

- Out of Sn^{2+} , Ni^{2+} , & Fe^{3+} , oxides as well as sulphides are formed by
 (a) Sn^{2+} & Ni^{2+} (b) Ni^{2+} & Fe^{3+} (c) Sn^{2+} & Fe^{3+} (d) All the above
- Color of complexes is satisfactorily explain by
 (a) Werner's theory (b) Valence Bond Theory (c) Crystal field Theory (d) Ligand Field Theory
- Which of the following system has maximum number of unpaired electrons?
 (a) d_6 (tetrahedral) (b) d_9 (octahedral) (c) d_7 (octahedral, high spin) (d) d_4 (octahedral, low spin)
- What is the oxidation state of Iron in Hemoglobin & Myoglobin Respectively?
 (a) 3, 2 (b) 2, 2 (c) 2, 3 (d) 3, 3
- During biological nitrogen fixation nitrifying bacteria converts
 (a) NO_3^- to NH_4^+ (b) N_2 to NH_4^+ (c) NH_4^+ to NO_3^- (d) NO_3^- to N_2
- Consider the following redox reaction: $2\text{MnO}_4^- + 3\text{ClO}_3^- + \text{H}_2\text{O} \rightarrow 3\text{ClO}_4^- + 2\text{MnO}_2 + 2\text{OH}^-$
 The reducing agent is (a) H_2O (b) ClO_3^- (c) MnO_2 (d) MnO_4^-
- Vanadium metal, V^{2+} , reacts spontaneously with Cd^{2+} , but not with Ti^{2+} . Based on these results, the order of oxidizing agents, from strongest to weakest, is
 (a) Cd^{2+} , V^{2+} , Ti^{2+} (b) V^{2+} , Ti^{2+} , Cd^{2+} (c) Ti^{2+} , Cd^{2+} , V^{2+} (d) Ti^{2+} , V^{2+} , Cd^{2+}
- How many NMR signals would be given by the compound $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_3$?
 (a) 3 (b) 4 (c) 5 (d) 2
- Classical mechanics does not provide satisfactory explanation for the following
 (a) Black Body radiation (b) Photoelectric Effect (c) Heat Capacities (d) All the above
- A quantitative relationship between the energy absorbed and energy emitted by a body was put forwarded by
 (a) Einstein (b) Kirchhoff (c) Hess (d) Fermi
- Valence Bond Theory of chemical bonding was put forward initially by
 (a) Heisenberg (b) Einstein (c) Heitler & Lodon (d) De-Broglie
- The Raman & IR spectra can tell us whether
 (a) a molecule is linear or non-linear (b) a molecule is symmetrical or asymmetrical
 (c) neither of these (d) both of the these
- In the Raman Spectra, the middle line is called as
 (a) Raman Line (b) Rayleigh Line (c) Functional Group Line (d) None of these
- A molecule reacted or formed per photon of light absorbed is called
 (a) Yield of reaction (b) Quantum of reaction (c) Quantum yield (d) Quantum Productivity
- The light emitted in chemiluminescent reaction is also called as
 (a) Cold light (b) Hot light (c) Bright light (d) none of these
- Chiral molecule has
 (a) no plane of symmetry (b) one plane of symmetry
 (c) infinite plane of symmetry (d) one line of symmetry
- An equimolar mixture of (+) and (-) Tartaric Acid is called as

- (a) enantiomers (b) optically active mixture (c) racemic mixture (d) asymmetric mixture
18. Optical activity is
(a) an additive property (b) constructive property (c) both of these (d) none of these
19. The substance which retain magnetic field when removed from the magnetic field is called
(a) paramagnetic (b) diamagnetic (c) ferrimagnetic (d) ferromagnetic
20. A diamagnetic substance is by/in the magnetic field
(a) attracted (b) repelled (c) rotated (d) revolved
21. A liquid boils when vapor pressure becomes equal to
(a) One atmospheric pressure (b) zero (c) very high (d) very low
22. Freezing point depression is measured by
(a) Beckman's Method (b) Rast Camphor Method (c) by Both (d) none of these
23. In one molal solution that contains 0.5 mole of a solute there is
(a) 1000gm of solvent (b) 1000ml of solvent (c) 500ml of solvent (d) 500gm of solvent
24. The law of relative lowering of vapor pressure was given by
(a) Van't Hoff (b) Ostwald (c) Raoult (d) Henry
25. Which of the following is a colligative property?
(a) molar refractivity (b) optical rotation (c) depression in freezing point (d) viscosity
26. The number of moles of a solute per kilogram of the solvent is called
(a) formality (b) normality (c) molarity (d) molality
27. The study of depression in freezing point of a solution is called
(a) osmotic pressure (b) ebullioscopy (c) cryoscopy (d) none of these
28. Reaction intermediates of E1 reaction is
(a) carbocation (b) carbanion (c) carbene (d) free radical
29. In the reaction between 2-hydroxy-3-methyl butane with conc. H₂SO₄ at high temperature, the number of alkene formed is (a) one (b) two (c) three (d) four
30. When propyne reacts with HgSO₄/H₂SO₄, the product is
(a) Propane (b) Propanol (c) Propanal (d) Propanone
31. Which of the following reagents can be used for the test of unsaturation?
(a) dil KMnO₄/OH⁻ (b) conc KMnO₄/OH⁻ (c) KMnO₄/H⁺ (d) Neutral KMnO₄
32. Which among the following reagent will give nucleophilic addition with carbonyl compound?
(a) HCN (b) RMgX (c) Alcohol (d) HCl
33. With which compound Grignard Reagent gives 3^o- alcohol?
(a) Formaldehyde (b) Acetaldehyde (c) Acetone (d) Methylcyanide
34. Which among the following reagents can be used for the test of carbonyl group in laboratory?
(a) NH₂OH (b) NH₂NH₂ (c) NaSO₃H (d) 2,4-DNPH
35. In which alkene anti-markovnikov's rule can be used?

- (a) Ethylene (b) 2-Butene (c) Propene (d) 2,3-dimethyl-2-butene
36. Which reagents give free radical addition with alkene?
(a) HBr (b) HCl (c) HI (d) HOH
37. Gattermann reaction is given by
(a) C₆H₆ (b) C₆H₅-CH₃ (c) C₆H₅-Cl (d) All of these
38. Benedict solution is used for the detection of which compound present in urine?
(a) Urea (b) Urea Acetate (c) Steroid (d) Glucose
39. Which one of the following compounds will not give aldol?
(a) CH₃CHO (b) CH₃CH₂CHO (c) CH₃CH₂COCH₃ (d) C₆H₅CHO
40. Grignard Reagent does not give carbonyl compounds with
(a) CO₂ (b) RCOCl (c) RCN (d) RCOOR
41. Benzaldehyde reacts with ammonia to form
(a) Benzaldehyde ammonia (b) Urotropine (c) Hydrobenzamide (d) Ammonium Chloride
42. First organic compound prepared in the laboratory was
(a) Acetic Acid (b) Urea (c) Formic acid (d) Methane
43. Tetravalency of carbon was proposed for the first time by
(a) Kekule (b) Couper (c) Kekule & Couper (d) van't Hoff
44. Organic solids can be purified by
(a) steam distillation (b) Crystallization (c) Fractional distillation (d) Simple distillation
45. Which of the following compound sublimate on heating?
(a) p-Dichlorobenzene (b) Urea (c) Thiourea (d) Tartaric acid
46. Sodium extract gives blood red coloration when treated with FeCl₃ conform presence of
(a) Only nitrogen (b) Only sulphur (c) Only halogens (d) Both nitrogen & sulphur
47. Percentage of carbon in organic compound is determined by
(a) Duma's method (b) Kjeldahl's method (c) Carius method (d) Liebig method
48. A compound containing 80% carbon & 20% hydrogen is likely to be
(a) C₆H₆ (b) CH₄ (c) C₂H₆ (d) C₃H₈
49. In sodium extract nitrogen is present as
(a) Sodamide (b) Sodium cyanide (c) Sodium nitrite (d) Sodium nitrate
50. Juice of sugarcane in factories is concentrated by
(a) Vacuum distillation (b) Steam distillation (c) Sublimation (d) Crystallization
51. Which of the following is photovoltaic cell?
(a) Barrier layer Cell (b) Bolometer (c) Golay Cell (d) Photo emissive cell
52. Which of the following compounds are transparent in UV region?
(a) Ethers (b) Alkyl amines (c) thioethers (d) All of them
53. The triatomic linear CO₂ molecule has the following fundamental vibrations
(a) 4 (b) 2 (c) 3 (d) 6

54. Which of the following vibrational mode is Raman active in CO_2 molecule?
(a) Symmetrical stretch (b) Asymmetrical stretch (c) Bending (d) All of these
55. How many types of hydrogens are present in the compound CH_2BrCl ?
(a) 2 (b) 1 (c) 3 (d) None
56. In an electrochemical cell, electrons travel in which direction?
(a) from the anode to the cathode through the external circuit (b) from the anode to the cathode through the porous cup (c) from the cathode to the anode through the external circuit (d) from the cathode to the anode through the porous cup.
57. Which acid is present in lemon?
(a) malic acid (b) citric acid (c) lactic acid (d) tartaric acid
58. What among following is used to produce artificial rain?
(a) copper oxide (b) carbon monoxide (c) silver iodide (d) silver nitrate
59. Oil of vitriol is
(a) nitric acid (b) sulphuric acid (c) hydrochloric acid (d) phosphoric acid
60. Which of the following can be used in preparation of dynamite?
(a) glycerol (b) ethyl alcohol (c) methyl alcohol (d) glycol
61. What is a mixture of potassium nitrate powdered charcoal and sulphur called?
(a) paint (b) aluminium (c) brass (d) gun powder
62. How many atoms are in one mole of CH_3OH ?
(a) 6 (b) 6.0×10^{23} (c) 12.0×10^{23} (d) 3.6×10^{24}
63. Which of the following compounds is a functional group isomer of ethanol?
(a) ethanol (b) acetic acid (c) diethyl ether (d) dimethyl ether
64. The synthetic element among the following is (a) Mo (b) U (c) Tc (d) Pa
65. Which of the following compounds displays optical isomerism?
(a) $\text{CH}_2(\text{OH})-\text{CH}_2(\text{OH})$ (b) $\text{CH}_3-\text{CHCl}-\text{COOH}$ (c) $\text{CH}_2=\text{CHCl}$ (d) $\text{CHCl}=\text{CHCl}$.
66. Which of the following will undergo an addition reaction with chlorine?
(a) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ (b) $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$ (c) C_6H_6 (d) $\text{CH}_3\text{CH}_2\text{COOH}$
67. Which of the following elements has the smallest atomic radius?
a) I b) B c) O d) Al
68. What is Calcium sulphate?
(a) epsom salt (b) blue vitriol (c) gypsum salt (d) potash alum
69. Para-xylene is the same as:
(a) 1,2-dimethylbenzene (b) 1,3-diethylbenzene (c) 1,3-dimethylbenzene (d) 1,4-dimethylbenzene
70. Which of the following formulas represents an alkene?
(a) $\text{CH}_3\text{CH}_2\text{CH}_3$ (b) CH_3CH_3 (c) $\text{CH}_3\text{CH}_2\text{CHCH}_2$ (d) $\text{CH}_3\text{CH}_2\text{Cl}$

71. How many unpaired electrons are there in a strong field iron (II) octahedral complex?
(a) 0 (b) 1 (c) 2 (d) 4
72. Some element groups of the periodic table are more likely to contain elements that are gases than other groups. Which of the following groups contains the greatest number of gaseous elements?
(a) IA (b) IIA (c) IVA (d) VIII (or 0)
73. Which of the following substances is the strongest reducing agent?
(a) Cl_2 (b) Cl^- (c) Br_2 (d) Br^-
74. Chlorine gas is prepared commercially by:
(a) electrolysis of carbon tetrachloride. (b) oxidation of chloride ion with $\text{F}_2(\text{g})$.
(c) electrolysis of $\text{NaCl}(\text{aq})$. (d) oxidation of chloride ion with $\text{Br}_2(\text{aq})$.
75. Which of the following has a pyramidal structure (molecular geometry)?
(a) CBr_4 (b) PF_3 (c) BF_3 (d) OF_2
76. What maximum mass of sulfuric acid can be produced from the sulfur contained in 100 kilograms of iron pyrite that is 75.0% FeS_2 ? (a) 84.4 kg (b) 123 kg (c) 136 kg (d) 144 kg
77. Which compound gives photochemical smog a brownish color?
(a) NO (b) HNO_2 (c) NO_2 (d) N_2O_4
78. What is the major mineral present in phosphate rock?
(a) $\text{Ca}_3(\text{PO}_4)_2$ (b) Na_2HPO_4 (c) $\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$ (d) NaH_2PO_4
79. In a surprisingly large number of their properties beryllium resembles aluminum, and boron resembles silicon. Such a relationship is called:
(a) amphoterism (b) an allotropic relationship (c) a diagonal relationship (d) the periodic law
80. The most abundant metal in the earth's crust is:
(a) Cu (b) Fe (c) Na (d) Al
81. The nitrate of which of the following cations would exhibit paramagnetism to the GREATEST extent? (a) Co^{3+} (b) Cr^{3+} (c) Fe^{3+} (d) Mn^{3+}
82. Which of the following combinations cannot produce a buffer solution?
(a) HNO_2 and NaNO_2 (b) HCN and NaCN (c) HClO_4 and NaClO_4 (d) NH_3 and $(\text{NH}_4)_2\text{SO}_4$
83. Which one of the following molecules has a dipole moment?
a) CS_2 b) CHCl_3 c) SF_6 d) CCl_4
84. Which one of the following is a strong electrolyte?
(a) H_2O (b) KF (c) HF (d) HNO_2
85. Which of the following weak acids ionizes to give the strongest conjugate base?
(a) HClO (b) CH_3COOH (c) HF (d) HCN
86. The entropy will usually increase when
I. a molecule is broken into two or more smaller molecules.
II. a reaction occurs that results in an increase in the number of moles of gas.
III. a solid changes to a liquid. IV. a liquid changes to a gas.

- (a) I only (b) II only (c) III only (d) I, II, III, and IV
87. Which statement is incorrect?
(a) At constant pressure, $H = E + P V$ (b) The thermodynamic symbol for entropy is S.
(c) Gibbs free energy is a state function. (d) For an endothermic process, H is negative.
88. For a gas, which pair of variables is inversely proportional to each other (if all other conditions remain constant)? (a) P, T (b) P, V (c) V, T (d) n, V
89. Which radioactive emanations have a charge of -1?
(a) neutrons (b) gamma rays (c) alpha particles (d) beta particles
90. Which of the following is classified as a metal?
(a) Ge (b) As (c) F (d) V
91. Which one of the following salts is insoluble in water?
(a) NH_4Cl (b) $Ca(NO_3)_2$ (c) $BaCO_3$ (d) Na_2S
92. What kind of radiation will travel through an electric field on a pathway that remains unaffected by the field? (a) a proton (b) a gamma ray (c) an electron (d) an alpha particle
93. The species that contains 24 protons, 26 neutrons and 22 electrons would be represented by the symbol: (a) $^{50}V^{3+}$ (b) $^{26}Cr^{2+}$ (c) $^{50}Cr^{2+}$ (d) $^{50}Mn^{2+}$
94. Which of the following is an ionic hydride?
(a) PH_3 (b) H_2S (c) HI (d) KH
95. Which of the following is the most basic oxide?
(a) N_2O_3 (b) N_2O_5 (c) P_4O_6 (d) Bi_2O_5
96. Which property is generally characteristic of an organic compound?
(a) low melting point (b) high melting point (c) soluble in polar solvents (d) insoluble in nonpolar solvents
97. Which radioactive isotope is used in geological dating?
(a) uranium-238 (b) iodine-131 (c) cobalt-60 (d) technetium-99
98. Which nuclide is a radioisotope used in the study of organic reaction mechanisms?
(a) carbon-12 (b) carbon-14 (c) uranium-235 (d) uranium-238
99. Which polymers occur naturally?
(a) Starch and nylon (b) starch and cellulose (c) protein and nylon (d) protein and plastic
100. The products of the fermentation of sugar are ethanol and

(a) water (b) oxygen (c) carbon dioxide (d) sulfur dioxide

Q.N.	Ans	Q.N.	Ans	Q.N.	Ans	Q.N.	Ans	Q.N.	Ans
1.	d	21.	a	41.	a	61.	d	81.	c
2.	c	22.	c	42.	b	62.	d	82.	c
3.	a	23.	d	43.	c	63.	d	83.	b
4.	b	24.	c	44.	b	64.	a	84.	b
5.	c	25.	c	45.	a	65.	b	85.	d
6.	b	26.	d	46.	d	66.	b	86.	d
7.	a	27.	c	47.	d	67.	c	87.	d
8.	b	28.	b	48.	c	68.	c	88.	b
9.	d	29.	b	49.	b	69.	d	89.	d
10.	b	30.	d	50.	a	70.	c	90.	d
11.	c	31.	a	51.	a	71.	a	91.	c
12.	d	32.	b	52.	d	72.	d	92.	b
13.	b	33.	c	53.	a	73.	d	93.	c
14.	c	34.	d	54.	a	74.	c	94.	d
15.	a	35.	c	55.	b	75.	b	95.	d
16.	a	36.	a	56.	a	76.	b	96.	a
17.	c	37.	d	57.	b	77.	c	97.	a
18.	b	38.	d	58.	c	78.	a	98.	b
19.	d	39.	d	59.	b	79.	c	99.	b
20.	b	40.	a	60.	a	80.	d	100.	c

Thermodynamics

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1. Internal energy of an ideal gas depends on
 - (a) Volume
 - (b) Temperature
 - (c) Pressure
 - (d) None of these
 2. Any series of operations so carried out that at the end, the system is back to its initial state is called
 - (a) Boyle's cycle
 - (b) Reversible process
 - (c) Adiabatic process
 - (d) Cyclic process
 3. One calorie is equal to
 - (a) 0.4184 Joule
 - (b) 4.184 Joule
 - (c) 41.84 Joule
 - (d) 418.4 Joule
 4. The total internal energy change for a reversible isothermal cycles is
 - (a) Always 100 calories per degree
 - (b) Always negative
 - (c) 0
 - (d) Always positive
 5. A well stoppered thermos flask contains some ice cubes. This is an example of a
 - (a) Closed system
 - (b) Open system
 - (c) Isolated system
 - (d) Non-thermodynamic system
 6. Identify the intensive quantity from the following
 - (a) Enthalpy and temperature
 - (b) Volume and temperature
 - (c) Enthalpy and volume
 - (d) Temperature and refractive index
 7. Which of the following units represents the largest amount of energy
 - (a) Electron volt
 - (b) Erg
 - (c) Joule
 - (d) Calorie
 8. Energy equivalent to one erg, one joule and one calorie is in the order
 - (a) $1 \text{ erg} > 1 \text{ joule} > 1 \text{ calorie}$
 - (b) $1 \text{ erg} > 1 \text{ calorie} > 1 \text{ joule}$
 - (c) $1 \text{ calorie} > 1 \text{ joule} > 1 \text{ erg}$
 - (d) $1 \text{ joule} > 1 \text{ calorie} > 1 \text{ erg}$

- 9 Which of the following is always negative for exothermic reaction?
 (a) ΔH (b) ΔS
 (c) ΔG (d) None of these
- 10 The relation between ΔE and ΔH is
 (a) $\Delta H = \Delta E - P \Delta V$ (b) $\Delta H = \Delta E + P \Delta V$
 (c) $\Delta E = \Delta V + \Delta H$ (d) $\Delta E = \Delta H + P \Delta V$
- 11 At constant T and P , which one of the following statements is correct for the reaction, $\text{CO(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$
 (a) ΔH is independent of the physical state of the reactants of that compound
 (b) $\Delta H > \Delta E$
 (c) $\Delta H < \Delta E$
 (d) $\Delta H = \Delta E$
- 12 For the reaction of one mole of zinc dust with one mole of sulphuric acid in a bomb calorimeter, ΔU and w correspond to
 (a) $\Delta U < 0, w = 0$ (b) $\Delta U = 0, w < 0$
 (c) $\Delta U > 0, w = 0$ (d) $\Delta U < 0, w > 0$
- 13 Which is not the correct relation between enthalpy (ΔH) and intrinsic energy (ΔE)
 (a) $\Delta H = \Delta E + P \Delta V$ (b) $\Delta H = \Delta E + nRT$
 (c) $\Delta H = \Delta E - P \Delta V$ (d) $\Delta E = \Delta H - P \Delta V$
- 14 The law of Lavoisier and Laplace illustrates
 (a) The principle of conservation of energy
 (b) Equivalence of mechanical and thermal energy
 (c) The principle of conservation of matter
 (d) Equivalence of mechanical and chemical energy
- 15 For the reaction $\text{N}_2 + 3\text{H}_2 = 2\text{NH}_3; \Delta H =$
 (a) $\Delta E - RT$ (b) $\Delta E - 2RT$
 (c) $\Delta E + RT$ (d) $\Delta E + 2RT$
- 16 If ΔH is the change in enthalpy and ΔE the change in internal energy accompanying a gaseous reaction
 (a) ΔH is always greater than ΔE
 (b) $\Delta H < \Delta E$ only if the number of moles of the products is greater than the number of the reactants
 (c) ΔH is always less than ΔE
 (d) $\Delta H < \Delta E$ only if the number of moles of the products is less than the number of moles of the reactants
- 17 "The resultant heat change in a reaction is the same whether it takes place in one or several stages." This statement is called
 (a) Lavoisier and Laplace law
 (b) Hess's law
 (c) Joule's law
 (d) Le-chatelier's principle
- 18 Hess's law of constant heat summation is based on
 (a) $E = mc^2$
 (b) Conservation of mass
 (c) First law of thermodynamics
 (d) None of the above
- 19 Consider the reaction : $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$ carried out at constant temperature and pressure. If ΔH and ΔU are the enthalpy and internal energy changes for the reaction, which of the following expression is true
 (a) $\Delta H = 0$ (b) $\Delta H = \Delta U$
 (c) $\Delta H < \Delta U$ (d) $\Delta H > \Delta U$
- 20 Which of the following is the correct equation
 (a) $\Delta U = \Delta Q - W$ (b) $\Delta W = \Delta U + \Delta Q$
 (c) $\Delta U = \Delta W + \Delta Q$ (d) None of these
- 21 Hess law is applicable for the determination of heat of
 (a) Reaction (b) Formation
 (c) Transition (d) All of these
- 22 Enthalpy for the reaction $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$ is
 (a) Positive (b) Negative
 (c) Zero (d) None
- 23 During an isothermal expansion of an ideal gas its
 (a) Internal energy increases
 (b) Enthalpy decreases
 (c) Enthalpy remains unaffected
 (d) Enthalpy reduces to zero
- 24 The work done in ergs for the reversible expansion of one mole of an ideal gas from a volume of 10 litres to 20 litres at 25°C is
 (a) $2.303 \times 298 \times 0.082 \log 2$
 (b) $298 \times 10^7 \times 8.31 \times 2.303 \log 2$
 (c) $2.303 \times 298 \times 0.082 \log 0.5$
 (d) $8.31 \times 10^7 \times 298 - 2.303 \log 0.5$
 (e) $2.303 \times 298 \times 2 \log 2$

- 25 For a reversible spontaneous change ΔS is
 (a) $\frac{\Delta E}{T}$ (b) $\frac{P\Delta V}{T}$
 (c) $\frac{q}{T}$ (d) $RT \log K$
- 26 When disorder of a system increases, the change is said to be
 (a) Exothermic (b) Non-spontaneous
 (c) Endothermic (d) Spontaneous
- 27 The spontaneous flow of heat is always
 (a) From low to high pressure
 (b) From high to high pressure
 (c) Unidirectional from lower temperature to higher temperature
 (d) Unidirectional from the higher to lower temperature
- 28 Mixing of non-reacting gases is generally accompanied by
 (a) Decrease in entropy
 (b) Increase in entropy
 (c) Change in enthalpy
 (d) Change in free energy
- 29 An irreversible process occurring isothermally in an isolated system leads to
 (a) Zero entropy
 (b) An increase in the total entropy of the system
 (c) A decrease in the total entropy of the system
 (d) None of these
- 30 The entropy values (in $JK^{-1} mol^{-1}$) of $H_{2(g)} = 130.6$, $Cl_{2(g)} = 223.0$ and $HCl_{(g)} = 186.7$ at 298 K and 1 atm pressure. Then entropy change for the reaction
 $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$ is
 (a) + 540.3 (b) + 727.3
 (c) - 166.9 (d) + 19.8
- 31 Which of the following is the least random state of water
 (a) Ice
 (b) Liquid water
 (c) Steam
 (d) All present same random state
- 32 Which one of the following process is non-spontaneous
 (a) Dissolution of $CuSO_4$ in water
 (b) Reaction between H_2 and O_2 to form water
 (c) Water flowing down hill
 (d) Flow of electric current from low potential to high potential
- 33 Which of the following is zero during adiabatic expansion of the gas
 (a) ΔT (b) ΔS
 (c) ΔE (d) None of these
- 34 The entropy of crystalline substances at absolute zero given by the third law of thermodynamics should be taken as
 (a) 100
 (b) 50
 (c) Zero
 (d) Different for different substances
- 35 In which state, the matter have highest entropy
 (a) Solid (b) Liquid
 (c) Gas (d) Equal in all
- 36 Which of the following pairs of a chemical reaction is certain to result in spontaneous reaction?
 (a) Exothermic and decreasing disorder
 (b) Endothermic and increasing disorder
 (c) Exothermic and increasing disorder
 (d) Endothermic and decreasing disorder
- 37 When one mole of monoatomic ideal gas at T K undergoes adiabatic change under a constant external pressure of 1 atm changes volume from 1 litre to 2 litre. The final temperature in Kelvin would be
 (a) $\frac{T}{2^{2/3}}$ (b) $T + \frac{2}{3 \times 0.0821}$
 (c) T (d) $T - \frac{2}{3 \times 0.0821}$
- 38 9.0 gm of H_2O is vaporised at $100^\circ C$ and 1 atm pressure. If the latent heat of vaporisation of water is $x J/gm$, then ΔS is given by
 (a) $\frac{x}{373}$ (b) $\frac{18x}{100}$
 (c) $\frac{18x}{373}$ (d) $\frac{1}{2} \times \frac{18x}{373}$
- 39 The ΔS for the vaporisation of 1 mol of water is 88.3 $J/mole K$. The value of ΔS for the condensation of 1 mole of vapour will be
 (a) 88.3 $J/mol K$ (b) $(88.3)^2 J/mol K$
 (c) - 88.3 $J/mol K$ (d) $\frac{1}{88.3} J/mol K$

- 26 For which reaction from the following, ΔS will be maximum
- $\text{Ca(s)} + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{CaO(s)}$
 - $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO(s)} + \text{CO}_2(\text{g})$
 - $\text{C(s)} + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
 - $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO(g)}$
- 27 The occurrence of a reaction is impossible if
- ΔH is +ve ; ΔS is also +ve but $\Delta H < T\Delta S$
 - ΔH is -ve ; ΔS is also -ve but $\Delta H > T\Delta S$
 - ΔH is -ve ; ΔS is +ve
 - ΔH is +ve ; ΔS is -ve
- 28 If the enthalpy of vaporization for water is $186.5 \text{ kJ mol}^{-1}$, the entropy of its vaporization will be
- $0.5 \text{ JK}^{-1}\text{mol}^{-1}$
 - $1.0 \text{ JK}^{-1}\text{mol}^{-1}$
 - $1.5 \text{ JK}^{-1}\text{mol}^{-1}$
 - $2.0 \text{ JK}^{-1}\text{mol}^{-1}$
- 29 Which of the following statement is true. The entropy of the universe
- Increases and tends towards maximum value
 - Decreases and tends to be zero
 - Remains constant
 - Decreases and increases with a periodic rate
- 30 When enthalpy and entropy change for a chemical reaction are $-2.5 \times 10^3 \text{ cal}$ and 7.4 cal deg^{-1} respectively. Predict the reaction at 298 K is
- Spontaneous
 - Reversible
 - Irreversible
 - Non-spontaneous
- 31 The total entropy change for a system and its surroundings increases, if the process is
- Reversible
 - Irreversible
 - Exothermic
 - Endothermic
- 32 For chemical reactions, the calculation of change in entropy is normally done
- At constant pressure
 - At constant temperature
 - At constant temperature and pressure both
 - At constant volume
- 33 When the value of entropy is greater, then the ability of work
- Is maximum
 - Is minimum
 - Is medium
 - None of these
- 34 Which of the following is true for the reaction $\text{H}_2\text{O(l)} = \text{H}_2\text{O(g)}$ at 100°C and 1 atmosphere
- $\Delta E = 0$
 - $\Delta H = 0$
 - $\Delta H = \Delta E$
 - $\Delta H = T\Delta S$
- 35 The enthalpy change for the transition of liquid water to steam, $\Delta H_{\text{vap}} = 37.3 \text{ kJ mol}^{-1}$ at 373 K . The entropy change for the process is
- $111.9 \text{ J mol}^{-1}\text{K}^{-1}$
 - $37.3 \text{ J mol}^{-1}\text{K}^{-1}$
 - $100 \text{ J mol}^{-1}\text{K}^{-1}$
 - $74.6 \text{ J mol}^{-1}\text{K}^{-1}$
36. When a solid is converted into liquid, entropy
- Becomes zero
 - Remains the same
 - Decreases
 - Increases
- 37 In a spontaneous process, the entropy of the system and its surroundings
- Equals zero
 - Decreases
 - Increases
 - Remains constant
- 38 The positive value of ΔS indicates that
- The system becomes less disordered
 - The system becomes more disordered
 - The system is in equilibrium position
 - The system tends to reach at equilibrium position
39. For reaction $2\text{Cl(s)} \rightarrow \text{Cl}_2(\text{s})$, the signs of ΔH and ΔS respectively are
- +, -
 - +, +
 - , -
 - , +
40. The enthalpy of water is 386 kJ . What is entropy of water
- 0.5 kJ
 - 1.03 kJ
 - 1.5 kJ
 - 22.05 kJ
- 41 For which of the processes is ΔS negative
- $\text{H}_2(\text{g}) \rightarrow 2\text{H(g)}$
 - $\text{N}_2(\text{g}) 1\text{atm} \rightarrow \text{N}_2(\text{g}) 8\text{atm}$
 - $2\text{SO}_3(\text{g}) \rightarrow 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$
 - $\text{C}_{(\text{diamond})} \rightarrow \text{C}_{(\text{graphite})}$
- 42 Identify the correct statement regarding entropy
- At 0°C , the entropy of a perfectly crystalline substance is taken to be zero
 - At absolute zero of temperature, the entropy of a perfectly crystalline substance is +ve
 - At absolute zero of temperature, the entropy of all crystalline substances is taken to be zero
 - At absolute zero of temperature, the entropy of a perfectly crystalline substance is taken to be zero
- 43 One mole of an ideal gas at 300K is expanded isothermally from an initial volume of 1 litre to 10 litres. The change in energy for this process is ($R = 2 \text{ cal mol}^{-1}\text{K}^{-1}$)
- 163.7 cal
 - 850.2 cal
 - 1381.1 cal
 - Zero
- 44 If 900 J/g of heat is exchanged at boiling point of water, then what is increase in entropy
- 43.4 J/mole
 - 87.2 J/mole
 - 900 J/mole
 - Zero

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45. An adiabatic process is one in which

- (a) Number of heat enters or leaves the gas
- (b) Temperature of the gas changes
- (c) The change in internal energy is equal to the mechanical workdone

46. The processes occurring in open system which permit the transfer of mass to and from the system, are known as

- (a) Flow process
- (b) non-flow processes
- (c) adiabatic processes
- (d) none of these

47. Workdone in free expansion process is

- (a) zero
- (b) minimum
- (c) maximum
- (d) positive

48. Which of the following is not property of the system

- (a) Temperature
- (b) Pressure
- (c) Specific volume
- (d) Heat
- (e) None of these

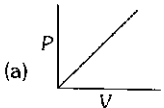
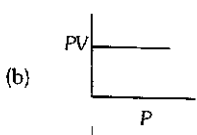
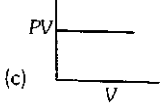
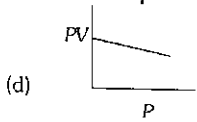
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Answer Key of Thermodynamics:-

(1)b (2) d (3)b (4) c (5) c (6)d (7)d (8)c (9) a (10)b (11)c (12)a (13)c (14)a (15)b
(16)d (17) b (18)c (19)c (20)c (21)b (22)b (23)c (24)b (25)c (26)d (27)d (28)b
(29)b (30)a (31) d (32)b (33)c (34)c (35)c (36)d (37)d (38)c (39)c (40)b (41)d
(42)a (43)a (44)a (45)d (46)a (47)a (48)d (49)e (50)e

• Gaseous State •

1. Which one of the following statements is not correct about the three states of matter i.e. solid, liquid and gaseous
 - (a) Molecules of a solid possess least energy whereas those of a gas possess highest energy
 - (b) The density of solid is highest whereas that of gases is lowest
 - (c) Gases like liquids possess definite volumes
 - (d) Molecules of a solid possess vibratory motion
2. The temperature and pressure at which ice, liquid water and water vapour can exist together are
 - (a) $0^{\circ}\text{C}, 1\text{ atm}$ (b) $2^{\circ}\text{C}, 4.7\text{ atm}$
 - (c) $0^{\circ}\text{C}, 4.7\text{ mm}$ (d) $-2^{\circ}\text{C}, 4.7\text{ mm}$
3. Which of the following is true about gaseous state
 - (a) Thermal energy = Molecular attraction
 - (b) Thermal energy \gg Molecular attraction
 - (c) Thermal energy \ll Molecular attraction
 - (d) Molecular forces \gg Those in liquids
4. Kinetic energy of molecules is highest in
 - (a) Gases (b) Solids
 - (c) Liquids (d) Solutions
5. Which of the following statement is correct
 - (a) In all the three states the molecules possess random translational motion
 - (b) Gases cannot be converted into solids without passing through liquid state
 - (c) One of the common property of liquids and gases is viscosity
 - (d) According to Boyle's law V/P is constant at constant T
6. A volume of 1 m^3 is equal to
 - (a) 1000 cm^3 (b) 100 cm^3
 - (c) 10 dm^3 (d) 10^6 cm^3
7. Which one of the following is not a unit of pressure
 - (a) Newton (b) Torr
 - (c) Pascal (d) Bar
8. 1°C rise in temperature is equal to a rise of
 - (a) 1°F (b) $9/5^{\circ}\text{F}$
 - (c) $5/9^{\circ}\text{F}$ (d) 33°F
9. Which of the following relations for expressing volume of a sample is not correct
 - (a) $1\text{L} = 10^3\text{ ml}$ (b) $1\text{ dm}^3 = 1\text{L}$
 - (c) $1\text{L} = 10^3\text{ m}^3$ (d) $1\text{L} = 10^3\text{ cm}^3$
10. One atmosphere is numerically equal to approximately
 - (a) $10^6\text{ dynes cm}^{-2}$ (b) $10^2\text{ dynes cm}^{-2}$
 - (c) $10^4\text{ dynes cm}^{-2}$ (d) $10^8\text{ dynes cm}^{-2}$
11. 2 gm of O_2 at 27°C and 760 mm of Hg pressure has volume
 - (a) 1.5 lit. (b) 2.8 lit.
 - (c) 11.2 lit. (d) 22.4 lit.
12. Pressure of a gas in a vessel can be measured by
 - (a) Barometer (b) Manometer
 - (c) Stalgometer (d) All the above
13. Volume occupied by a gas at one atmospheric pressure and 0°C is $V\text{ mL}$. its volume at 273 K will be
 - (a) $V\text{ ml}$ (b) $V/2\text{ ml}$
 - (c) $2V$ (d) None of these
14. Which one of the following statements is wrong for gases
 - (a) Gases do not have a definite shape and volume
 - (b) Volume of the gas is equal to the volume of the container confining the gas
 - (c) Confined gas exerts uniform pressure on the walls of its container in all directions
 - (d) Mass of the gas cannot be determined by weighing a container in which it is enclosed
15. Which of the following exhibits the weakest intermolecular forces
 - (a) NH_3 (b) HCl
 - (c) He (d) H_2O
16. N_2 is found in a litre flask under 100 kPa pressure and O_2 is found in another 3 litre flask under 320 kPa pressure. If the two flasks are connected, the resultant pressures is
 - (a) 310 kPa (b) 210 kPa
 - (c) 420 kPa (d) 365 kPa
 - (e) 265 kPa
17. If P, V, T represent pressure, volume and temperature of the gas, the correct representation of Boyle's law is
 - (a) $V \propto \frac{1}{T}$ (at constant P) (b) $PV = RT$
 - (c) $V \propto 1/P$ (at constant T) (d) $PV = nRT$
18. At constant temperature, in a given mass of an ideal gas
 - (a) The ratio of pressure and volume always remains constant
 - (b) Volume always remains constant
 - (c) Pressure always remains constant
 - (d) The product of pressure and volume always remains constant

- 19 Air at sea level is dense. This is a practical application of
- (a) Boyle's law (b) Charle's law
(c) Avogadro's law (d) Dalton's law
- 20 If 20 cm^3 gas at 1 atm . is expanded to 50 cm^3 at constant T , then what is the final pressure
- (a) $20 \times \frac{1}{50}$ (b) $50 \times \frac{1}{20}$
(c) $1 \times \frac{1}{20} \times 50$ (d) None of these
- 21 Which of the following statement is false
- (a) The product of pressure and volume of fixed amount of a gas is independent of temperature
(b) Molecules of different gases have the same K.E. at a given temperature
(c) The gas equation is not valid at high pressure and low temperature
(d) The gas constant per molecule is known as Boltzmann constant
- 22 Which of the following graphs represent Boyle's law
- (a)  (b) 
(c)  (d) 
- 23 Densities of two gases are in the ratio $1 : 2$ and their temperatures are in the ratio $2 : 1$, then the ratio of their respective pressures is
- (a) $1 : 1$ (b) $1 : 2$
(c) $2 : 1$ (d) $4 : 1$
- 24 At constant pressure, the volume of fixed mass of an ideal gas is directly proportional to
- (a) Absolute temperature (b) Degree centigrade
(c) Degree Fahrenheit (d) None
- 25 Which of the following expression at constant pressure represents Charle's law
- (a) $V \propto \frac{1}{T}$ (b) $V \propto \frac{1}{T^2}$
(c) $V \propto T$ (d) $V \propto d$
- 26 Use of hot air balloons in sports and meteorological observations is an application of
- (a) Boyle's law (b) Newtonic law
(c) Kelvin's law (d) Charle's law
- 27 A 10 g of a gas at atmospheric pressure is cooled from 273°C to 0°C keeping the volume constant, its pressure would become
- (a) $1/2 \text{ atm}$ (b) $1/273 \text{ atm}$
(c) 2 atm (d) 273 atm
- 28 Pressure remaining the same, the volume of a given ~~an ideal gas increases for every degree centigrade~~ temperature by definite fraction of its volume at
- (a) 0°C (b) Its critical temperature
(c) Absolute zero (d) Its Boyle temperature
- 29 A certain sample of gas has a volume of 0.2 litre measured at 1 atm . pressure and 0°C . At the same pressure but 273°C , its volume will be
- (a) 0.4 litres (b) 0.8 litres
(c) 27.8 litres (d) 55.6 litres
- 30 400 cm^3 of oxygen at 27°C were cooled to -3°C without change in pressure. The contraction in volume will be
- (a) 40 cm^3 (b) 30 cm^3
(c) 44.4 cm^3 (d) 360 cm^3
- 31 The pressure p of a gas is plotted against its absolute temperature T for two different constant volumes, V_1 and V_2 . When $V_1 > V_2$, the
- (a) Curves have the same slope and do not intersect
(b) Curves must intersect at some point other than $T = 0$
(c) Curve for V_2 has a greater slope than that for V_1
(d) Curve for V_1 has a greater slope than that for V_2
- 32 Two closed vessels of equal volume containing air a pressure P_1 and temperature T_1 are connected to each other through a narrow tube. If the temperature in one of the vessels is now maintained at T_1 and that in the other a T_2 , what will be the pressure in the vessels
- (a) $\frac{2P_1T_1}{T_1 + T_2}$ (b) $\frac{T_1}{2P_1T_2}$
(c) $\frac{2P_1T_2}{T_1 + T_2}$ (d) $\frac{2P_1}{T_1 + T_2}$
- 33 "One gram molecule of a gas at N.T.P. occupies 22.4 litres ." This fact was derived from
- (a) Dalton's theory
(b) Avogadro's hypothesis
(c) Berzelius hypothesis
(d) Law of gaseous volume
- 34 In a closed flask of 5 litres , 1.0 g of H_2 is heated from 300 to 600 K . which statement is not correct
- (a) Pressure of the gas increases
(b) The rate of collision increases
(c) The number of moles of gas increases
(d) The energy of gaseous molecules increases
- 35 Which one of the following statements is false
- (a) Avogadro number = 6.02×10^{21}
(b) The relationship between average velocity (\bar{v}) and room mean square velocity (u) is $\bar{v} = 0.9213 u$
(c) The mean kinetic energy of an ideal gas is independent of the pressure of the gas
(d) The root mean square velocity of the gas can be calculated by the formula $(3RT / M)^{1/2}$

- 36 Postulate of kinetic theory is
 (a) Atom is indivisible
 (b) Gases combine in a simple ratio
 (c) There is no influence of gravity on the molecules of a gas
 (d) None of the above
- 37 According to kinetic theory of gases,
 (a) There are intermolecular attractions
 (b) Molecules have considerable volume
 (c) No intermolecular attractions
 (d) The velocity of molecules decreases after each collision
- 38 In deriving the kinetic gas equation, use is made of the root mean square velocity of the molecules because it is
 (a) The average velocity of the molecules
 (b) The most probable velocity of the molecules
 (c) The square root of the average square velocity of the molecules
 (d) The most accurate form in which velocity can be used in these calculations
- 39 Kinetic energy of a gas depends upon its
 (a) Molecular mass (b) Atomic mass
 (c) Equivalent mass (d) None of these
- 40 The kinetic theory of gases predicts that total kinetic energy of a gaseous assembly depends on
 (a) Pressure of the gas
 (b) Temperature of the gas
 (c) Volume of the gas
 (d) Pressure, volume and temperature of the gas
- 41 According to kinetic theory of gases, the energy per mole of a gas is equal to
 (a) $1.5 RT$ (b) RT
 (c) $0.5 RT$ (d) $2.5 RT$
- 42 Internal energy and pressure of a gas per unit volume are related as
 (a) $P = \frac{2}{3} E$ (b) $P = \frac{3}{2} E$
 (c) $P = \frac{1}{2} E$ (d) $P = 2E$
- 43 The translational kinetic energy of an ideal gas depends only on its
 (a) Pressure (b) Force
 (c) Temperature (d) Molar mass
- 44 Helium atom is two times heavier than a hydrogen molecule at $298 K$, the average kinetic energy of helium is
 (a) Two times that of a hydrogen molecule
 (b) Same as that of a hydrogen molecule
 (c) Four times that of a hydrogen molecule
 (d) Half that of a hydrogen molecule
- 45 Which of the following is valid at absolute zero
 (a) Kinetic energy of the gas becomes zero but the molecular motion does not become zero
 (b) Kinetic energy of the gas becomes zero and molecular motion also becomes zero
 (c) Kinetic energy of the gas decreases but does not become zero
 (d) None of the above
- 46 The average *K.E.* of an ideal gas in calories per mole is approximately equal to
 (a) Three times the absolute temperature
 (b) Absolute temperature
 (c) Two times the absolute temperature
 (d) 1.5 times the absolute temperature
- 47 According to kinetic theory of gases, for a diatomic molecule
 (a) The pressure exerted by the gas is proportional to the mean velocity of the molecules
 (b) The pressure exerted by the gas is proportional to the root mean square velocity of the molecules
 (c) The root mean square velocity is inversely proportional to the temperature
 (d) The mean translational kinetic energy of the molecules is proportional to the absolute temperature
- 48 At STP, $0.50 \text{ mol } H_2$ gas and $1.0 \text{ mol } He$ gas
 (a) Have equal average kinetic energies
 (b) Have equal molecular speeds
 (c) Occupy equal volumes
 (d) Have equal effusion rates
- 49 Which of the following expressions correctly represents the relationship between the average molar kinetic energy, $\overline{K.E.}$, of CO and N_2 molecules at the same temperature
 (a) $\overline{KE}_{CO} = \overline{KE}_{N_2}$
 (b) $\overline{KE}_{CO} > \overline{KE}_{N_2}$
 (c) $\overline{KE}_{CO} < \overline{KE}_{N_2}$
 (d) Cannot be predicted unless the volumes of the gases are given
- 50 Vander Waal's equation is applicable only to
 (a) Ideal gases
 (b) Non-ideal gases
 (c) Real gases
 (d) None of these

Answer key of Gaseous State:-

- (1) c (2) c (3) b (4) a (5) c (6) d (7) a (8) b (9) c (10) a (11) a (12) b (13) a (14) d
 (15) c (16) e (17) c (18) d (19) a (20) a (21) a (22) b (23) a (24) a (25) c (26) d
 (27) a (28) a (29) a (30) a (31) a (32) c (33) c (34) b (35) c (36) d (37) c (38) d
 (39) d (40) b (41) a (42) a (43) c (44) b (45) b (46) a (47) d (48) a (49) a (50) b

VSEPR Theory

MULTIPLE CHOICE QUESTIONS

10.1 According to the VSEPR theory, the geometry of the SO_3 molecule is:

M

- A. pyramidal
- B. tetrahedral
- C. trigonal planar
- D. distorted tetrahedron
- E. square planar

Answer: C

10.2 The geometry of the SF_4 molecule is

M

- A. tetrahedral
- B. trigonal pyramidal
- C. trigonal planar
- D. square planar
- E. distorted tetrahedron

Answer: E

10.3 Use VSEPR theory to predict the geometry of the PCl_3 molecule.

M

- A. linear
- B. bent
- C. trigonal planar
- D. trigonal pyramid
- E. tetrahedral

Answer: D

10.4 According to VSEPR theory the geometry of the PH_3 molecule is best described as:

M

- A. linear
- B. trigonal planar
- C. tetrahedral
- D. bent
- E. trigonal pyramidal

Answer: E

10.5 The geometry of the CS_2 molecule is best described as:

E

- A. linear
- B. trigonal planar
- C. tetrahedral
- D. bent
- E. trigonal pyramidal

Answer: A

10.6 The geometry of the ClF_3 molecule is best described as:

M

- A. distorted tetrahedron
- B. trigonal planar
- C. tetrahedral
- D. T-shaped
- E. trigonal pyramidal

Answer: D

10.7 According to the VSEPR theory, the geometry of the atoms in the carbonate ion, CO_3^{2-} is:

M

- A. square planar
- B. tetrahedral
- C. pyramidal
- D. trigonal planar
- E. octahedral

Answer: D

10.8 According to the VSEPR theory, which one of the following species is linear?

E

- A. H_2S B. HCN C. BF_3 D. H_2CO E. SO_2

Answer: B

10.9 According to VSEPR theory which one of the following molecules is trigonal bipyramidal?

M

- A. SF_4 B. XeF_4 C. NF_3 D. SF_6 E. PF_5

Answer: E

10.10 According to VSEPR theory which one of the following molecules is bent?

E

- A. CO_2 B. C_2H_2 C. SO_2 D. BeCl_2 E. KrF_2

Answer: C

10.11 According to VSEPR theory, which one of the following molecules has a bent geometry?

M

- A. Cl_2O B. CO_2 C. HCN D. CCl_4 E. none of these

Answer: A

10.12 Which one of the following molecules has tetrahedral geometry?

E

- A. XeF_4 B. BF_3 C. AsF_5 D. CF_4 E. NH_3

Answer: D

10.13 According to VSEPR theory, which one of the following molecules has a tetrahedral geometry?
E

- A. NH_3 B. CCl_4 C. CO_2 D. SF_4 E. PCl_5

Answer: B

10.14 The bond angle in Cl_2O is expected to be approximately:
M

- A. 90° B. 109.5° C. 120° D. 145° E. 180°

Answer: B

10.15 The F — S — F bond angles in SF_6 are:
H

- A. 90°
B. 109.5°
C. 120°
D. 180°
E. 90° and 180°

Answer: E

10.16 The F — Cl — F bond angles in ClF_3 are:
M

- A. 90° only
B. 109.5° only
C. 120° only
D. 180° only
E. 90° and 180°

Answer: E

10.17 According to the VSEPR theory, the F — As — F bond angles in the AsF_4^- ion are predicted to be:
M

- A. 109.5°
B. 90° and 120°
C. 180°
D. $<109.5^\circ$
E. $>90^\circ$, $>120^\circ$, and $<180^\circ$

Answer: E

10.18 Which one of the following molecules is nonpolar?
M

- A. NH_3
B. OF_2
C. CH_3Cl
D. H_2O
E. BeCl_2

Answer: E

10.19 Complete the sentence. The PCl_5 molecule has:
M

- A. nonpolar bonds, and is a nonpolar molecule.
- B. nonpolar bonds, but is a polar molecule.
- C. polar bonds, and is a polar molecule.
- D. polar bonds, but is a nonpolar molecule.

Answer: D

10.20 Which one of the following molecules has a dipole moment?
M

- A. BeCl_2
- B. Br_2
- C. BF_3
- D. IBr
- E. CO_2

Answer: D

10.21 Which one of the following molecules has no dipole moment?
M

- A. CO B. CH_2Cl_2 C. SO_3 D. SO_2 E. NH_3

Answer: C

10.22 Which one of the following is a polar molecule?
M

- A. PBr_5
- B. CCl_4
- C. BrF_5
- D. XeF_2
- E. XeF_4

Answer: C

10.23 Predict the molecular geometry and polarity of the SO_2 molecule.
M

- A. linear, polar
- B. linear, nonpolar
- C. bent, polar
- D. bent, nonpolar
- E. None of these is correct.

Answer: C

10.24 Predict the geometry and polarity of the CS_2 molecule.
M

- A. linear, polar
- B. linear, nonpolar
- C. tetrahedral, nonpolar
- D. bent, nonpolar
- E. bent, polar

Answer: B

10.25 Indicate the type of hybrid orbitals used by the central atom in PCl_3 .

H

- A. sp B. sp^2 C. sp^3 D. sp^3d E. sp^3d^2

Answer: C

10.26 Indicate the type of hybrid orbitals used by the central atom in CCl_4 .

M

- A. sp B. sp^2 C. sp^3 D. sp^3d E. sp^3d^2

Answer: C

10.27 Indicate the type of hybrid orbitals used by the central atom in SF_6 .

H

- A. sp B. sp^2 C. sp^3 D. sp^3d E. sp^3d^2

Answer: E

10.28 What is the hybridization of the As atom in the AsF_5 molecule?

M

- A. sp B. sp^2 C. sp^3 D. sp^3d E. sp^3d^2

Answer: D

10.29 What is the hybridization of the central atom in NO_3^- ?

M

- A. sp B. sp^2 C. sp^3 D. sp^3d E. sp^3d^2

Answer: B

10.30 Which one of the following molecules has sp^2 hybridization at the central atom?

M

- A. SO_2 B. N_2O C. BeCl_2 D. NF_3 E. PF_5

Answer: A

10.31 What is the hybridization of As in the AsF_4^- ion?

M

- A. sp B. sp^2 C. sp^3 D. sp^3d E. sp^3d^2

Answer: D

10.32 What is the hybridization of the central atom in ClO_3^- ?

H

- A. sp B. sp^2 C. sp^3 D. sp^3d E. sp^3d^2

Answer: C

10.33 Which of the following covalent species have the same geometries?

M

- A. NH_2^- and H_2O
- B. NH_2^- and BeH_2
- C. H_2O and BeH_2
- D. NH_2^- , H_2O , and BeH_2

Answer: A

10.34 Which of the following molecules have the same geometries?

M

- A. SF_4 and CH_4
- B. CO_2 and H_2O
- C. CO_2 and BeH_2
- D. N_2O and NO_2

Answer: C

10.35 Predict the molecular geometry of SO_3 .

M

- A. trigonal planar
- B. trigonal pyramidal
- C. tetrahedral
- D. T-shaped

Answer: A

10.36 Which pair is geometrically similar?

M

- A. SO_2 and CO_2
- B. CO_2 and OF_2
- C. PH_3 and BF_3
- D. SO_2 and O_3

Answer: D

10.37 The fact that BCl_3 is a planar molecule while NCl_3 is pyramidal can be explained several different ways. Which is the best rationalization?

M

- A. Nitrogen is more electronegative than boron.
- B. The nitrogen atom in NCl_3 has a lone pair of electrons whereas the boron atom in BCl_3 does not.
- C. The nitrogen atom is smaller than the boron atom.
- D. The boron atom in BCl_3 is sp^3 hybridized, while the nitrogen atom in NCl_3 is sp^2 hybridized.

Answer: B

10.38 M NH_3 (pyramidal geometry) reacts with BF_3 (planar geometry) to form the addition compound, H_3NBF_3 . What is the geometry around the nitrogen and boron centers in the addition compound?

- A. Both centers are tetrahedral.
- B. Nitrogen–tetrahedral and boron–linear.
- C. Nitrogen–pyramidal and boron–planar.
- D. Nitrogen–planar and boron–pyramidal.

Answer: A

10.39 E Which geometry is associated with an sp hybridized atom?

- A. pyramidal
- B. tetrahedral
- C. trigonal planar
- D. linear

Answer: D

10.40 M The geometry for SeF_3^+ is:

- A. trigonal pyramidal.
- B. square planar.
- C. tetrahedral.
- D. rectangular planar

Answer: A

10.41 E Which of the following covalent species is planar?

- A. NH_3
- B. SO_3^{2-}
- C. CO_3^{2-}
- D. H_3O^+

Answer: C

10.42 E Which of the following molecules is linear?

- A. H_2O
- B. NH_3
- C. NO_2
- D. CO_2
- E. H_2S

Answer: D

10.43 E Which of the following statements is true of methane?

- A. It is a tetrahedral molecule.
- B. It contains single and double bonds.
- C. It contains 80% hydrogen by weight.
- D. It does not occur in nature.
- E. It is a polar molecule.

Answer: A

10.44 The ammonium ion is symmetrical, with the nitrogen at the center of a tetrahedron of four equivalent hydrogens. The N atom in the ion may best be described as using:

E

- A. only sp^3 hybridized orbitals.
- B. only sp^2 hybridized orbitals.
- C. sp^2 and s orbitals.
- D. sp^2 and p orbitals.

Answer: A

10.45 Which type of hybrid orbital is used by carbon in CO_2 ?

E

- A. sp
- B. sp^2
- C. sp^3
- D. dsp^3

Answer: A

10.46 Which is the largest bond angle?

M

- A. angle O–S–O in SO_4^{2-}
- B. angle Cl–C–Cl in CCl_3
- C. angle F–Be–F in BeF_2
- D. angle H–O–H in H_2O

Answer: C

10.47 In Molecular Orbital theory, the bond order =

E

- A. the total number of valence electrons available for bonding.
- B. (the number of electrons in bonding MOs) + (the number of electrons in antibonding MOs).
- C. (the number of electrons in bonding MOs) - (the number of electrons in antibonding MOs).
- D. $\frac{(\text{number of electrons in bonding MOs}) - (\text{number of electrons in antibonding MOs})}{2}$
- E. $\frac{(\text{number of electrons in bonding MOs}) + (\text{number of electrons in antibonding MOs})}{2}$

10.48 What is the bond order of N_2 , for which the MO electron configuration is: $\sigma_{2s}^2 \sigma_{2s}^{*2} \pi_{2py}^2 \pi_{2pz}^2 \sigma_{2px}^2$

E

- A. 1
- B. 2
- C. 3
- D. 4
- E. none of these

Answer: C

10.49 Which of the following substances is an example of a homonuclear diatomic molecule?

E

- A. O₃
- B. NO
- C. He
- D. F₂
- E. NH₃

Answer: D

SHORT ANSWER QUESTIONS

10.50 Use VSEPR theory to predict the molecular geometries of

H

- a. H₃O⁺ (hydronium ion) _____
- b. CO₃²⁻ _____
- c. SF₄ (sulfur tetrafluoride) _____

Answer: a. trigonal pyramid b. trigonal planar c. distorted tetrahedron

10.51 Use VSEPR theory to explain why the water molecule is bent, rather than linear.

E

Answer: The central oxygen atom must distribute 4 pairs of electrons around itself. Two are lone pairs.

10.52 Using periodic trends arrange the following molecules in order of increasing dipole moment: NH₃, PH₃, AsH₃.

M

Answer: AsH₃ < PH₃ < NH₃

10.53 Explain why CO₂ is nonpolar, but OCS is polar.

M

Answer: In CO₂, the two bond moments point in opposite directions and are of equal magnitude. Therefore they cancel. But in OCS, even though the two bond moments point in opposite directions, they are not of the same magnitude and so do not cancel.

10.54 The N — N — H bond angles in hydrazine N₂H₄ are 112°. What is the hybridization of the nitrogen orbitals predicted by valence bond theory?

M

Answer: sp²

10.55 Indicate the number of π - bonds in each of these molecules.

E

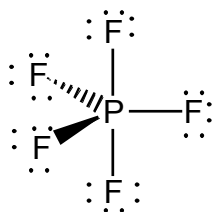
- a. C₂H₄ _____
- b. C₂H₆ _____
- c. N₂H₂ _____

Answer: a. 1 b. 0 c. 1

- 10.56 a. According to the VSEPR theory the geometrical structure of PF_5 is _____ ?
M
- b. In a sketch it would look like this.
- c. The F — P — F bond angles are _____
- d. PF_5 is (polar; nonpolar). (Circle one)

Answer:

- a. trigonal bipyramidal
b.



- c. 90° , 120° , and 180°
d. nonpolar

- 10.57 a. How does the geometrical structure of PF_5 differ from that of IF_5 ?
M
- b. IF_5 is (polar; nonpolar). (Circle one)

Answer: a. PF_5 is trigonal bipyramidal, whereas IF_5 is square pyramidal b. polar

- 10.58 Ozone (O_3) is an allotropic form of oxygen. Use VSEPR theory to predict the geometry
M of the ozone molecule.

Answer: bent

- 10.59 Which should have the longer bond, B_2 or B_2^- ?
H

Answer: B_2^-

- 10.60 Which should have the longer bond, O_2 or O_2^+ ?
M

Answer: O_2

10.61 Using the VSEPR Theory match the shapes of the molecules with the formula.
M

- | | |
|----------------------------|--------------------|
| _____ 1. BeCl ₂ | a. Linear |
| _____ 2. H ₂ O | b. Trigonal planar |
| _____ 3. SiCl ₄ | c. Bent |
| _____ 4. BCl ₃ | d. Tetrahedral |
| _____ 5. NH ₃ | e. Octahedral |
| | f. Pyramidal |

Answer:

- __a__ 1. BeCl₂
 __c__ 2. H₂O
 __d__ 3. SiCl₄
 __b__ 4. BCl₃
 __f__ 5. NH₃

10.62 Complete the following table.
H

Hybrid type	Geometry of electron pairs
a _____	linear
b sp ²	_____
c _____	trigonal bipyramidal
d _____	octahedral

Answer:

Hybrid type	Geometry of electron pairs
a sp	linear
b sp ²	trigonal planar
c dsp ³	trigonal bipyramidal
d sp ³ d ²	octahedral

10.63 The two — CH₂ groups in C₂H₄ do not rotate freely around the bond connecting them, although the two — CH₃ groups in C₂H₆ have almost unhindered rotation around the C — C bond. Why?
M

Answer: The C₂H₄ has pi bonding between the carbon atoms. Pi bonding restricts rotation.

10.64 In benzene, what is the hybridization on each carbon atom?
E

Answer: sp²

10.65 Predict the geometry around the central atom in each of the following molecules:
M

- a PO₄³⁻ b SO₄²⁻ c XeO₄

Answer: All are tetrahedral

10.66 Which of the following molecules should be polar?

M

a CH_3OH b H_2O c CH_3OCH_3

Answer: a and b and c (mildly polar)

10.67 Which of the following molecules are bent?

M

a. H_2S b. CO_2 c. ClNO d. NH_2^- e. O_3

Answer: a, c, d, and e

10.68 Which of the following molecules are planar?

H

a. SO_3 b. SO_3^{2-} c. NO_3^- d. PF_3 e. BH_3

Answer: a, c, and e

TRUE-FALSE QUESTIONS

10.69 According to the VSEPR theory all of the electron pair-electron pair repulsions
M about the central atom in PCl_3 are of equal strength.

Answer: F

10.70 The BrF_5 molecule has polar bonds and has a dipole moment.
M

Answer: T

10.71 Pi bonds are covalent bonds in which the electron density is concentrated above
E and below the inter-nuclear axis, but not cylindrically around the axis.

Answer: T

10.72 The hybridization of B in the BF_3 molecule is sp^3 .
M

Answer: F

10.73 A bonding molecular orbital is of lower energy (more stable) than the atomic
M orbitals from which it was formed.

Answer: T

10.74 The σ_{2s} MO is lower in energy than the σ_{2p_x} MO.
E

Answer: T

10.75 Based on the MO diagram for N_2 ($\sigma_{2s}^2 \sigma_{2s}^{*2} \pi_{2py}^2 \pi_{2pz}^2 \sigma_{2px}^2$), N_2 should be paramagnetic.
E

Answer: F

10.76 Molecular Orbital theory provides an explanation for the observation that O_2 is a diamagnetic molecule.
E

Answer: F