Department of Examinations, Sri Lanka

අධ්‍යාපන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2014 අගෝස්තු
இலங்கைப் பரீட்சைத் திணைக்களம்
General Certificate of Education (Adv. Level) Examination, August 2014

රසායන විද්‍යාව I
இரசாயனவியல் I
Chemistry I

02 E I

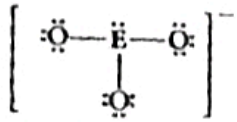
පැය දෙකයි
இரண்டு மணித்தியாலம்
Two hours

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.***

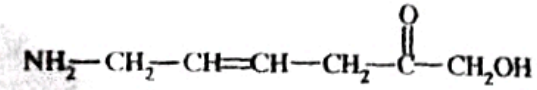
Universal gas constant	$R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$
Avogadro constant	$N_A = 6.022 \times 10^{23}\ \text{mol}^{-1}$
Planck's constant	$h = 6.626 \times 10^{-34}\ \text{J s}$
Velocity of light	$c = 3 \times 10^{8}\ \text{m s}^{-1}$

1. The neutron was discovered by
(1) Niels Bohr. (2) Ernest Rutherford. (3) James Chadwick.
(4) Albert Einstein. (5) Eugen Goldstein.

2. 

In the structure given above, **E** is an element belonging to the *p*-block of the Periodic Table. To which group does element **E** belong?
(1) Group 13/III A (2) Group 14/IV A (3) Group 15/V A
(4) Group 16/VI A (5) Group 17/VII A

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



(1) 1–amino–6–hydroxy–2–hexen–5–one
(2) 6–amino–1–hydroxy–4–hexen–2–one
(3) 6–amino–2–oxo–4–hexen–1–ol
(4) 6–hydroxy–5–oxo–2–hexenamine
(5) 6–hydroxy–5–oxo–2–hexenylamine

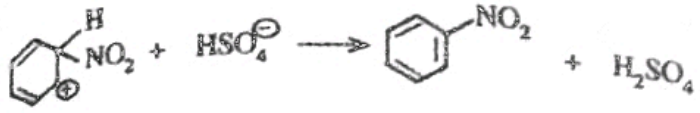
4. The maximum number of electrons having quantum numbers $n = 3$ and $l = 2$ in an atom are
(1) 2 (2) 4 (3) 6 (4) 8 (5) 10

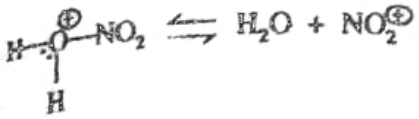
5. Of the following, which one has the highest boiling point?
(1) H_2 (2) He (3) Ne (4) Xe (5) CH_4

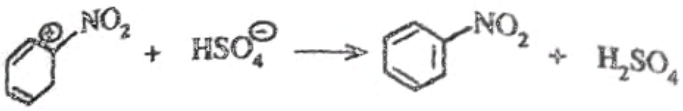
6. What mass of NaCl (to the nearest gram) would contain the same total number of ions as 285 g of $MgCl_2$? (Na = 23, Mg = 24, Cl = 35.5)
(1) 176 g (2) 263 g (3) 303 g (4) 351 g (5) 527 g

7. The solubility product of the salt XY_3 at 25 °C is $4.32 \times 10^{-10}\ \text{mol}^4\ \text{dm}^{-12}$ The concentration of Y^- in a saturated solution of XY_3 is
(1) $2.0 \times 10^{-3}\ \text{mol dm}^{-3}$ (2) $6.0 \times 10^{-3}\ \text{mol dm}^{-3}$ (3) $1.1 \times 10^{-2}\ \text{mol dm}^{-3}$
(4) $3.8 \times 10^{-3}\ \text{mol dm}^{-3}$ (5) $4.0 \times 10^{-3}\ \text{mol dm}^{-3}$

8. Which of the following reactions is not likely to take place during nitration of benzene?

(1) 

(2) 

(3) 

(4) 

(5) 

9. When PCl_5 reacts with an equimolar quantity of water, the products are
(1) $POCl_3$ and HCl (2) H_3PO_4 and HCl (3) H_3PO_3 and HCl
(4) H_3PO_4 and $POCl_3$ (5) $POCl_3$ and H_2

10. The shape and electron pair geometry of F_4ClO^- ion are respectively,
(1) trigonal bipyramidal and square pyramidal.
(2) square pyramidal and octahedral.
(3) trigonal bipyramidal and octahedral.
(4) square pyramidal and trigonal bipyramidal.
(5) octahedral and square pyramidal.

11. Which of the following statements is correct with respect to an isolated system?
(1) Boundary of the system allows matter to exchange.
(2) Boundary of the system does not allow matter to exchange but allows heat to exchange.
(3) Boundary of the system allows matter or heat to exchange but it does not allow work to exchange.
(4) Boundary of the system does not allow matter, heat and work to exchange.
(5) Boundary of the system allows matter, heat and work to exchange.

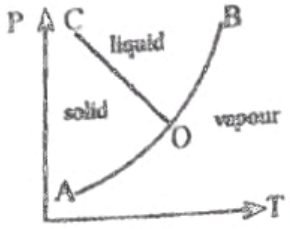
12. Which of the following statements regarding 3*d* elements is false?
(1) The electronegativity of 3*d* elements generally increases across the period from left to right.
(2) The first ionization energy of a 3*d* element involves the removal of a 4*s* electron.
(3) The melting points of 3*d* elements are not as high as the melting points of the 3*s* elements.
(4) The highest oxidation number for the first five 3*d* elements is equal to the total number of 4*s* and 3*d* electrons of the element.
(5) The densities of 3*d* elements are much higher than the densities of the 3*s* elements.

13. The density of an 18.0% (by mass) solution of $(NH_4)_2SO_4$ is 1.10 g cm^{-3}. The molarity of this $(NH_4)_2SO_4$ solution is (H = 1, N = 14, O = 16, S = 32)
(1) 1.4 M (2) 1.5 M (3) 1.7 M (4) 2.0 M (5) 2.1 M

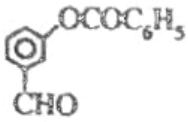
14. The standard enthalpy of combustion of C(s) is −393.5 kJ mol^{-1}. The standard enthalpy of formation values of CO(g) and $H_2O(g)$ are −110.5 kJ mol^{-1} and −241.8 kJ mol^{-1} respectively.
The standard enthalpy change of the reaction $CO_2(g) + H_2(g) \longrightarrow CO(g) + H_2O(g)$ is
(1) 524.8 kJ mol^{-1} (2) −262.5 kJ mol^{-1} (3) 41.2 kJ mol^{-1}
(4) −41.2 kJ mol^{-1} (5) 262.5 kJ mol^{-1}

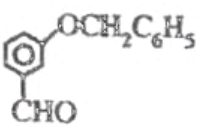
15. The solubility product of the sparingly soluble hydroxide MOH is 1.0×10^{-8} mol^2 dm^{-6}. The pH of a saturated solution of MOH is
(1) 4.0 (2) 6.0 (3) 8.0 (4) 10.0 (5) 12.0

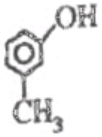
16. Consider the phase diagram given below.

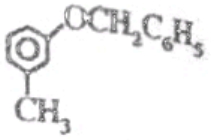


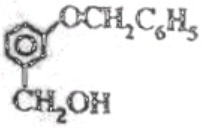
Which line segment/s gives/give the T, P conditions at which the liquid and solid phases are in equilibrium?
(1) OA (2) OB (3) OC (4) AO and OB (5) AO and OC

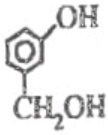
17. When  is reacted with Zn/Hg and conc. HCl, the product/products obtained is/are

(1) 

(2)  + $C_6H_5CO_2H$

(3) 

(4) 

(5)  + $C_6H_5CO_2H$

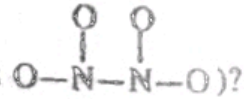
18. The gas A dissociates at temperature T, according to the elementary reaction, $A(g) \longrightarrow 2B(g) + C(g)$. n-moles of gas A were kept in a rigid container and allowed to dissociate at temperature T. The initial pressure is P_0 and the pressure at time t is P. Identify which of the following terms is proportional to the rate of reaction at time t.
(1) $2P_0 - P$ (2) $3P_0 - 2P$ (3) $3P_0 - P$ (4) $P - P_0$ (5) $P_0 - 3P$

19. Consider the following two equilibria.

$$MBr(s) + 2S_2O_3^{2-}(aq) \rightleftharpoons [M(S_2O_3)_2]^{3-}(aq) + Br^-(aq) \quad \text{equilibrium constant} = K_1$$

$$M^+(aq) + 2S_2O_3^{2-}(aq) \rightleftharpoons [M(S_2O_3)_2]^{3-}(aq) \quad \text{equilibrium constant} = K_2$$

Given that $K_1 = 8.5$ and $K_2 = 1.7 \times 10^{13}$ mol^{-2} dm^6, the solubility product of MBr is
(1) 1.7×10^{-13} mol^2 dm^{-6} (2) 5.0×10^{-13} mol^2 dm^{-6}
(3) 5.9×10^{-14} mol^2 dm^{-6} (4) 1.4×10^{-12} mol^2 dm^{-6}
(5) 1.4×10^{14} mol^2 dm^{-6}

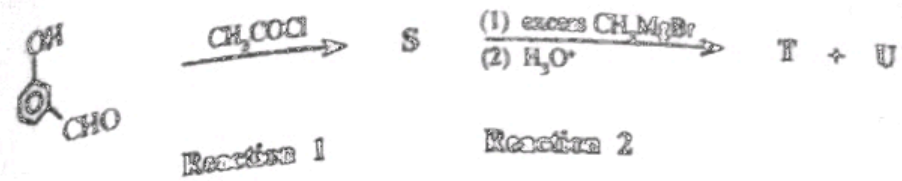
20. How many resonance structures can be drawn for the molecule N_2O_4 (skeleton )?
(1) 2 (2) 3 (3) 4 (4) 5 (5) 6

21. Which of the following statements is false with regard to Scandium (Sc)?
(1) The most stable positive oxidation state of Sc is +3.
(2) Sc^{3+} does not have d electrons.
(3) In general, compounds of Sc are white.
(4) Sc is the first of the 3d elements.
(5) Sc is a transition element.

22. Oxalic acid ($H_2C_2O_4$) is a dibasic acid with $K_1 = 5.4 \times 10^{-2}$ mol dm^{-3} and $K_2 = 5.3 \times 10^{-5}$ mol dm^{-3}. What is the equilibrium constant for the reaction given below?

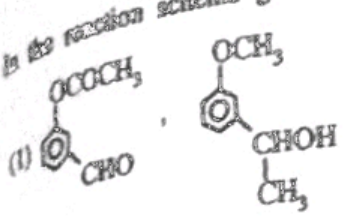
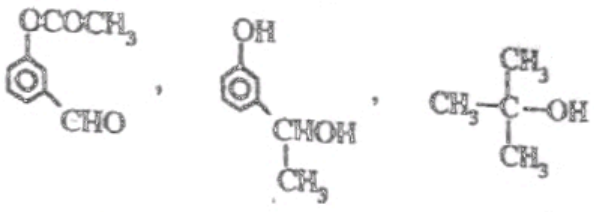
$$H_2C_2O_4(aq) + 2H_2O(l) \rightleftharpoons 2H_3O^+(aq) + C_2O_4^{2-}(aq)$$

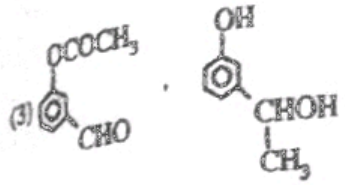
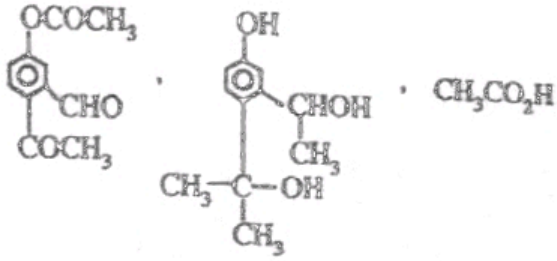
(1) 5.4×10^{-2} mol^2 dm^{-6} (2) 5.3×10^{-4} mol^2 dm^{-6}
(3) 2.9×10^{-5} mol^2 dm^{-6} (4) 1.0×10^{2} mol^2 dm^{-6}
(5) 9.8×10^{-3} mol^2 dm^{-6}

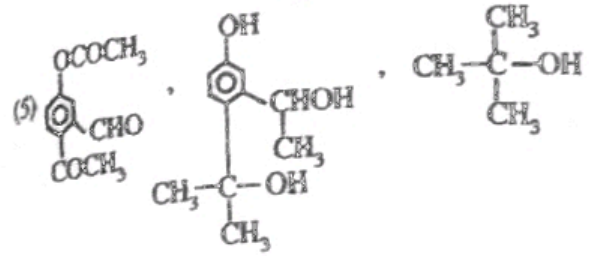


Reaction 1 Reaction 2

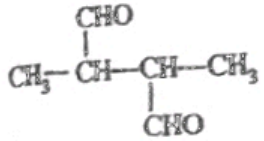
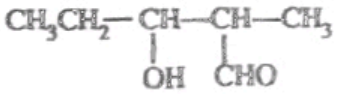
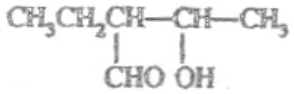
In the reaction scheme given above, the structures of S, T and U are respectively,

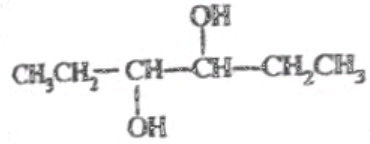
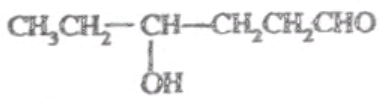
(1)  (2) 

(3)  (4) 

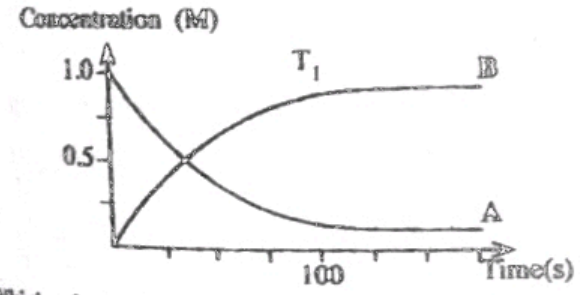
(5) 

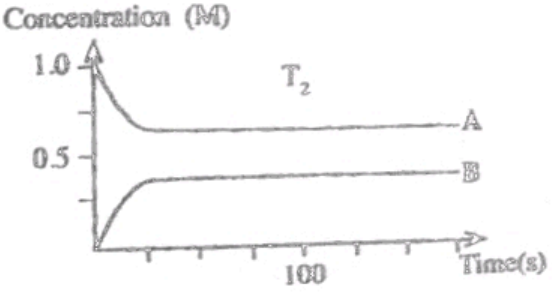
24. The structure of the compound arising from the self condensation of CH_3CH_2CHO in the presence of aqueous NaOH is

(1)  (2)  (3) 

(4)  (5) 

25. Variation of the concentration with time for the reaction A $\rightleftharpoons$ B at temperatures T_1 and T_2 is given below. Note that only A is present at $t = 0$.





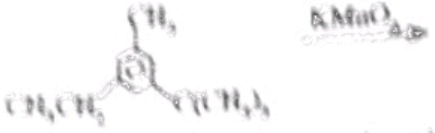
Which of the following statements is true?

(1) $T_2 > T_1$ and forward reaction is endothermic
(2) $T_2 < T_1$ and forward reaction is endothermic
(3) $T_2 > T_1$ and forward reaction is exothermic
(4) $T_2 < T_1$ and forward reaction is exothermic
(5) $T_2 = T_1$ and forward reaction is endothermic

26. Identify the cation which gives

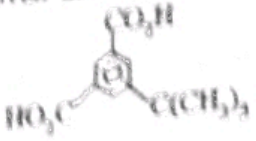
(i) a black precipitate with H_2S in the presence of OH^-,
(ii) no precipitate with H_2S in dilute HCl and
(iii) a blue solution with concentrated HCl.

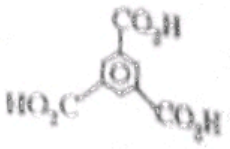
(1) Cu^{2+} (2) Mn^{2+} (3) Ni^{2+} (4) Fe^{3+} (5) Co^{2+}

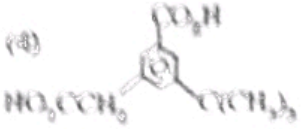
27. 

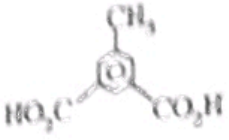
The major product obtained from the reaction given above is

(1) 

(2) 

(3) 

(4) 

(5) 

28. The principal products obtained when Li, Na, K and Mg react with excess oxygen at atmospheric pressure are respectively,

(1) Li_2O, Na_2O, K_2O_3 and MgO.
(2) Li_2O, Na_2O_2, KO_2 and MgO.
(3) Li_2O, Na_2O_2, KO_2 and $Mg(O_2)_2$.
(4) LiO_2, Na_2O, KO_2 and MgO_2.
(5) Li_2O, Na_2O_2, KO_2 and MgO_2.

29. What is the electromotive force of the following cell?

$$M(s)\left|M^{2+}(aq)\right|\left|N^{3+}(aq)\right|N(s)$$

$E^{\circ}_{M^{2+}/M} = -0.72V$ $\quad$ $E^{\circ}_{N^{3+}/N} = 0.28V$

(1) 1.00 V (2) 0.44 V (3) −1.00 V (4) − 0.44 V (5) 2.04 V

30. Consider the reaction given below.

$$3W(g) + X(g) \rightleftharpoons 2Y(g) + Z(g)$$

If the reaction was initiated by adding an equal number of moles of W and X, which of the following is correct at equilibrium?

(1) [Y] = [Z] (2) [Z] > [Y] (3) [W] = [X] (4) [X] > [W] (5) [X] < [W]

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

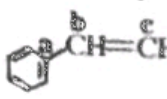
(1) if only (*a*) and (*b*) are correct.
(2) if only (*b*) and (*c*) are correct.
(3) if only (*c*) and (*d*) are correct.
(4) if only (*d*) and (*a*) are correct.
(5) if **any other** number or combination of responses is correct.

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 statements is/are **always true** about a spontaneous reaction that occurs at temperature T?

(*a*) Reaction must have a positive entropy change.
(*b*) Reaction must have a negative enthalpy change.
(*c*) Enthalpy change of the reaction must be negative if the entropy change is negative.
(*d*) Enthalpy change of the reaction must be negative if the entropy change is positive.

32. **Which of the following** statements is/are **true** regarding the molecule  ?

(*a*) All carbon atoms are sp^2 hybridized.
(*b*) All carbon, carbon bond lengths are equal.
(*c*) Carbon atoms labelled as a, b and c lie in a straight line.
(*d*) Carbon atom a and hydrogen atoms attached to carbons b and c lie on the same plane.

Which of the following statements is/are **false** with regard to the manufacture of NH_3 using N_2 and H_2 gases as raw materials?

(a) N_2 is obtained by the fractional distillation of liquid air.
(b) NH_3 formed is continuously removed by liquefying it.
(c) The reaction between N_2 and H_2 is endothermic.
(d) The pressure and temperature used are 250 atm and 850 °C respectively.

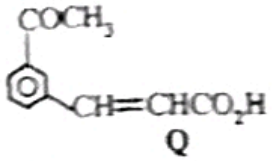
Consider the following reaction taking place in a closed system.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g) \quad \Delta H = -93.0 \text{ kJ mol}^{-1}$$

Which statement/statements given below is/are **correct** with regard to this reaction?

(a) Increase in pressure at constant temperature, increases the amount of product formed.
(b) Increase in temperature at constant pressure, decreases the amount of product formed.
(c) Use of a catalyst, increases the amount of product formed.
(d) Use of a catalyst, increases the activation energy of the reverse reaction.

Which of the following statements is/are **true** regarding compound **Q**?



Q

(a) **Q** can exist in two stereoisomeric forms.
(b) The product obtained when **Q** is reacted with Br_2/CCl_4 does **not** exhibit optical isomerism.
(c) The product obtained when **Q** is reacted with H_2 in the presence of Pd exhibits optical isomerism.
(d) The product obtained when **Q** is reacted with $NaBH_4$ exhibits optical isomerism.

Which of the following statements is/are **true** with regard to electromagnetic radiation of wavelength 200 nm?

(a) It has a higher frequency than radiation of wavelength 400 nm
(b) It is in the visible region of the electromagnetic spectrum.
(c) In a vacuum, it has a higher velocity than radiation of wavelength 400 nm.
(d) Its photon has a higher energy than a photon of radiation of wavelength 100 nm.

Which of the following method/s can be used to prevent the oxidation of Fe^{2+} to Fe^{3+} in an aqueous solution?

$$O_2 + 4H^+ + 4e \longrightarrow 2H_2O \quad E^\circ = 1.23\text{ V}$$

$E^\circ_{Fe^{3+}/Fe^{2+}} = 0.77\text{V}$ $\quad E^\circ_{Fe^{2+}/Fe} = -0.44\text{V}$ $\quad E^\circ_{Zn^{2+}/Zn} = -0.76\text{V}$ $\quad E^\circ_{Ag^+/Ag} = 0.80\text{V}$

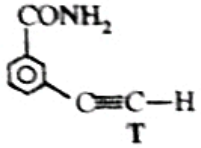
(a) Adding a small amount of Fe metal to the solution
(b) Adding a small amount of Zn^{2+} to the solution
(c) Adding a small amount of Ag metal to the solution
(d) Adding a small amount of Zn metal to the solution

Which of the following is/are **true** about the equilibrium given below?

$$KNO_3(s) + H_2O(l) \rightleftharpoons K^+(aq) + NO_3^-(aq)$$

(a) To observe the equilibrium, $KNO_3(s)$, $K^+(aq)$, $NO_3^-(aq)$ and $H_2O(l)$ must all be present.
(b) The expression for the equilibrium constant does not contain the terms $[KNO_3(s)]$ and $[H_2O(l)]$ because they can be considered as constants.
(c) Increasing $K^+(aq)$ concentration in the system drives the point of equilibrium to the right.
(d) Addition of $KNO_3(s)$ to the system drives the point of equilibrium to the right.

Which of the following statements is/are **true** regarding the compound **T**?



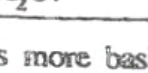
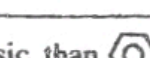
T

(a) When **T** is heated with aqueous NaOH, ammonia is liberated.
(b) Ammonia is produced in the reaction of **T** with $NaNH_2$.
(c) Metallic silver is deposited as a silver mirror, when **T** is reacted with ammoniacal $AgNO_3$.
(d) An aldehyde is formed, when **T** is reacted with dilute H_2SO_4 in the presence of Hg^{2+} ions.

40. Which of the following statements is/are true regarding polymers?
(a) PVC is a thermosetting polymer.
(b) Nylon 6,6 is made by the polymerization of 1,6–diaminohexane and hexanedioic acid.
(c) Urea–formaldehyde and phenol–formaldehyde are both thermoplastic polymers.
(d) Polystyrene is made by the addition polymerization of styrene monomers.

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.	Solid sulphur reacts with hot concentrated H_2SO_4 to give SO_3 and H_2O.	Hot concentrated H_2SO_4 acts as a dehydrating agent.
42.	 is more basic than 	The lone pair of electrons on the nitrogen atom of an amide is delocalized onto the carbonyl group by resonance.
43.	When Zn^{2+} is added to a solution containing Cu^{2+}, metallic Cu is displaced.	The standard reduction potential of Cu^{2+} is more positive than the standard reduction potential of Zn^{2+}
44.	The reaction of NH_3 with Na gives H_2 as a product, whereas the reaction of NH_3 with Cl_2 gives N_2 as a product.	NH_3 acts as an oxidizing as well as a reducing agent.
45.	The boiling point of 2,2–dimethylbutane is higher than the boiling point of n-hexane.	In molecules, as the surface area decreases the strength of dispersion forces decreases.
46.	All the molecules in an ideal gas move at the same speed.	There are no intermolecular attractive forces in an ideal gas.
47.	H_2O_2 is used in the manufacture of nitric acid from ammonia.	H_2O_2 always acts as an oxidizing agent.
48	Benzene diazonium chloride reacts with phenol to give an orange coloured compound.	Diazonium salts act as nucleophiles.
49.	The rate of an elementary reaction increases with increasing concentration of reactants.	The rate of an elementary reaction is always linearly proportional to the concentrations of the reactants.
50.	Formation of ozone at the lower level in the atmosphere requires the presence of hydrocarbons.	Hydrocarbons react with oxygen in the presence of light to produce ozone.

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