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:
- A sample of an unknown element, "X," is presented. It is determined experimentally that the X^{2+} ion has the following electron configuration: [Ar] $3d^6$.
- Determine the identity of element "X."
- 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:
  - S^{2-}
  - Fe^{3+}
  - N^{3-}
  - 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.
- 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:

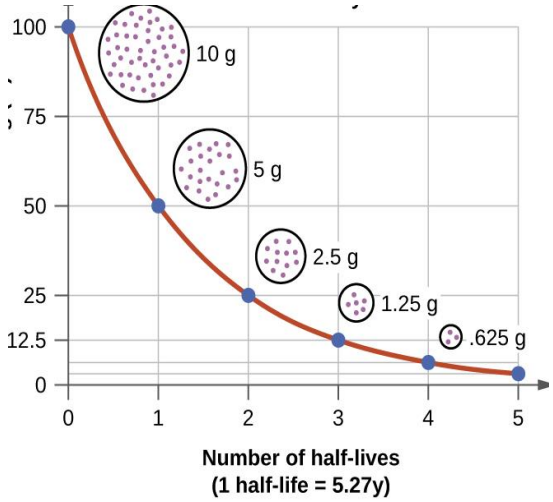
a) Identify the elements:
Determine the names and symbols of elements X, Y, and Z based on the provided information. Explain your reasoning for each identification.

b) Electronic Configurations:
- Write the ground-state electronic configurations for the neutral atoms of elements X, Y, and Z.
- Write the electronic configurations for the ions formed Y^{2-} and Z^{+}.

c) Quantum Numbers:
- 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 Y^{2-} 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.

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

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

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

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

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

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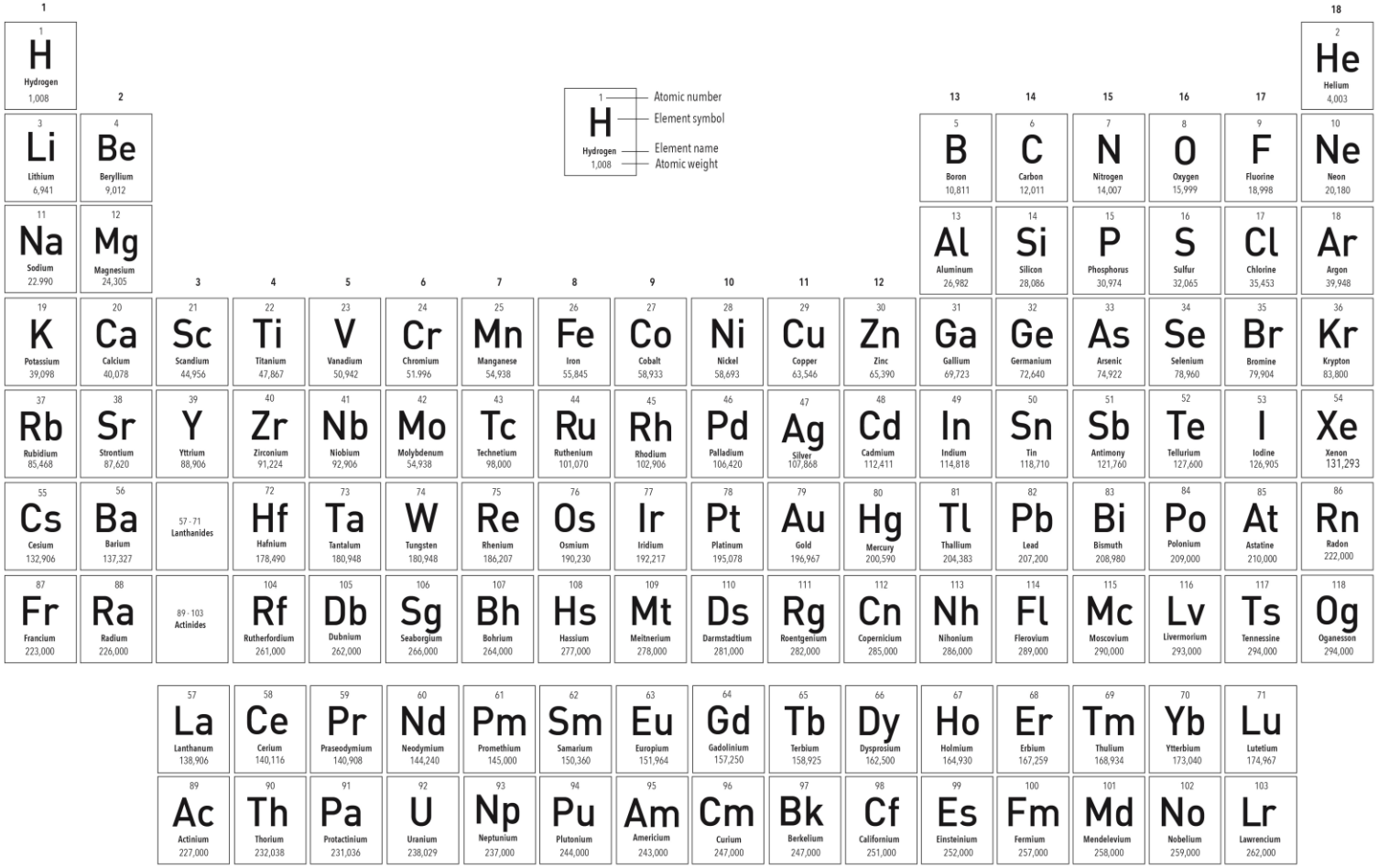
PERIODIC TABLE OF THE ELEMENTS



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