

Exam #1 Chem151
(35 points)

01 Oct 2015

Name:

Question 1 (6 points)

(a) Sketch the Rutherford model and describe the location of the three subatomic particles.

(b) How many *electrons* are there in 52.6 mg of neutral titanium (Ti) metal?

(c) Titanium has five stable isotopes with the following natural abundance percentages. Calculate the expected molar mass based on these percentages.

Mass Number	Percentage
46	8.25%
47	7.44%
48	73.72%
49	5.41%
50	5.18%

Question 2 (4 points)

True or false?

- (a) The most common isotope of argon (Ar) is probably ^{39}Ar . _____
- (b) When radon (Rn) loses one alpha-particle, it turns into polonium (Po). _____
- (c) The cation Na^+ has the same number of protons as neutral Mg. _____
- (d) 3 moles of methane (CH_4) has more mass than 2 moles of neon (Ne). _____
- (e) The isotopes ^{14}C and ^{16}O have the same number of neutrons. _____
- (f) Positrons are emitted when an isotope has too many neutrons. _____
- (g) Alpha-rays have the most penetrating power. _____
- (h) When ^{32}P decays into ^{32}S , a beta-ray is emitted from the nucleus. _____

Question 3 (5 points)

50-50 homogeneous mixtures by atom (not by mass) of the platinum-ruthenium (Pt/Ru) alloy are used as solid electrodes for direct methanol fuel cells.

- (a) Sketch an atomistic picture of the electrode.
- (b) The electrode is often more effective if oxygen is added to form a Pt/Ru-oxide. If the composition of an electrode is now PtRuO_4 , calculate the %mass of each element.

Question 4 (6 points)

(a) The work function of Mg is 3.68 eV. Prove that no wavelength of visible light can eject an electron from Mg.

(b) Electrons can be ejected from Mg by short wavelength ultraviolet light (at 225nm). Calculate the (i) maximum kinetic energy and (ii) the deBroglie wavelength of the ejected electron.

Question 5 (4 points)

(a) Calculate the wavelength of the photon emitted when an electron falls from the $n = 5$ level to the $n = 3$ level in the hydrogen atom.

(b) Without doing any calculations, explain which of the following two emitted photons will have shorter wavelength than the photon in (a): An electron falling from the $n = 6$ to $n = 4$ level, or from the $n = 4$ to $n = 2$ level.

Question 6 (6 points)

(a) Write the ground state electron configuration of the following:

(i) Si (silicon) atom

(ii) Cd^{2+} (cadmium) cation

(iii) I^{-} (iodide) anion

(b) Order the following atoms from *largest to smallest size*: Arsenic, Phosphorus, Sulfur, Tin (the Latin name for tin is “stanum”)

(c) Order the same atoms in (b) from *smallest to largest ionization energy*.

Question 7 (4 points)

(a) What values of the four quantum numbers are allowed for an electron in a $4p$ orbital?

(b) How many $4p$ electrons does arsenic (As) have?

(c) Write the four quantum numbers for each $4p$ electronic in arsenic.

Constants, Equations and Conversions

$$m_e = 9.109 \times 10^{-31} \text{ kg}$$

$$m_p = 1.673 \times 10^{-27} \text{ kg}$$

$$m_n = 1.675 \times 10^{-27} \text{ kg}$$

$$h = 6.626 \times 10^{-34} \text{ Js}$$

$$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$$

$$N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$$

$$c = 3.00 \times 10^8 \text{ ms}^{-1}$$

$$R_H = 1.097 \times 10^7 \text{ m}^{-1}$$

$$E_{\text{photon}} = hf = \frac{hc}{\lambda}$$

$$\frac{1}{\lambda} = R_H \left(\frac{1}{n_{\text{low}}^2} - \frac{1}{n_{\text{high}}^2} \right)$$

$$p = \frac{h}{\lambda}$$

$$\text{H-like atoms/ions: } E_n = \frac{-Z^2(13.6\text{eV})}{n^2}$$

Extra Credit (2 points – all or nothing)

Assuming you punched your calculator correctly, there is a discrepancy between the result you calculated in Question 1(c) and the value found on the periodic table for a naturally occurring sample of titanium. What might be the issue here?