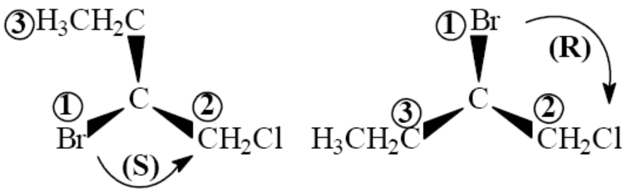


(D)(a)



Thus, the structures are enantiomers.

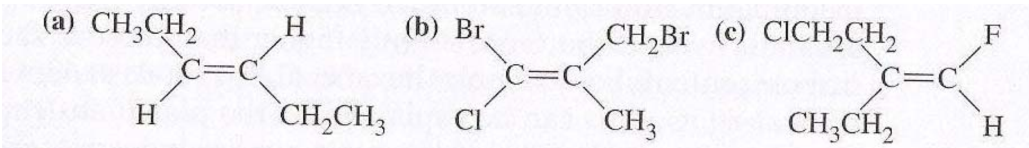
(b)



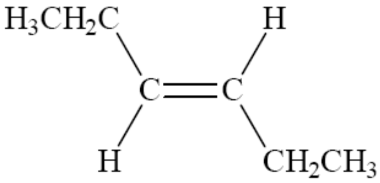
Thus, the structures are enantiomers.

Q7 :

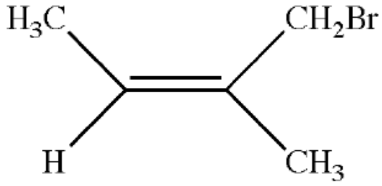
Assign a configuration to each of the following alkens:



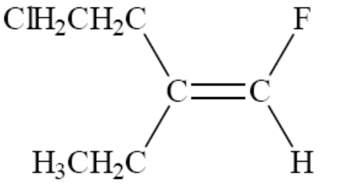
(M)(a) This is the (E) stereoisomer



(b) This is the (Z) stereoisomer



(c) This is the (Z) stereoisomer



Ch28

Q1 :

Of the following, the one that is not a constituent of a nucleic acid chain is (a) purine base; (b) phosphate group; (c) glycerol; (d) pentose sugar; (e) pyrimidine base.

(E) The answer is (c). Glycerol is part of the triglycerides.

Q2 :

The structure of the DNA molecule is best described as (a) a random coil; (b) a double helix; (c) a pleated sheet; (d) partly coiled; (e) a branched chain.

(E) The answer is (b), double helix.

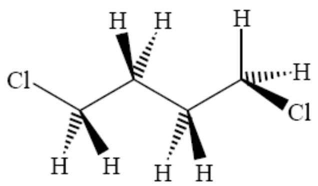
Q3 :

Which molecule is not optically active?

(a) 1,2-dichlorobutane; (b)1,4-dichlorobutane; (c) 1,3-dichlorobutane;

(d) 1,2-dichloropropane; (e) none of these.

(M) The answer is (b), 1,4-dichlorobutane. See structure below:



Q4 :

Which of the following amino acid does not have a chiral carbon?

(a) glycine; (b) alanine; (c) threonine; (d) lysine; (e) none of these.

(E) The answer is (a), glycine. It is the only non-chiral amino acid, because the –R group is just –H.

Q5 :

Enantiomers always (a) have an asymmetric carbon; (b) have different physical properties; (c) change the color of light; (d) rotate polarized; (e) none of these.

(E) The answer is (d), they always rotate plane-polarized light.