Chapter Two : Qualitative Chemistry

Creative Essay Type

1. ▶ Read the given stem :

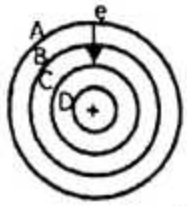
Element	Atomic no.
X	1
Y	24

[Notre Dame College, Dhaka]

a. Give the common electronic configuration of transition elements? 1
b. Heat of neutralization is always exothermic- why? 2
c. For the electron of 'X' show that, the wave length of emission spectrum of highest energy is inversely proportional to its Rydberg constant. 3
d. Analyze the precautions of storing the given solution in a laboratory? 4

Ans: See HSC EV Chemistry 1st Paper 2nd Chapter Note Ques. No. 32 of Answer Paper.

2. ▶

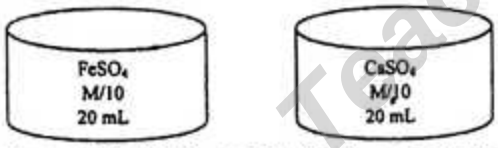


[BAF Shaheen College, Dhaka]

a. What chelating agent? 1
b. How can catalyst effect the rate of reaction of activation energy- Explain. 2
c. Show the total orbital of A shell on basis of l and m. 3
d. Evaluate mathematically if the electron transfer to shell and discuss in which region of electro magnetic radiation transmitted in the above stem. 4

Ans: See HSC EV Chemistry 1st Paper 2nd Chapter Note Ques. No. 33 of Answer Paper.

3. ▶ Answer the questions based on the electronic configuration–



The Ksp values of $Fe(OH)_2$ and $Ca(OH)_2$ are 5×10^{-17} and 4.8×10^{-6} respectively. *[Adamjee Cantonment College, Dhaka]*

a. What is activation energy? 1
b. Molar equilibrium constant can never be zero or infinitive- explain. 2
c. Determine the ionic product (Kip) of $CaSO_4$ in stem solution. 3
d. For what maximum concentration of OH^- ion, $Fe(OH)_2$ will be precipitated out but $Ca(OH)_2$ will not in the stem solutions-explain mahtematically. 4

Ans: See HSC EV Chemistry 1st Paper 2nd Chapter Note Ques. No. 37 of Answer Paper.

4. ▶

50 ml 6×10^{-4}M $ZnSO_4$ solution	40 ml 0.05M NaOH solution
A	B

K_{sp} of $Zn(OH)_2$ is 1×10^{-17}.

a. What is the IUPAC name of compound $[CoCl_2(NH_3)_4]^+$? 1
b. Which one is more acidic between H_2SO_4 and HNO_3 and why? 2
c. How the identifications of ions are done? Explain. 3
d. Will be the precipitation formed or not if solution A and B are mixed together? Justify. 4

Ans: See HSC EV Chemistry 1st Paper 2nd Chapter Note Ques. No. 48 of Answer Paper.

5. ▶ Observe the following information.

Solution–A :	80 mL 0.1 M $Cr_2(SO_4)_3$
Solution–B :	120 mL 0.1 M NaOH

Solubility product of $Cr(OH)_3$ at 25°C is 4.5×10^{-15}

[Birshrestha Noor Mohammad Public College, Dhaka]

a. What is flame test? 1
b. Why concentrated HCl is used during crystallization of edible salt? 2
c. Determine solubility product of compound of solution-A. 3
d. What will happen if two solutions are mixed? Analzye mathematically. 4

Ans: See HSC EV Chemistry 1st Paper 2nd Chapter Note Ques. No. 35 of Answer Paper.

▸ Question No. a (Knowledge based)

Ques-1. What is sigma bond? *[D.B., Dj.B., S.B.J.B.-18]*

Ans: The bond created due to face to face overlapping of the two valence orbitals during the creation of covalent bond is known as sigma bond.

Ques-2. What is orbital? *[D.B.-17]*

Ans: The region around the nucleus where the probability of finding revolving and fixed energy electron cloud is 90–95%, that region of electron cloud is called orbital.

Ques-3. What is α-particle? *[R.B.-16]*

Ans: The heleum nucleus formed of two protons and two neutrons is called α-particle ($^4_2He^{2+}$).

Ques-4. What is vacuum distillation? *[Dj.B.-17]*

Ans: The process of separating a liquid from a mixture by distillating at a lower temperature by reducing the boiling point of the liquid by reducing the atmospheric pressure on it is called vaccum distillation.

Ques-5. What is orbit? *[Ctg.B.-17]*

Ans: According to Bohr's atomic model, the fixed circular path around the nucleus for the rotation of electrons is called orbit.

Ques-6. What is R_f? *[S.B.-17]*

Ans: The ratio of the distance travelled by the constituent and the solvent in paper chromatography is denoted by R_f.

Ques-7. What is spectrum? *[R.B., C.B., Ctg.B., B.B. 18]*

Ans: When light rays of sunlight are separated from one another according to this wavelengths then it is known as spectrum.

▸ Question No. b (Comprehension based)

Ques-1. In which orbital between 3d and 4p electron will enter first? *[D.B.-16]*

Ans: In which orbital the electron will enter first is determined by Aufbau's principle or $(n + l)$. According to ths principle, the orbital of which $(n + l)$ value is low has low energy and electron will enter to it first. But if the $(n + l)$ value of two orbitals are same, then electron will enter the orbital whose n value is lower. For both 3d and 4p orbital the $(n + l)$ value is 5. But for 3d orbital the n value is 3 and for 4p orbital the n value is 4.

So, electron will enter 3d orbital first.

Ques-2. Write down the principle of chromatography. *[Dj.B.-16]*

Ans: Chromatography is mainly a separation technique which is mainly applied for the separation of molecular mixture. In this technique, on a large surface like (i) taking an adsorbant in a glass column or burette, (ii) on liquid on a solid base the mixture is absorbed. Then if liquid or gas is run through it then the constituents of the mixture are separated based on their different adsorption rate. How much a substance will be adsorbed on the adsorbant is dependent on the nature of that substance. If the substance is polar then generally adsorption is more. The separation by chromatography is suspended on the rate of adsorption and the rate of mobile phase.

Ques-3. At 25°C the solubility of KNO_3 is 31.6, what do you mean by it? *[C.B-17]*

Ans: At a fixed temperature the amount of solute expressed in gram is dissolved in 100gm of solvent to produce saturated solution, that amount of solute is called the solibility of that solute. The solibility of KNO_3 at 25°Cis 31.6 means, 31.6gm KNO_3 at 25°C dissolves into 100gm of solvent and produce saturated solution.

Ques-4. Bohr's theory is applicable for He^- — Explain. *[Ctg.B.-17]*

Ans: We know that, Bohr's atomic model is more accurate than Rutherford's atomic model. This is because, one of the principle of Bohr's atomic model is, when electron enters from one energy level to another, then the electron absorbs or radiates a fixed amount of energy. As a result a line is formed in the atomic spectrum. Again Bohr's atomic model can explain the spectrum of H atom having only one electron or ions having one electron (He^+, Li^{2+}). But it can't explain the spectrum having many electron.

So, as there is only one electron in He^+, here Bohr's theory is applicable.

Ques-5. Why ether is not completely dehydrated during distillation? *[J.B.-17]*

Ans: During the distillation of ether it is not completely dehydrated because pure ether can form per-oxide in presence of atmospheric oxygen. As a result there is a chance of explosion at the end of distillation. The reaction of ether with atmospheric oxygen is;

$$C_2H_5 - O - C_2H_5 + \frac{1}{2}O_2 \longrightarrow C_2H_5 - O - O - C_2H_5$$

Di-ethyl ether — Di-ethyl peroxide

Creative Multiple Choice

1. Which is the quantum set of the two electrons of the outer most shell of calcium? *[D.B.-17]*

ⓐ $n = 4, l = 0, m = 0, s = +\frac{1}{2}, \frac{1}{2}$

ⓑ $n = 3, l = 1, m = 0, s = +\frac{1}{2}, +\frac{1}{2}$

ⓒ $n = 4, l = 1, m = 0, s = -\frac{1}{2}, -\frac{1}{2}$

ⓓ $n = 4, l = 2, m = 1, s = +\frac{1}{2}, -\frac{1}{2}$ **ⓐ**

2. Which is the correct electron configuration?

a. 1s 2s ← 2p → : ⇅ ⇅ ⇅ ⇅ ☐

b. 1s 2s ← 2p → : ⇅ ⇅ 1 ⇅ ☐

c. 1s 2s ← 2p → : ⇅ ⇅ 1 1 1

d. 1s 2s ← 2p → : ⇅ ⇅ ☐ 1 ⇅

ⓒ

3. What is MRI?

ⓐ Magnetic Resonance Imging
ⓑ Movable Resonance Imaging
ⓒ Nuclear Magnetic Resonance
ⓓ Nuclear Radiation **ⓐ**

4. Color of Na in flame test—

ⓐ Red ⓑ Brick red
ⓒ Golden yellow ⓓ Violet **ⓒ**

5. "Rutherford's theory is similar to solar system"– where is the failure?

ⓐ Rotation of electrons and planets
ⓑ Positions of electrons and planets
ⓒ Positions of electrons and planets
ⓓ Attraction between charged particle and nucleus and attractive force between planet and sun **ⓑ**

6. What is used to identify fake passport? *[D.B.-17]*
ⓐ γ-ray ⓑ X-rays
ⓒ IR-radiation ⓓ UV-radiation **d**

7. Which set is the value of m for 3d orbital? *[D.B.-16]*
ⓐ 0 ⓑ −1, 0, +1
ⓒ −2, −1, 0, +1, +2 ⓓ −3, −2, −1, 0, +1, +2, +3 **c**

8. Which one is correct for solubility principle?
ⓐ $K_{sp} = \sqrt{S}$ ⓑ $S = \sqrt{K_{sp}}$
ⓒ $S = Ks^2p$ ⓓ $K_{sp} = S$ **b**

9. What depends on subsidiary quantum number?
ⓐ Number of energy levels of atoms
ⓑ Number of sublevels in energy levels
ⓒ Principal quantum number
ⓓ Position of electrons **b**

10. What is its wave number, if the red radiation has a wavelength of 7000 Å? *[S.B.-17]*
ⓐ 1.428×10^{-3}nm ⓑ $14.28 \times 10^{3}cm^{-1}$
ⓒ $1.428 \times 10^{-3}m^{-1}$ ⓓ 14.28×10^{-3}Å **b**

11. Which one is correct for more stability?
ⓐ $s^2 d^4$ ⓑ $s^2 d^9$
ⓒ $s^1 d^{10}$ ⓓ $s^2 f^{13}$ **c**

12. How many electrous are there in 3d subshell of Fe^{2+}?
ⓐ 5 ⓑ 6
ⓒ 8 ⓓ 10 **b**

13. Which indicates isotone?
a. $^{31}_{15}P, ^{32}_{16}S$ ⓑ $^{64}_{29}Cu, ^{64}_{30}Zn$
ⓒ $^{12}_{6}C, ^{13}_{6}C$ ⓓ $^{2}_{1}H, ^{2}_{1}H$ **a**

14. Which element is used for the treatment of cancer?
ⓐ Ra ⓑ Fr
ⓒ Th ⓓ Rn **d**

15. Which salt is soluble in water?
ⓐ AgF ⓑ AgBr
ⓒ AgCl ⓓ AgI **a**

16. From which orbital electrons are transferred for more stability?
ⓐ s ⓑ p
ⓒ d ⓓ f **a**

17. Which sequence is correct according to aufbau principle? *[R. B.-17]*
ⓐ 4s < 3d < 4p ⓑ 3d < 3s < 4p
ⓒ 4d < 5s < 5p ⓓ 5s < 5p < 4d **a**

18. What is the value of R for hydrogen?
ⓐ 230 cm^{-1} ⓑ 560 cm^{-1}
ⓒ 109678 cm^{-1} ⓓ 1800 cm^{-1} **c**

19. Which substance is used as coated screen in Rutherford's α-particle scattering? *[D.B.-16]*
ⓐ Au ⓑ ZnS
ⓒ PbS ⓓ Ra **b**

20. The presence of which material creates fluorescence of UV-radiation in real notes?
ⓐ Application of computer graphix
ⓑ Water print
ⓒ Excited atom
ⓓ Liquid compound **b**

21. How many phases are there in chromatography? *[Ctg.B.-17]*
ⓐ 1 ⓑ 2
ⓒ 3 ⓓ 4 **b**

22. In which region Lymann series are created in hydrogen Bectra?
ⓐ Ultraviolet ⓑ Visible
ⓒ Infrared ⓓ Microwave **a**

23. What is NMR?
ⓐ Radio waves ⓑ Infrared radiation
ⓒ Magnetic resonance image
ⓓ Nuclear magnetic resonance **d**

24. Which ion shows violet colour in flame test? *[B.B.-17]*
ⓐ Na^+ ⓑ K^+
ⓒ Ca^{2+} ⓓ Cu^{2+} **b**

25. Used to detect NH_4^+ ion in solution —
ⓐ Oxalic acid ⓑ Nessler's solution
ⓒ Vitamin ⓓ Fenton's reagent **b**

26. Which one is not present in testing Cu^{2+} ion?
ⓐ H_2S gas ⓑ HCl
ⓒ NaOH ⓓ HNO_3 **d**

27. 50g of KNO_3 is obtained when 100g saturated solution of KNO_3 is vapourised at 50°C. What is the solubility of KNO_3 at that temperature? *[R.B.-17]*
ⓐ 200 ⓑ 150
ⓒ 100 ⓓ 50 **c**

28. Which value of R_f is not acceptable in paper chromatography? *[C.B.-17]*
ⓐ 0.5 ⓑ 0.7
ⓒ 0.9 ⓓ 1.1 **d**

29. In which series of hydrogen atomic spectra, radiation of visible range can be observed? *[Dj.B.-17]*
ⓐ Paschen ⓑ Hymann
ⓒ Balmer ⓓ Bracket **c**

30. What is the solubility if 30 g of solute is dissolved in 100g saturated solution? *[R.B.-16]*
ⓐ 30 ⓑ 40
ⓒ 75 ⓓ 100 **b**

31. What is the colour of the precipitate of Al^{3+} ion test?
ⓐ White ⓑ Deep blue
ⓒ Bluish green ⓓ Black **a**

32. Which one is purified by sublimation process?
ⓐ NaCl ⓑ Benzoic acid
ⓒ KCl ⓓ Sugar **b**

33. What is added when a solution is heated in the beginning of crystallisation process?
ⓐ Activated carbon ⓑ Na
ⓒ HCl ⓓ HNO_3 **a**

34. Which one is mostly used in solvent extraction?

ⓐ HCl ⓑ HNO_3

ⓒ $CaCl_2$ ⓓ Ethoxyethane **d**

35. The equation for determining the angular momentum of an electron in an atom's 2nd energy shell — *[B.B.-17]*

ⓐ $mvr = \frac{2h}{\pi}$ ⓑ $mvr = \frac{h}{2\pi}$

ⓒ $mvr = \frac{h}{\pi}$ ⓓ $mvr = \frac{4h}{\pi}$ **c**

36. What is the solubility product if the solubility of CaF_2 is 0.0002 mol/L? *[All Board-18]*

ⓐ 2.3×10^{-11} ⓑ 3.2×10^{-11}

ⓒ 2.3×10^{-10} ⓓ 3.2×10^{-10} **b**

37. Mass of α- particle is — than mass of electron.

ⓐ More ⓑ Much higher

ⓒ Less ⓓ Equal **b**

38. The solubility of Bi_2S_3 is S. What is the solubility product? *[All Board-18]*

ⓐ $108S^5$ ⓑ $27S^3$

ⓒ $16S^2$ ⓓ $4S^3$ **a**

39. If the energy of the first orbit of hydrogen atom is E_1, what will be the energy of the 3rd orbit? *[Dj.B.-16]*

ⓐ $E_1 \times \frac{1}{9}$ ⓑ $E_1 \times 9$

ⓒ $E_1 \times \frac{1}{3}$ ⓓ $E_1 \times 3$ **a**

40. Which of the following rules is applied to calculate the number of electrons in a subshell? *[C.B.-17]*

ⓐ $2(2l + 1)$ ⓑ $(2l + 1)$

ⓒ $(n + 1)$ ⓓ $2n^2$ **a**

▶ Multiple Completion Based Questions

41. In an evaporation process —

i. Water is mixed with the collected liquid of organic compound

ii. Separation of organic liquid and water by using funnel

iii. Amount of incoming and outgoing vapour is unequal

Which one is correct?

ⓐ i & ii ⓑ i & iii

ⓒ ii & iii ⓓ i, ii & iii **a**

42. For n = 3 —

i. 3f orbital is not possible

ii. if l = 2, m = −2, −1, 0, + 1, +2

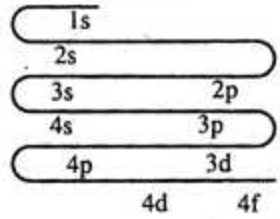
iii. l = 0, 1, 2

Which one is correct?

ⓐ i & ii ⓑ i & iii

ⓒ ii & iii ⓓ i, ii & iii **c**

43. In the configuration —



i. Positions of electrons (Aufbau principle) are shown

ii. Electrons will enter into 4th orbital before 5th orbital

iii. 1s < 2s < 2p < 3s < 3p < 3d < 4s sequence is included

Which one is correct?

ⓐ i & ii ⓑ i & iii

ⓒ ii & iii ⓓ i, ii & iii **a**

44. In paper chromatography —

i. Filter paper should be cut at a definite shape

ii. R_f is to be determined

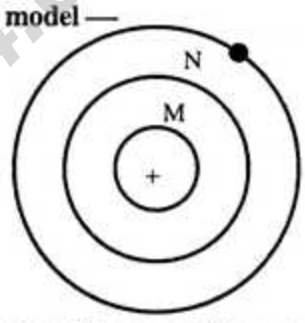
iii. Solvent front has to be marked with a pencil

Which one is correct?

ⓐ i & ii ⓑ i & iii

ⓒ ii & iii ⓓ i, ii & iii **d**

45. In the model —



i. Amount of energy at Nth enrgy level is fixed

ii. Energy will be emitted when electron jumps back to lower energy level

iii. The amount of emitted or absorbed energy, ΔE = hv

Which one is correct?

ⓐ i & ii ⓑ i & iii

ⓒ ii & iii ⓓ i, ii & iii **d**

46. Applicable for the value of R_f — *[Dj.B.-17]*

i. Ratio of distance travelled by solute and solvent

ii. Ratio of distance travelled by solvent and solute

iii. Value is less than one (1)

Which one is correct?

ⓐ i & ii ⓑ i & iii

ⓒ ii & iii ⓓ i, ii & iii **b**

47. Expression of Planck's equation is —

i. $mvr = \frac{nh}{2\pi}$ ii. $E = hv$

iii. $\Delta E = \frac{hc}{\lambda}$

Which one is correct?

ⓐ i & ii ⓑ i & iii

ⓒ ii & iii ⓓ i, ii & iii **c**

48. Bohr's atom model—

i. Theory related to energy emission
ii. Theory related to energy level
iii. Theory related to electron & proton

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

49. For orbital — *[C.B.-16]*

i. $l = 1$ ii. $m = +1, 0, -1$
iii. orbital number = 2

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

50. Magnetic quantum number —

i. Expresses electron spin
ii. Value of m depends on l-value
iii. $m = o$ to ± 1

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **c**

51. For orbitals — *[All Board-18]*

i. $l = 1$ ii. $m = +1.0 - 1$
iii. orbital numbers–2

Which one is correct?

ⓐ i & ii ⓑ ii & iii
ⓒ i & iii ⓓ i, ii & iii **a**

52. The ion $[Co(NH_3)_6]^{3+}$ is —

i. Octahedral ii. d^2sp^3 hybridised
iii. Paramagnetic

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

53. For the element having atomic number of 19 —

i. The last electron is in 3d subshell
ii. 4s energy level is incomplete
iii. Energy sequence is: $1s < 2s < 3p < 3s < 3p < 4s < 3d < 4p$

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **c**

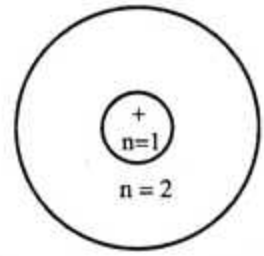
54. Use of chromatography — *[S.B.-15]*

i. Separation and purification of organic compounds
ii. Identification of pollutants created due to pollution
iii. Extraction of red dye from pepper powder

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **d**

55. At second energy level of the model —



i. $l = 0, 1$
ii. Electron numbers = 8 (2nd enrgy level)
iii. Electron configuration – $1s^2 2s^2 2p^4$

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **d**

56. For the identification of Ca^{2+} ion —

i. $(CH_3COO)_2Ca + NH_4OOC - COONH_4 \longrightarrow 2CH_3COONH_4 + Ca$ (O–C=O, O–C=O)
ii. Addition of ammonium oxalate forms white precipitate
iii. Precipitate calcium oxalate is not soluble in HCl

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

Read the following statement and answer question numbers 57 and 58:

The serial number of principal energy levels of electrons in an atom is called principal quantum number. It is denoted by 'n'. Here, n = 1, 2, 3, 4 etc are positive integers.

57. If the value of principal quantum number is more than 4, what will be maxiumm number of electrons?

ⓐ 32 ⓑ 64
ⓒ not more than 32 ⓓ 18 **c**

58. For 4th energy shell —

i. Is called N shell
ii. Maximum electron containing capacity is 32
iii. The higher the value of n, the smaller the size of atom

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **a**

Observe the following equations and answer the questions 59 and 60:

$aF_2 \rightleftharpoons Ca^{2+} + 2F^-$ and $PbCrO_4 \rightleftharpoons Pb^{2+} + CrO_4^{2-}$

59. For the given compounds —

i. $K_{sp\,(CaF_2)} = [Ca^{2+}] \times [F^-]^2$
ii. $K_{sp\,(PbCrO_4)} = [Pb^{2+}] \times [CrO_4^-]^4$
iii. Among all electrons, two will have spin direction

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **b**

60. What will happen if the product of $[Ca^{2+}]$ and $[F^-]$ exceeds the solubility product?

ⓐ Soluble ⓑ Partly soluble
ⓒ Precipitation ⓓ Partly insoluble **ⓒ**

Read the following stem and answer question numbers 61 and 62:

Utpal considered an element of period 3 and group IV A and observed that the both electrons of s orbital of 3rd energy shell differed only in one of the following:
size, shape, orientation and spin direction.

61. Which principle is followed by Uptal's observation?

ⓐ Aufbau principle
ⓑ Hund's rule
ⓒ Bohr's principle
ⓓ Pauli's exclusion principle **ⓓ**

62. In the last orbit of the element of the stem —

i. Number of orbitals = 9
ii. Number of electrons will be 18
iii. Among all electrons, two will have spin direction

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **ⓓ**

Read the following stem and answer the following two questions: *[S.B.-17]*

$Ca(OH)_2 + aq \longrightarrow \boxed{A} + 2OH^-$

63. Applicable information for A of the stem —

i. Brick red colour is observed in flame test
ii. White colour is obtained with $(NH_4)_2C_2O_4$
iii. Known as lime

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **ⓒ**

64. If the concentration of OH^- is 0.02M, what will be the pH?

ⓐ 12, 60 ⓑ 12, 30
ⓒ 1.70 ⓓ 1.40 **ⓑ**

Read the following stem and answer question numbers 65 & 66:

Period 2	Group 1A		
	Li	Be	B
	X	Z	Al
	X	Z	Y
	Rb	Sr	In
	Cs	Ba	Tl

65. What is the colour of Z in flame test?

ⓐ Violet ⓑ Pink
ⓒ Colourless ⓓ Bluish green **ⓒ**

66. Reasons for showing different colors by X, Y and Z are —

i. Their salts form metal chlorides with concentrated HCl
ii. Formed metal chlorides absorb different wavelengths
iii. Complementary colours create the burner flame

Which one is correct?

ⓐ i & ii ⓑ i & iii
ⓒ ii & iii ⓓ i, ii & iii **ⓓ**

Answer question numbers 67 and 68:

The wavelength of an emitted radiation from a source is 412 nm.

67. What is the emitted radiation?

ⓐ γ-ray ⓑ X-ray
ⓒ Violet radiation ⓓ Infrated radiation **ⓒ**

68. What is the frequency of the used radiation if velocity of light is 3×10^8 m/s?

ⓐ 7.28×10^{14} Hz ⓑ 7.217×10^{10} Hz
ⓒ 7.28×10^{20} Hz ⓓ 7.317×10^{7} Hz **ⓐ**