Name _____ Date _____ Code _____
IB Physics: Atomic and Nuclear.

1. The mass of an electron:
   A. is almost the same as that of a neutron
   B. is negative
   C. equals that of a proton
   D. is zero if the electron is at rest
   E. is much less than that of a proton

2. The mass of a neutron:
   A. equals that of an electron
   B. equals that of a proton
   C. is a little more than that of a proton
   D. is exactly that of a proton plus an electron
   E. is as yet unmeasured

3. The atomic number of an element is:
   A. the whole number nearest to its mass
   B. the number of protons in its nucleus
   C. the number of neutrons minus the number of protons
   D. the number of neutrons in its nucleus
   E. its order of discovery

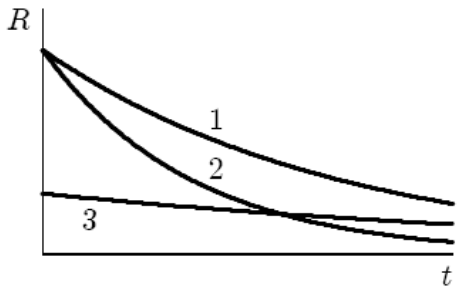
4. Let Z denote the atomic number and A denote the mass number of a nucleus.
   The number of neutrons, N, in this nucleus is:
   A. $N = Z + A$
   B. $N = A - Z$
   C. $N = A - 2Z$
   D. $N = A$
   E. $N = 2A - Z$

5. The greatest binding energy per nucleon occurs for nuclei with masses near that of:
   A. helium
   B. sodium
   C. iron
   D. mercury
   E. uranium

6. The half-life of a radioactive substance is:
   A. half the time it takes for the entire substance to decay
   B. usually about 50 years
   C. the time for radium to change into lead
   D. calculated from $E = mc^2$
   E. the time for half the substance to decay

7. The relation between the disintegration constant λ and the half-life $T_{½}$ of a radioactive substance is:
   A. $\lambda = 2\ T_{½}$
   B. $\lambda = 1/\ T_{½}$
   C. $\lambda = 2/\ T_{½}$
   D. $\lambda\ T_{½} = \ln 2$
   E. $\lambda\ T_{½} = \ln(1/2)$

8. The graph shows the activity R as a function of time t for three radioactive samples.
Rank the samples according to their half-lives, shortest to longest.
A. 1, 2, 3
B. 1, 3, 2
C. 2, 1, 3
D. 2, 3, 1
E. 3, 1, 2



9. The half-life of radium is about 1600 years. If a rock initially contains 10 g of radium, the amount left after 8000 years will be about:

A. 938 mg B. 620 mg
C. 313 mg D. 160 mg
E. less than 160 mg

10. Starting with a sample of pure ^{66}Cu, 7/8 of it decays into Zn in 15 minutes.
The corresponding half-life is:

A. 15 minutes B. 5 minutes C. 7 minutes
D. 3.75 minutes E. 10 minutes

11. The isotope, tritium, has a half-life of 12.3 years. Assume we have 10 kg of the substance. How much tritium will be left after 30 years?

A. .20 kg B. 1.8 kg C. .18 kg D. 1.7 kg E. 4.1 kg

12. What value of *Z* (atomic number) and *A* (mass number) result in the following alpha decay?

$$^{238}_{92}\mathrm{U} \rightarrow {}^{A}_{Z}\mathrm{X} + \alpha$$

A. $Z = 92$; $A = 238$ B. $Z = 91$; $A = 238$ C. $Z = 90$; $A = 234$
D. $Z = 93$; $A = 238$ E. $Z = 88$; $A = 236$

13. Of the three common types of radiation (alpha, beta, gamma) from radioactive sources, electric charge is carried by:

A. only beta and gamma B. only beta
C. only alpha and gamma D. only alpha
E. only alpha and beta

14. An alpha particle is:

A. a doubly-ionized helium atom B. a collection of two or more electrons
C. a hydrogen atom D. the ultimate unit of positive charge
E. sometimes negatively charged

15. An alpha particle is emitted from a radioactive source with an energy of 5 MeV. How fast is it moving (in m/s)? (All answers are approximate.)

A. 2.4×10^7 B. 1.5×10^7 C. 3.7×10^7 D. 4.6×10^7 E. 2.1×10^7

16. A radium atom, ^{226}Ra (Z = 86) emits an alpha particle.
The number of protons in the resulting atom is:

A. 84 B. 85 C. 86 D. 88 E. some other number

17. The mass of the ^{12}C (Z = 6) nucleus is 12.00 u. Using the data on your formula page, calculate the mass defect of ^{12}C . Show all work.

A. .00348 u B. .06719 u C. .03881 u
D. .09564 u E. .08665 u F. .09894 u

18. From your answer to #17, calculate the total binding energy for the ^{12}C nucleus. Again, show all work.

A. 7.4 MeV B. 89 MeV C. 931 MeV
D. 1200 MeV E. 1700 MeV F. 92.2 MeV

19. From your answer to #18, calculate the binding energy per nucleon for the ^{12}C nucleus. Again, show all work.

A. 1.0 MeV B. 7.4 MeV C. 89 MeV
D. 931 MeV E. 1200 MeV F. 7.68 MeV

20. The nucleus of ^{246}Pu (Z = 94) undergoes radioactive decay by emitting 3, $^{4}He_2$ alpha particles and 2, $^{0}e_{-1}$ beta particles, Atomic number now?

A. 88 B. 89 C. 90 D. 91 E. 92

21. The difference between a proton and a neutron was given in terms of quarks. What is it?

A. only one quark B. exactly two quarks
C. a total of three quarks D. udd E. uud

22. What are the 5 particle detectors? _____

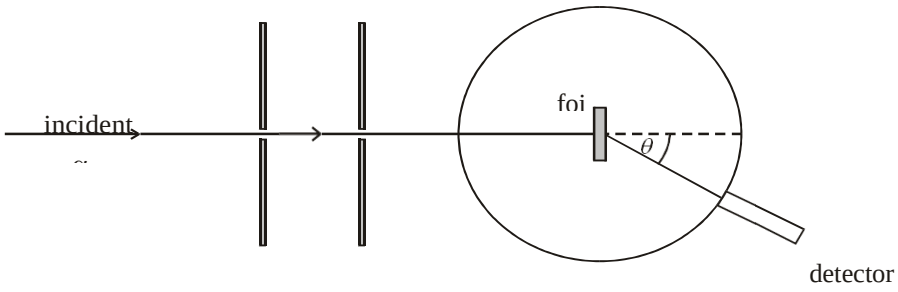
_____

_____

23. If an electron was converted completely to energy, how much would it produce? Show all work.

A. 3.16 MeV B. .213 MeV C. .512 MeV D. 1.05 MeV E. 6.28 MeV

24. In an α-particle scattering experiment (Rutherford, Gold-foil), the number *n* of particles incident per unit time on a detector was determined for different angles of deflection θ.



What would the graph of the variation of θ with n look like?