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கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2016 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2016

රසායන විද්‍යාව I இரசாயனவியல் I Chemistry I	02 E I	පැය දෙකයි இரண்டு மணித்தியாலம் Two hours

Instructions:

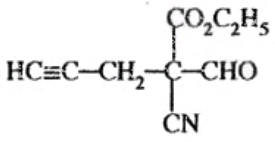
* *Periodic Table is provided.*
* *This paper consists of 08 pages.*
* *Answer **all** the questions.*
* ***Use of calculators is not allowed.***
* *Write your **Index Number** in the space provided in the answer sheet.*
* *Follow the instructions given on the back of the answer sheet carefully.*
* *In 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. Green light of wave length 4.42×10^{-7} m is observed in the emission spectrum of hydrogen. The energy of one photon of this green light is
   (1) 4.5×10^{-19} kJ (2) 2×10^{-19} kJ (3) 1.5×10^{-19} kJ
   (4) 4.5×10^{-22} kJ (5) 19.9×10^{-26} kJ

2. Which one of the following atoms in its gaseous state will liberate the largest amount of energy when it gains an electron?
   (1) S (2) P (3) Na (4) Mg (5) Ne

3. What is the IUPAC name of the compound X?



   [X]

   (1) ethyl 2–formyl–2–nitrile–4–pentynoate
   (2) 2–cyano–2–ethoxycarbonyl–4–pentynal
   (3) 2–ethoxycarbonyl–2–nitrile–4–pentynal
   (4) ethyl–2–cyano–2–formyl–4–pentynoate
   (5) ethyl 2–cyano–2–formyl–4–pentynoate

4. Which of the following statements regarding sizes of ions formed by *s* and *p* block elements is **false**?
   (1) Cations are always smaller than their neutral atoms.
   (2) Anions are always larger than their neutral atoms.
   (3) The size of cations decreases from left to right across a period.
   (4) The size of anions increases from left to right across a period.
   (5) The size of anions formed by elements of second period are larger than cations formed by elements of third period.

5. The sets of quantum numbers associated with the last two electrons of an atom in an element are (3, 0, 0, +½) and (3, 0, 0, – ½). The element is
   (1) Li (2) Na (3) Mg (4) Al (5) K

[See page two

6. A 0.60 g sample of KIO_3 was dissolved in water and excess KI was added to it. The minimum amount of 3.0 mol dm^{-3} HCl required to completely convert KIO_3 to I_3^- is, (O = 16, K = 39, I = 127)
(1) 1.0 cm^3 (2) 4.7 cm^3 (3) 5.6 cm^3 (4) 10.2 cm^3 (5) 33.6 cm^3

7. At 25 °C, the solubility product, K_{sp} of MnS(s) is 5.0×10^{-15} mol^2 dm^{-6}. The acid dissociation constants K_1 and K_2 for H_2S(aq) are 1.0×10^{-7} mol dm^{-3} and 1.0×10^{-13} mol dm^{-3} respectively. The equilibrium constant, K_c for the reaction, $MnS(s) + 2H^+(aq) \rightleftharpoons Mn^{2+}(aq) + H_2S(aq)$ is
(1) 2.0×10^{-16} (2) 5.0×10^{-8} (3) 20 (4) 5.0×10^{5} (5) 2.0×10^{7}

8. An organic compound A contains 39.97% of C, 6.73% of H and 53.30% of O, by weight. What is the empirical formula of A? (H = 1, C = 12, O = 16)
(1) $C_6H_8O_2$ (2) $C_2H_4O_2$ (3) $C_3H_7O_3$ (4) $C_3H_6O_3$ (5) CH_2O

9. Which of the following statements is **false** with regard to the chemistry of Lithium (Li) and its compounds?
(1) Lithium reacts with oxygen gas to give Li_2O.
(2) Lithium has the highest melting point among the group I metals.
(3) The basicity of LiOH is less than that of NaOH.
(4) Li_2CO_3 has the lowest thermal stability among the group I carbonates.
(5) LiCl gives a blue colour when subjected to the flame test.

10. The oxidation states of $N^{①}$ and $N^{②}$ in the most stable Lewis structure of the F_2NNO molecule respectively are (skeleton, $F-\overset{\overset{F}{|}}{N^{①}}-N^{②}-O$)
(1) +2 and +2 (2) +1 and +3 (3) +2 and +3 (4) +1 and +2 (5) +3 and +1

11. Consider the reaction, $CH_4(g) + CO_2(g) \rightleftharpoons 2CO(g) + 2H_2(g)$.
When 0.60 mol of CH_4(g) and 1.00 mol of CO_2(g) were introduced into a closed rigid container of volume 1.00 dm^3 at 25 °C and the system was allowed to reach equilibrium, 0.40 mol of CO(g) was formed. The value of the equilibrium constant, K_c (mol^2 dm^{-6}) for the reaction is
(1) 0.04 (2) 0.08 (3) 0.67 (4) 1.20 (5) 8.00

12. The chemical formula of diamminebromidodicarbonylhydridocobalt(III) chloride according to IUPAC rules is
(1) $[Co(CO)_2BrH(NH_3)_2]Cl$ (2) $[CoBr(CO)_2(NH_3)_2H]Cl$
(3) $[Co(NH_3)_2Br(CO)_2H]Cl$ (4) $[CoBr(CO)_2H(NH_3)_2]Cl$
(5) $[CoHBr(CO)_2(NH_3)_2]Cl$

13. The following procedure was used to determine the sulphur content in a coal sample. A coal sample of mass 1.60 g was burned in oxygen gas. The SO_2 gas formed was collected in a solution of H_2O_2. This solution was then titrated with 0.10 mol dm^{-3} NaOH. The volume of NaOH required to reach the end point was 20.0 cm^3. The percentage of sulphur in the coal sample is (S = 32)
(1) 1.0 (2) 2.0 (3) 4.0 (4) 6.0 (5) 8.0

14. Combustion of ethylene, C_2H_4(g) is shown in the following reaction.

$$C_2H_4(g) + 3O_2(g) \longrightarrow 2CO_2(g) + 2H_2O(g) \quad \Delta H = -1323 \text{ kJ mol}^{-1}$$

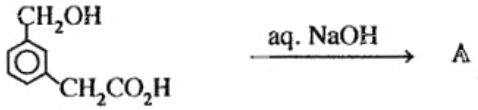
What is the value of ΔH (in kJ mol^{-1}) if the combustion produces water in the liquid state, H_2O(l) rather than water in the gaseous state, H_2O(g)? (ΔH for $H_2O(g) \longrightarrow H_2O(l)$ is -44 kJ mol^{-1})
(1) −1235 (2) −1279 (3) −1323 (4) −1367 (5) −1411

15. The vapour pressure of benzene at 25 °C is 12.5 kPa. When an unknown non-volatile substance was dissolved in 100 cm^3 of benzene at this temperature, the vapour pressure of the solution was found to be 11.25 kPa. The mole fraction of the unknown substance in the above solution is
(1) 0.05 (2) 0.10 (3) 0.50 (4) 0.90 (5) 0.95

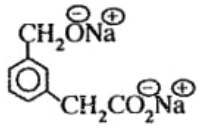
[See page three

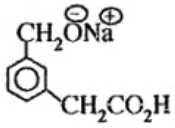
16. A buffer solution can be prepared by mixing a weak acid (K_a = 4.0 × 10^{-7} mol dm^{-3}) and a strong base. The ratio of the concentrations of acid to base (acid : base) needed to prepare a buffer solution at pH = 6 is

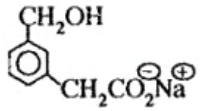
(1) 1 : 1 (2) 2 : 1 (3) 2 : 5 (4) 5 : 1 (5) 5 : 2

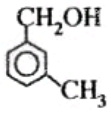
17. 

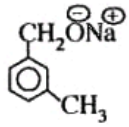
The major product A obtained from the reaction given above is

(1) 

(2) 

(3) 

(4) 

(5) 

18. The rate law for the reaction $NO_2(g) + CO(g) \longrightarrow NO(g) + CO_2(g)$ is, Rate = $k[NO_2]^2$. If a small amount of CO(g) is introduced to a closed rigid container in which this reaction is taking place at a given temperature, which of the following statements is **true** regarding the changes that would take place?

(1) Both k and reaction rate increase.
(2) Both k and reaction rate remain unchanged.
(3) Both k and reaction rate decrease.
(4) k increases and reaction rate remains unchanged.
(5) k remains unchanged and reaction rate increases.

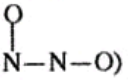
19. At 25 °C, given that.

$M(s) + 3Ag^+(aq) \longrightarrow 3Ag(s) + M^{3+}(aq)$ $\quad E^\circ_{cell}$ = 2.46 V

$Ag^+(aq) + e \longrightarrow Ag(s)$ $\quad E^\circ$ = 0.80 V

The standard reduction potential for the half-reaction, $M^{3+}(aq) + 3e \longrightarrow M(s)$ at 25 °C is

(1) −1.66 V (2) −0.06 V (3) 0.06 V (4) 1.66 V (5) 3.26 V

20. How many resonance structures can be drawn for the molecule N_2O_3 ? (skeleton, )

(1) 2 (2) 3 (3) 4 (4) 5 (5) 6

21. Which of the following statements is **true** with regard to transition metals and their compounds?

(1) The electronic configuration of copper is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}$.
(2) All elements that have d-electrons are 'transition elements'.
(3) The electronic configuration of Ti in TiO_2 is the same as that of Sc in $ScCl_3$.
(4) Acidity of the oxides of a given transition metal decreases with increase in oxidation state of the metal ion.
(5) Transition metals in the $3d$ series can have the quantum number $m_l = \pm 3$.

[See page four

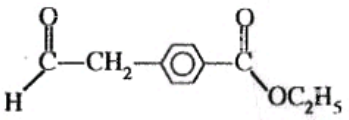
22. The equilibrium $PCl_3(g) + 3NH_3(g) \rightleftharpoons P(NH_2)_3(g) + 3HCl(g)$ exists in a closed container at a constant temperature. If the volume of the container is increased by keeping the temperature constant, which of the following is true regarding the changes that could take place in the rates of forward and reverse reactions?

	Forward reaction	Reverse reaction
(1)	increases	decreases
(2)	decreases	increases
(3)	decreases	decreases
(4)	increases	increases
(5)	no change	no change

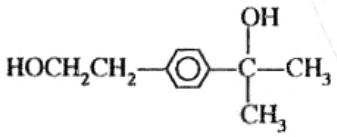
23. When solid ammonium chloride, $NH_4Cl(s)$ is dissolved in water at 25 °C, the temperature of the solution decreases. Which of the following is true of $\Delta H°$ and $\Delta S°$ for the process?

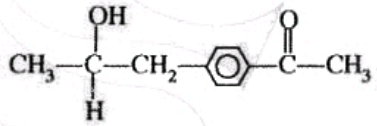
	$\Delta H°$	$\Delta S°$
(1)	positive	positive
(2)	positive	negative
(3)	positive	zero
(4)	negative	positive
(5)	negative	negative

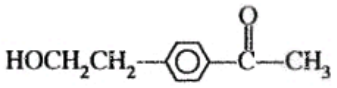
24. Which of the following statements is false regarding 3*d* transition metals and their compounds?
(1) Oxides of some metals are amphoteric.
(2) Some metals and metal oxides are used in industry as catalysts.
(3) Electronegativity of 3*d* transition metals is higher than 4*s* metals.
(4) Only one element shows the oxidation state of +7.
(5) Oxoions such as MnO_4^-, $Cr_2O_7^{2-}$ are resistant to reduction.

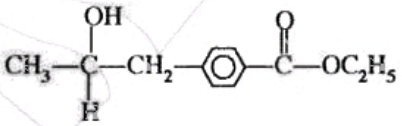
25. 

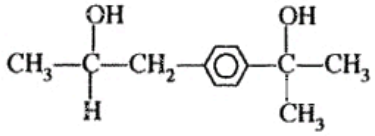
The major product obtained, when the compound above is reacted with excess CH_3MgBr, and then hydrolyzed is

(1) 

(2) 

(3) 

(4) 

(5) 

26. $CH_3COCH_2CONH_2 \xrightarrow[(2)\ H^+/H_2O]{(1)\ LiAlH_4} X \xrightarrow{CH_3COCH_3} Y$

In the reaction scheme given above, the structures of X and Y respectively are

(1) $CH_3CH(OH)CH_2CONH_2$, $CH_3CH(OH)CH_2CON{=}C(CH_3)_2$

(2) $CH_3CH(OH)CH_2CH_2NH_2$, $CH_3CH(OH)CH_2CH_2N{=}C(CH_3)_2$

(3) $CH_3COCH_2CH_2NH_2$, $CH_3COCH_2CH_2N{=}C(CH_3)_2$

(4) $CH_3COCH_2CH_2NH_2$, $CH_3COCH_2CH_2NHCOCH_3$

(5) $CH_3CH(OH)CH_2CH_2NH_2$, $CH_3CH(OH)CH_2CH_2NHCOCH_3$

[See page five

27. Which of the following statements is **false** with regard to NH_3?
(1) NH_3 can act only as a base.
(2) NH_3 burns in oxygen to give N_2 gas.
(3) NH_3 gives a brown colour with Nessler's reagent.
(4) NH_3 reacts with Li to give Li_3N and H_2 gas.
(5) NH_3 has a bond angle less than 109° 28' but greater than that in NF_3.

28. An electrochemical cell was constructed using $Zn^{2+}(aq)/Zn(s)$ and $Sn^{2+}(aq)/Sn(s)$ electrodes. Which of the following statements correctly describes the operation of the cell?

$$E^{\circ}_{Zn^{2+}(aq)/Zn(s)} = -0.76\,V, \qquad E^{\circ}_{Sn^{2+}(aq)/Sn(s)} = -0.14\,V$$

(1) Zn electrode is the cathode, Zn is oxidized, electrons flow from Sn to Zn.
(2) Zn electrode is the cathode, Sn is oxidized, electrons flow from Sn to Zn.
(3) Sn electrode is the anode, $Zn^{2+}(aq)$ is reduced, electrons flow from Zn to Sn.
(4) Zn electrode is the anode, Zn is oxidized, electrons flow from Zn to Sn.
(5) Zn electrode is the anode, $Sn^{2+}(aq)$ is reduced, electrons flow from Sn to Zn.

29. Which one of the following statements about $C_6H_5NH_2$ is **false**?
(1) Reacts with CH_3COCl to form an amide.
(2) Evolves ammonia when heated with aqueous NaOH.
(3) Reacts with bromine water to give a white precipitate.
(4) Gives a phenol when reacted with nitrous acid.
(5) Less basic than $C_6H_5CH_2NH_2$.

30. Four saturated solutions of silver acetate in contact with $CH_3COOAg(s)$ are placed in four beakers. How does the solubility of silver acetate change, when the following solutions are added separately to each of the beakers?

CH_3COONa, dil. HNO_3, NH_4OH, $AgNO_3$

	CH_3COONa	dil. HNO_3	NH_4OH	$AgNO_3$
(1)	increases	increases	increases	increases
(2)	decreases	decreases	decreases	decreases
(3)	decreases	increases	increases	decreases
(4)	decreases	increases	decreases	decreases
(5)	decreases	decreases	increases	decreases

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. Consider the reaction given below.

$$2HI(g) \rightleftharpoons I_2(s) + H_2(g) \quad \Delta H^{\circ} = -52.96\ kJ\ mol^{-1}$$

Which of the following statements is/are **correct** when the reaction takes place in a closed container?
(*a*) Increasing the temperature and decreasing the pressure drives the equilibrium to the right.
(*b*) Increasing the temperature and decreasing the pressure drives the equilibrium to the left.
(*c*) Decreasing the temperature and increasing the pressure drives the equilibrium to the right.
(*d*) Decreasing the temperature and increasing the pressure drives the equilibrium to the left.

[*See page six*

32. Which of the following statements is/are **true** regarding the molecule CH_2=CHCHO ?
(*a*) All three carbon atoms are sp^2 hybridized.
(*b*) All three carbon atoms lie in a straight line.
(*c*) All three carbon atoms do not lie in the same plane.
(*d*) All three carbon atoms lie in the same plane.

33. Some of the reactions associated with the Solvay process are
(*a*) $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$
(*b*) $NaCl + NH_3 + H_2O + CO_2 \longrightarrow NaHCO_3 + NH_4Cl$
(*c*) $Na_2CO_3 + CO_2 + H_2O \longrightarrow 2NaHCO_3$
(*d*) $Ca(OH)_2 + 2NH_4Cl \longrightarrow CaCl_2 + 2NH_4OH$

34. Which of the following statements is/are always **true** regarding the rate of an elementary reaction?
(*a*) The rate can be increased by increasing temperature.
(*b*) The rate can be increased by removing the products from the reaction medium.
(*c*) The rate of the reaction depends on the rate of the slowest step.
(*d*) Rate of the reaction can be increased by making $\Delta G < 0$.

35. Which of the following statements is/are **true** regarding 4–pentenal?
(*a*) Shows geometric isomerism.
(*b*) The compound obtained when reacted with HBr does not show optical isomerism.
(*c*) The compound obtained when reacted with HBr shows optical isomerism.
(*d*) The compound obtained when reacted with CH_3MgBr shows optical isomerism.

36. Which of the following statements is/are **false** with regard to nitric acid?
(*a*) Pure nitric acid is a light yellow liquid.
(*b*) All N—O bond lengths in nitric acid are equal.
(*c*) Nitric acid cannot act as a reducing agent.
(*d*) It is used in the manufacture of an important fertilizer, ammonium nitrate.

37. C(s) reacts with $O_2(g)$ to produce 0.40 mol of $CO_2(g)$, with the release of 40 kJ of heat. Which of the following statements is/are **true** for the above system? (C = 12, O = 16)
(*a*) 100 kJ of heat is required to decompose one mole of $CO_2(g)$ into C(s) and $O_2(g)$.
(*b*) 25 kJ of heat is required to form 11 g of $CO_2(g)$.
(*c*) Sum of enthalpies of products is less than the sum of enthalpies of reactants.
(*d*) Sum of enthalpies of products is greater than the sum of enthalpies of reactants.

38. Which of the following statements is/are **true** for a balanced chemical equation of an elementary reaction?
(*a*) The order of reaction is the same as molecularity.
(*b*) The order of reaction is less than the molecularity.
(*c*) The order of reaction is higher than the molecularity.
(*d*) Molecularity cannot be zero.

39. Which of the following statements is/are **true** regarding the molecule given below?

$$CH_2=CH(CH_2)_3-\overset{\overset{O}{\|}}{C}-NH_2$$

(*a*) Decolourizes bromine water.
(*b*) Liberates ammonia when warmed with an aqueous NaOH solution.
(*c*) Gives an orange coloured precipitate with 2,4–DNP reagent.
(*d*) Gives a primary amine when treated with $NaBH_4$.

40. Consider the compounds given below.

(A) HCHO (B) NH_2CONH_2 (C) C_6H_5OH
(D) $HO_2C(CH_2)_4CO_2H$ (E) $H_2N(CH_2)_6NH_2$

Which of the pairs given below will produce thermosetting polymers when reacted under the appropriate conditions?
(*a*) A and B (*b*) A and C (*c*) C and D (*d*) D and E

[See page seven

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.	Sucrose when treated with concentrated H_2SO_4 gives a black mass.	Concentrated H_2SO_4 is a strong oxidizing agent.
42.	In the addition reaction between $CH_3CH{=}CH_2$ and HX, the $CH_3CH_2\overset{\oplus}{C}H_2$ carbocation is formed easily as an intermediate.	Alkyl groups attached to a positively charged carbon atom release electrons through C—C, σ-bonds towards the positively charged carbon and increase the stability of the carbocation.
43.	The average molecular speed of $H_2(g)$ at 80 °C is lower than that of $N_2(g)$ at 40 °C.	Average molecular speed is directly proportional to the square root of temperature and inversely proportional to the square root of molar mass.
44.	Reactivity of alkali metals with water increases on going down the group.	Strong metallic bonds are formed when the size of the metal atom increases.
45.	$CH_3C{\equiv}CH$ gives a red precipitate when treated with ammoniacal Cu_2Cl_2.	The acidic terminal hydrogen in alkynes can be displaced by metals.
46.	All spontaneous reactions are exothermic.	For any reaction $\Delta G = \Delta H + T\Delta S$
47.	The reaction between $N_2(g)$ and $H_2(g)$ to produce $NH_3(g)$ is endothermic.	$NH_3(g)$ is used in the synthesis of nitric acid and urea.
48.	Mirror images of bromochloromethane are enantiomers.	Enantiomers are non superimposable mirror images of each other.
49.	The solubility of barium oxalate, $BaC_2O_4(s)$ is less in acidic aqueous medium than in water.	The conjugate acid of $C_2O_4^{2-}$ is the weak acid $H_2C_2O_4$.
50.	Enzymes present in root nodules of certain plants are capable of fixing N_2.	N_2 molecule is unreactive mainly because of the presence of the N—N triple bond.

* * *

[See page eight

The Periodic Table

	1 H																2 He
1	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
2	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
3	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
4	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
5	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
6	87 Fr	88 Ra	Ac-Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub	113 Uut	...				
7																		

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