Chemistry 142 Name KEY \_\_\_ \_\_\_\_\_\_

Martin Larter

Exam 4 May 2015

Page 1 (28 points)

Page 2 (25 points)

Page 3 (16 points)

Page 4 (19 points)

Page 5 (16 points)

Total (104 points)

Percent (100 %)

**All work must be shown to receive credit. Give all answers to the correct number of significant figures**

**Constants**

|  |  |  |
| --- | --- | --- |
| NA = 6.022 x 1023 mol-1 | Proton= | Neutron = |
| R = 8.3145 J/(mol K) = 0.08206 L atm/(mol K) | c = |  |
| 1 MeV = 1.60 x 10-13 J | e- = 0.000548597 amu |  |

Grossmont College

Periodic Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IA |  |  |  |  |  |  |  |  |  |  | |  |  |  |  |  | VIIA | NOBLE GASES |
| 1  **H**  1.008 | IIA |  |  |  |  |  |  |  |  |  | |  | IIIA | IVA | VA | VIA | 1  **H**  1.008 | 2  **He**  4.002 |
| 3  **Li**  6.941 | 4  **Be**  9.012 |  |  |  |  |  |  |  |  |  | |  | 5  **B**  10.81 | 6  **C**  12.01 | 7  **N**  14.01 | 8  **O**  16.00 | 9  **F**  19.00 | 10  **Ne**  20.18 |
| 11  **Na**  23.00 | 12  **Mg**  24.30 | IIIB | IVB | VB | VIB | VIIB | VIII VIII VIII | | | | IB | IIB | 13  **Al**  27.00 | 14  **Si**  28.09 | 15  **P**  30.97 | 16  **S**  32.06 | 17  **Cl**  35.45 | 18  **Ar**  39.95 |
| 19  **K**  39.10 | 20  **Ca**  40.08 | 21  **Sc**  44.96 | 22  **Ti**  47.90 | 23  **V**  50.94 | 24  **Cr**  52.00 | 25  **Mn**  54.94 | 26  **Fe**  55.85 | 27  **Co**  58.93 | 28  **Ni**  58.70 | | 29  **Cu**  63.55 | 30  **Zn**  65.38 | 31  **Ga**  69.72 | 32  **Ge**  72.59 | 33  **As**  74.92 | 34  **Se**  78.96 | 35  **Br**  79.90 | 36  **Kr**  83.80 |
| 37  **Rb**  85.47 | 38  **Sr**  87.62 | 39  **Y**  88.91 | 40  **Zr**  91.22 | 41  **Nb**  92.91 | 42  **Mo**  95.94 | 43  **Tc**  (99) | 44  **Ru**  101.1 | 45  **Rh**  102.9 | 46  **Pd**  106.4 | 47  **Ag**  107.9 | | 48  **Cd**  112.4 | 49  **In**  114.8 | 50  **Sn**  118.7 | 51  **Sb**  121.8 | 52  **Te**  127.6 | 53  **I**  126.9 | 54  **Xe**  131.3 |
| 55  **Cs**  132.9 | 56  **Ba**  137.3 | 57  **La**  138.9 | 72  **Hf**  178.5 | 73  **Ta**  180.9 | 74  **W**  183.9 | 75  **Re**  186.2 | 76  **Os**  190.2 | 77  **Ir**  192.2 | 78  **Pt**  195.1 | 79  **Au**  197.0 | | 80  **Hg**  200.6 | 81  **Tl**  204.4 | 82  **Pb**  207.2 | 83  **Bi**  209.0 | 84  **Po**  (209) | 85  **At**  (210) | 86  **Rn**  (222) |
| 87  **Fr**  (223) | 88  **Ra**  226.0 | 89  **Ac**  227.0 | 104  **Rf**  (261) | 105  **Db**  (262) | 106  **Sg**  (263) | 107  **Bh**  (262) | 108  **Hs**  (265) | 109  **Mt**  (266) | 110  **??**  (269) |  | |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 58  **Ce**  140.1 | 59  **Pr**  140.9 | 60  **Nd**  144.2 | 61  **Pm**  (147) | 62  **Sm**  150.4 | 63  **Eu**  152.0 | 64  **Gd**  157.3 | 65  **Tb**  158.9 | 66  **Dy**  162.5 | 67  **Ho**  164.9 | 68  **Er**  167.3 | 69  **Tm**  168.9 | 70  **Yb**  173.0 | 71  **Lu**  175.0 |
| 90  **Th**  232.0 | 91  **Pa**  231.0 | 92  **U**  238.0 | 93  **Np**  (237) | 94  **Pu**  (244) | 95  **Am**  (243) | 96  **Cm**  (247) | 97  **Bk**  (247) | 98  **Cf**  (251) | 99  **Es**  (252) | 100  **Fm**  (257) | 101  **Md**  (258) | 102  **No**  (259) | 103  **Lr**  (260) |

Section 1: Multiple Choice (2 points/question)

1. The binding energy is defined as the amount of energy
2. Absorbed when electrons are added to an ion.
3. Absorbed when protons and neutrons form a nucleus.
4. Released when electrons are removed from the atom.
5. **Required to break apart a nucleus into individual protons and neutrons.**
6. None of the above
7. A "critical mass" of uranium-235 is
8. The atomic mass of this, the lightest radioactive isotope.
9. The atomic mass of this (or any other) isotope necessary for it to become radioactive.
10. Because it is a very powerful chain reaction.
11. The crowd at a Springfield "Isotopes" game.
12. **The mass of the isotope necessary to sustain a nuclear chain reaction**
13. The curie is a measure of the
14. **Number of disintegrations per second of a radioactive substance.**
15. Total energy absorbed by an object exposed to a radioactive source.
16. Lethal threshold for radiation exposure.
17. Number of alpha particles emitted by exactly one gram of a radioactive substance.
18. None of these is correct.
19. Which of the following nuclear processes results in an increase in the number of neutrons in the product element?

|  |  |
| --- | --- |
| 1. Alpha emission | 1. Beta emission |
| 1. Positron emission | 1. Electron capture |

|  |  |  |
| --- | --- | --- |
| 1. I and II | 1. **III and IV** | 1. I, II, and III |
| 1. II, III, and IV | 1. I, II, III, and IV |  |

|  |
| --- |
| 1. List the different types of nuclear radiation (alpha, beta, and gamma) in order of increasing penetrating power. |

|  |  |  |
| --- | --- | --- |
| 1. **alpha < beta < gamma** | 1. beta < alpha < gamma | 1. gamma < alpha < beta |
| 1. gamma < beta < alpha | 1. alpha < gamma < beta |  |

1. The smallest number of stable nuclei has a \_\_\_\_\_\_\_\_\_ number of protons and a \_\_\_\_\_\_\_\_\_ number of neutrons.

|  |  |  |
| --- | --- | --- |
| 1. even, even | 1. even, odd | 1. **odd, odd** |
| 1. odd, even | 1. Both b and d | |

1. Which of the following compounds could contain exactly one triple bond?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1. C5H12 | 1. C5H10 | 1. C6H12 | 1. **C6H10** | 1. None of these contain a triple bond |

|  |  |
| --- | --- |
| 1. What role does cadmium metal (Cd) play in a nuclear reactor? | |
| 1. slows down the fission neutrons (moderator) | |
| 1. transfers heat from the reactor to the heat exchanger (primary coolant) | |
| 1. undergoes fission (fuel rods) | |
| 1. transfers heat from the condenser to the environment (cooling tower) | |
| 1. **controls chain reaction (control rods)** | |

1. Structural isomers have
2. Different molecular formulas and different structures.
3. Different molecular formulas but the same structure.
4. The same molecular formula and the same structure.
5. **The same molecular formula but different structures.**
6. None of these



1. The molecular formula of

|  |  |  |
| --- | --- | --- |
| 1. Is C7H14 | 1. Is C6H14 | 1. **Is C7H8** |
| 1. Is C7H9 | 1. Is C6H8 |  |

1. Consider the three isomeric alkanes n-hexane, 2,3-dimethylbutane, and 2- methylpentane. Which of the following correctly lists these compounds in order of increasing boiling point?
2. **2,3-dimethylbutane < 2-methylpentane < n-hexane**
3. 2-methylpentane < n-hexane < 2,3-dimethylbutane
4. 2-methylpentane < 2,3-dimethylbutane < n-hexane
5. n-hexane < 2-methylpentane < 2,3-dimethylbutane
6. n-hexane < 2,3-dimethylbutane < 2-methylpentane
7. Consider the molecule *trans*-2-butene. Which statement is true?
8. The molecule has two pi bonds.
9. There is free rotation around every bond in the molecule.
10. *Cis*-2-butene is its structural isomer.
11. **Carbon #2 exhibits sp2 hybridization.**
12. None of these
13. Hydrogenation of an alkene converts it to an

|  |  |  |
| --- | --- | --- |
| 1. **alkane** | 1. alkyne | 1. alcohol |
| 1. aldehyde | 1. carboxylic acid | |

1. Which structure can exhibit optical isomerism (chiral)?

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | 1. None of these are optical isomers |  |

Short Answer (76 points)

1. (4 points) List and describe two differences between nuclear reactions and ordinary chemical reactions
2. While nuclear reaction takes place in the atom’s nucleus, the electrons in the atom are responsible for Chemical reactions.
3. The chemical reactions involve the transfer, loss, gain and sharing of electrons and nothing takes place in the nucleus. Nuclear reactions involve the decomposition of the nucleus and have nothing to do with the electrons.
4. In a nuclear reaction, the protons and neutrons react inside the nucleus and in chemical reactions the electrons react outside the nucleus.
5. When comparing the energies, a chemical reaction involves only low energy change, where as a nuclear reaction has a very high-energy change.
6. (9 points) Determine the type of decay for the following isotopes to make the compound fall in the valley stability and why
7. Aluminum-28

N/Z = 15/13 > 1.0 so the likely decay type is beta decay

Need to convert a neutron to a proton brings ratio to 1

n → H + ;

1. Titanium-42

N/Z = 20/22 < 1.0 so the likely decay type is by positron emission or electron capture

Need to convert a proton to a neutron. A new nuclide with lower atomic number is formed

H + e → n

1. Plutonium-239

Most heavy isotopes with Z > 83 decay by emission of alpha particles (He).

1. (12 points) For each of the following decays, write out a nuclear equation predicting the products of the decay:

Electron capture by Nb-83

Nb + e → Zr

b) Beta (-) decay of Ta-186

Ta → W + e

c) Alpha decay of Hf-157

Hf → Yb + He

d) Beta (+) decay of Ne-18

Ne → F + e

1. (6 points) A person goes to get radiation treatment for cancer utilizing “brachytherapy” in which a small radioactive source is placed directly into the body. The radiation center has some newly created radioactive sources of 192Ir. They start out as 10. Curie sources. Under computer control and robot inserts the source using a long a needle into the patient’s body and holds it there for the treatment. When the source is new, the treatment is 30. minutes.

Given that the half-­‐life of 192Ir is 74 days, what would be the intensity of the source that was originally 10 Curies after 3 months?

1. (10 points) The binding energy per nucleon for Mg-27 is 8.288 MeV/nucleon. Calculate the atomic mass of Mg-27.
2. (4 points) Explain the similarities and differences between fusion and fission.

They are both nuclear reactions and release large amounts of energy. The mass loss arises from both reactions, which is converted to energy.

Fusion involves two light nuclei such as hydrogen and helium coming together to form a larger nucleus. Fusion requires higher temperature to overcome the repulsion between two positively charged nuclei. Fission is splitting of a heavy nucleus (U-235 is a good example) with a neutron to form smaller nuclei.

1. (5 points) A friend takes Rampiril to control high blood pressure. Identify the indicated functional groups 1-5



|  |  |
| --- | --- |
|  | Functional Groups |
| 1 | ester |
| 2 | amine |
| 3 | amide |
| 4 | Carboxylic acid |
| 5 | aromatic |

1. (4 points) State whether the structures in each pair below are identical, constitutional isomers, or not related.

 Answer not related



Answer constitutional isomers

1. (6 points) Nomenclature: Write complete names for each of the following:



1. (6 points) Draw the following molecules in structural formula

a) 5-tert-butyl-2-octyne b) trans-5-ethylhept-3-ene

 

1. (3 points) Draw the structure of the organic product of the following reaction.



1. (4 points) Explain oxidation and reduction with respect to organic compounds.

In organic chemistry, we think of oxidation and reduction from the point of view of the carbon atoms in the organic molecule. Thus, oxidation is the gaining of oxygen or the losing of hydrogen by a carbon atom.

Reduction is then the loss of oxygen or the gaining of hydrogen by a carbon atom.

1. (3 points) Draw the dimer that is formed by the reaction of HOOCCH2CH2CH2COOH and H2NCH2CH2CH2CH2NH2?

