AL/2019/02/E-I(NEW)

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NEW

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2019 අගෝස්තු
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2019 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2019

16.08.2019 / 0830 - 1030

රසායන විද්‍යාව I
இரசாயனவியல் I
Chemistry I

02 E I

පැය දෙකයි
இரண்டு மணித்தியாலம்
Two hours

Instructions:

* *Periodic Table is provided.*
* *This paper consists of 09 pages.*
* *Answer **all** the questions.*
* ***Use of calculators is not allowed.***
* *Write your **Index Number** in the space provided in the answer sheet.*
* *Follow the instructions given on the back of the answer sheet carefully.*
* *In each of the questions 1 to 50, pick one of the alternatives from (1), (2), (3), (4), (5) which is **correct or most appropriate** and **mark your response on the answer sheet with a cross** (×) **in accordance with the instructions given on the back of the answer sheet.***

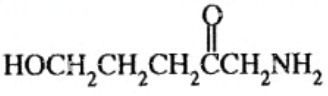
Universal gas constant $R = 8.314\ J\ K^{-1}\ mol^{-1}$
Avogadro constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$
Planck's constant $h = 6.626 \times 10^{-34}\ J\ s$
Velocity of light $c = 3 \times 10^{8}\ m\ s^{-1}$

1. Consider the following statements, I and II.
   I. The energy absorbed or released by atoms is quantized.
   II. Small particles under appropriate conditions show wave properties.
   The two scientists who proposed the theories as given by statements I and II respectively are,
   (1) Louis de Broglie and Albert Einstein
   (2) Max Planck and Louis de Broglie
   (3) Max Planck and Ernest Rutherford
   (4) Niels Bohr and Louis de Broglie
   (5) Louis de Broglie and Max Planck

2. The maximum number of electron pairs of an atom that are associated with principal quantum number $n = 3$ is,
   (1) 3 (2) 4 (3) 5 (4) 8 (5) 9

3. The number of stable resonance structures that can be drawn for the oxalate ion $\left[C_2O_4^{2-} / (O_2C-CO_2)^{2-}\right]$ is,
   (1) 2 (2) 3 (3) 4 (4) 5 (5) 6

4. What is the IUPAC name of the following compound?



   (1) 5-hydroxy-2-oxo-1-pentanamine
   (2) 1-amino-5-hydroxy-2-oxopentane
   (3) 1-amino-5-hydroxy-2-pentanone
   (4) 5-hydroxy-1-amino-2-pentanone
   (5) 5-amino-4-oxo-1-pentanol

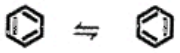
5. Identify the pair of elements which has the largest difference in electronegativities.
   (1) B and Al (2) Be and Al (3) B and Si (4) B and C (5) Al and C

[See page two

6. The electron pair geometry and shape around the two nitrogen atoms (labelled as N^1 and N^2) in the H_2NNO molecule (skeleton: $H—N^1—N^2—O$) respectively are,

N^1		N^2	
(1) tetrahedral	pyramidal	trigonal planar	angular
(2) pyramidal	trigonal planar	trigonal planar	angular
(3) trigonal planar	pyramidal	trigonal planar	trigonal planar
(4) tetrahedral	pyramidal	angular	trigonal planar
(5) tetrahedral	angular	trigonal planar	trigonal planar

7. Which of the following statements is **incorrect** regarding benzene?
(1) The resonance hybrid of benzene is depicted as follows:



(2) All six carbon atoms of benzene are sp^2 hybridized.
(3) The bond lengths between any two carbon atoms of benzene have the same value.
(4) All the C—C—C and the C—C—H bond angles of benzene have the same value.
(5) All the hydrogen atoms of benzene lie in the same plane.

8. $TiCl_4(g)$ reacts with liquid magnesium metal ($Mg(l)$) to give Ti(s) metal and $MgCl_2(l)$ at high temperature. When 0.95 kg of $TiCl_4(g)$ is made to react with 97.2 g of $Mg(l)$, the reactant that is completely consumed (this is commonly referred to as limiting reactant) and the amount of Ti(s) metal formed respectively are, (Molar mass: $TiCl_4 = 190\ g\ mol^{-1}$; $Mg = 24.3\ g\ mol^{-1}$; $Ti = 48\ g\ mol^{-1}$)
(1) $TiCl_4$ and 96 g (2) Mg and 96 g (3) Mg and 48 g
(4) $TiCl_4$ and 192 g (5) Mg and 192 g

9. The ideal gas equation can be expressed in the form, $P = \rho\frac{RT}{M}$ where ρ is the density of the gas, M is the molar mass (g mol^{-1}) of the gas, P is the pressure (Pa) and T is the temperature (K). If the units of R are J mol^{-1} K^{-1}, units of ρ in this equation should be,
(1) kg m^{-3} (2) g m^{-3} (3) g cm^{-3}
(4) g dm^{-3} (5) kg cm^{-3}

10. The **decreasing** order of conductivity of the following aqueous solutions including H_2O is,
0.01 M KCl, 0.1 M KCl, 0.1 M HAC; (HAC = acetic acid; M = mol dm^{-3})
(1) H_2O > 0.1 M HAC > 0.1 M KCl > 0.01 M KCl
(2) 0.01 M KCl > 0.1 M HAC > 0.1 M KCl > H_2O
(3) 0.01 M KCl > 0.1 M KCl > 0.1 M HAC > H_2O
(4) 0.1 M KCl > 0.01 M KCl > 0.1 M HAC > H_2O
(5) 0.1 M HAC > H_2O > 0.01 M KCl > 0.1 M KCl

11. The correct answer when the chemical species SO_2, SO_3, SO_3^{2-}, SO_4^{2-} and SCl_2 are arranged in the **increasing** order of the electronegativity of sulphur (S) atom is,
(1) $SCl_2 < SO_3^{2-} < SO_2 < SO_3 < SO_4^{2-}$
(2) $SO_3 < SO_4^{2-} < SO_2 < SO_3^{2-} < SCl_2$
(3) $SO_3^{2-} < SO_4^{2-} < SCl_2 < SO_3 < SO_2$
(4) $SCl_2 < SO_3^{2-} < SO_4^{2-} < SO_2 < SO_3$
(5) $SCl_2 < SO_4^{2-} < SO_3^{2-} < SO_2 < SO_3$

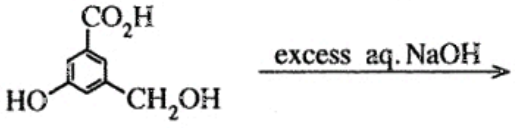
[See page three

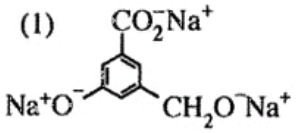
12. Which of the following answers gives the maximum hydroxide concentration that can exist in a 1.775 mol dm^{-3} aqueous solution of $MgCl_2$ at 25 °C? At this temperature, solubility product of $Mg(OH)_2$ is 7.1×10^{-12} mol^3 dm^{-9}.

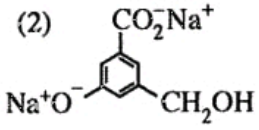
(1) 4.0×10^{-6} mol dm^{-3} (2) 2.0×10^{-6} mol dm^{-3} (3) 1.775×10^{-12} mol dm^{-3}

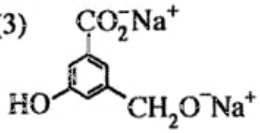
(4) $\sqrt{7.1} \times 10^{-6}$ mol dm^{-3} (5) 1.0×10^{-6} mol dm^{-3}

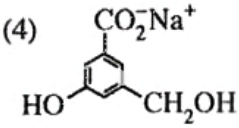
13. What is the major product of the following reaction?

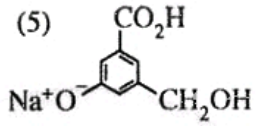


(1) 

(2) 

(3) 

(4) 

(5) 

14. Identify the correct statement from the following.

(1) The bond angle of NF_3 is larger than the bond angle of NH_3.
(2) Elements in group 17 (or 7A) exhibit oxidation states from −1 to +7.
(3) Monoclinic sulphur is the most stable allotrope of sulphur at room temperature.
(4) The density of graphite is higher than the density of diamond.
(5) Aluminium chloride satisfies the octet rule in the gaseous state.

15. The standard electromotive force of the electrochemical cell $Mn(s)\left|Mn^{2+}(aq)\right|\left|Br^-(aq)\right|Br_2(g)\left|Pt(s)\right.$ is 2.27 V. The standard reduction potential of $Br_2(g)\left|Br^-(aq)\right.$ is 1.09 V. The standard reduction potential of $Mn^{2+}(aq)\left|Mn(s)\right.$ is,

(1) −3.36 V (2) −1.18 V (3) 0.59 V (4) 1.18 V (5) 3.36 V

16. The enthalpy change of vaporization and the entropy change of vaporization of a liquid are, 45.00 kJ mol^{-1} and 90.0 J K^{-1} mol^{-1} respectively. The boiling point of the liquid is,

(1) 45.0 °C (2) 62.7 °C (3) 100.0 °C (4) 135.0 °C (5) 227.0 °C

17. What is the incorrect statement about $C_6H_5\overset{+}{N}\equiv NCl^-$?

(1) $C_6H_5\overset{+}{N}\equiv NCl^-$ can be obtained by reacting aniline with HNO_2 $(NaNO_2/HCl)$ at 0 – 5 °C.
(2) $C_6H_5\overset{+}{N}\equiv NCl^-$ reacts with KI to give iodobenzene.
(3) The $C_6H_5\overset{+}{N}\equiv N$ ion can act as an electrophile.
(4) When an aqueous solution of $C_6H_5\overset{+}{N}\equiv NCl^-$ is heated, it decomposes to give benzene.
(5) $C_6H_5\overset{+}{N}\equiv NCl^-$ reacts with phenols in a basic medium to give coloured compounds.

18. $H_2S(g)$ reacts with $O_2(g)$ to give only water vapour ($H_2O(g)$) and $SO_2(g)$, as products. When 4 dm^3 of $H_2S(g)$ reacts with 10 dm^3 of $O_2(g)$ at a constant pressure and 250 °C, the finai volume of the mixture is,

(1) 6 dm^3 (2) 8 dm^3 (3) 10 dm^3 (4) 12 dm^3 (5) 14 dm^3

[See page four

19. A mixture of A(g) and D(g) was introduced in to a rigid evacuated container at the temperature T. At this temperature, both A(g) and D(g) decompose according to the elementary reactions given below.

$2A(g) \rightarrow B(g) + 3C(g)$; rate constant k_1

$D(g) \rightarrow B(g) + 2C(g)$

The initial pressure of the container P, changed to 2.7 P after the complete decomposition of both reactants. The initial rate of decomposition of A(g) at this temperature is, (R is the universal gas constant)

(1) $1.7k_1\left(\frac{P}{RT}\right)$ (2) $2.7k_1\left(\frac{P}{RT}\right)$ (3) $0.09k_1\left(\frac{P}{RT}\right)^2$

(4) $2.89k_1\left(\frac{P}{RT}\right)^2$ (5) $7.29k_1\left(\frac{P}{RT}\right)^2$

20. An organic compound (X) decolourizes bromine water (Br_2/H_2O). X does not give a precipitate with ammoniacal CuCl. When X is treated with an acidic $K_2Cr_2O_7$ solution, a green coloured solution is obtained. X could be:

(1) $CH_3\underset{OH}{\underset{|}{C}}HCH_2C{\equiv}C{-}H$ (2) $CH_3\underset{CH_3}{\underset{|}{\overset{OH}{\overset{|}{C}}}}CH_2C{\equiv}C{-}CH_3$ (3) $CH_3\underset{OH}{\underset{|}{C}}HCH_2CH{=}CHCH_3$

(4) $HOCH_2\underset{CH_3}{\underset{|}{C}}HC{\equiv}C{-}H$ (5) $CH_3\underset{OH}{\underset{|}{C}}HCH_2CH_2CH_2CH_3$

21. A buffer solution of pH 5.0 was prepared by mixing equal volumes of a 0.10 mol dm^{-3} monobasic weak acid solution and a 0.10 mol dm^{-3} solution of the sodium salt of this acid. The pH of the resultant solution, when 20.00 cm^3 of this buffer solution was mixed with 90.00 cm^3 of 0.10 mol dm^{-3} weak acid solution, is,

(1) 3.0 (2) 4.0 (3) 4.5 (4) 5.5 (5) 6.0

22. Consider the following three aqueous solutions.

ℙ - a weak acid,

ℚ - an equimolar mixture of the weak acid and its sodium salt,

ℝ - titration mixture at the equivalence point of the titration of the weak acid and a strong base

When each solution is diluted by the same amount at constant temperature, the pH of ℙ, ℚ and ℝ respectively, will

(1) decrease, increase, not change. (2) increase, not change, decrease.
(3) increase, not change, not change. (4) increase, not change, increase.
(5) increase, increase, increase.

23. The incorrect statement with regard to the oxoacids of chlorine HOCl, $HClO_2$, $HClO_3$ and $HClO_4$ is,

(1) The shapes around chlorine in $HClO_2$, $HClO_3$ and $HClO_4$ respectively are angular, pyramidal and tetrahedral.
(2) The oxidation states of chlorine in HOCl, $HClO_2$, $HClO_3$ and $HClO_4$ respectively are +1, +3, +5 and +7.
(3) The acid strength of the oxoacids varies as $HOCl < HClO_2 < HClO_3 < HClO_4$.
(4) All these oxoacids contain at least one double bond.
(5) All these oxoacids contain at least one OH group.

24. The density of an aqueous acidic solution at 25 °C is 1.0 kg dm^{-3}. If the pH of this solution is 1.0, its H^+ concentration in ppm would be,

(1) 0.1 (2) 1 (3) 100 (4) 1000 (5) 10,000

[See page five

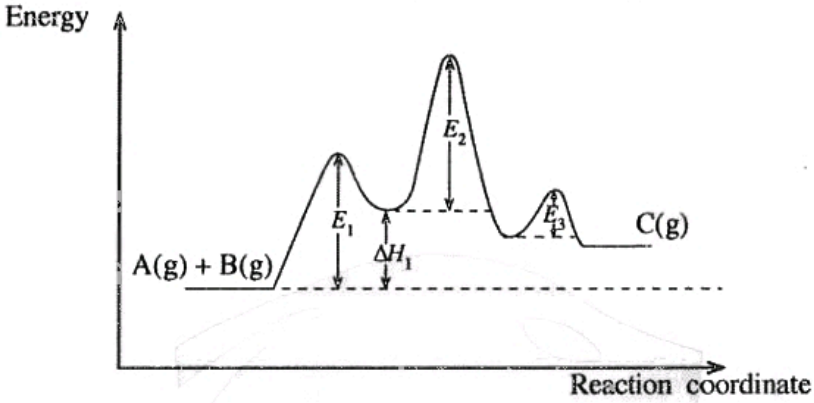
25. A 25.0 g sample of polluted air containing ozone (O_3) is treated with an acidic solution containing excess KI. Ozone is converted to O_2 and H_2O during this reaction. The iodine liberated is titrated with 0.002 mol dm^{-3} $Na_2S_2O_3$ solution. Volume of $Na_2S_2O_3$ required was 25.0 cm^3. The mass percent of O_3 in the air sample is, (O = 16)

(1) 4.8×10^{-3} (2) 6.4×10^{-3} (3) 9.6×10^{-3} (4) 1.0×10^{-2} (5) 3.2×10^{-2}

26. Which of the following reaction steps is not present in the Born-Haber cycle of NaCl(s) formation?

(1) $Na^+(aq) + Cl^-(aq) \longrightarrow NaCl(aq)$ (2) $Na(s) \longrightarrow Na(g)$ (3) $Cl_2(g) \longrightarrow 2Cl(g)$
(4) $Cl(g) + e \longrightarrow Cl^-(g)$ (5) $Na^+(g) + Cl^-(g) \longrightarrow NaCl(s)$

27. Activation energy of the elementary reaction A(g) + B(g) $\longrightarrow$ C(g) is *Ea*. This reaction is catalysed by the metal M. The energy diagram of the catalysed reaction is given below.

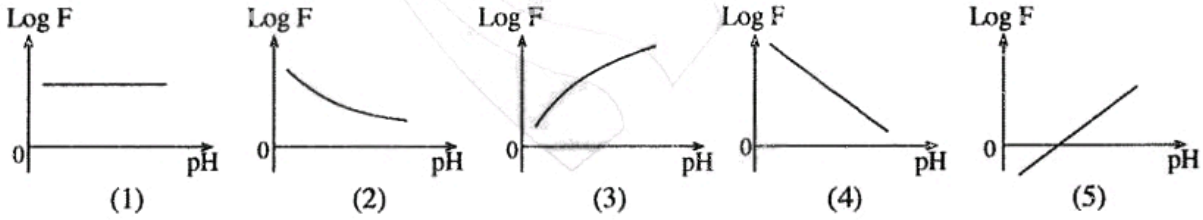


Which of the following is always correct with regard to this reaction?

(1) $Ea < E_1$ (2) $Ea = E_1 + E_2 + E_3 - \Delta H_1$ (3) $Ea < E_1$, $Ea < E_2$ and $Ea < E_3$
(4) $Ea > E_1 + E_2$ (5) $Ea > \Delta H_1 + E_2$

28. For a weak acid, it can be given that $F = \dfrac{\text{Amount of the acid dissociated}}{\text{Amount of the acid undissociated}}$

Which of the following graphs shows the relationship between Log F and pH?



29. Which of the following statements with regard to polymers is correct?

(1) Nylon is an addition polymer.
(2) Teflon is a condensation polymer.
(3) Bakelite is a linear polymer.
(4) The number of carbon atoms in the repeating unit of natural rubber is 4.
(5) Small covalent molecules are eliminated when monomers combine to form condensation polymers.

30. Two ideal gases that do not react with each other are separated by a valve and kept in a rigid container. This system is maintained at constant temperature and pressure. Which of the following correctly describes the change in Gibbs energy, enthalpy and entropy of the system respectively when the valve is opened?

(1) decreased, decreased, decreased (2) decreased, decreased, increased
(3) decreased, unchanged, increased (4) decreased, increased, increased
(5) increased, increased, increased

[See page six

For each of the questions 31 to 40, one or more responses out of the four responses (*a*), (*b*), (*c*) and (*d*) given is/are correct. Select the correct response/responses. In accordance with the instructions given on your answer sheet, mark

(1) if only (*a*) and (*b*) are correct.
(2) if only (*b*) and (*c*) are correct.
(3) if only (*c*) and (*d*) are correct.
(4) if only (*d*) and (*a*) are correct.
(5) if any other number or combination of responses is correct.

Summary of above Instructions

(1)	(2)	(3)	(4)	(5)
Only (*a*) and (*b*) are correct	Only (*b*) and (*c*) are correct	Only (*c*) and (*d*) are correct	Only (*d*) and (*a*) are correct	Any other number or combination of responses is correct

31. Which of the following statement/statements is/are correct with regard to simple covalent molecules containing oxygen and sulphur atoms?
(*a*) H_2O shows amphoteric properties.
(*b*) The boiling point of H_2O_2 is higher than the boiling point of H_2O.
(*c*) H_2O_2 can act as an oxidizing agent only in an acidic medium.
(*d*) Both H_2S and SO_2 have the capacity to act only as reducing agents.

32. Which of the following statement/statements is/are correct with regard to hydrocarbons?
(*a*) All hydrocarbons give CO_2 and H_2O when completely reacted with excess O_2.
(*b*) All alkynes react with Grignard reagents to give alkynylmagnesium halides.
(*c*) The boiling point of a branched alkane is higher than the boiling point of an unbranched alkane with the same relative molecular mass.
(*d*) None of the hydrocarbons react with aqueous NaOH.

33. If an endothermic reaction occurs spontaneously at constant temperature and pressure, then,
(*a*) enthalpy of the system decreases. (*b*) entropy of the system increases.
(*c*) enthalpy of the system increases. (*d*) entropy of the system does not change.

34. Which of the following statement/statements is/are correct regarding the precipitation of metal ions by passing $H_2S(g)$ in to their aqueous solutions?
(*a*) When the pressure of $H_2S(g)$ is decreased, the sulphide ion concentration is increased.
(*b*) When the temperature is increased, the sulphide ion concentration is decreased.
(*c*) Addition of $Na_2S(s)$ to the solution, decreases the dissociation of dissolved $H_2S(aq)$.
(*d*) Increase in pH of the solution decreases sulphide ion concentration.

35. Which of the following is/are nucleophilic substitution reaction/reactions?

(*a*) $CH_3\overset{\overset{O}{\|}}{C}-H + HCN \longrightarrow CH_3\overset{\overset{OH}{|}}{C}HCN$

(*b*) $CH_3CH_2OH + PCl_3 \longrightarrow CH_3CH_2Cl$

(*c*) $CH_3\underset{\underset{CH_3}{|}}{C}HCl + NaOH \longrightarrow CH_3\underset{\underset{CH_3}{|}}{C}HOH$

(*d*) $CH_3\underset{\underset{CH_3}{|}}{C}HCH_3 + Cl_2 \xrightarrow{h\upsilon} CH_3\overset{\overset{Cl}{|}}{\underset{\underset{CH_3}{|}}{C}}CH_3$

[See page seven

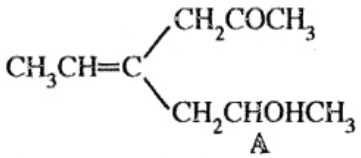
36. Which of the following statement/statements is/are correct regarding the elevation of carbon dioxide level in the atmosphere?
(*a*) It contributes to the increase in acidity of sea water.
(*b*) It reduces the hardness of water bodies.
(*c*) It strongly absorbs UV radiation coming from the sun.
(*d*) It does not contribute to acid rain.

37. Which of the following statement/statements is/are correct with regard to 3*d*-block elements?
(*a*) Zn has the highest first ionization energy among the 3*d*-block elements.
(*b*) In contrast to the ions of most main group elements (*s* and *p*-block), 3*d*-block metal ions rarely attain the noble gas configuration.
(*c*) Although the electronegativities of 3*d*-block elements are higher than the electronegativities of the corresponding *s*-block elements, their atomic radii are smaller than the atomic radii of the corresponding *s*-block elements.
(*d*) The 3*d*-block elements that form colourless compounds are Ti and Zn.

38. Volatile liquids A and B having saturated vapour pressures P_A° and P_B° $\left(P_A^\circ \neq P_B^\circ\right)$ form an ideal solution. A mixture of the liquids A and B is in equilibrium with their vapour phase, in a closed container. When the volume of the container is increased and the equilibrium is re-established at the same temperature, which of the following statement/statements is/are correct?
(*a*) While some amount of A and B go to the gas phase, the composition of the liquid phase remains unchanged.
(*b*) While some amount of A and B go to the gas phase, the composition of the gas phase remains unchanged.
(*c*) While some amount of A and B go to the gas phase, the composition of the liquid phase changes.
(*d*) While some amount of A and B go to the gas phase, the composition of the gas phase changes.

39. Which of the following statement/statements is/are correct regarding an aqueous solution of a weak acid?
(*a*) Conductivity of the solution increases as the concentration of the weak acid decreases.
(*b*) Conductivity of the solution increases as the temperature increases.
(*c*) Conductivity of the solution decreases but the fraction dissociated of the weak acid increases as more water is added to the solution.
(*d*) When NaCl(s) is dissolved in the weak acid solution, conductivity decreases.

40. Which of the following statement/statements regarding compound A is/are correct?



A

(*a*) A exhibits geometric isomerism.
(*b*) A does not exhibit optical isomerism.
(*c*) The product obtained when A is reacted with pyridinium chlorochromate (PCC) exhibits optical isomerism.
(*d*) The product obtained when A is reacted with pyridinium chlorochromate does not exhibit geometric isomerism.

[*See page eight*

● In question Nos. 41 to 50, two statements are given in respect of each question.
From the Table given below, select the response, out of the responses (1), (2), (3), (4) and (5), that best fits the two statements and mark appropriately on your answer sheet.

Response	First Statement	Second Statement
(1)	True	True, and correctly explains the first statement
(2)	True	True, but does not explain the first statement correctly
(3)	True	False
(4)	False	True
(5)	False	False

	First Statement	Second statement
41.	Among the halogens, I_2 is a solid whereas Br_2 is a liquid.	London forces become stronger with increase in molecular surface area.
42.	At a given pressure, the spontaneity of the reaction between N_2 and H_2 to give NH_3 drops with increasing temperature.	Entropy change of the reaction between N_2 and H_2 to give NH_3 is negative.
43.	Essential oils are generally extracted from plant materials by steam distillation.	Essential oils have a high solubility in water.
44.	A spontaneous reaction always has a negative Gibbs energy change no matter what the conditions are.	Gibbs energy change can be used to predict the direction of a reaction only under constant temperature and constant pressure conditions.
45.	Solubility of 1-butanol in water is less than the solubility of methanol in water.	The solubility of alcohols in water decreases as the size of the non-polar alkyl group increases relative to the polar OH group.
46.	The reaction, $CH_3-CH=CH_2 \xrightarrow{HBr} CH_3-\underset{\displaystyle Br}{\underset{\vert}{CH}}-CH_3$ is a nucleophilic addition reaction.	A secondary carbocation is formed as a reaction intermediate in the following reaction. $CH_3-CH=CH_2 \xrightarrow{HBr} CH_3-\underset{\displaystyle Br}{\underset{\vert}{CH}}-CH_3$
47.	Coke is used in several industrial processes.	Coke is only used industrially as a fuel.
48.	The carbonyl carbon atom of a ketone and the other atoms bonded to it lie in the same plane.	The carbonyl carbon atom of a ketone is sp^2 hybridized.
49.	Any two ideal gases have the same average kinetic energies at the same temperature.	At a given temperature, the average speed of gas molecules adjust according to their masses.
50.	Although CFC contribute to ozone layer depletion, the contribution from HFC is negligible.	HFC undergoes complete decomposition before reaching the upper atmosphere.

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The Periodic Table

1	1 H																2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	La- Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	Ac- Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr