CONTINUOUS ASSESSMENT TERM I S5 CHEMISTRY

TOPIC 1: ATOMIC STRUCTURE & ELECTRONIC CONFIGURATION DURATION: 2 hours

INSTRUCTIONS: Attempt all the Items

Item 1:

The annual Intergalactic Chemistry Competition is underway! This year, delegates from across the Milky Way and beyond have gathered to showcase their understanding of atomic structure and electron configurations. You are a representative from Earth, competing against brilliant minds from nebulae far and wide.

The competition consists of a series of challenges, each testing your ability to determine the electron configurations of various atoms and ions. The judges, a panel of highly intelligent plasma beings, are looking for accuracy, clarity, and the ability to explain your reasoning. **Your Tasks:**

a) The Mystery Element:

- $_{\odot}$ A sample of an unknown element, "X," is presented. It is determined experimentally that the X²⁺ ion has the following electron configuration: [Ar] 3d⁶.
- o Determine the identity of element "X."
- o Write the full electron configuration of the neutral atom "X."
- Explain the process you used to arrive at your answer.

b) The Charged Particle Challenge:

- Write the electron configurations for the following ions:
 - S²⁻
 - Fe³⁺
 - N³⁻
 - Cu⁺
- Explain any variations in electron configuration from the neutral atoms.

c) The Excited State Puzzle:

- An atom of phosphorus (P) is excited, and one of its electrons jumps to a higher energy level.
- o Write a possible excited-state electron configuration for phosphorus.
- Explain why this is considered an excited state.

d) The Transition Metal Anomaly:

- Write the electron configuration for the Chromium (Cr) atom.
- Explain why the electron configuration deviates from the expected Aufbau principle filling order.

Good luck, Earth representative! The fate of your planet's scientific reputation rests on your shoulders!

Item 2

The Mysterious Elements of Planet Xylo

Dr. Hamid, an astrophysicist, has discovered a new planet, Xylo, with an atmosphere composed of previously unknown elements. After analyzing the emitted light spectra, he has determined the following properties of three elements found on Xylo:

• Element X: This element has 16 protons in its nucleus.

- **Element Y:** This element forms a stable ion with a -2 charge and has the electronic configuration of [Ar].
- **Element Z:** This element has 19 electrons when it forms a +1 ion.

Tasks:

a) Identify the elements:

Determine the names and symbols of elements X, Y, and Z based on the provided information. Explain your reasoning for each identification.

b) Electronic Configurations:

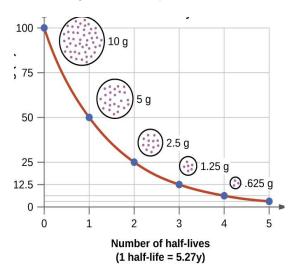
- Write the ground-state electronic configurations for the neutral atoms of elements X, Y, and Z.
- o Write the electronic configurations for the ions formed Y2- and Z+.

c) Quantum Numbers:

- o For element X, identify the set of four quantum numbers (n, l, ml, ms) for the last electron in its ground-state electronic configuration.
- For the last electron added to create the Y²⁻ ion, identify the set of four quantum numbers.

ITEM 3

A team of archaeologists has unearthed a strange artifact from an ancient civilization. This artifact emits a faint, but measurable, level of radiation. The team is unsure of its origin, purpose, or potential danger. They have collected samples and data, and they need your help to understand the artifact and its implications. The Isotope in the artifact is found to treat cancer, and the drug dose is only effective when its concentration is above 6g in the body.



Radioactive elements	Half-life (Days)
Am-241	157800.0
Cd-109	462.60
Ce-139	137.50
Co-57	271.26
Co-60	1925.40
Cs-137	11019.00
Sn-113	115.10
y-88	106.60
Hg-203	46.72
Sr-85	64.78

Your Task:

As a team of scientific consultants, you are tasked with analyzing the data and providing a comprehensive report to the archaeologists. Your report should include:

- **d)** Using the provided data identify the radioactive isotope present in the artifact.
- e) Explain the process of radioactive decay and how it relates to the data you have been given. Include relevant equations like the decay equation
- f) Calculate the number of doses a cancer patient will take in a span of 36 years.

Item 4:

Dr. Sharma Nakigozi is a medical physicist working in a large hospital. A patient, Mr. Patel, has been diagnosed with a suspected cancerous tumor. To accurately locate and assess the tumor's size and spread, the medical team plans to use a diagnostic imaging technique involving a radioactive tracer. Later, Mr. Patel will undergo targeted radiation therapy to destroy the cancerous cells. Mr. Patel is scared of the prescribed proceedings.

TASK:

As a student of chemistry, you are requested to allay Mr. Patel's fear by:

- a) Describe how a radioactive tracer (such as technetium-99m), is used in medical imaging to diagnose Mr. Patel's condition. What properties make it suitable for this application?
- b) Discuss the principles behind radiation therapy and how it utilizes radioactivity to treat Mr. Patel's cancer. What are the potential risks and benefits of this treatment?
- c) If the radioactive tracer used in the imaging has a half-life of 6 hours, and the initial dose administered to Mr. Patel is 10 counts, how much of the tracer will remain in his body after 24 hours? Show your calculations.

Item 5

A research laboratory focused on nuclear chemistry, where scientists are investigating the decay of various isotopes to understand their stability and potential applications in medicine and energy. During an experiment, they observed that samples of different isotopes undergo decay by emission of radiations to form new chemical species.

Task:

As a student of Chemistry, you are required to help the researchers write balanced nuclear equations for the reactions and identify the Particles formed or emitted(X).

Note: The periodic table is provided

a)
$$X \rightarrow {}^{97}_{41} Nb + {}^{0}_{-1} \beta$$

b)
$$^{205}\text{Bi} \rightarrow ^{205}\text{Pb} + X$$

c)
$$^{26}_{12}$$
Mg $^{1}_{1}$ p $\rightarrow ^{4}_{2}$ a + X

d)
$$^{238}_{92}$$
U + $^{12}_{6}$ C \rightarrow X + 6 $^{1}_{0}$ n

e)
$$^{59}_{27}$$
Co + $^{2}_{1}$ H \rightarrow $^{60}_{27}$ Co + X

f)
$$^{97}\text{Tc} \rightarrow ^{97}\text{Mo} + X$$

g)
$$^{53}_{24}$$
Cr + $^{4}_{2}$ a $\rightarrow ^{1}_{0}$ n + X

h)
239
Pu $\rightarrow ^{235}$ U + X

i)
$$^{20}_{8}O \rightarrow ^{20}_{9}F + X$$

j)
$$X + {}^{4}_{2}He \rightarrow {}^{17}_{8}O + {}^{1}_{1}H$$

k)
$$^{26}_{12}$$
Mg + \times \rightarrow $^{24}_{11}$ Na + $^{4}_{2}$ He

I)
$$^{252}_{98}$$
Cf \rightarrow $^{142}_{56}$ Ba + X + 4 $^{1}_{0}$ n

m)
$$^{235}_{92}U \rightarrow X + 7^{4}_{2}He + 4^{0}_{-1}\beta$$

AC Actinium 227,000 Scandium 44,956 Yttrium 88,906 Lanthanum 138,906 89 · 103 Actinides 104 Rutherfordium 261,000 Cerium 140,116 40 Zirconium 91,224 Thorlum 232,038 Hafnium 178,490 PERIODIC TABLE OF Protactinium 231,036 Praseodymius 140,908 105 Dubnium 262,000 Vanadium 50,942 41 Niobium 92,906 73 Tantalum 180,948 Seaborgium 24 Chremium 51.996 42 42 Molybdenum 54,938 Neodymium 144,240 74 Tungsten 180,948 Uranium 238,029 Promethium 107 Bohrium 264,000 93 Neptunium 237,000 Rhenium 186,207 25 Manganese 54,938 43 7C Technetium 98,000 5m Samarium 150,360 Plutonium 244,000 108 Hassium 277,000 05 05 05 05 05 05 05 05 05 05 05 05 05 101,070 Americium 243,000 Meitnerium 278,000 Cobalt 58,933 Cm Curium 247,000 Darmstadtium 281,000 Gadolinium 157,250 Platinum 195,078 Nickel 58,693 ĦΕ Berkelium 247,000 29 Cuu Copper 63,546 47 Ag 107,868 79 79 79 79 7111 1111 1111 782,000 Terbium 158,925 Dyspresium 162,500 Hg Mercury 200,590 112 Con Copernicium 285,000 Zn Zn 65,390 48 Cadmium 112,411 Californium 251,000 **ELEMENTS** Thaillium 204,383 99 **Ensteinium** 252,000 Holmium 164,930 13 Aluminum 26,982 31 31 Gallium 69,723 49 114,818 10,811 100 Fermium 257,000 Po 107,200 32 Ge Germanium 72,640 50 Sn Tin 118,710 68 Erbium 167,259 114 Flerovium 289,000 Silicon 28,086 Carbon 12,011 Thullum 168,934 101 Mendelevium 258,000 83 Bismuth 208,980 115 Moscovium 290,000 Arsenic 74,922 51 Sh 75 Phosphorus 30,974 Nitrogen 14,007 102 Nobelium 259,000 Livermorium 293,000 70 **Ytterbium** 173,040 Polonium 209,000 52 Tellurium 127,600 \$elenium 78,960 0xygen 15,999 sulfur 32,065

35 Bromine 79,904

36 Krypton 83,800 54 Xenon 131,293 17 Chlorine 35,453

Argon 39,948

17 Fluorine 18,998

Neon 20,180

Magnesium 24,305

20 Calcium 40,078

Lithium 6,941

1,008

Francium 223,000

Radium 226,000

Cestum 132,906

Barlum 137,327

174,967
103
Lawrendum
262,000

117 Tennessine 294,000

118 Oganesson 294,000 Astatine 210,000

Radon 222,000