

九十二學年度 原子科學 系(所) 甲 組碩士班研究生招生考試

科目 近代物理 科號 3201 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. 15%

A microscopic system of mass m is influenced by a simple harmonic oscillator potential, $V(x) = \frac{1}{2}m\omega^2x^2$, where ω is the angular frequency.

(a) Show that $\Delta x \Delta p$ is consistent with uncertainty relationship.

Hint: for ground state, $\langle x^2 \rangle = \frac{\hbar}{2m\omega}$.

(b) Discuss the selection rule for electric dipole radiation emitted or absorbed by a SHO.

2. 25%

The $A=40$ isobaric chain has 9 isobars listed below.

- (a) Identify the stable isobars.
 (b) One of the radioactive isobars has unique decay properties. Discuss the possible decay modes of this particular isobar.
 (c) With simple detection system in the laboratory, how to prove the possible decay modes discussed in (b) happen? Answer by specifying the types and properties of the things you measure. Note: chemical analysis is not allowed.

Isobar	Atomic Mass (u)
${}_{14}\text{Si}$	40.005797
${}_{15}\text{P}$	39.991047
${}_{16}\text{S}$	39.975470
${}_{17}\text{Cl}$	39.970413
${}_{18}\text{Ar}$	39.962384
${}_{19}\text{K}$	39.964000
${}_{20}\text{Ca}$	39.962591
${}_{21}\text{Sc}$	39.977965
${}_{22}\text{Ti}$	39.990499

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A sample of hydrogen atom is placed in a 0.05-T magnetic field. Discuss in details the changes in $2p_{3/2}$ to $1s_{1/2}$ spectral line.

4. 15%

Bob and Bob Jr. stand at open doorways at opposite ends of an airplane hangar 24 m long. Anna owns a spaceplane, 40 m long as it sits on the runway. Anna takes off in here spaceplane, then swoops through the hangar at constant velocity. At precisely zero time on both Bob's clock and Anna's, Bob sees the nose of Anna's spaceplane reach his doorway. At time zero on his clock, Bob Jr. sees the tail of Anna's spaceplane at his doorway.

(a) How fast is Anna's spaceplane moving?

(b) What will Anna's clock read when she sees the tail of her spaceplane at the doorway where Bob Jr. is standing?

(c) How far will Anna say the nose of her spaceplane is from Bob at this time?

5. 15%

What are the possible energy states for atomic carbon? Please use spectroscopic notions. Indicate the ground state.

6. 15%

What are the three important ways in which electromagnetic radiation interacts with matter? Give brief description to each way.