Time: 2:30 PM to 3:45 PM

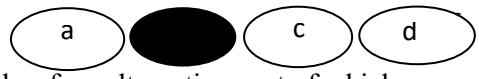
Question Paper Code: 31

Roll No. of Student's													

Write the question paper code mentioned above on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated. Note that the same Question Paper Code appears on each page of the question paper.

Instructions to Candidates:

1. Use of mobile phone, smart watch, and iPad during examination is STRICTLY **PROHIBITED.**
2. In addition to this question paper, you are given OMR Answer Sheet along with candidate's copy.
3. On the OMR sheet, make all the entries carefully in the space provided **ONLY** in **BLOCK CAPITALS** as well as by properly darkening the appropriate bubbles.
   Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.
4. On the OMR Answer Sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling the bubbles.
5. Your **14-digit roll number and date of birth** entered on the OMR Answer Sheet shall remain your login credentials means login id and password respectively for accessing your performance / result in Indian Olympiad Qualifier in Chemistry 2021-22 (Part I).
6. Question paper has two parts. In part A-1(Q. No.1 to 24) each question has four alternatives, out of which **only one** is correct. Choose the correct alternative and fill the appropriate bubble, as below.

Q.No.12 

In part A-2 (Q. No. 25 to 32) each question has four alternatives out of which any number of alternative(s) (1, 2, 3, or 4) may be correct. You have to choose **all** correct alternative(s) and fill the appropriate bubble(s), as shown

Q.No.30 

7. For **Part A-1,** each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A-2,** you get 6 marks if all the correct alternatives are marked and no incorrect. No negative marks in this part.
8. Rough work should be done in the space provided. There are **10** printed pages in this paper
9. Use of **non- programmable scientific** calculator is allowed.
10. No candidate should leave the examination hall before the completion of the examination.
11. After submitting answer paper, take away the question paper & Candidate's copy of OMR for your reference.

Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR answer sheet.

OMR answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED. Scratching or overwriting may result in a wrong score.

DO NOT WRITE ON THE BACK SIDE OF THE OMR ANSWER SHEET.

Instructions to Candidates (Continued) :

You may read the following instructions after submitting the answer sheet.

12. **Comments/Inquiries/Grievances regarding this question paper, if any, can be shared on the Inquiry/Grievance column on www.iapt.org.in on the specified format till January 29, 2022.**
13. **The answers/solutions to this question paper will be available on the website: www.iapt.org.in by January 27, 2022.**

14. **CERTIFICATES and AWARDS:**

Following certificates are awarded by IAPT/ACT to students, successful in the Indian Olympiad Qualifier in Chemistry 2021-22 (Part I)

(i) "CENTRE TOP 10 %" To be downloaded from iapt.org.in after 15.03.22
(ii) "STATE TOP 1 %" Will be dispatched to the examinee
(iii) "NATIONAL TOP 1 %" Will be dispatched to the examinee
(iv) "GOLD MEDAL & MERIT CERTIFICATE" to all students who attend OCSC – 2022 at HBCSE Mumbai
Certificate for centre toppers shall be uploaded on iapt.org.in

15. List of students (with centre number and roll number only) having score above MAS will be displayed on the website: **www.iapt.org.in** by **February 06, 2022 See the Minimum Admissible Score Clause** on the Student's brochure on the web.

16. List of students eligible for evaluation of IOQC 2021-22 (Part II) shall be displayed on www.iapt.org.in by February 10, 2022.

Useful constants

Charge of electron, $e = 1.602 \times 10^{-19} C$

Mass of electron, $m_e = 9.1 \times 10^{-31} kg$

Planck's constant, $h = 6.626 \times 10^{-34} J\,s$

Speed of light, $c = 3.0 \times 10^{8} ms^{-1}$

Avogadro constant, $N_A = 6.022 \times 10^{23} mol^{-1}$

Molar gas constant, $R = 0.082 L\,atm\,mol^{-1} K^{-1}$

$= 8.314 J\,mol^{-1}\,K^{-1}$

CHEMISTRY 2021-22 (Part I) (NSEC 2021 – 22)

Time: 75 Minutes **Max. Marks: 120**

Attempt All Thirty Two Questions

A – 1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT. BUBBLE THE CORRECT OPTION

1. The correct order of CFSE of the following complex ions is
$[Zn(NH_3)_4]^{2+}$, $[Co(NH_3)_6]^{2+}$, $[Co(NH_3)_6]^{3+}$, $[Ir(NH_3)_6]^{3+}$

(a) $[Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(NH_3)_6]^{2+} > [Zn(NH_3)_4]^{2+}$
(b) $[Zn(NH_3)_4]^{2+} > [Co(NH_3)_6]^{2+} > [Co(NH_3)_6]^{3+} > [Ir(NH_3)_6]^{3+}$
(c) $[Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Zn(NH_3)_4]^{2+} > [Co(NH_3)_6]^{2+}$
(d) $[Co(NH_3)_6]^{3+} > [Ir(NH_3)_6]^{3+} > [Co(NH_3)_6]^{2+} > [Zn(NH_3)_4]^{2+}$

2. Solvents are classified as polar and nonpolar based on their dipole moments.
Given below are some solvents.
(p)1,2-dibromobenzene (q) diisopropylether (r) trans-1,2-dichloroethene
(s) 1,2-dichloroethane (t) N-ethyl-N-methylpropan-1-amine
The set in which all solvents are polar is
(a) p, s, t (b) p, q, r (c) r, s, t (d) q, r, t

3. Which of the following statement/s is/are correct?

I. Half-life is 50 % of the total time taken for the completion of a reaction
II. Collision frequency (Z), which is the number of collisions per second per unit volume, is same as the rate constant of the reaction
III. A change in the activation energy of a reaction at a particular temperature will result in a proportional change in the rate and rate constant of the reaction at the same temperature
IV. All first order reactions are not unimolecular
V. For a zero order reaction, slope of a plot of $t_{1/2}$ Vs. initial concentration will be zero

(a) I, IV (b) II only (c) IV only (d) II, III,V

4. The orange colour of $K_2Cr_2O_7$ and yellow colour of K_2CrO_4 are, respectively, due to
(a) charge transfer transitions and d-d transitions
(b) d-d transitions and charge transfer transitions
(c) charge transfer transitions in both
(d) d-d transitions in both

5. One mole of neon (atomic mass = 20 g mol^{-1}) and one mole of argon (atomic mass = 40 g mol^{-1}) are stored in two separate containers I and II, at temperature T and 2T respectively. If both the gases are assumed to behave ideally

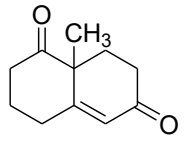
(a) K.E. and average velocity of the gas molecules will be the same in both I and II

(b) K.E. and average velocity of the gas molecules in II will be twice that of the gas molecules in I

(c) K.E. of the gas molecules in II will be twice that in I and average velocity of the gas molecules in both I and II will be the same

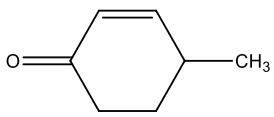
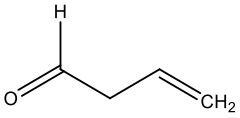
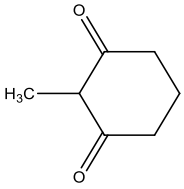
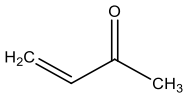
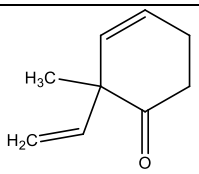
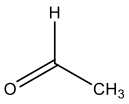
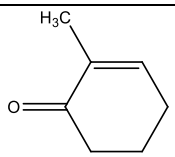
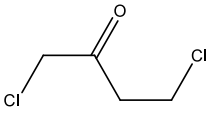
(d) Both K.E. and average velocity of the gas molecules in I will be twice that of the gas molecules in II

6. An aldehyde/ketone in the presence of a base forms a carbanion at the α-position which can react with a carbonyl group in an Aldol type of reaction. It can also react with an olefinic double bond which is activated by groups like CO, CN, NO_2 attached to the double bond. The latter reaction is an addition reaction across the double bond. Wieland-Miescher ketone is an important synthetic intermediate used to synthesize many compounds

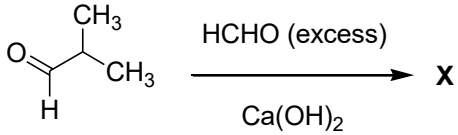


Wieland-Miescher Ketone

The pair of starting materials suitable for preparation of Wieland-Miescher ketone through a base catalysed reaction is

(a)	 	(b)	 
(c)	 	(d)	 

7. '**X**' in the following reaction is



2-methylpropanal

(a) 2,2-Dimethyl-1,3-propanediol

(b) 2-Methylpropan-1-ol

(c) iso-butyric acid

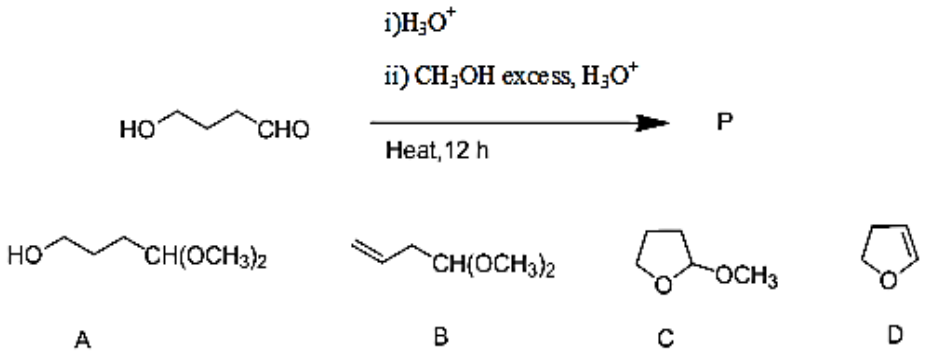
(d) 3-Hydroxy-2,2-dimethylpropanal

8. When 0.805 g of the potassium salt $(CH_2)_n(COOK)_2$ of a dibasic organic acid was reduced, 0.323 g of potassium was obtained. Molar mass of the acid is
(a) 194 (b) 116 (c) 118 (d) 156

9. Among (i) HCl, (ii) HOClO, (iii) $HOClO_2$ and (iv) $HOClO_3$, which cannot undergo a disproportionation reaction?
(a) Only (i) (b) (ii) and (iii) (c) (i) and (iv) (d) (ii), (iii) and (iv)

10. The electronic transition in He^+ ion that will occur at the same wavelength as that of the n = 2 to n = 1 transition in H atom is
(a) n = 2 to n = 1 (b) n = 3 to n = 1 (c) n = 3 to n = 2 (d) n = 4 to n = 2

11. '**P**' in the following reaction is



(a) A (b) B (c) C (d) D

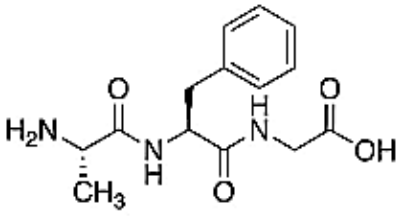
12. The number of stereoisomers is maximum for (ox = $C_2O_4^{2-}$)
(a) $[Co(ox)_3]^{3-}$ (b) $[Co(ox)_2ClBr]^{3-}$ (c) $[Co(ox)Cl_2Br_2]^{3-}$ (d) $[CoCl_3Br_3]^{3-}$

13. Maximum number of electrons with m_s = ½ which can be accommodated in subshells having total three nodes is
(a) 10 (b) 16 (c) 20 (d) 32

14. The Hinsberg test of the compound **X** produces a solid compound **Y** that is insoluble in 10 % aq. NaOH. **Y** dissolves in 10 % aq. sulphuric acid. The compound **X** is
(a) $NH_2CH_2CH_2CH_2N(CH_3)_2$ (b) $(CH_3)_2NCH_2CH_2NHCH_3$
(c) $NH_2CH_2C(CH_3)_2CH_2NH_2$ (d) $(CH_3)_2NCH_2N(CH_3)_2$

15. An ionic species, M^{3+}, is isoelectronic with $CuCl_2$ and has (Z+2) neutrons. The molar mass of M^{3+} is
(a) 128 (b) 62 (c) 68 (d) 134

16. In compound **X,** the number of chiral centres and the number of peptide linkages are, respectively



X

(a) 2,3 (b) 3,2 (c) 2,2 (d) 3,3

17. Which of the following reactions is *NOT* an example of Lewis acid-Lewis base reaction?

(a) $Zn + I_3^- \rightarrow Zn^{2+} + 3I^-$ (b) $I_2 + I_3^- \rightarrow I_5^-$

(c) $CoCl_3 + Cl^- \rightarrow CoCl_4^-$ (d) $SO_3 + H_2O \rightarrow H^+ + HSO_4^-$

18. A student intended to prepare 1000 mL of a 10 ppm solution of K^+ from KCl. He made appropriate calculations, weighed the salt accordingly and prepared the solution. However, after making the solution, he realized that the salt he used was KNO_3 and not KCl. The concentration of K^+ (ppm) in this prepared solution is

(a) 7.37 (b) 10.00 (c) 13.55 (d) 3.86

19. Oxide A is soluble in NaOH, oxide B in HCl and oxide C in both. The correct set of A, B and C is

	A	B	C
(a)	CO_2	SO_2	PbO_2
(b)	CO_2	Na_2O	ZnO
(c)	SO_2	ZnO	SnO_2
(d)	SO_2	BaO	Na_2O

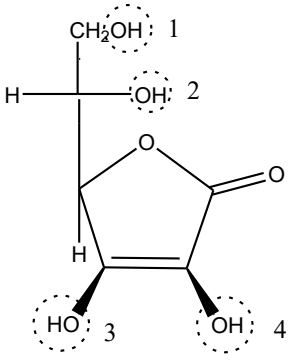
20. Ascorbic acid (Vitamin C), a naturally occurring water soluble vitamin and abundantly found in lemon, shows antioxidant properties. In ascorbic acid, the OH with the lowest pKa is

(a) 1

(b) 2

(c) 3

(d) 4



Ascorbic Acid

21. Compound **'X'** ($C_7H_{12}O_2$) gives - i) a positive silver mirror test and ii) a yellow precipitate on treatment with I_2/NaOH. The compound **'X'** is

(a) 2-hydroxy-3,3-dimethylcyclopentanone (b) 2,5-heptanedione

(c) 2,2-dimethyl-3-oxopentanal (d) 2,2-dimethyl-4-oxopentanal

22. If the ratio of the concentrations of the oxidized and reduced forms of a species in an electrochemical reaction can be given as [Ox]/[Red] = 1.0×10^{-3}, the correct expression among the following at 25°C is

(a) $E = E^o + \frac{1}{3}(0.0592/n)$ (b) $E - E^o = 3 \times (0.0592/ n)$

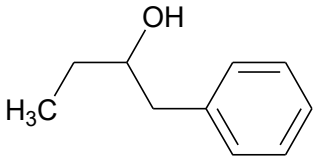
(c) $E = E^o - \frac{1}{3}(0.0592/n)$ (d) $E - E^o = (0.0592/n)^{1/3}$

23. Among the following numbers, the one in which all the zeros are significant is

(a) 0.0004 (b) 0.0400 (c) 40.000 (d) 0.0040

24. Among the following sets of compounds, the one in which a reaction between them followed by hydrolysis that *does not* lead to the formation of 1-phenyl-2- butanol is

(a) phenylacetaldehyde and ethylmagnesium bromide
(b) butanal and phenylmagnesium bromide
(c) propanal and benzylmagnesium bromide
(d) 1-phenyl-2-butanone and $NaBH_4$



1-phenyl-2-butanol

A-2

ANY NUMBER OF OPTIONS 4, 3, 2 or 1 MAY BE CORRECT

MARKS WILL BE AWARDED ONLY IF ALL CORRECT OPTIONS ARE BUBBLED, AND NO WRONG OPTION

25. At room temperature**,** NaCl(s) and KCl(s) were taken in equal masses and dissolved in equal volumes of water in two separate closed containers I and II respectively.
Of the following, correct option/s is/are

(a) To compare molarities in (I) and (II), masses of both the solutions need to be known

(b) Molalities cannot be compared without measuring the mass of water added in each case

(c) If (I) and (II) are completely transferred into another container (III), [Cl^-] in (III) will be sum of that in (I) and (II)

(d) Information given is sufficient to compare the vapour pressures in (I) and (II)

26. In a pair of isomers of molecular formula C_5H_8, both the compounds undergo catalytic hydrogenation to form compounds of molecular formula C_5H_{10}. On ozonolysis followed by oxidative workup (H_2O_2), one of the isomers gives a diacid ($C_5H_8O_4$) while the other isomer gives a ketoacid ($C_5H_8O_3$). The pair/s which give/s above set of reactions is/are

(a) 3-ethylcyclopropene and 1-pentyne

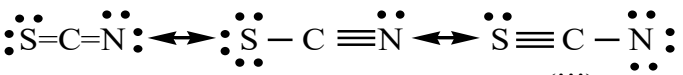
(b) cyclopentene and 1-methylcyclobutene

(c) 1-methylcyclobutene and 3-methylcyclobutene

(d) 1,2-dimethylcyclopropene and 3-methylcyclobutene

27. The resonance structures of SCN^- are given below along with the S-C and C-N bond lengths

	S-C (in pm)	C-N (in pm)
SCN^-	165	117
Single bond	181	147
Double bond	155	128
Triple bond	-----	116



(i) (ii) (iii)

Among the following, the *incorrect* statement/s is/ are

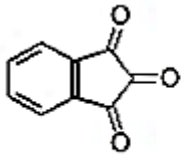
(a) The contribution from resonance structures (i) and (ii) is more important than that from structure (iii)

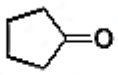
(b) The formal charge on S in structure (iii) is zero

(c) The degree of contribution of these structures is in the order: i > ii > iii

(d) The formal charge on N in structure (ii) is zero

28. The compound/s which form/s stable hydrate/s is/are


(a)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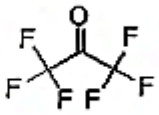
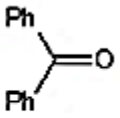
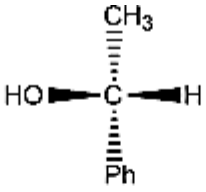
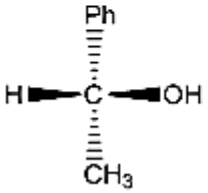

(c)

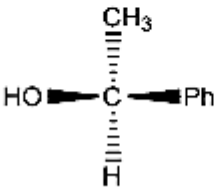

(d)

(a) a (b) b (c) c (d) d

29. The formula/e which also represent/s a compound with formula **X** is/are


X


a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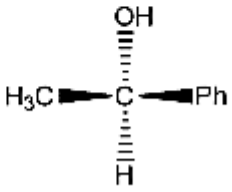
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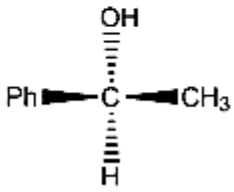
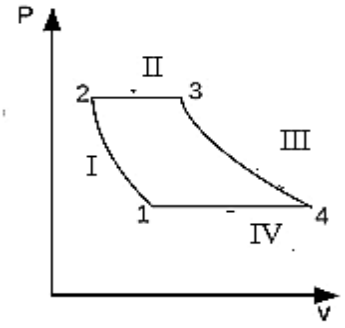

d

(a) a (b) b (c) c (d) d

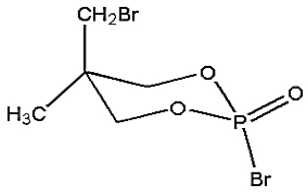
30. Following is the *P* vs *V* plot of a cyclic process 1 →2, 2 →3, 3 →4, 4 →1, denoted as I, II, III and IV respectively for a system of one mole of an ideal gas.

Assume that there is heat exchange between the system and surroundings only in II and IV.
Which of the following is/are correct?

(a) In II and IV ΔS is zero
(b) In I and III, ΔS is zero
(c) I and III are isothermal and reversible
(d) In II and IV, change in internal energy of the gas (ΔU) is zero



31. For the given compound, % s character of phosphorous hybrid orbitals which contribute to various bonds are given in the table below.

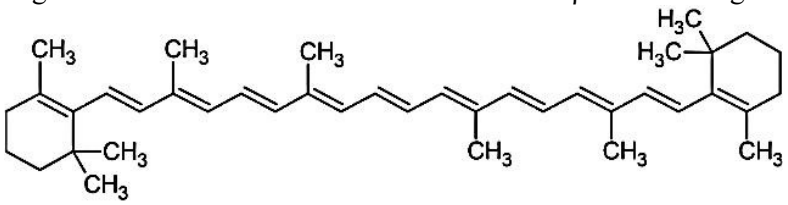


Bond	% s character
P=O	40
P-Br	< 20
P-O	20

This difference in % 's' character of various phosphorous bonds could be due to

(a) The large size of bromine atom
(b) The large electronegativity difference between P and O
(c) Increased overlap of σ-orbitals of terminal P-O bond
(d) Stronger covalent character of P-O in cyclic oxygen atoms

32. β-carotene and related compounds are plant pigments that give red, orange and yellow vegetables their vibrant colour. The structure of β-carotene is given below.



It is approved as a food additive in many countries. The correct statement/s that describe/s β-carotene is/are

(a) It is a strong oxidizing agent
(b) It reacts with singlet oxygen, an excited form of O_2, to produce an epoxide
(c) It absorbs red/yellow light of electromagnetic spectrum
(d) It comes in the oil phase when carrots are cooked in oil and water in a curry

IUPAC Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H hydrogen [1.0078, 1.0082]																	2 He helium 4.0026
3 Li lithium [6.938, 6.997]	4 Be beryllium 9.0122											5 B boron [10.806, 10.821]	6 C carbon [12.009, 12.012]	7 N nitrogen [14.006, 14.008]	8 O oxygen [15.999, 16.000]	9 F fluorine 18.998	10 Ne neon 20.180
11 Na sodium 22.990	12 Mg magnesium [24.304, 24.307]	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	13 Al aluminium 26.982	14 Si silicon [28.084, 28.086]	15 P phosphorus 30.974	16 S sulfur [32.059, 32.076]	17 Cl chlorine [35.446, 35.457]	18 Ar argon [39.792, 39.963]
19 K potassium 39.098	20 Ca calcium 40.078(4)	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	31 Ga gallium 69.723	32 Ge germanium 72.630(8)	33 As arsenic 74.922	34 Se selenium 78.971(8)	35 Br bromine [79.901, 79.907]	36 Kr krypton 83.798(2)
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224(2)	41 Nb niobium 92.906	42 Mo molybdenum 95.95	43 Tc technetium	44 Ru ruthenium 101.07(2)	45 Rh rhodium 102.91	46 Pd palladium 106.42	47 Ag silver 107.87	48 Cd cadmium 112.41	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60(3)	53 I iodine 126.90	54 Xe xenon 131.29
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49(2)	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23(3)	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium [204.38, 204.39]	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesson

Key: atomic number / Symbol / name / conventional atomic weight / standard atomic weight

57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium	62 Sm samarium 150.36(2)	63 Eu europium 151.96	64 Gd gadolinium 157.25(3)	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
89 Ac actinium	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

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