CHEMISTRY (CODE - 043)

CHAPTER TEST - QUESTION PAPER

Class XI (2026-27) | Chapter 2: Structure of Atom

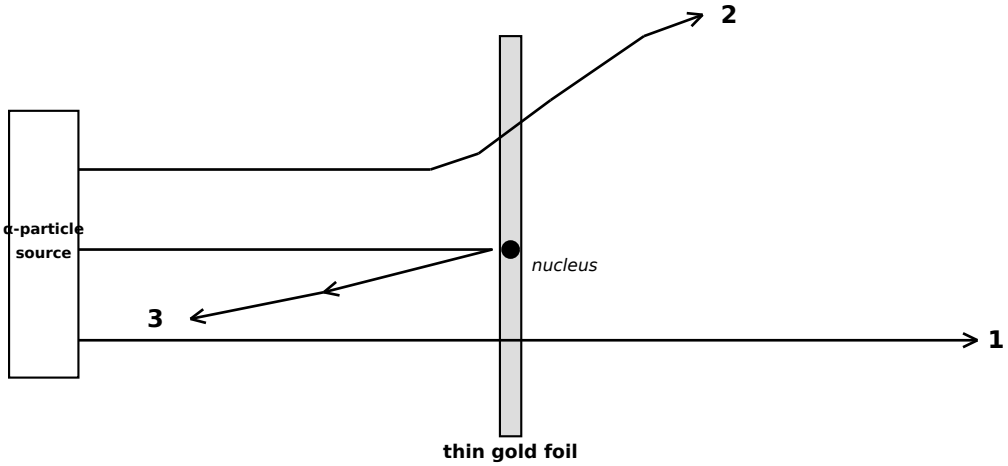
Time: 1 hour 30 minutes | Max. Marks: 35

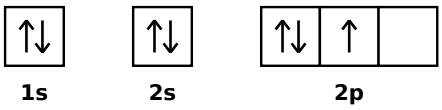
GENERAL INSTRUCTIONS:

1. Read the following instructions carefully.
2. There are 20 questions in this question paper with internal choice.
3. SECTION A consists of 12 questions carrying 1 mark each (Q. 1 to 9 are multiple-choice questions and Q. 10 to 12 are Assertion–Reason questions).
4. SECTION B consists of 4 very short answer questions carrying 2 marks each.
5. SECTION C consists of 2 short answer questions carrying 3 marks each.
6. SECTION D consists of 1 case-based question carrying 4 marks.
7. SECTION E consists of 1 long answer question carrying 5 marks.
8. All questions are compulsory. Internal choice is provided in Q. 16 (Section B) and Q. 20 (Section E).
9. Use of log tables and calculators is not allowed.
10. Constants: $h = 6.626 \times 10^{-34}$ J s; $c = 3 \times 10^{8}$ m s^{-1}; $m_e = 9.11 \times 10^{-31}$ kg; 1 eV = 1.602×10^{-19} J; $R_H = 1.097 \times 10^{7}$ m^{-1}; E_n (H) = $-2.18 \times 10^{-18}/n^2$ J.

SECTION A

Questions 1 to 9 are multiple-choice questions. Only one of the choices is correct. Questions 10 to 12 are Assertion–Reason questions.

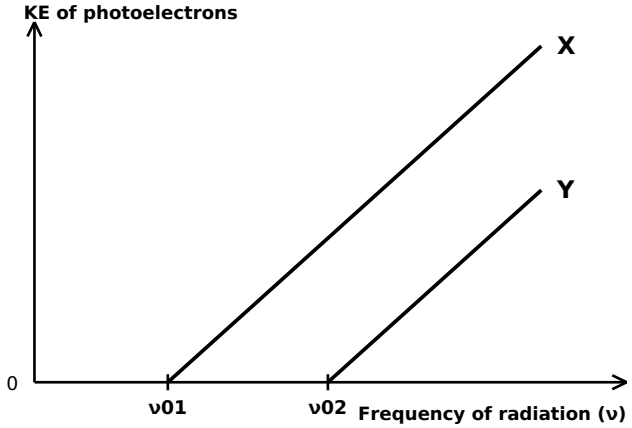
1	The number of neutrons in the ion $^{56}_{26}Fe^{3+}$ is: A. 26 B. 30 C. 23 D. 33	1
2	The figure shows three paths (1, 2 and 3) of α-particles in Rutherford's gold-foil experiment.  Which option correctly explains the three paths? A. 1 – passes straight, most of the atom is empty space; 2 – slightly deflected, repelled by the positive nucleus; 3 – rebounds, meets the dense positive nucleus head-on B. 1 – passes straight because the nucleus is large; 2 – deflected by electrons; 3 – absorbed by the nucleus C. 1 – repelled by the electron cloud; 2 – attracted by the nucleus; 3 – foil is too thin D. 1 and 3 – pass through empty space; 2 – rebounds from the nucleus	1
3	The frequency of light of wavelength 600 nm ($c = 3 \times 10^{8}$ m s^{-1}) is: A. 5×10^{14} Hz B. 2×10^{-15} Hz C. 1.8×10^{17} Hz D. 5×10^{12} Hz	1

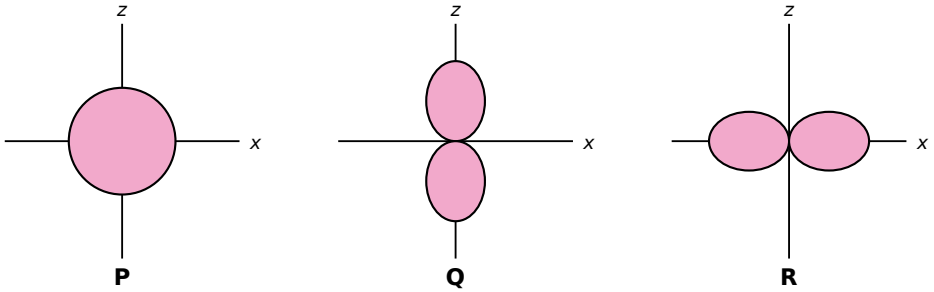
4	The total number of orbitals present in the shell with principal quantum number n = 4 is: A. 4 B. 8 C. 16 D. 32	1
5	Which of the following orbitals is **not** possible? A. 3d B. 2d C. 4f D. 5s	1
6	The number of protons, neutrons and electrons in four species P, Q, R and S is given below: **Species** / **Protons** / **Neutrons** / **Electrons** P / 18 / 22 / 18 Q / 19 / 21 / 18 R / 20 / 20 / 18 S / 18 / 20 / 18 Which statement is correct? A. P and S are isotopes; P, Q and R are isobars B. P and S are isobars; Q and R are isotopes C. Q and S are isotopes; P and R are isobars D. P and Q are isotopes; R and S are isobars	1
7	A student wrote the orbital diagram of nitrogen as shown. *Orbital diagram of an element (Z = 7) as written by a student*  **1s** **2s** **2p** Which rule or principle is violated in this diagram? A. Aufbau principle B. Pauli exclusion principle C. Hund's rule of maximum multiplicity D. Heisenberg uncertainty principle	1
8	The number of radial nodes in a 3p orbital is: A. 0 B. 1 C. 2 D. 3	1
9	The energy of the electron in the hydrogen atom in the n = 1 orbit is -2.18×10^{-18} J. The energy of the electron in the n = 2 orbit of He^{+} is: A. -2.18×10^{-18} J B. -8.72×10^{-18} J C. -5.45×10^{-19} J D. -1.09×10^{-18} J	1
10	Questions 10 to 12 are Assertion (A) and Reason (R) type questions. Select the correct option. **Assertion (A):** The ground-state valence electronic configuration of chromium is $3d^5 4s^1$ and not $3d^4 4s^2$. **Reason (R):** Half-filled subshells have extra stability due to symmetrical distribution of electrons and larger exchange energy. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1

11	**Assertion (A):** Bohr's model satisfactorily explains the line spectrum of the hydrogen atom. **Reason (R):** Bohr's model also explains the spectra of all multi-electron atoms. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1
12	**Assertion (A):** In potassium, the last electron enters the 3d orbital before the 4s orbital. **Reason (R):** The orbital with the lower (n + l) value has the lower energy. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1

SECTION B

Questions 13 to 16 are very short answer questions carrying 2 marks each.

13	The graph shows the variation of the kinetic energy (KE) of photoelectrons with the frequency of the incident radiation for two metals X and Y. The threshold frequencies are ν_{01} and ν_{02}.  (i) What does the slope of the lines represent? Why are the two lines parallel? [1] (ii) Which metal has the higher work function? Give a reason. [1]	2
14	Light of wavelength 500 nm is used in an experiment. (i) Calculate the energy of one photon of this light. [1] (ii) Calculate the number of photons that together provide 1 J of energy. [1]	2
15	Four sets of quantum numbers are given below: **Set** | **n** | **l** | **m_l** | **m_s** (a) | 3 | 2 | −3 | +½ (b) | 2 | 2 | 0 | −½ (c) | 4 | 1 | 0 | +½ (d) | 2 | 1 | 0 | +1 Identify the sets that are **not** possible and give a reason for each.	2

16	The figure shows the boundary surface diagrams of three orbitals P, Q and R of the shell n = 2.  (i) Identify the orbitals P, Q and R. [1] (ii) Which two of these are degenerate in a multi-electron atom? How many angular nodes does Q have? [1] **OR** Using the (n + l) rule, arrange the orbitals 3d, 4s, 3p and 4p in increasing order of energy. Show the (n + l) value of each.	2

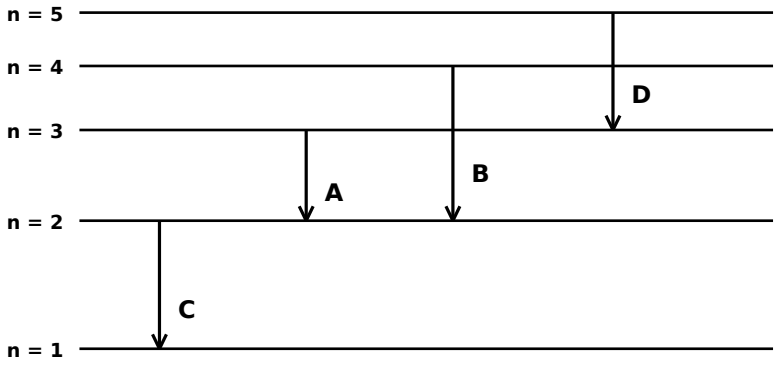
SECTION C

Questions 17 and 18 are short answer questions carrying 3 marks each.

17	The work functions of three metals are given below. Radiation of wavelength 500 nm falls on each metal. (1 eV = 1.602×10^{-19} J) <table><tr><th>Metal</th><th>Cs</th><th>K</th><th>Na</th></tr><tr><td>Work function (eV)</td><td>1.9</td><td>2.3</td><td>2.75</td></tr></table> (i) Calculate the energy of the photon in eV and state which metals show photoelectric emission. [1] (ii) Calculate the kinetic energy (in J) of the electron ejected from caesium. [1] (iii) Calculate the velocity of this photoelectron. [1]	3
18	(i) Calculate the de Broglie wavelength of an electron moving with a velocity of 1.0×10^6 m s^{-1}. [1.5] (ii) Calculate the de Broglie wavelength of a cricket ball of mass 0.15 kg moving at 40 m s^{-1}. [1] (iii) Why is the wave nature of the cricket ball not observed? [0.5]	3

SECTION D

Question 19 is a case-based question carrying 4 marks.

19	**Spectrum of the hydrogen atom** When the electron of a hydrogen atom jumps from a higher energy level to a lower one, a photon is emitted and a line is seen in the spectrum. Four such transitions A, B, C and D are shown in the energy-level diagram. *Energy levels of the hydrogen atom (not to scale)*  (i) Name the spectral series to which the transitions A, C and D belong. [1] (ii) Calculate the wavelength of the radiation emitted in transition B ($R_H = 1.097 \times 10^7$ m^{-1}). [1] (iii) Calculate the energy of the photon emitted in transition C. [1] (iv) How many different emission lines are possible when an electron falls from n = 5 to the ground state? [1]	4

SECTION E

Question 20 is a long answer question carrying 5 marks.

20	(i) State Pauli's exclusion principle and Hund's rule of maximum multiplicity. [2] (ii) Write the electronic configurations of chromium (Z = 24) and copper (Z = 29) and explain why they are exceptions to the expected order. [2] (iii) How many unpaired electrons are present in iron (Z = 26)? [1] **OR** (i) State two postulates of Bohr's model of the atom. [2] (ii) Calculate the radius of the third Bohr orbit of Li^{2+} ($r_n = 52.9 \times n^2/Z$ pm). [1] (iii) Calculate the energy of the electron in the second orbit of Li^{2+}. [1] (iv) Give one reason why Bohr's model fails for multi-electron atoms. [1]	5

***** END OF QUESTION PAPER *****