UNIT 6 CONCEPTUAL TEST   Name: _____
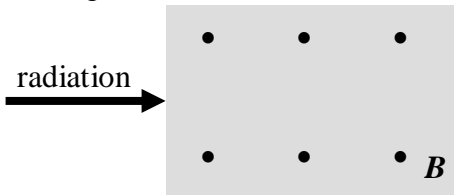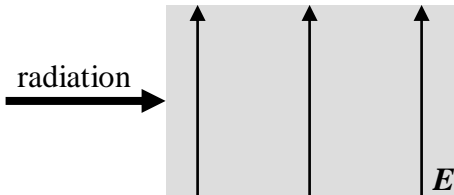**Suggested Time: 30 minutes**

1. For the nucleus $_Z^A X$:   # of p+ : _____   # of n : _____   # of nucleons: _____

2. Which force holds the nucleus together? _____

3. Compare the 3 types of radioactivity.

    #1. _____   Penetration: _____   Strong or weak ionizer? _____

    Danger / Protection: _____

    #2. _____   Penetration: _____   Strong or weak ionizer? _____

    Danger / Protection: _____

    #3. _____   Penetration: _____   Strong or weak ionizer? _____

    Danger / Protection: _____

4. Predict the deflection of the three particles in:
    a)   a magnetic field   b)   an electric field

5. For nuclear equations, the top numbers obey conservation of _____

    while the bottom numbers obey conservation of _____.

6. For nuclear decay, what happens to the overall mass? _____

    This mass converts to _____, obeying conservation of _____.

7. For a fictional parent nucleus $_{11}^{20} G$ and daughter nucleus *D*, write complete balanced decay
    equations if the parent goes through: (Note: Ignore gamma emissions)

    a)   alpha decay   _____

    b)   beta-negative decay   _____

    c)   beta-positive decay   _____

8. What is a transmutation reaction? _____

9. When does gamma decay occur? _____

10. Which would result in greater radioactivity: Small or large sample _____

    Short or long half-life? _____

11. What is the charge when an atom is singly ionized? _____   doubly ionized? _____

12. Compare alpha and beta particles in terms of ionization and directness of path through materials.

13. Does fission require small or large nuclei? _____   How is it started? _____

    Advantages of fission? _____

    Disadvantages of fission? _____

14. Does fusion require small or large nuclei? _____   How is it started? _____

    Advantages of fusion? _____

    Disadvantages of fusion? _____

15. A neutral particle emits an alpha particle to the right and a gamma photon to the left. The gamma photon then decays into an electron and a positron. Sketch the tracks made in the cloud chamber.
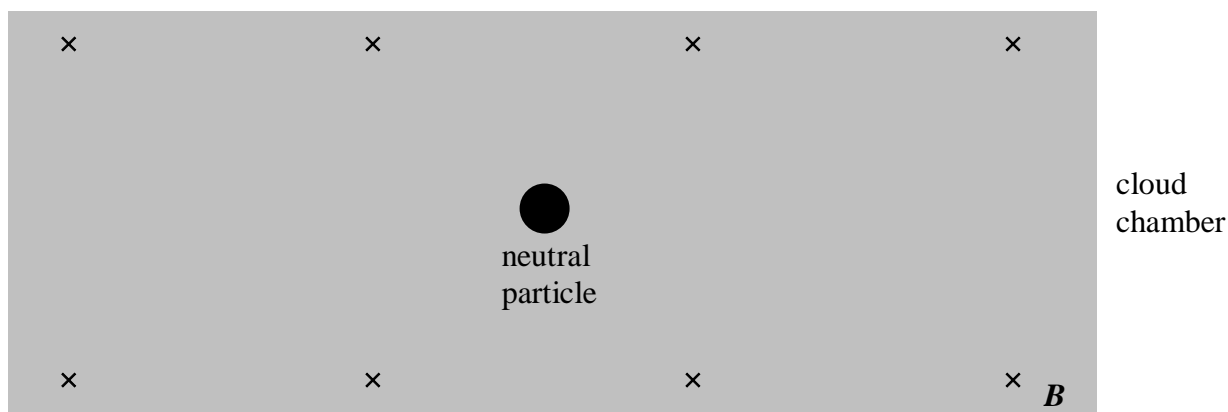
16. Why are high energy particles needed to study the nucleus? _____

17. Why do particle accelerators lose a lot of energy? _____

18. List the 4 fundamental forces in order from greatest to least strength.

    #1. _____   #2. _____   #3. _____   #4. _____

19. Identify the 3 major categories of subatomic particles. Describe (if possible) and give examples.

    #1. _____   Description _____   Example _____

    #2. _____   Description _____   Example _____

    #3. _____   Description _____   Example _____

20. What is an antiparticle? _____

    What happens when they collide with its corresponding particle? _____

21. For each decay, identify the change in quark and the emitted particles.

    #1. Beta-negative   Change in quark: _____   Emitted particles _____

    #2. Beta-positive   Change in quark: _____   Emitted particles _____

22. In the end, which of the following is true? (Circle one)

    Loving the Physics! ☺   Tolerating the Physics   Glad that Physics is ending! ☹

MACHINE SCORED (Show full work)   **Suggested Time: 60 minutes**

NR. 1   Use the following number convention:

$$1 = 40 \qquad 2 = 53 \qquad 3 = 93 \qquad 4 = 133$$

For the isotope zirconium-93 (Zr-93),

the number of protons would be ____*(a)*____
the number of neutrons would be ____*(b)*____
the number of nucleons would be ____*(c)*____

Your values of *a*, *b*, and *c* are ___, ___, and ___.

2.   Isotopes have

A.   the same number of protons and the same number of neutrons
B   different number of protons but the same number of neutrons
C.   the same number of protons but different number of neutrons
D.   different number of protons and different number of neutrons

3.   Which of the following is NOT true about the strong nuclear force?
A.   It is always a force of attraction.
B.   It acts only between neutrons.
C.   It is strong only when the distances are extremely short.
D.   All of the above are true about the strong nuclear force.

4.   Radiation is directed through a thin piece of paper. Detectors on the other side of the paper notice that one type of radiation is now missing. The missing radiation is most likely

A.   alpha particles   B.   beta particles
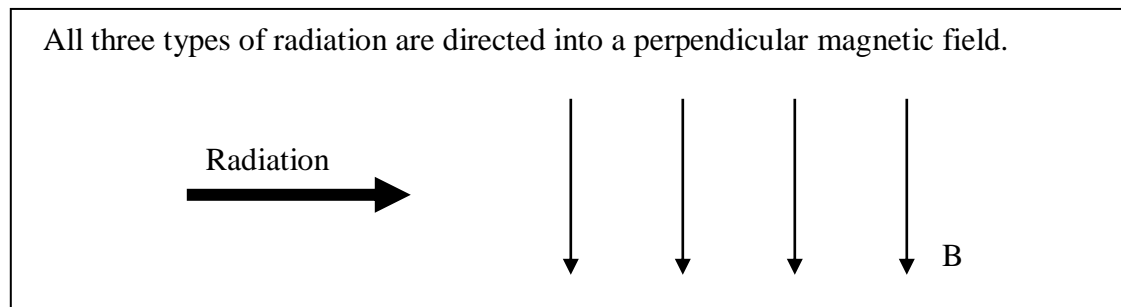C.   gamma radiation   D.   neutrinos

5.   Manganese-50 (Mn-50) goes through alpha decay. The daughter nucleus would be

A.   chromium-50 (Cr-50)
B.   chromium-46 (Cr-46)
C.   vanadium-50   (V-50)
D.   vanadium-46 (V-46)

6.   A radioisotope went through beta-negative decay and the resulting daughter nucleus is arsenic-75 (As-75). What is the identity of the parent nucleus?

A.   Selenium-75 (Se-75)
B.   Bromine-79 (Br-79)
C.   Germanium-75 (Ge-75)
D.   Gallium-71 (Ga-71)

Use the following information to answer the next question.

All three types of radiation are directed into a perpendicular magnetic field.

Radiation →

↓ ↓ ↓ ↓ B

NR. 7   Use the following number convention:

1 = Right ($\rightarrow$)   2 = Left ($\leftarrow$)   3 = Upward ($\uparrow$)   4 = Downward ($\downarrow$)

5 = Into the page ($\times$)   6 = Out of the page ($\bullet$)   7 = No deflection

Alpha particles would deflect ___***(a)***___
Beta particles would deflect ___***(b)***___
Gamma radiation would deflect ___***(c)***___

Your values of ***a***, ***b***, and ***c*** are ___, ___, and ___.

NR. 8   A radioisotope has a half-life of 17 hours. The amount of sample left after 1.5 days would be _____ %.

Answer to 2 sig digs.

NR. 9   A 480 g sample of a radioisotope is left on a shelf. After 9.20 minutes, 360 g of the sample has transmuted into different elements. The half life of the radioisotope would be _____ minutes.

Answer to 3 sig digs.

NR. 10 A doubly-ionized copper-65 (64.927792 u) ion is accelerated from rest through a potential difference of 25.0 kV. The final speed of the ion is ***a.bc*** $\times 10^d$ m/s.

The values of ***a***, ***b***, ***c***, and ***d*** are ___, ___, ___, and ___.

NR. 11 A singly-ionized ion enters a 71.0 mT
perpendicular magnetic field at a speed
of 29.0 km/s. If it is deflected into
uniform circular motion with a radius
of 5.60 cm, then the mass of the ion,
in scientific notation, is _____ $\times 10^w$ kg.

>   *Answer to 3 sig digs.*

*Use the following graph to answer
the next 3 questions.*

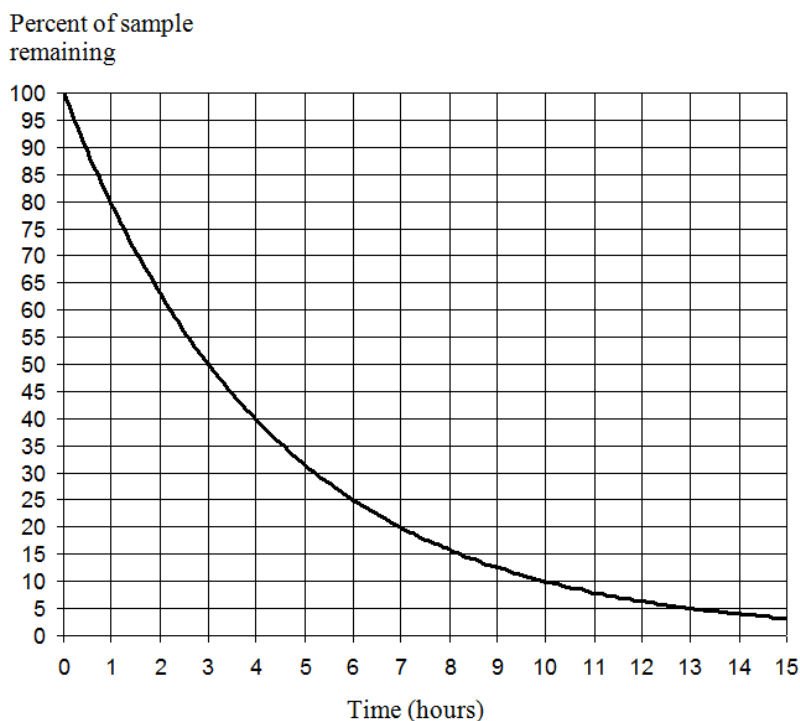**NR. 12** The half-life of the
radioisotope is _____ h.

>   *Answer to 2 sig digs.*

NR. 13 The time it would take for
a 200 Bq sample of the
radioisotope to reduce to
80 Bq is _____ hours.

>   *Answer to 2 sig digs.*

Percent of sample
remaining

Time (hours)

NR. 14   You start with 77 g of the
sample. The amount of
sample left after 13 hours
is _____ g.

>   *Answer to 2 sig digs.*

NR. 15   An incident electron must have a
minimum speed of 3.90×10^7 m/s
to ionize an atom. The ionization
energy of the atom is ***a.bc*** $\times 10^d$ eV.

The values of ***a***, ***b***, ***c***, and ***d***
are ___, ___, ___, and ___.

16. In a particle accelerator, phosphorous-31 (P-31) is bombarded by an alpha particle. After the
collision, 3 protons are emitted. What is the resulting daughter nucleus?

>   A. Neon-24 (Ne-24)
>   B. Sulphur-30 (S-30)
>   C. Silicon-32 (Si-32)
>   D. Calcium-38 (Ca-38)

NR. 17 A triply-ionized lithium-7 (7.016005 u) atom travels undeflected through a velocity selector, having mutually perpendicular electric and magnetic fields. If the speed of the ion is 800 km/s and the strength of the electric field is 4.20×10^5 V/m, then the strength of the magnetic field, in scientific notation, is _____ $\times 10^w$ T.

Answer to 3 sig digs.

NR. 18 A parent nucleus, initially at rest, undergoes alpha decay and no gamma photon is emitted. If the alpha particle is emitted at a speed of 5.70×10^6 m/s, then the recoil speed of the 3.92×10^{-25} kg daughter nucleus is $a.bc \times 10^d$ m/s

The values of a, b, c, and d are ___, ___, ___, and ___.

NR. 19 During a nuclear reaction, 70 MeV of energy is liberated. The mass defect associated with this energy would be $a.b \times 10^{-cd}$ kg.

The values of a, b, c, and d are ___, ___, ___, and ___.

20. When uranium-235 (U-235) is combined with a neutron, it goes through fission. If one of the daughter nuclei is lanthanum-140 and 2 neutrons are emitted, then the other daughter nucleus is

    A. bromine-94 (Br-94)
    B. krypton-94 (Kr-94)
    C. bromine-96 (Br-96)
    D. krypton-96 (Kr-96)

21. Two deuterium (H-2) nuclei are forced together in a fusion reaction. If the daughter nucleus is tritium (H-3), then the other by-product is

    A. an alpha particle
    B. a neutron
    C. a proton
    D. another tritium nucleus

NR. 22 A kaon particle has a mass of 8.76×10^{-28} kg,
which is equivalent to _____ MeV/c^2.

Answer to 3 sig digs.

NR. 23 Titanium−48 has a nuclear mass of 47.947947 u.
The nuclear binding energy is $\textbf{\textit{a.b}} \times 10^{-cd}$ J.

The values of $\textbf{\textit{a}}$, $\textbf{\textit{b}}$, $\textbf{\textit{c}}$, and $\textbf{\textit{d}}$
are ___, ___, ___, and ___.

24. Nitrogen-13 is known to go through beta-positive decay. Which of the following is true?

	Daughter nucleus	Other particle emitted
A.	Carbon	Neutrino
B.	Carbon	Antineutrino
C.	Oxygen	Neutrino
D.	Oxygen	Antineutrino

NR. 25   When Pm−145 decays to Pr−141, the mass
defect is 3.60×10^{-3} u. If an alpha particle
is emitted with a speed of 8.00×10^6 m/s,
then the maximum frequency of the gamma
ray emitted is $\textbf{\textit{a.b}} \times 10^{cd}$ Hz.

The values of $\textbf{\textit{a}}$, $\textbf{\textit{b}}$, $\textbf{\textit{c}}$, and $\textbf{\textit{d}}$
are ___, ___, ___, and ___.

26. What is the charge of the subatomic particle $\bar{u}\,d$?

    A. −1   B. Neutral

    C. +1   D. $+\frac{2}{3}$

27. What is the charge of the subatomic particle $\bar{u}\,\bar{d}\,\bar{d}$?

    A. −1   B. Neutral

    C. +1   D. $+\frac{2}{3}$

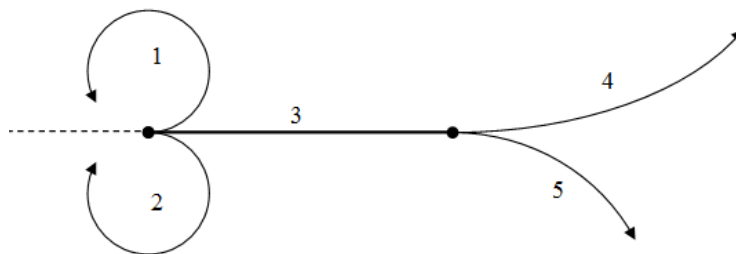28. Which of the following is true about the 3 categories of subatomic particles?

	Leptons	**Hadrons**	**Field particles**
A.	Don't experience the strong nuclear force	Include photons	Do experience the strong nuclear force
B.	Do experience the strong nuclear force	Don't experience the strong nuclear force	Include photons
C.	Include photons	Do experience the strong nuclear force	Don't experience the strong nuclear force
D.	Don't experience the strong nuclear force	Do experience the strong nuclear force	Include photons

29. If the particle **udd** decays to **uud,** then what else is emitted?

     A. An electron and a neutrino
     B. A positron and a neutrino
     C. An electron and an antineutrino
     D. A positron and an antineutrino

Use the information below to answer the next 3 questions

The particle tracks shown are observed using a cloud chamber. There is a magnetic field through the region that acts out of the page.

30. Which of the following are likely a particle – antiparticle pair?

     A. 1 and 2   B. 4 and 5   C. 1 and 3   D. 2 and 4

31. Which of the following is true?

     A. Particle 1 is positively-charged, while particle 3 is a neutral particle.
     B. Particle 1 is positively-charged, while particle 3 is a gamma photon.
     C. Particle 1 is negatively-charged, while particle 3 is neutral.
     D. Particle 1 is negatively-charged, while particle 3 is a gamma photon.

32. Assume particles 2, 4, and 5 are moving at the same speed. If they were ranked in order of increasing charge-to-mass ratio, then the order would be

     A. 2, 4, 5
     B. 2, 5, 4
     C. 4, 5, 2
     D. 5, 4, 2