Sri Lanka National Chemistry Olympiad

Preliminary Selection Test – 2025

Answer ALL questions Number of Pages 13 Time: 2 hours and 30 minutes

Composition: **45 Multiple Choice Questions**

a. Should indicate all your answers in the boxes of the answer sheet provided to you.
b. Select the best answer out of the 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 answer.)
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												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H 1.008	2 2A																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. Arrange the following ions in the order of increasing ionic radius: Ca^{2+},Cl^{-},S^{2-},K^{+},O^{2-}

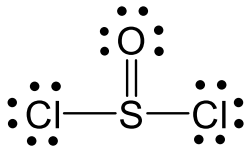
   (a) $Ca^{2+}<K^{+}<Cl^{-}<O^{2-}<S^{2-}$
   (b) $K^{+}<Ca^{2+}< Cl^{-}<S^{2-}<O^{2-}$
   (c) $K^{+}<Ca^{2+} <O^{2-}<S^{2-} <Cl^{-}$
   (d) $Ca^{2+}<K^{+}<Cl^{-}< O^{2-} <S^{2-}$
   (e) None of the above

2. Arrange the following elements in order of increasing first ionization energy: Na,Al,Cl,Si,Mg

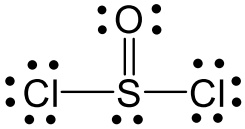
   (a) Cl<Si<Al<Mg<Na
   (b) Na<Mg<Si<Al<Cl
   (c) Mg<Na<Al<Si<Cl
   (d) Na<Mg<Al<Si<Cl
   (e) Na<Al<Mg<Si<Cl

3. Which of the Lewis structure below best represents the molecule $SOCl_2$?

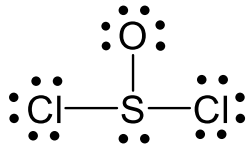
(a)



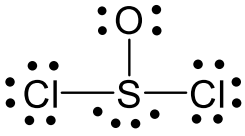
(b)



(c)



(d)



(e) None of the above

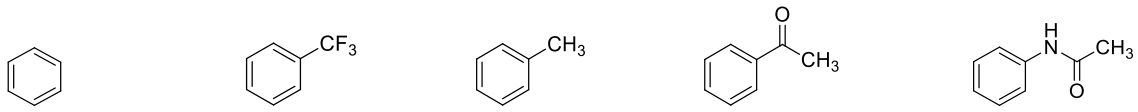
4. In the addition of hydrogen bromide to alkynes, which of the following species is formed as an intermediate?
   (a) vinyl anion
   (b) vinyl cation
   (c) vinyl radical
   (d) carbene
   (e) allylic anion

5. Which of the reactions given below forms acetic acid as the major organic product?
   (a) Oxidizing methanol with potassium permanganate and sulfuric acid
   (b) Distilling Calcium acetate in the presence of calcium formate
   (c) Oxidizing acetaldehyde with potassium dichromate and sulphuric acid
   (d) Heating glycerol with sulfuric acid
   (e) Heating glycerol with potassium permanganate

6. The bond shapes of sulfur dichloride (SCl_2), silane (SiH_4), carbon disulfide (CS_2) and sulfur trioxide (SO_3) are;
   (a) Angular, tetrahedral, linear and trigonal planar, respectively.
   (b) Tetrahedral, planar, angular and trigonal planar, respectively.
   (c) Angular, tetrahedral, trigonal planar, and linear, respectively.
   (d) Angular, tetrahedral, angular, and trigonal planar, respectively.
   (e) None of the above is correct

7. Which is most reactive in electrophilic substitution reaction?

(a) (b) (c) (d) (e)



8. Consider the complex $K_3[Fe(C_2O_4)_3]$. The coordination number of the central atom and the geometry of the complex is;
   (a) 3 and trigonal planar
   (b) 3 and pyramidal
   (c) 6 and octahedral
   (d) 6 and square planar
   (e) 4 and Octahedral

9. When an organic compound A reacts with sodium metal it forms B. Then when heating with conc. sulfuric acid, A reacts with B to give diethyl ether. Identify A and B.
   (a) CH_3OH and CH_3ONa
   (b) C_4H_9OH and C_4H_9ONa
   (c) C_2H_5OH and C_2H_5ONa
   (d) CH_3OH and C_4H_9ONa
   (e) C_2H_5OH and CH_3ONa

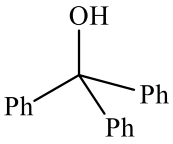
10. Select the compound with +6 oxidation number at the transition metal
   (a) $KMnO_4$
   (b) CrO_2Cl_2
   (c) $K_2[Ni(CN)_4]$
   (d) $[Cu(NH_3)_4]SO_4$
   (e) $CoSO_4$

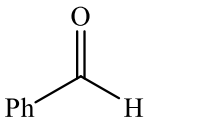
11. A cylinder contains a mixture of carbon monoxide (CO) and carbon dioxide (CO_2) gases, with a total pressure of 3.00 atm at 100 °C (373 K)**.** The cylinder is then cooled to –100 °C (173 K)**.** At this temperature, CO remains a gas but CO_2 solidifies and solid CO_2 exerts a vapor pressure of 0.30 atm due to sublimation. The total pressure in the cylinder at this temperature is 1.20 atm**.** What is the mole fraction of CO_2 in the original gas mixture?
   (a) 0.20 (b) 0.35 (c) 0.50 (d) 0.67 (e) 0.75

12. At 150 °C and 1 atm pressure, 2.00 L of propane (C_3H_8) reacts completely with excess oxygen. What volumes of carbon dioxide (CO_2) and water vapor (H_2O) are produced under the same conditions?

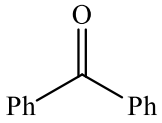
    (a) 3.00 L of CO_2 and 4.00 L of H_2O
    (b) 6.00 L of CO_2 and 6.00 L of H_2O
    (c) 9.00 L of CO_2 and 12.00 L of H_2O
    (d) 2.00 L of CO_2 and 2.00 L of H_2O
    (e) 6.00 L of CO_2 and 8.00 L of H_2O

13. A student wants to synthesize the following alcohol using the Grignard reaction. Which pair/s of reactants do you recommend for synthesis of the expected alcohol?

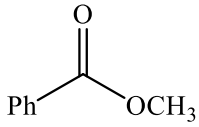


(I) 

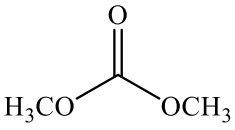
+ 2 PhMgBr

(II) 

+ PhMgBr

(III) 

+ 2 PhMgBr

(IV) 

+ 3 PhMgBr

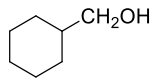
    (a) III only
    (b) I and IV
    (c) II and III
    (d) I, III and IV
    (e) II, III and IV

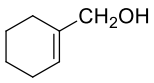
14. The IUPAC name of the coordination compound $K_2[Co(H_2O)(CN)_5]$ is;
    (a) Dipotassium monoaquapentacyanocobalt(III)
    (b) Potassium aquapentacyanocobaltate(II)
    (c) Monoaquapentacyanocobalt(III) potassium(II)
    (d) Potassium monoaquapetacyanocobaltate(II)
    (e) Potassium aquapentacyanocobaltate(III)

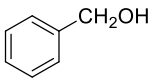
15. Hydrogen is an essential gas with numerous applications in the modern world. It is primarily produced through the steam reforming of methane. This two-step process begins with methane (CH_4) reacting with water to generate hydrogen (H_2) and carbon monoxide (CO). In the second step, carbon monoxide reacts with water to produce carbon dioxide (CO_2) and additional hydrogen. Calculate the mass of CO_2 produced during this process for every 1.0 kg of hydrogen.

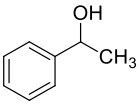
    (a) 0.27 kg (b) 0.88 kg (c) 1.0 kg (d) 2.2 kg (e) 5.5 kg

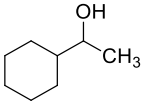
16. Which compound is the least reactive in hydrochloric acid?

(a) 

(b) 

(c) 

(d) 

(e) 

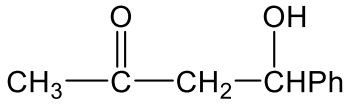
17. Ammonia is another valuable chemical widely used across various industries. It is primarily produced through the Haber process, which involves the reaction of nitrogen and hydrogen. However, hydrogen production is not environmentally friendly, as it releases CO_2. To address this issue, capturing the emitted CO_2 is a viable solution. If 7 kg of CO_2 is released for every 1 kg of hydrogen produced, calculate the mass of CO_2 that must be captured to produce 40,000 kg of ammonia. Assume 51% by mass of H_2 converted to ammonia.

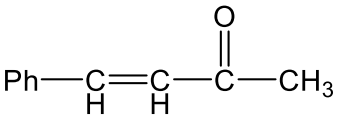
(a) 13800 kg (b) 40000 kg (c) 70000 kg (d) 96600 kg (e) None of the above

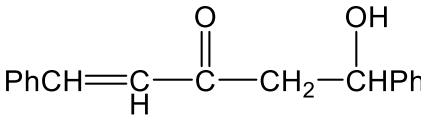
18. A 0.5000 g solid mixture containing $CaSO_4$ is dissolved in water and treated with an excess of $Ba(NO_3)_2$, resulting in the precipitation of 0.7021 g of $BaSO_4$. The percentage $CaSO_4$ in the mixture is

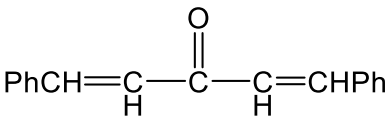
(a) 71.2 % (b) 73.6 % (c) 78.5 % (d) 81.9 % (e) 90.4 %

19. What is the main product when one mole of propanone reacts with two moles of benzaldehyde in the presence of aqueous NaOH?

(a) 

(b) 

(c) 

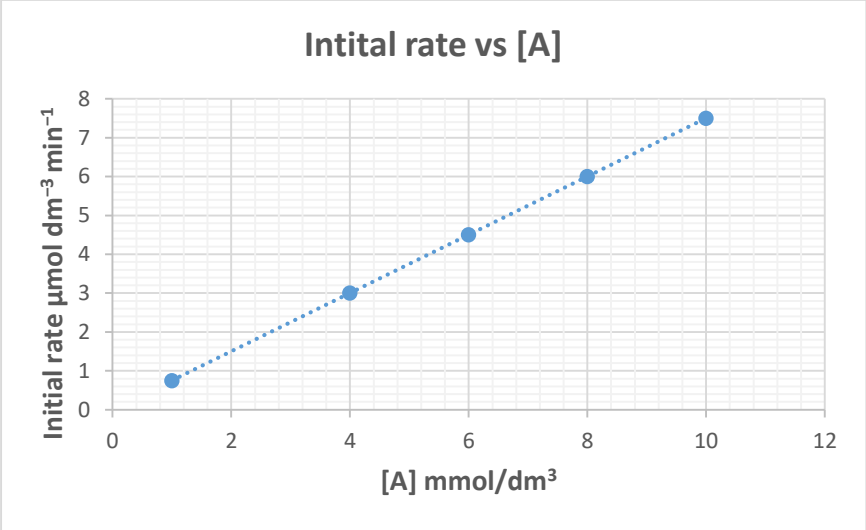
(d) 

(e) None of the above

20. Toluene, $C_6H_5CH_3$, is oxidized by air under carefully controlled conditions to benzoic acid, $C_6H_5CO_2H$, which is used to prepare the food preservative sodium benzoate, $C_6H_5CO_2Na$. What is the percent yield of a reaction that converts 1.00 kg of toluene to 1.21 kg of benzoic acid?

(a) 81 % (b) 92 % (c) 96 % (d) 77 % (e) 121 %

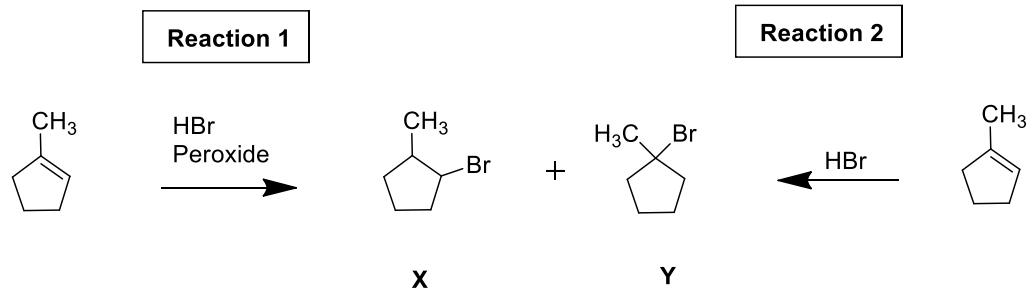
21. In a certain first-order reaction, reactant A is converted into product B. During a kinetic experiment, the initial rate of product formation was measured in μmol dm^{-3} min^{-1} and plotted against the concentration of A mmol/dm^3, as shown in the graph below. The rate constant for this reaction is



(a) $0.58\ min^{-1}$ (b) $0.75\ min^{-1}$ (c) $5.8 \times 10^{-4}\ min^{-1}$ (d) $7.5 \times 10^{-4}\ min^{-1}$

(e) Information is not sufficient to calculate

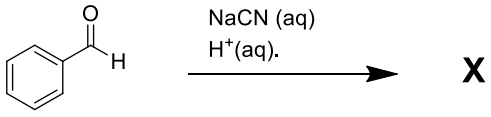
22. HBr addition reaction of 1-methylcyclopentene with or without peroxides can give the same or different main product, **X** or **Y** in reaction 1 and 2 given below.



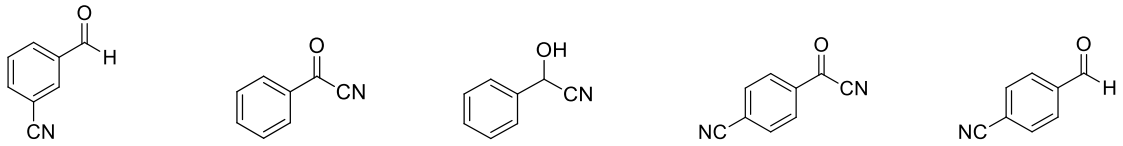
Which of following (a)-(e) indicates the main products?

(a) **X** from both reactions
(b) **Y** from both reactions
(c) **X** from reaction 1 and **Y** from reaction 2
(d) **Y** from reaction 1 and **X** from reaction 2
(e) None of the above

23. What is the major product of the following reaction?



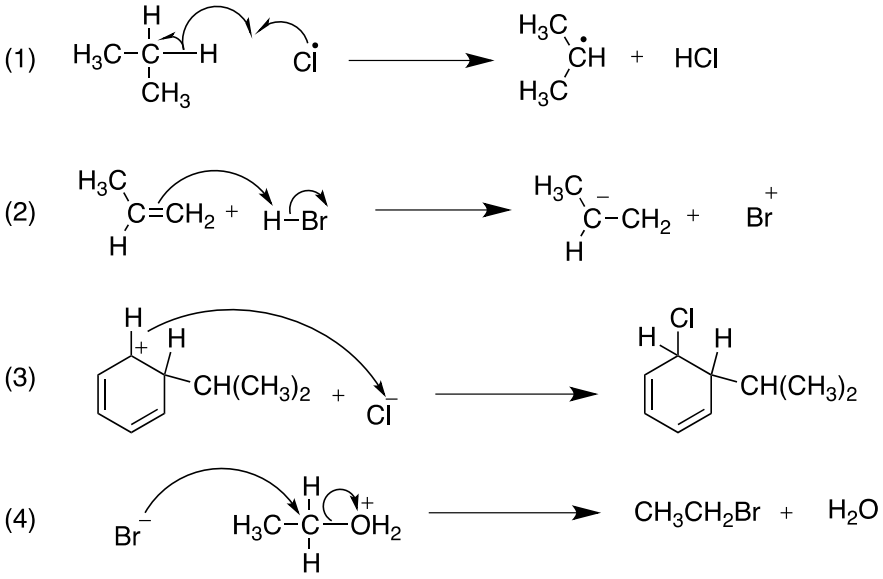
(a) (b) (c) (d) (e)



24. According to the United States Environmental Protection Agency, remedial actions are required when the concentration of lead in tap water reaches 15 ppb. It was found that two sample solutions, A and B, in 300 mL glasses contain 3.8 μg and 4.6 μg of lead, respectively. Which of the following statements is correct?

(a) Both samples A & B need remedial actions
(b) Only sample A need remedial action
(c) Only sample B need remedial action
(d) None of the samples need remedial actions
(e) Data is not sufficient to reach a conclusion

25. Which of the following mechanistic steps is/are incorrect?



(a) Only (1) and (2) (b) Only (2) and (3) (c) Only (3) and (4) (d) Only (1) and (4)

(e) Any other number of combination of responses correct

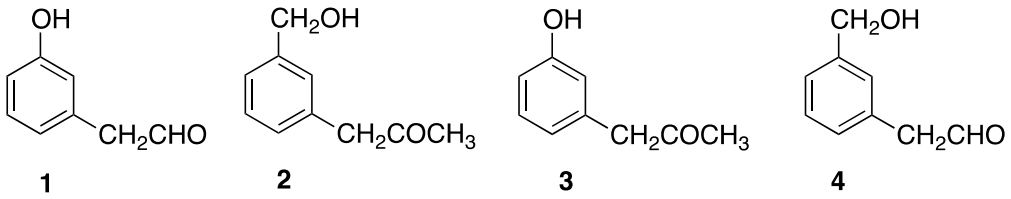
26. Ammonia borane (BNH_6) is an extensively studied material for chemical hydrogen storage. How many covalent bonds does BNH_6 molecule contain?

    (a) 6 (b) 7 (c) 8 (d) 9 (e) none of the above

27. Hydrogen is obtained when BNH_6 is hydrolyzed with water. What could be the byproduct formed in this reaction? (There is only one byproduct)

    (a) Boric acid (H_3BO_3)
    (b) Borazine ($B_3N_3H_6$)
    (c) Ammonium metaborate (NH_4BO_2)
    (d) Sodium borate ($Na_2B_4O_7$)
    (e) Boron trifluoride (BF_3)

28. Consider the following compounds.



Which of the above compounds show/s all the following observations?

- An orange color precipitate is formed when reacted with 2,4-dinitrophenylhydrazine.
- Liberates H_2 when reacted with sodium.
- A brick red color precipitate is formed when reacted with a solution of copper (II) tartrate in aqueous NaOH.

(a) Only (1) and (2) (b) Only (2) and (3) (c) Only (3) and (4) (d) Only (1) and (4)
(e) None of the above

29. The reaction below is first-order with respect to A, and the half-life ($t_{1/2}$) is 40 seconds:

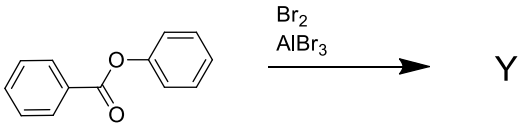
$$A \rightarrow B+C$$

    The fraction of the initial amount of substance A that will be consumed after 60 seconds is

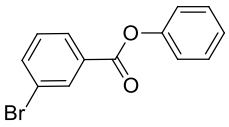
    (a) 0.35 (b) 0.65 (c) 0.70 (d) 0.77 (e) 0.80

    The integrated rate equation for a first-order reaction is: $\log\left(\frac{A_0}{A}\right) = \frac{kt}{2.30}$

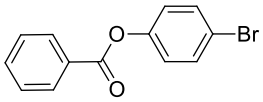
30. What is the major product of the following reaction?



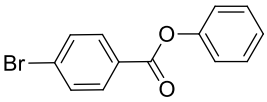
(a)



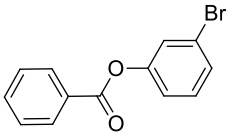
(b)



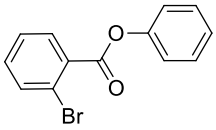
(c)



(d)



(e)



31. A solution is prepared by mixing 6.0 mg of sodium ions (in the form of NaCl), 6.00 g of glucose ($C_6H_{12}O_6$), and 94.00 g of water. How many ppm of Na^+ does this solution contain?

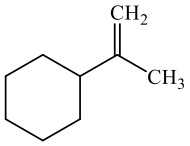
(a) 49.99 ppm (b) 59.64 ppm (c) 59.96 ppm (d) 59.99 ppm (e) 60.00 ppm

32. 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 mL 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 $M_xI_y.zH_2O$ is,

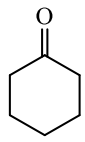
(a) 1.11×10^{-3} mol (b) 2.64×10^{-4} mol (c) 5.57×10^{-4} mol (d) 3.69×10^{-4} mol

(e) 2.79×10^{-4} mol

33. Which of the following is the best choice to prepare the following compound using the Wittig reaction?

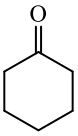


(a)



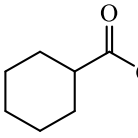
and CH_3CH_2Br/PPh_3

(b)



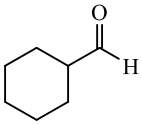
and CH_3Br/PPh_3

(c)



and CH_3Br/PPh_3

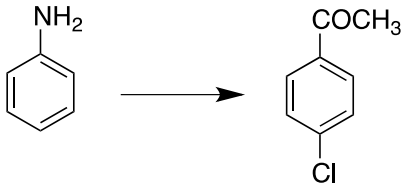
(d)



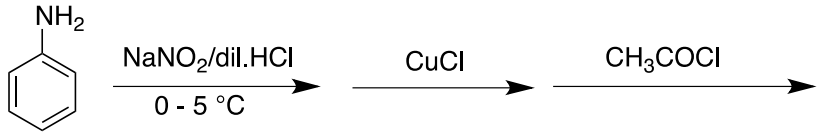
and CH_3CH_2Br/PPh_3

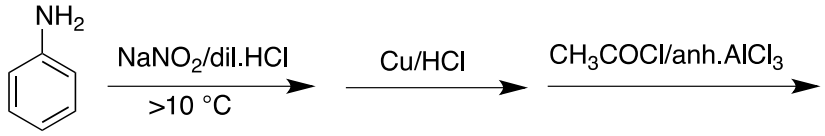
(e) None of the above

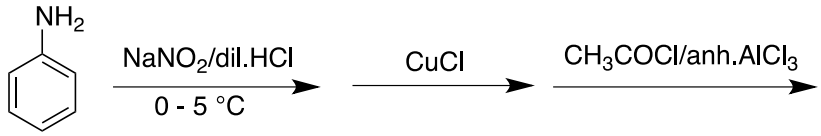
34. The conversion given above could be done by

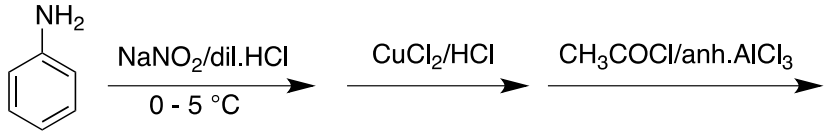


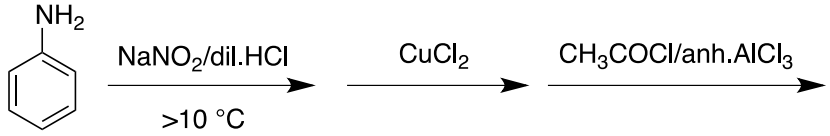
The conversion given above could be done by

(a) 

(b) 

(c) 

(d) 

(e) 

Questions 35 and 36 based on the following description.

Concentration of copper(II) iodate, $Cu(IO_3)_2$ can be determined in an acidic solution by iodometry. When 25.00 cm^3 of a saturated aqueous solution of $Cu(IO_3)_2$ was titrated, it required 20.00 cm^3 of a 0.1500 molar sodium thiosulphate solution to reach the end point.

35. 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

36. 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

37. Critical temperature of a substance is the lowest temperature above which its gaseous state cannot be liquified, regardless of the pressure. Choose the expression where the substances CO_2, N_2O, methanol, *n*-butane, and *n*-pentane are arranged in the order of increasing critical temperatures.

(a) $N_2O < CO_2 <$ *n*-butane < *n*-pentane < methanol
(b) $CO_2 < N_2O <$ *n*-butane < *n*-pentane < methanol
(c) $N_2O < CO_2 <$ methanol < *n*-butane < *n*-pentane
(d) *n*-butane < *n*-pentane < $CO_2 < N_2O <$ methanol
(e) *n*-butane < *n*-pentane < $N_2O < CO_2 <$ methanol

Questions **38** and **39** based on the following description.

Van der Waals equation describes the behaviour of a real gas. It is given by

$$\left(P + \frac{a}{V_m^2}\right)(V_m - b) = RT,$$

where P is the pressure, V_m is the molar volume, R is the gas constant, T is the thermodynamic temperature, and a and b are two constants. Since it describes the behaviour of a real gas at any temperature and pressure, it can describe a gas at its critical point (i.e. critical temperature and pressure). Starting from definitions, it can be shown that the critical molar volume (V_C) is given by $V_C = 3b$, and the critical temperature (T_C) is given by

$$T_C = \frac{8a}{27Rb}$$

38. Select the correct expression for critical pressure P_C.

(a) $P_C = \frac{a}{b}$ (b) $P_C = \frac{a}{b^2}$ (c) $P_C = \frac{a}{9b^2}$ (d) $P_C = \frac{a}{27b^2}$ (e) $P_C = \frac{27a}{b^2}$

39. The compression factor (Z) is defined as

$$Z = \frac{PV}{RT}.$$

What is the critical compression factor (Z_C)?

(a) $Z_C = 0.125$ (b) $Z_C = 0.25$ (c) $Z_C = 0.375$ (d) $Z_C = 0.5$ (e) $Z_C = 0.625$

40. Two ideal gas samples, each containing 1 mol of gas are separated by a divider in a chamber. Each gas is at temperature T and volume V . The entropies of the gas samples are S_1 and S_2. Then the divider is removed and the gases are allowed to mix. What could be the final entropy (S_F) of the mixture?

(a) $S_F = S_1 + S_2$

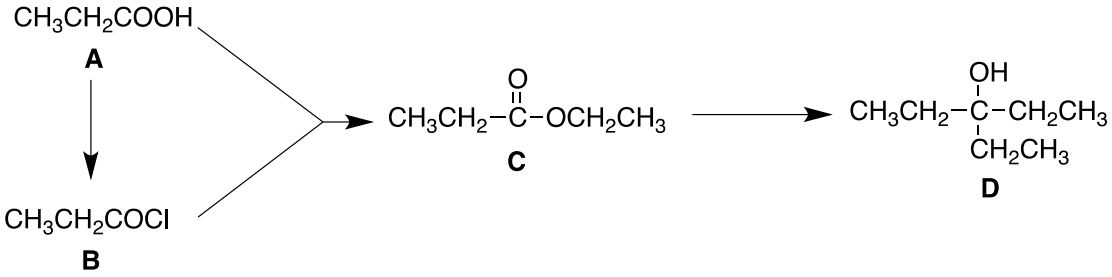
(b) $S_F = \dfrac{S_1 + S_2}{2}$

(c) $S_F = S_1 - S_2$

(d) $S_F = S_1 + S_2 - 2R\ln 2$

(e) $S_F = S_1 + S_2 + 2R\ln 2$

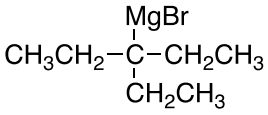
41.



Which of the following statements is/are true regarding the reaction scheme given above.

(1) Ethanol can be used to convert **A** to **C** as well as **B** to **C**.

(2) Excess of CH_3MgBr can be used convert **C** to **D**.

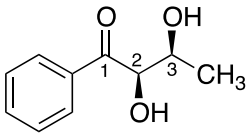
(3) **D** forms from  with dil. H_2SO_4.

(4) **A** is a weaker acid than CH_3COOH.

(a) Only (1) and (2) (b) Only (2) and (3) (c) Only (3) and (4) (d) Only (1) and (4)

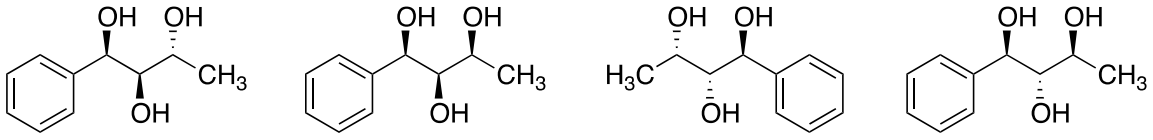
(e) Any other number of combination of responses correct

Answer questions **42** to **44** based on the reaction of the following compound with sodium borohydride ($NaBH_4$) in methanol.



42. The number of stereoisomers formed during the above reaction are,
    (a) 2 (b) 4 (c) 6 (d) 8 (e) None of the above

43. The correct structures of the stereoisomers formed in the above reaction are,

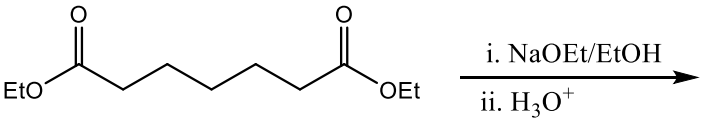


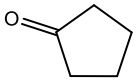
    (a) Only (1) and (2) (b) Only (2) and (3) (c) Only (3) and (4) (d) Only (4) and (5)

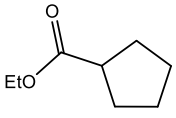
    (e) Any other number of combination of responses correct

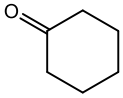
44. The stereochemical relationship of the pair of stereoisomers formed in the above reaction is**,**
    (a) Enantiomeric
    (b) Diastereomeric
    (c) Meso compounds
    (d) Identical compounds
    (e) None of the above

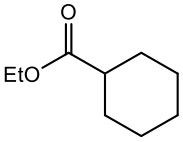
45. What is the main product of the following reaction?

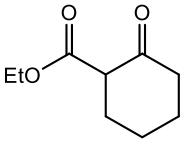


(a) 

(b) 

(c) 

(d) 

(e) 

……END……