**Problems from 27.2 - Atomic Physics**

**Closest Approach:**  and  q1 = 2e, q2 = Ze

1. An alpha particle (m = 6.64x10−27 kg) going 5.14x106 m/s will get how close to a silver (Z = 47) nucleus if it hits head on? (2.47x10-13 m)
2. A speeding alpha particle (m = 6.64x10−27 kg) hits a mercury (Z = 80) nucleus head on. If it comes within 17.0 nm of the nucleus’ center, how fast was it going to start with? (2.56x104 m/s)
3. An alpha particle (m = 6.64x10−27 kg) going 4.12x106 m/s will get how close to a bismuth (Z = 83) nucleus if it hits head on? (6.80x10-13 m)
4. A speeding alpha particle (m = 6.64x10−27 kg) hits a lead (Z = 82) nucleus head on. If it comes within 12.0 nm of the nucleus’ center, how fast was it going to start with? (3.08x104 m/s)
5. An alpha particle (m = 6.64x10−27 kg) going 2.37x106 m/s will get how close to a gold (Z = 79) nucleus if it hits head on? (1.95x10-12 m)

**Electron Transitions:**  and 

1. What is the wavelength of the photon associated with an electron transition from n = 3 to n = 1 in a hydrogen atom? Is the photon being absorbed, or emitted? (103 nm, emitted)
2. What is the wavelength of the photon associated with an electron transition from n = 3 to n = 6 in a hydrogen atom? Is the photon being absorbed, or emitted? (1095 nm, absorbed)
3. What is the wavelength of the photon associated with an electron transition from n = 2 to n = 1 in a hydrogen atom? Is the photon being absorbed, or emitted? (122 nm, emitted)
4. What is the wavelength of the photon associated with an electron transition from n = 2 to n = 4 in a hydrogen atom? Is the photon being absorbed, or emitted? (487 nm, absorbed)
5. What is the wavelength of the photon associated with an electron transition from n = 6 to n = 2 in a hydrogen atom? Is the photon being absorbed, or emitted? (411 nm, emitted)

**Nuclear Radius or Heisenberg:**  or  or 

1. What is the radius of C-14 nucleus? (2.89x10-15 m)
2. What is the likely mass number of a nucleus with a radius of 3.51x10-15 m? (25)
3. To effect an alpha decay, an alpha particle must “borrow” 31.1 MeV of energy. What time does it have to escape? (1.06x10-23 s)
4. An Alpha particle takes 1.80x10-23 s to "tunnel" through a potential barrier. What is the amount of energy it can "borrow" during this time in MeV? (18.3 MeV)
5. An electron has an uncertainty in its velocity of ±2.10x104 m/s. What is the minimum uncertainty in its position? (1.38x10-9 m)
6. An electron has an uncertainty in its position of 2.40x10-10 m (total range) . What is the minimum uncertainty (the total range) of its velocity? (2.41x105 m/s)
7. A proton has an uncertainty in its position of 3.51x10-15 m (total range). What is the minimum uncertainty (the total range) of its velocity? (8.98x106 m/s)
8. A proton has an uncertainty in its velocity of ±4.30x106 m/s. What is the minimum uncertainty in its position? (3.66x10-15 m)

Part **A**: Find the missing particle:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **a** | **b** | **c** | **d** |
| **1** | τ- → π- + πo + ??  υτ | ??→ π+ + πo +  τ+ | τ- → υτ + ?? +  e- | τ+ → + e+ + ??  υe |
| **2** | τ- → ?? + μ- +  υτ | τ+ → ?? + μ+ + υμ | ?? → e- + + υμ  μ- | μ+ → e+ + ?? +  υe |
| **3** | μ- → e- + + υμ + e+ + ??  e- | μ+ → e+ + ?? + + e+ + e-  υe | → π+ + ?? +  μ- | K+ → ?? + υμ  μ+ |

Part **B**: For these reactions, indicate if it is possible, or indicate every law it violates:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **a** | **b** | **c** | **d** |
| **1** | p + n → K+ + ηo + Ξo  No, baryon number, Strangeness | p + n → p + +  No, charge and baryon number | n + n → Λo + Σo  No, Strangeness | n + n → Ω+ + Ω-  No, baryon number |
| **2** | p + p → Ω+ + e+ + Λo + Σo + n  No, Le, Strangeness | p + p → p + n + n + Ω+  No, Strangeness | p + p → τ+ + υτ + μ+ +  No, Baryon and Lμ | p + n → n + n + τ+ + υτ  Yes |
| **3** | p + → τ- + Λo + Ω+ +  No, Strangeness | p + → τ+ + τ-  No, charge | + n → τ+ + τ-  Yes | p + → Σ- + Ω+  No, Strangeness |
| **4** | p + p → p + p + πo  yes | p + p → p + n + π+  yes | n + n → Ξ+ + + Ω- + n + n + n  yes | π- + p → πo + n + π- + π+  yes |

Part **C**: Write the quark combinations that make up a proton and a neutron: p = n =

Identify the following quark combinations as either a meson, or a baryon. Determine the baryon number, strangeness, and the charge of each:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Baryon or Meson? | B = ? | S = ? | q = ? |
| 1 | s | M | 0 | 0 | 0 |
| 2 | dsc | B | +1 | -1 | 0 |
| 3 |  | B | -1 | 0 | -2 |
| 4 | s | M | 0 | -1 | -1 |
| 5 | d | M | 0 | +1 | 0 |
| 6 | sss | B | +1 | -3 | -1  Data Packet reference for decays: |
| 7 |  | B | -1 | 0 | -2 |
| 8 | u | M | 0 | +1 | +1 |
| 9 | c | M | 0 | 0 | +1 |
| 10 |  | B | -1 | +2 | 0 |
| 11 | ucc | B | +1 | 0 | +2 |
| 12 | s | M | 0 | -1 | 0 |