Answer ALL questions   Number of Pages   16   Time: 1 hour and 50 minutes

Composition **46** Multiple Choice Questions.   <mark>Paper Code: CHO-PST-D</mark>

a.   Should indicate all your answers in the answer sheet provided to you.

b.   Select the best answer out of ethe five choices for each question and mark a cross using a **carbon pen** (blue/black) as shown below.

17.	(a)	(b)	(c)	~~(d)~~	(e)

c.   Mark only **one answer** to each question. (Marks will not be given for marking more than one answers.)

d.   Clearly write your **index number** on the top right-hand corner of the answer sheet.

Calculators (scientific and normal) are allowed, but any other electronic devices (smart watches) are not allowed.

PERIODIC TABLE OF THE ELEMENTS

1 1A																		18 8A
1 **H** 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A		2 **He** 4.003
3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00		10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45		18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90		36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9		54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)		86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac** (227)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 **Ds** (281)	111 **Rg** (272)	112 **Cn** (285)	113 (Uut) (284)	114 **Fl** (289)	115 (Uup) (288)	116 **Lv** (293)	117 (Uus) (294)		118 (Uuo) (294)

58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

Physical Constants

Gas Constant 8.314 J mol^{-1} K^{-1}	Avogadro Number 6.022×10^{23} mol^{-1}	0 °C = 273 K 1 atm = 760 mm Hg = 1.013 bar
Plank constant 6.6×10^{-34} m^2 kg s^{-1}	Standard temperature and pressure: 273 K and 100 kPa	

(1) Which of the following shows the correct order of the net dipole moment of the given compounds?
  a. PH_3 < Benzene < NH_3
  b. $CHCl_3$ < CCl_4 < SO_2
  c. CS_2 < H_2O < BF_3
  d. CCl_4 < $CHCl_3$ < H_2O
  e. BF_3 < NH_3 < NF_3

(2) Which of the following statements is **not** correct?
  a. The catalytic effect increases with increasing surface area of a solid catalyst.
  b. The operation of a catalyst involves changes in the reaction pathway that involves a lower energy of activation.
  c. Catalyst lowers the energy of activation of the forward reaction without affecting the energy of activation of the reverse reaction.
  d. Catalyst does not affect the overall enthalpy change of the reaction.
  e. Catalyst is also involved in the reaction that is taking place.

Questions **(3)** and **(4)** are based on the following description.

Concentration of copper(II) iodate, $Cu(IO_3)_2$ can be determined in an acidic solution by iodometry.

A 25.00 cm^3 of saturated aqueous solution of $Cu(IO_3)_2$ required 20.00 cm^3 of 0.1500 M sodium thiosulphate to reach the end point.

(3) Which of the following is correct?
  a. Copper oxidizes during the reaction
  b. Copper disproportionate during the reaction
  c. Copper does not involve in the reaction
  d. Copper interferes the end point detection
 e. Copper reduces during the reaction.

(4) The initial concentration of copper(II) in the solution is,
  a. 0.0092 M
  b. 0.0369 M
  c. 0.0185 M
  d. 0.0144 M
  e. 0.0230 M

(5) Boiling point of the compound X is 77 °C. When vaporized the gas X has a density of 5.0 g L^{-1} at 1 bar and 97 °C. The compound X is,
  a. CCl_4 b. CCl_2 c. C_2Cl_2 d. CCl_3H e. Cl_2H_2

(6) NO and O_2 gasses are initially placed in separate chambers as shown in the figure below.
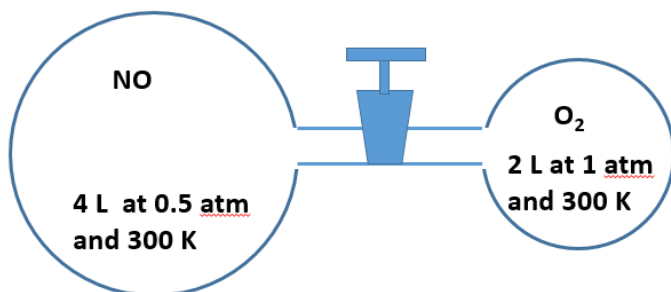
When the valve is opened two gasses are mixed and react immediately to form NO_2. Assume that the temperature remains constant at 300 K. What would be the partial pressure of remaining oxygen gas?

    a. 0 atm   b. 1/6 atm   c. 1/4 atm   d. 1/3 atm   e. 1/2 atm

(7) Consider the following statements related to the surface tension.
    A. Surface tension of a liquid is independent of the temperature of the liquid.
    B. Impurities present in a liquid considerably affects the surface tension.
    C. Raindrops are spherical because of air resistance.

Which of the above statement/s is/are false?

    a. A
    b. B
    c. C
    d. A and C
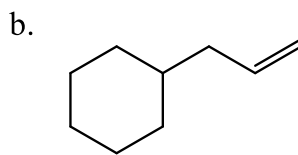   e. B and C

(8) The $HClO_4$ molecule contains:
    a.   13 lone pairs, 1π bond, and 4σ bonds
    b.   9 lone pairs, no π bonds, and 6 σ bonds
    c.   8 lone pairs, 2 π bonds, and 7 σ bonds
    d.   2 lone pairs, 3 π bonds, and 4σ bonds
    e.   11 lone pairs, no π bonds, and 5 σ bonds

(9) Select the bond order of dioxygen ion (O_2^+)
    a. 3.5
    b. 2.0
    c. 1.5
    d. 2.5
    e. 0

(10) Which alkene is most reactive in acid-catalyzed hydration?

a.

b.

c.

d.

e.
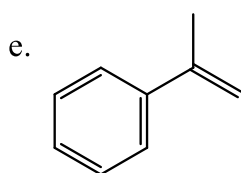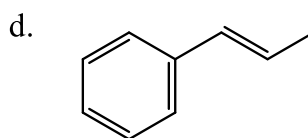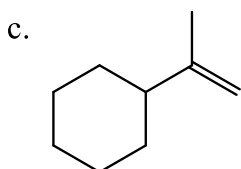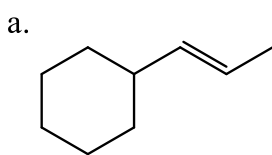
Answer: e

(11) Which of the following properties is an extensive property?
   a. Standard enthalpy of combustion of $C_3H_8(g)$
   b. Molar heat capacity of a substance
   c. Enthalpy of hydration of $Na^+(g)$
   d. Change of entropy of a liquid during vaporization
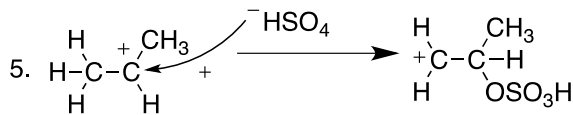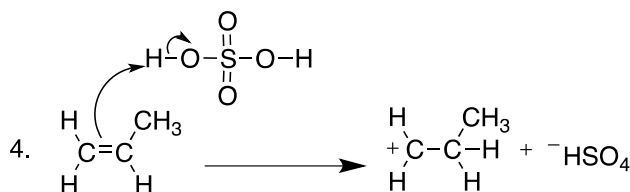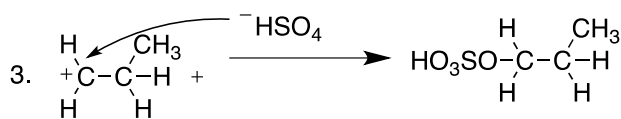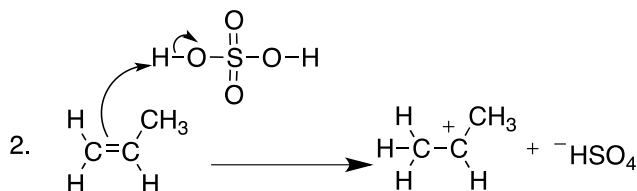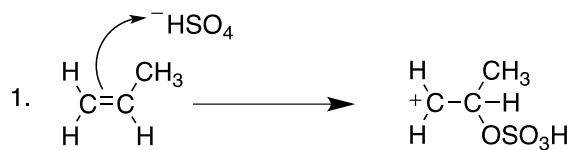   e. Molar enthalpy of neutralization

(12) The coordination number of $[PtCl_6]^{4-}$ is,
   a. 2
   b. 3
   c. 4
   d. 5
   e. 6

(13) A solution is prepared by mixing 4.0 mg of sodium ions (in the form of NaCl), 4.00 g of glucose ($C_6H_{12}O_6$), and 96 g of water. The concentration of Na^+ of this solution in ppm is,
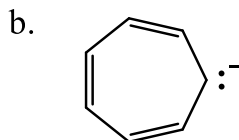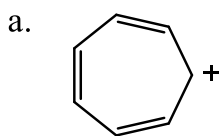   a. 29.99
   b. 33.44
   c. 39.99
   d. 78.98
   e. 42.31

(14) Which of the following represents a correct step/s of the mechanism of the reaction between propene and cold concentrated H_2SO_4?

1. [Structure: propene $CH_2=CH-CH_3$ with $^-HSO_4$ attacking, arrow to carbocation H–C$^+$–C–H with CH3 and OSO3H]

2. [Structure: $H-O-S(=O)(=O)-O-H$ sulfuric acid attacking propene $C=C$, arrow to $H-C-C^+$ product with CH3 and H, plus $^-HSO_4$]

3. [Structure: carbocation $^+C-C-H$ (CH3, H) reacting with $^-HSO_4$, arrow to $HO_3SO-C-C-H$ product with CH3]

4. [Structure: sulfuric acid $H-O-S(=O)(=O)-O-H$ attacking propene $C=C$, arrow to $^+C-C-H$ (CH3) plus $^-HSO_4$]

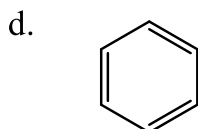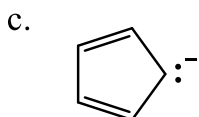5. $H-C-C^+$ (CH3, H) reacting with $^-HSO_4$, arrow to $^+C-C-H$ product with CH3 and OSO3H

a. Only (1) and (2)   b. Only (2) and (3)   c. Only (3) and (4)   d. Only (4) and (5)
e. Any other number of combination of responses correct

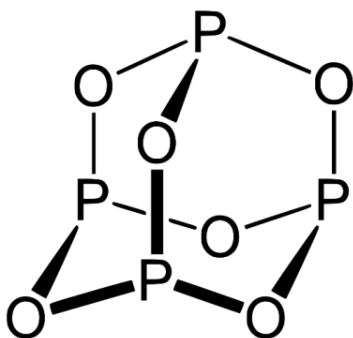(15) Which of the following is not aromatic?

a. [cycloheptatrienyl cation, +]

b. [cycloheptatrienyl anion, :–]   Answer: b

c. [cyclopentadienyl anion, :–]

d. [benzene]

e. both b and c

(16)   Structure of a common phosphorous oxide (Y) is given in the figure below.

Consider the following statements regarding the above molecule.

(I)   Oxidation state of P is +5.

(II)   Both P and O have a complete octet.

(III)   Bond angle OPO is larger than that of POP

Correct statement/s is/are,

   a. Only I   b. Only II   c. Only I & III   d. Only II and III   e. All

(17)   Above phosphorous oxide (X) reacts with NaOH to form disodium hydrogen phosphite (Na_2HPO_3) and water as products. How many moles of NaOH are required to neutralize one mole of X?

            a. 2   b. 3   c. 4   d. 6   e. 8

(18)   A sample of 25.00 cm³ unknown sodium carbonate was titrated against primary standard HCl solution in the presence of phenolphthalein and methyl orange indicators separately and end point burette readings of 25.00 cm³ and 50.00 cm³, respectively was obtained. What is the end point burette readings that can be obtained in the presence of phenolphthalein and methyl orange indicators, respectively if the burette is filled with the unknown sodium carbonate solution and the titration flask contains 25.00 cm³ of standard HCl solution?

   a. 25.00 cm³, 25.00 cm³
   b. 25.00 cm³, 50.00 cm³
   c. 50.00 cm³, 25.00 cm³
   d. 50.00 cm³, 50.00 cm³
   e. None of the above

(19) In order to form back bonding, the donor atom should have,
  a. Lone pair of electrons
  b. Empty orbitals
  c. Electrons in its 3d energy level
  d. The ability to form covalent bonding
  e. High electronegativity

(20) Which of the following statements is correct regarding the thermochemical properties of a system?
  a. Gibbs energy change should be positive for a reaction to be spontaneous.
  b. Gibbs energy is temperature independent.
  c. A reaction has a possibility to become spontaneous when the standard entropy change is large and positive.
  d. The units of enthalpy change and entropy change are the same.
  e. The sign of the entropy change can be always predicted by observing the balanced chemical equation.

(21) A neutral molecule having the general formula XY_3 has two lone pairs of electrons on X. What is the hybridization of X?
  a. sp
  b. sp^2
  c. sp^3
  d. sp^3d
  e. sp^3d^2

(22) Amount of ethanol present in a liquor sample can be easily analyzed by titrating a known volume of liquor sample with a standard potassium dichromate solution under acidic conditions. The ethanol present in the sample gets converted into acetic acid upon reaction with potassium dichromate. Which of the following statements is true regarding the above titrimetric procedure?
  a. Using nitric acid as the acidifying agent will lead to wrong end point volumes.
  b. Ethanol acts as the oxidizing agent in the reaction between potassium dichromate and ethanol.
  c. Four electrons are gained by one ethanol molecule when getting converted to acetic acid.
  d. Addition of small amount of deionized water to the titration flask will lead to lower end point volumes.
  e. Heating the mixture in the titration flask will lead more accurate endpoint volumes.

(23) What of the following is not a pair of resonance structures?

a.

b.

c.

d.
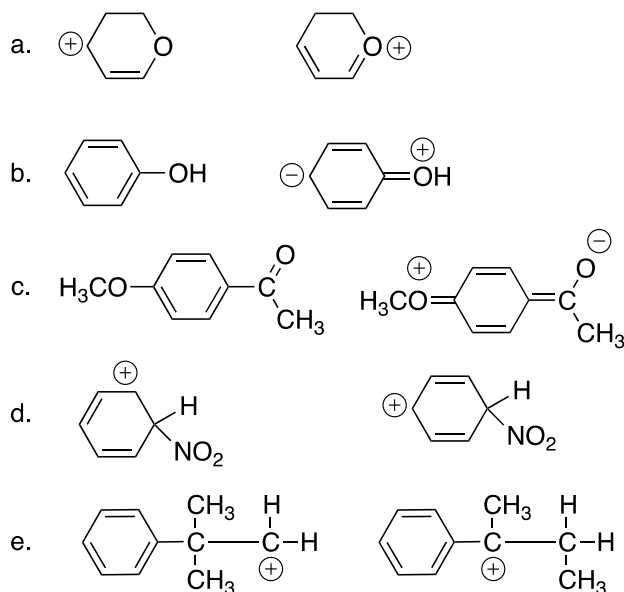
e.   Answer: e

(24) Which of the following statements is true regarding lattice enthalpy?
    a. The greater the lattice enthalpy, the weaker the forces between the ions in a solid.
    b. Forces between the ions are not completely lost in the gaseous state.
    c. There is significant extent of attraction between ions in gaseous state.
    d. Lattice enthalpy can be regarded as a measure of the strength of the forces between the ions in an ionic solid.
    e. Lattice energy can be calculated using the relationship, $\Delta G = \Delta H - T\,\Delta S$.

(25) Methane gas is the main component of Liquefied Natural Gas (LNG). It is advantageous to transport methane longer distance in liquid form than in gaseous form. For such purpose, 2310 kg of methane gas was stored in a container having a volume of 4.0 m^3 at -159 °C. Determine how many times larger is the energy density per unit volume of liquefied methane than that of gaseous methane in cylinders under 300 bar pressure at room temperature (27 °C) (Assume that methane behaves as an ideal gas)

    a. 0.27   b. 3.0   c. 27   d. 30   e. 270

(26) Which of the following statements is true?
    a. Rb has a higher melting point than K
    b. Na has a lower boiling point than Cs
    c. Li has a higher density than Rb
    d. Na has a higher atomic radius than Rb
    e. None of the above

(27)   Consider the following statements on electron affinity of elements

   (I)   Electron affinity of Chlorine (Cl) is greater than that of Bromine (Br)

   (II)   Electron affinity of Selenium (Se) is greater than that of Bromine (Br)

   (III) Fluorine is the element with the largest electron affinity in the periodic table

   Which of the above statement/s is/are true?

      a. Only I   b. Only III   c. Only I and III   d. All   e. None of the above combinations

(28)   From the list given below, which response contains only the properties of phosphorus trichloride, PCl_3.

                (1) trigonal planar
                (2) one lone pair of electrons on P
                (3) sp^2 hybridized at P
                (4) polar molecule
                (5) polar bonds

      a. 1, 4, 5
      b. 2, 3, 4
      c. 1, 2, 4
      d. 2, 4, 5
      e. None of the above combinations

   •   Answer to the questions (29)-(31) based on the compound A given below.

A
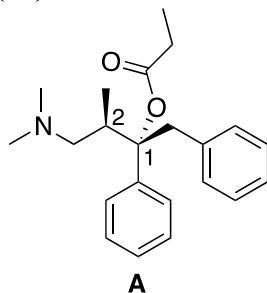
(29)   The number of stereoisomers of the compound A are,

      a. 1   b. 2   c. 3   d. 4   e. 5

(30)   The absolute configuration of the C-1 and C-2 respectively are,

      a. R,R   b. S,R   c. R,S   d. S,S   e. None of the above

(31)   Which of the following pairs is/are diastereomers of the above compound?

1.

2.

3.

4.

5.
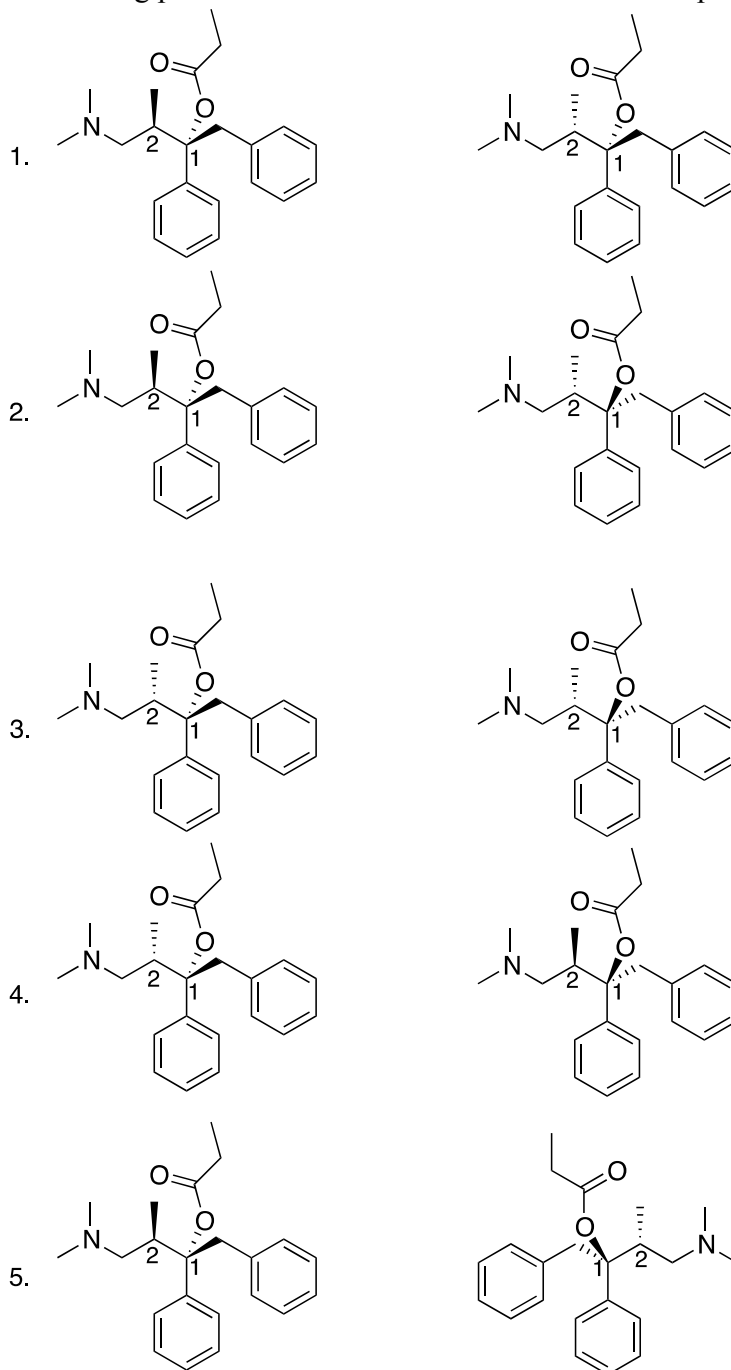
a. Only (1) and (2)   b. Only (2) and (3)   c. Only (3) and (4)   d. Only (1) and (3)
e. Any other number of combination of responses correct

(32) The work function of K is 2.2 eV and that of Ni is 5.0 eV, where 1 eV = 1.60×10^{-19} J. Violet light of wavelength 4000 Å cause the photoelectric effect

    a. in both K and Ni
    b. in K but not in Ni
    c. in Ni but not in K
    d. in neither Ni nor K
    e. Information given is not enough to decide

(33) A salt has a formula of the type $M_xL_y.zH_2O$. In this formula M^{n+} is a metal cation, L^{b-} is a polyatomic anion and x, y and z are all unknown integers. $M^{(n-1)+}$ and I_2 are formed when M^{n+} reacts with I^-. If 27.85 cm^3 of 0.02 M sodium thiosulphate is required to titrate 0.3452 g sample of the salt dissolved with excess KI, the amount of M^{n+} present in 0.3452 g of solid $M_xL_y.zH_2O$ is,

    a. 1.11 x 10^{-3} mol
    b. 2.64 x 10^{-4} mol
    c. 5.57 x 10^{-4} mol
    d. 3.69 x 10^{-4} mol
    e. 2.79 x 10^{-4} mol

(34) Consider the following reaction sequence.
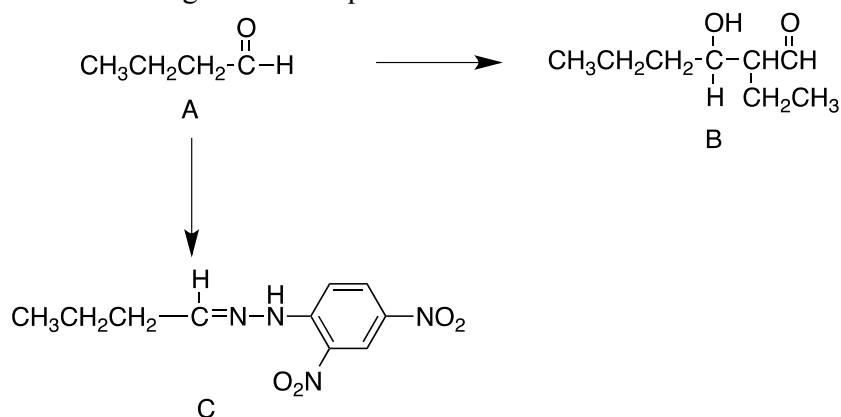
Which of the following statement/s is/are correct?

1. Reaction of 2 mol of **A** with aqueous NaOH gives **B**.
2. **A** reacts with 2,4-dinitrophenylhydrazine to give **C**.
3. $NaBH_4$ can be used to convert **A** to $CH_3CH_2CH_2CH_2OH$.
4. **A** and **B** can be identified using Tollen's reagent.

    a. Only (1) and (2) correct
    b. Only (2) and (3) correct
    c. Only (3) and (4) correct
    d. Only (1) and (3) correct
    e. Any other number or combination of responses correct

- Answer the following questions **(35)-(37)** related to Diels-Alder reaction.

The Diels-Alder reaction, a concerted [4+2]-cycloaddition between a conjugated diene and a dienophile which yields a substituted cyclohexene derivative, was discovered in 1928 by Prof. Otto Diels and his coworker Kurt Alder.
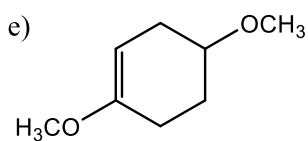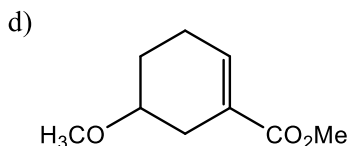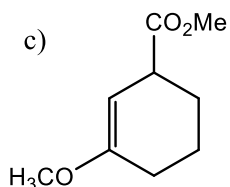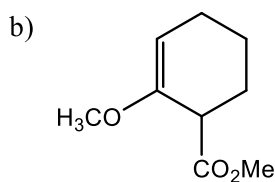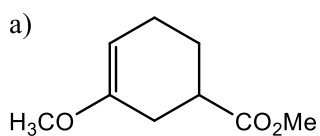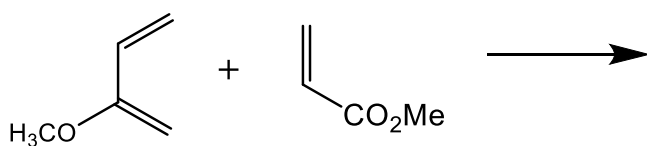
(35)   Which of the following dienophiles is the most reactive with dienes?

a.

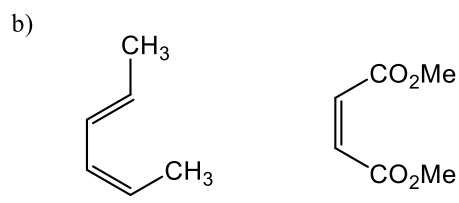b.   OEt

c.

Answer c

d.   MeO$_2$C   CO$_2$Me

e.   CO$_2$Me
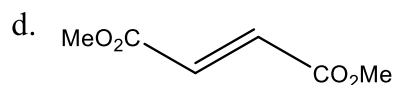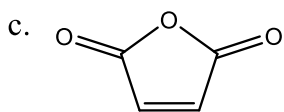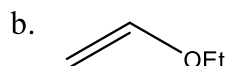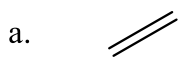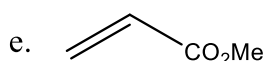
(36)   Which constitutional isomer is the major product of the following reaction?

H$_3$CO   +   CO$_2$Me   →

a)   H$_3$CO   CO$_2$Me

b)   H$_3$CO   CO$_2$Me

c)   CO$_2$Me   H$_3$CO

d)   H$_3$CO   CO$_2$Me

e)   OCH$_3$ H$_3$CO

Give maks for all. there is a mistake in the answers

(37) Which of the following diene and dienophile pairs give the following Diels-Alder adduct?

CH_3

CO_2Me

CO_2Me

CH_3

a)

CH_3

MeO_2C

CH_3

CO_2Me

b)

CH_3

CH_3

CO_2Me

CO_2Me

c)

CH_3

CO_2Me

CO_2Me

CH_3

d)

CH_3

MeO_2C

CH_3

CO_2Me

e)

CH_3

CH_3

MeO_2C

CO_2Me
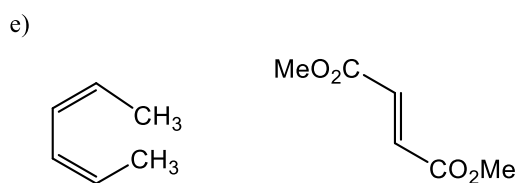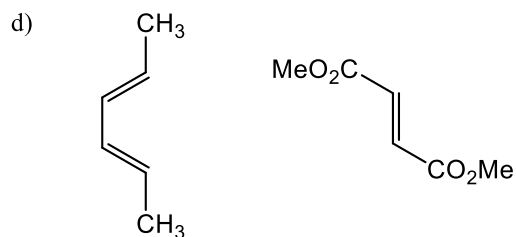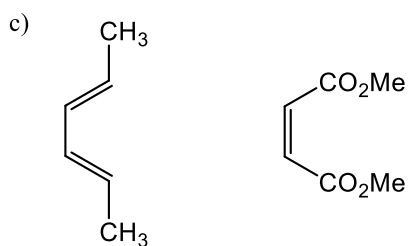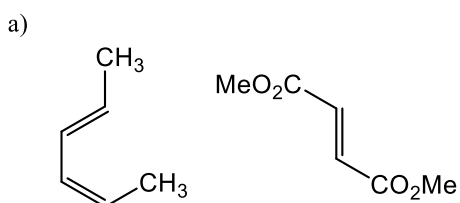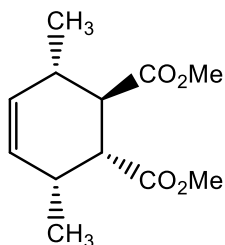
Answer: d/e (consider either d or e)

(38) The first law of thermodynamics is given by,

$$\Delta U = Q - W$$

where ΔU is the change in internal energy U of the system, Q is the net heat transferred into the system and W is the net work done by the system.

Suppose there is heat transfer of 30.00 J to a system, while the system does 10.00 J of work. Later, there is heat transfer of 20.00 J out of the system while 4.00 J of work is done on the system. The net change in internal energy of the system, in J, is,

a. −16.00   b. −4.00   c. −10.00   d. 4.00   e. 16.00

(39) Which of the following statements is false regarding the titration between oxalic acid and potassium permanganate in acidic medium?

    a. Heating of the solution in the titration flask increases the rate of the reaction between potassium permanganate and oxalic acid.

    b. Heating of the solution in the titration flask decreases the activation energy barrier of the reaction.

    c. Heating of the solution in the titration flask increases the feasibility for the reaction to happen.

    d. Potassium permanganate acts as a self-indicator.

    e. Stoichiometry for potassium permanganate : oxalic acid is 2 : 5
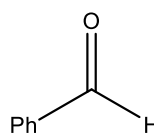
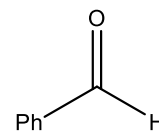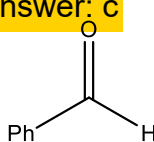(40) Which combination of carbonyl compounds gives α,β-unsaturated ketone by an aldol condensation?
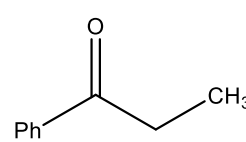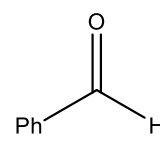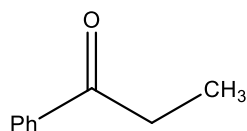

(a)
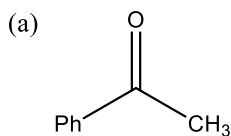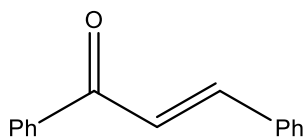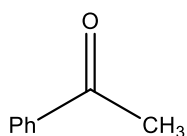
(b)

(c) answer: c
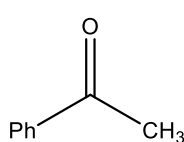
(d)

(e)
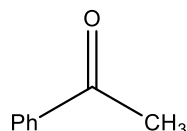
(41) Electrons are ejected from a metal surface with kinetic energy of E eV when radiation of λ nm wavelength shines on it. If h and c are Planck constant and speed of light respectively, correct expression for the threshold frequency is

    a. $\frac{c}{\lambda} + \frac{E}{h}$ b. $\frac{c}{\lambda} - \frac{E}{h}$ c. $\frac{c}{\lambda}\frac{E}{h}$ d. $\frac{c}{\lambda} - \frac{h}{E}$ e. None of the above

(42) According to the third law of thermodynamics, the entropy of a perfect crystal at absolute zero (0 Kelvin) is zero. This means that
      a. Heisenberg uncertainty principle is not valid at 0 K.
      b. All molecules have zero vibrational energy at 0 K.
      c. It is easy to reach absolute zero temperature.
      d. The third law of thermodynamics violates the second law of thermodynamics.
      e. All molecular motions should cease at 0 K.

(43) Relationship between the boiling point (T) and pressure of a hydrocarbon is given by the following equation.

$$\log P\ /bar\ = 2.01 - \frac{801}{T\ /K - 1.4}$$

The boiling point of this hydrocarbon at atmospheric pressure is,

    a. 51.4 K   b. 202.1 K   c. 401.4 K   d. 801 K   e. Not enough data to calculate

(44) Out of following five statements about bonding theories one is false. Select the false statement.
      a. Valence bond theory and molecular orbital theory can be described as two different views of the same thing.
      b. When one considers the molecular orbitals resulting from the overlap of any two specific atomic orbitals, the bonding orbitals are always lower in energy than the antibonding orbitals.
      c. Molecular orbitals are generally described as being more delocalized than hybridized atomic orbitals.
      d. One of the shortcomings of molecular orbital theory is, its inability to account for a triple bond in the nitrogen molecule, N_2.
      e. One of the shortcomings of valence bond theory is, its inability to account for the paramagnetism of the oxygen molecule, O_2.
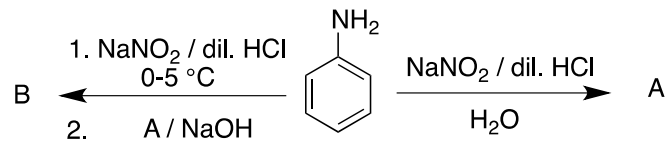
(45) Boltzmann formulated a simple relationship between entropy (S) and the number of possible microstates of a system, which is denoted by the symbol Ω. This relationship is given by,

$$S = k_B \ln \Omega$$

where k_B is the Boltzmann constant. The smallest possible value of Ω is,

    a. -1 b. 0   c. 1   d. 2   e. 3

(46)

In the reaction scheme above, the structures of **A** and **B** are respectively,

a. ,

b. ,

c. ,

d. ,

e. ,

Answer: c

……………………..END……………………..