MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) Choose the INCORRECT statement.
A) An alpha particle is the nucleus of a helium-4 atom.
B) A positron is like a beta particle but with a positive charge.
C) Gamma rays are emitted from a nucleus in an excited state.
D) Radioactivity is the emission of ionizing radiation.
E) A beta particle is a neutron.

Answer: E

2) Consider the following nuclear reactions.

$$^{27}_{13}\text{Al} + ^{4}_{2}\text{He} \rightarrow \underline{1} + ^{1}_{0}\text{n}$$

$$\underline{1} \rightarrow ^{30}_{14}\text{Si} + \underline{2}$$

What are the nuclides 1 and 2, respectively?

A) $^{30}_{14}$Si and $^{0}_{-1}\beta$ B) $^{30}_{12}$Mg and 2 $^{0}_{+1}\beta$ C) $^{30}_{16}$S and $^{0}_{-1}\beta$ D) $^{30}_{15}$P and $^{0}_{+1}\beta$

Answer: D

3) What is the decay constant for ^{131}I if the half-life is 8.04 d?
A) $9.98 \times 10^{-7}\ s^{-1}$ B) $4.81 \times 10^{-4}\ s^{-1}$ C) $3.48 \times 10^{-6}\ s^{-1}$ D) $9.31 \times 10^{-5}\ s^{-1}$

Answer: A

4) Which of the following is FALSE?
A) An e^- capture converts a proton to a neutron in the nucleus of an atom.
B) A β^+ decay converts a proton to a neutron in the nucleus of an atom.
C) A β^- decay results in a decrease in atomic number.
D) A β^- particle is essentially an e- originating from the nucleus.
E) A β^- decay is accompanied by the emission of a neutrino.

Answer: C

5) Half-life is:
I) the time for a sample to decay completely.
II) constant for a given radioisotope.
III) the time required for half of a sample to decay.
IV) inversely proportional to the decay constant.
A) I and II
B) I, II, and III
C) I and III
D) I, III, and IV
E) II, III, and IV

Answer: E

6) ^{8}Be $\rightarrow$ ^{4}He + _____
A) ^{3}Be B) ^{8}He C) ^{4}Li D) ^{12}C E) ^{4}He

Answer: E

7) Which of the following statements concerning alpha decay is INCORRECT?
A) It involves nuclides with atomic number larger than 83 and mass number larger than 200.
B) It has great penetrating power, but little ionizing power.
C) It often leaves the nucleus in an excited state.
D) The alpha particle is made up of two protons and two neutrons.
E) The atomic number decreases by two.

Answer: B

8) Phosphorus-32 has a half-life of 14.3 days. How many grams remain from a 10.0 gram sample after 30.0 days?
A) 0.340 g B) 7.18 g C) 2.34 g D) 4.64 g E) 3.59 g

Answer: C

9) A wooden artifact is subjected to radiocarbon dating. The activity associated with its ^{14}C content is 12 dis min^{-1} g^{-1}. A sample of wood from a modern source gave 15 dis min^{-1} g^{-1}. If the half-life of ^{14}C is 5730 y, what is the age of the artifact?
A) 7.2×10^3 y B) 1.3×10^3 y C) 1.8×10^3 y D) 800 y

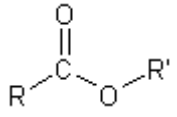
Answer: C

10) Emission of which one of the following leaves both atomic number and mass number unchanged?
A) positron
B) alpha particle
C) gamma radiation
D) neutron
E) beta ray

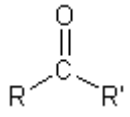
Answer: C

11) Which of the following classes of organic compounds and their general structural formulas have been correctly matched?

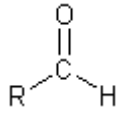
I) ester:



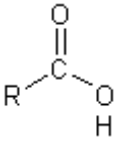
II) Aldehyde:



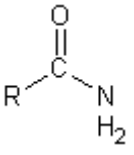
III) Ketone:



IV) Carboxylic acid:



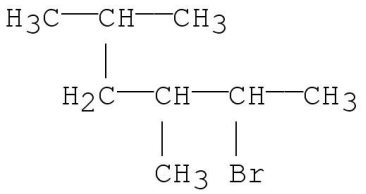
V) Amide:



A) I), IV), and V)
B) II), III), and V)
C) I), II), and V)
D) III), IV), and V)
E) II), IV), and V)

Answer: A

12) What is the IUPAC name for the following molecule?



A) 2-bromo-3,5-dimethylhexane
B) 3,5-dimethyl-2-bromohexane
C) 2-bromo-3-methyl-4-propylbutane
D) 2-bromo-4-isopropyl-3-methylbutane
E) 2-bromo-5,5,3-trimethylpentane

Answer: A

13) What are heterocyclic compounds?
A) They are cyclic compounds in which two or more carbon rings are connected with C-C bons (for example biphenyl)
B) They are cyclic compounds in which carbon ring is connected to another ring not containing carbon atoms
C) They are cyclic compounds that can have more than one stable conformation
D) They are cyclic compounds in which carbon has one or more substituents that are neither hydrogen or another carbon atom
E) They are cyclic compounds in which one or more atoms are not carbon atoms

Answer: E

14) Which class of compounds is most oxidized?
A) acids B) alkanes C) ketones D) alcohols E) aldehydes

Answer: A

15) Give the name for $CH_3CH{=}CHCH_3$.
A) 2-butene B) 3-butene C) 2-propene D) 2-butane E) 2-pentene

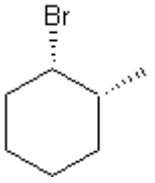
Answer: A

16) What is the condensed structural formula for 2-pentyne?
A) $CH_3CH{\equiv}CHCH_2CH_3$
B) $CH_3CH{\equiv}CCH_2CH_2CH_3$
C) $CH_3C{\equiv}CCH_3$
D) $CH_3C{\equiv}CCH_2CH_3$
E) $CH_2{\equiv}CHCH_2CH_2CH_3$

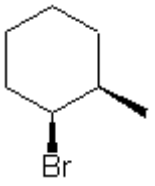
Answer: D

17) Which of the following structures represent the structure of trans-1-bromo-2-methylcyclohexane?

A)

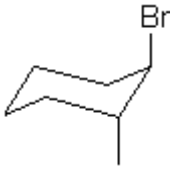


B)

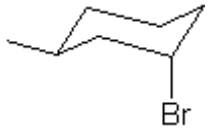


C)

D)



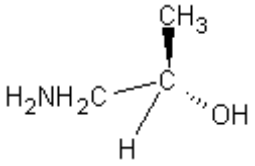
E)



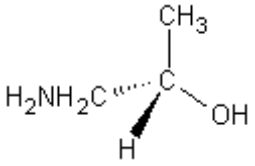
Answer: D

18) Which of the following structures represents a structure of R isomer of 1-amino-2-propanol?

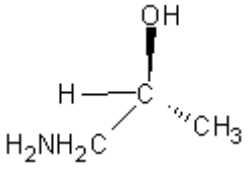
A)



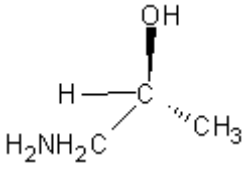
B)



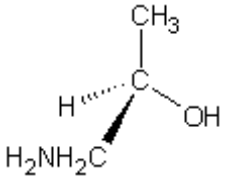
C)



D)

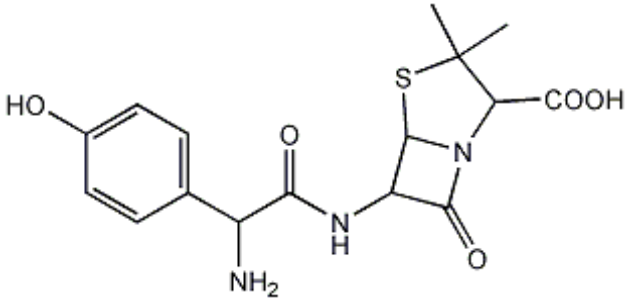


E)



Answer: E

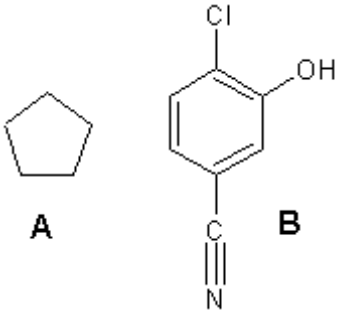
19) How many chiral carbon atoms can you find in the molecule below?



A) 1 B) 2 C) 3 D) 4 E) 5

Answer: D

20) What is the degree of unsaturation for the following compounds?



$C_{20}H_{32}ClN$

C

A) For A the degree of unsaturation is 1, for B is 6 and for C is 4.
B) For A the degree of unsaturation is 1, for B is 6 and for C is 5.
C) For A the degree of unsaturation is 1, for B is 5 and for C is 6.
D) For A the degree of unsaturation is 0, for B is 6 and for C is 5.
E) For A the degree of unsaturation is 1, for B is 4 and for C is 5.

Answer: B

21) Which class of compounds is the least reactive?
A) aldehydes
B) alkyl halides
C) alcohols
D) ketones
E) ethers

Answer: E

22) $C_4H_{10}O$ has how many skeletal isomers?
A) 6 B) 12 C) 11 D) 7 E) 8

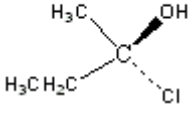
Answer: D

23) Combustion of 493 mg of a hydrocarbon gave 1549 mg CO_2 and 633.9 mg H_2O. What is the molecular formula if the molecular weight is subsequently found to be 42?
A) CH_2 B) C_3H_6 C) C_6H_{12} D) C_2H_2O E) CO_2

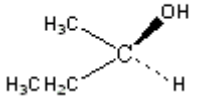
Answer: B

24) Which of the following chiral compounds is(are) S enantiomer(s)?

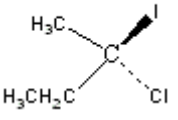
I.



II.



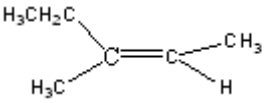
III.

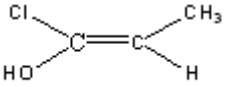


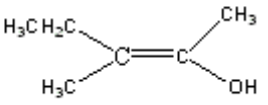
A) I B) II C) III D) I + II E) II + III

Answer: A

25) Which of the following compounds is(are) Z configuration(s)?

I. 

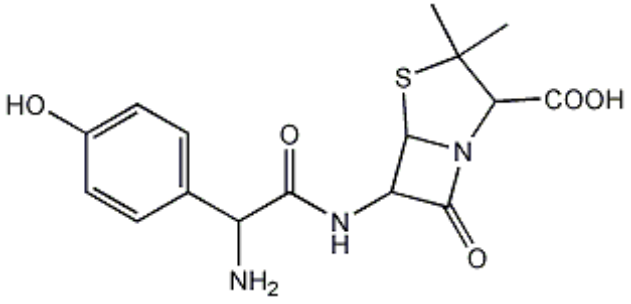
II. 

III. 

A) I B) II C) III D) I + II E) I + II + III

Answer: D

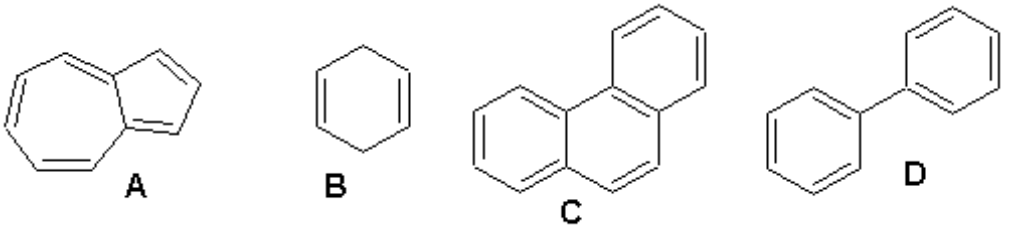
26) Calculate the degree of unsaturation for the molecule below:



A) 3 B) 5 C) 7 D) 9 E) 11

Answer: D

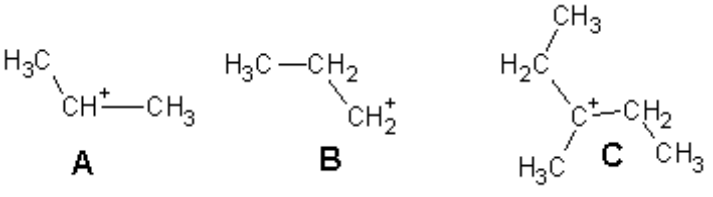
27) Which of the following four molecules are aromatic?



A) A, C, D B) A, B, D C) B, C D) B, D E) A, D

Answer: A

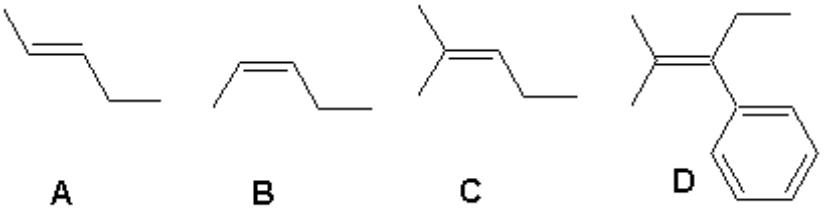
28) Arrange the following carbocations in order of *decreasing* stability:



A) A > B > C B) A > B > C C) B > A > C D) C > A > B E) C > B > A

Answer: D

29) Arrange the following alkenes according to their *increasing* stability:



A) A < B < C < D
B) C < A < B < D
C) B < A < C < D
D) C < B < A < D
E) B < C < A < D

Answer: C

30) What is a dehydration reaction?

A) Dehydration is elimination of water molecule from an alcohol molecule to produce alkene.
B) Dehydration reaction is deprotonation of a substrate with a strong base in E2 mechanism.
C) Dehydration reaction is removal of one equivalent of H_2 from an alkane to produce alkene.
D) Dehydration reaction is one of the steps in chain-reaction polymerization.
E) Dehydration reaction is removal of crystalline water.

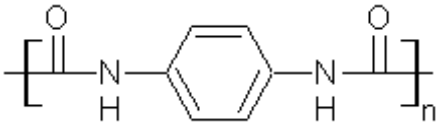
Answer: A

31) What are the three characteristic steps in a chain-reaction polymerization?

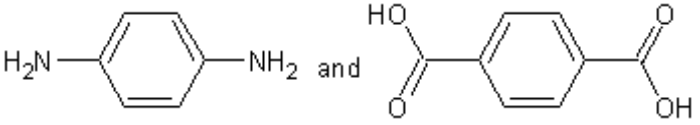
A) racemization, propagation and quenching
B) breaking, elongation and quenching
C) propagation, formation and termination
D) initiation, propagation and termination
E) initiation, elongation and termination

Answer: D

32) Which type of polymerization and which monomer(s) would you use to prepare poly(1,4-phenylenediformamide) with the following structure?

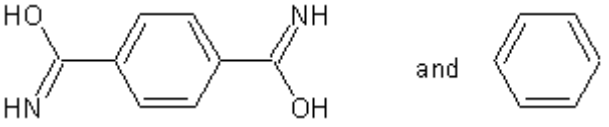


A)



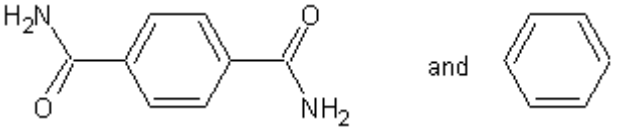
with step-reaction polymerization

B)



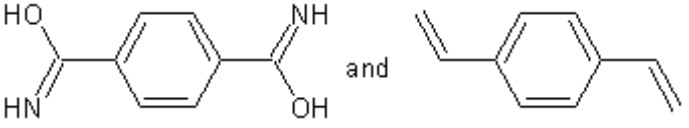
with condensation polymerization

C)



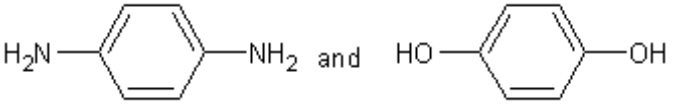
with chain reaction polymerization

D)



with chain reaction polymerization

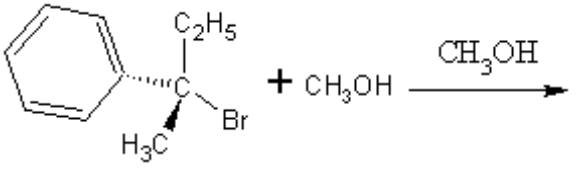
E)



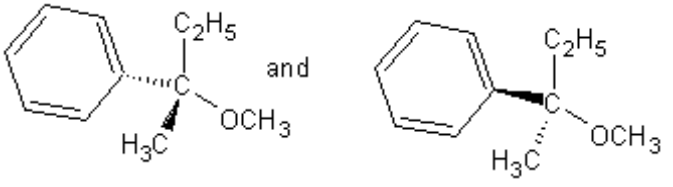
with chain reaction polymerization

Answer: A

33) Identify the product(s) and mechanism for the following reaction:

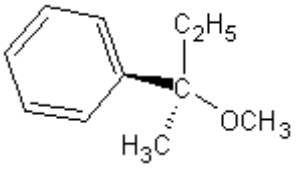


A)



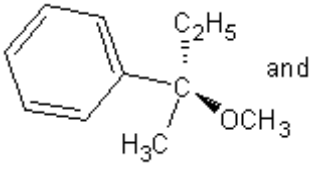
S_N2 mechanism

B)

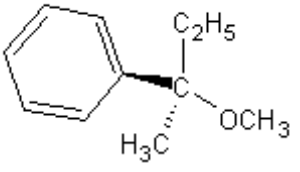


S_N2 mechanism

C)

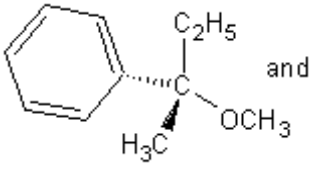


and

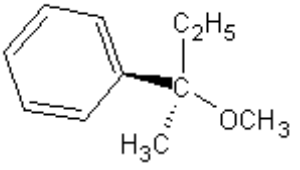


S_N1 mechanism

D)

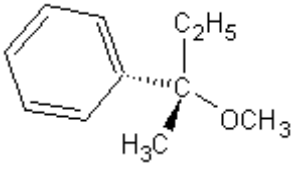


and



S_N1 mechanism

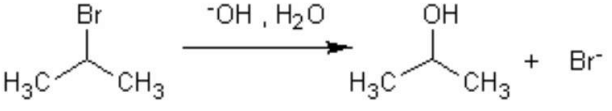
E)



S_N2 mechanism

Answer: D

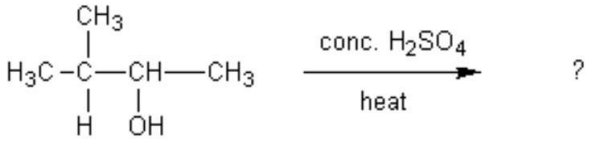
34) The formation of isopropanol (rubbing alcohol) through the following hydrolysis is known as what type of general reaction?



A) addition reaction
B) elimination
C) aromatic substitution
D) substitution reaction
E) oxidation

Answer: D

35) What alkene(s) would be produced in the following reaction?



A) pentene and 1-methylpentene
B) 3-methyl-2-pentene
C) 3-methylbutene
D) 2-methyl-2-butene and 3-methylbutene
E) 2-methyl-2-butene

Answer: D

36) Choose the INCORRECT statement.
A) Salts of fatty acids are called soaps.
B) Glycerides can be hydrolyzed in alkaline solution to glycerol and salts of fatty acids.
C) Saturated fatty acids have multiple double bonds.
D) When the long chain monocarboxylic acids are removed from a triglyceride they are called fatty acids.
E) The hydrolysis of triglycerides is called saponification.

Answer: C

37) Choose the INCORRECT statement.
A) Fats and oils are glyceryl esters.
B) Pure fats and oils are colorless, odorless and tasteless.
C) Oils are liquid at room temperature.
D) Triglycerides are glyceryl esters.
E) Oils have predominately saturated acid components.

Answer: E

38) Enantiomers ALWAYS:
A) have different chemical properties
B) have an asymmetric carbon
C) have different physical properties
D) rotate polarized light
E) change the color of light

Answer: D

39) Cellulose and starch are both polymers of glucose units, but most animals can only use starch as a source of carbohydrate in their diets. Why are most animals incapable of digesting cellulose?
A) Most animals do not produce enzymes which are capable of hydrolyzing β linkages between glycoses.
B) This statement is incorrect. Most animals can digest cellulose.
C) The glucose units of cellulose are in the open chain form and cannot be hydrolyzed by the cyclic-sugar specific enzymes of animals.
D) Starch contains α linkages between carbons 1 and 4, where as cellulose contains β linkages between carbons 1 and 2.
E) The polymer of cellulose is simply too long to be completely digested by animals.

Answer: A

40) Amino acids are joined into proteins by:
A) a beta 1-4 linkage
B) peptide bonds
C) DNA
D) an ester
E) a 3'-5' linkage

Answer: B

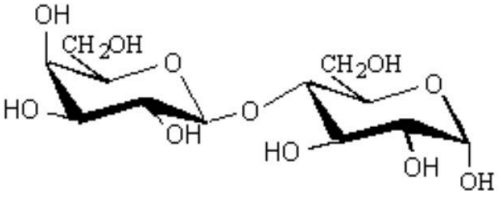
41) By definition, exergonic reaction has:
A) ΔG= negative value
B) ΔH= positive value
C) ΔG= positive value
D) ΔS = positive value
E) ΔH= negative value

Answer: A

42) Glycine is a(n):
A) optically active compound
B) lipid
C) carbohydrate
D) nucleic acid
E) amino acid

Answer: E

43) Lactose, the sugar found in milk, is a disaccharide of galactose and glucose in a 1,4 linkage. What is the configuration of the 1,4 linkage between the two glycoses in lactose?



A) β configuration
B) α configuration
C) chair configuration
D) axial configuration
E) D configuration

Answer: A

44) All amino acids always contain one chemical element which is absent in the structures of carbohydrates. This element is _____.
A) phosphorus B) sulfur C) nitrogen D) oxygen E) carbon

Answer: C

45) A protein molecule has a molecular weight of 7.70×10^5. The mass percent of magnesium in the protein is 3.16×10^{-3}%. How many magnesium atoms are there in one protein molecule?
A) 1 B) 2 C) 3 D) 24 E) 5

Answer: A

46) When the equation for the oxidation of glucose is balanced, the coefficients are: _____.

$C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

A) 4, 2, 4, 2 B) 1, 3, 6, 6 C) 2, 6, 12, 12 D) 1, 6, 6, 6 E) 1, 9, 6, 12

Answer: D

47) Which of the following structural elements cannot be found in DNA?

A) pentose B) purine C) phosphate D) pyrimidine E) heme

Answer: E

48) Which complex ion possesses the largest number of unpaired electrons?

A) $Mn(CN)_6^{4-}$

B) $Cu(NH_3)_4^{2+}$

C) $CoCl_4^{2-}$

D) $Fe(H_2O)_6^{3+}$

E) $Cr(NH_3)_6^{2+}$

Answer: D

49) Of the following complex ions: $[CoCl(NH_3)_5]^{2+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(H_2O)_6]^{3+}$, one appears pink, two are yellow, and one blue. Which is blue?

A) both $[Co(en)_3]^{3+}$ and $[Co(H_2O)_6]^{3+}$

B) $[CoCl(NH_3)_5]^{2+}$

C) $[Co(NH_3)_6]^{3+}$

D) $[Co(H_2O)_6]^{3+}$

E) $[Co(en)_3]^{3+}$

Answer: D

50) The net formation constant for tetraamminezinc(II) is 4.1×10^8. What would be the approximate potential of the galvanic cell symbolized below?

$Zn/Zn(NH_3)_4^{2+}$ (1.0 M), NH_3(1.0 M)//Zn^{2+}(1.0 M)/Zn

A) 0.25 V B) 0.51 V C) 1.02 V D) 0.76 V E) 0.00 V

Answer: A