The final exam will consist of 40 multiple choice questions plus five other questions model on (or taken from) the homework.

The 40 multiple choice questions will contain about 20 questions from Chapts 39, 40 & 41 that are similar to the questions in this study guide.

Electron mass = $m_e = 9.1 \times 10^{-31}$ kg; $m_e c^2 = 0.511$ MeV

Proton mass = $m_p = 1.673 \times 10^{-27}$ kg; $m_p c^2 = 938.3$ MeV

Neutron mass = $m_n = 1.675 \times 10^{-27}$ kg; $m_n c^2 = 939.6$ MeV

Planck's constant = $h = 6.63 \times 10^{-34}$ Js; $hc = 1240$ eV nm

speed of light $c = 3 \times 10^{8}$ m/s

1. An antiproton is an atomic particle that has **(read sect. 41-2)**
- **a)** the mass of a proton and the charge of an electron. ←
- **b)** the mass of an electron and the charge of a proton.
- **c)** the mass of a neutron and the charge of a proton.
- **d)** the mass of a proton and the charge of a neutron.
- **e)** the mass of an electron and the charge of a positron.

2. A certain radioactive element has a half-life of 20 d. The time it will take for 7/8 of the atoms originally present to disintegrate is **(read sect 40-2; study example 40-2)**
- **a)** 20 d
- **b)** 40 d
- **c)** 60 d ←
- **d)** 80 d
- **e)** 100 d

3. Which of these nuclear reactions is possible? **(Conserve charge & baryon number)**
- **a)** ${}^{10}_{5}\mathrm{B} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{13}_{7}\mathrm{N} + {}^{1}_{1}\mathrm{H}$
- **b)** ${}^{23}_{11}\mathrm{Na} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{20}_{10}\mathrm{Ne} + {}^{4}_{2}\mathrm{He}$ ←
- **c)** ${}^{10}_{5}\mathrm{B} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{11}_{5}\mathrm{B} + \beta^{-} + n$
- **d)** ${}^{14}_{7}\mathrm{N} + {}^{1}_{1}\mathrm{H} \rightarrow {}^{12}_{6}\mathrm{C} + \beta^{-} + \nu$
- **e)** None of these is possible.

4. A conservation law that is not universal but applies only to certain kinds of interactions is conservation of **(Read sect 41-3; study example 41-3)**

a) lepton number
b) baryon number
c) spin
d) charge
e) strangeness ←

5. In quantum electrodynamics (QED), electromagnetic forces are mediated by **(Read sect 41-5; study Table 41-4)**

a) the interaction of electrons.
b) hadrons.
c) action at a distance.
d) the weak nuclear interaction.
e) the exchange of virtual photons. ←

6. What are the numbers of protons Z and neutrons N in the missing fragment of the following fission reaction? **(Conserve charge and baryon number)**

$$ {}^{1}_{0}n + {}^{235}_{92}U \rightarrow \; ? \; + {}^{140}_{55}Cs + 4\,{}^{1}_{0}n $$

a) $Z = 55$ and $N = 37$
b) $Z = 37$ and $N = 55$ ←
c) $Z = 92$ and $N = 37$
d) $Z = 37$ and $N = 92$
e) $Z = 37$ and $N = 58$

7. Conservation laws that describe events involving the elementary particles include the conservation of **(Read sect 41-3; study examples 41-2 & 41-3)**

a) energy.
b) linear and angular momentum.
c) electric charge.
d) baryon and lepton numbers.
e) All of these are correct. ←

8. The energy released by the nuclear bomb that destroyed Hiroshima was equivalent to 12.4 kilotons of TNT. This is equivalent to 9.0×10^{26} MeV. The mass that was converted into energy in this explosion was **(Convert MeV→Joules, use $E=mc^2$)**

a) 1.6 kg
b) 1.6×10^{-3} kg ←
c) 1.4×10^{14} kg
d) 1.1×10^{10} kg
e) 120 kg

9. Redshift measurements of a galaxy yield a recession of 1700 km/s. Hubble's constant H is 23 km/s/10^6 c·y. The distance to the galaxy is approximately (**Use Eqn 41-9)**

a) 36×10^6 c·y
b) 47×10^6 c·y
c) 53×10^6 c·y
d) 66×10^6 c·y
e) 74×10^6 c·y ←

10. A moderator is used to slow **(Read sect 40-4, especially page 1300)**

a) protons
b) alpha particles
c) neutrons ←
d) beta particles
e) photons

11. In the decay scheme **(Conserve charge and electron lepton number)**

$$^{A}_{Z}P \rightarrow {}^{A}_{Z-1}D + \_\_\_\_\_ + \_\_\_\_\_$$

the blanks should contain

a) β^+ and n
b) β^- and ν
c) β^- and p
d) β^+ and ν ←
e) β^+ and β^-

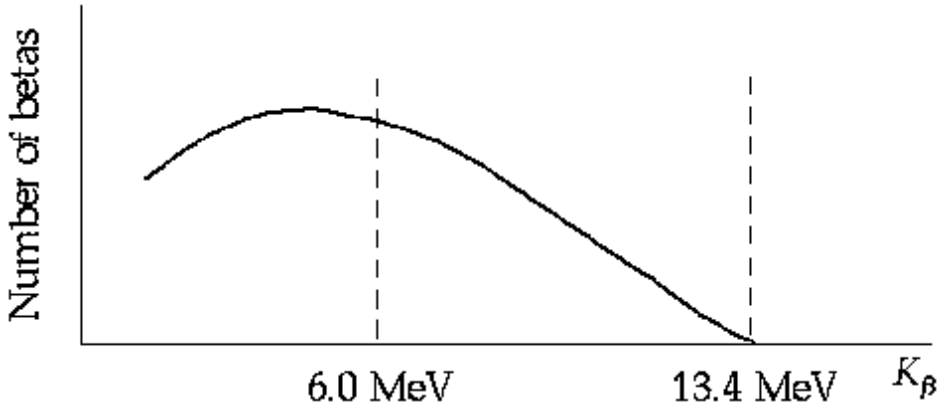
12. An electron traveling at 0.980*c* has a total energy of **(Use eqn 39-25)**
- **a)** 0.245 MeV
- **b)** 0.511 MeV
- **c)** 0.756 MeV
- **d)** 1.736 MeV
- **e)** 2.55 MeV ←

13. The correct expression relating the energy E of a particle to its rest mass m_0, its momentum p, and the speed of light c, is **(see eqn 39-28)**
- **a)** $E^2 = p^2c^2 + m_0c^2$
- **b)** $E^2 = p^2c^2 + (m_0c)^2$
- **c)** $E^2 = p^2c + (m_0c^2)^2$
- **d)** $E^2 = pc^2 + (m_0c^2)^2$
- **e)** $E^2 = p^2c^2 + (m_0c^2)^2$ ←

14. Fission occurs because the average binding energy per nucleon for the fission fragments is higher than that for the original nucleus. The change in binding energy per nucleon is approximately **(Stare at Figure 40-3 and/or 40-9)**
- **a)** 0.20 MeV
- **b)** 1.0 MeV ←
- **c)** 7.0 MeV
- **d)** 28 MeV
- **e)** 0.20 keV

15. The charge of the particle *dds* is **(Read sect 41-4; study table 41-2)**
- **a)** e
- **b)** (1/3)e
- **c)** (–2/3)e
- **d)** –e ←
- **e)** zero

16. **(Read sect 40-2, especially pg 1291)**



The beta spectrum for ^{12}B decay is shown in the graph. The kinetic energy of an emitted β particle is 6.00 MeV. The energy of the associated neutrino is approximately

a) 6.00 MeV
b) 13.4 MeV
c) 7.40 MeV ←
d) 11.3 MeV
e) 2.54 MeV

17. The cosmic microwave background radiation is **(Read sect 41-8, especially pgs 1330-31)**

a) radiation from the quasars that is redshifted.
b) produced from processes going on all over the present universe.
c) radiation from the Sun.
d) radiation from the Big Bang that was around when electons and protons conbined to form neutral hydrogen atoms. ←
e) radiation produced from electron-positron annihilation in the intergalatic regions.

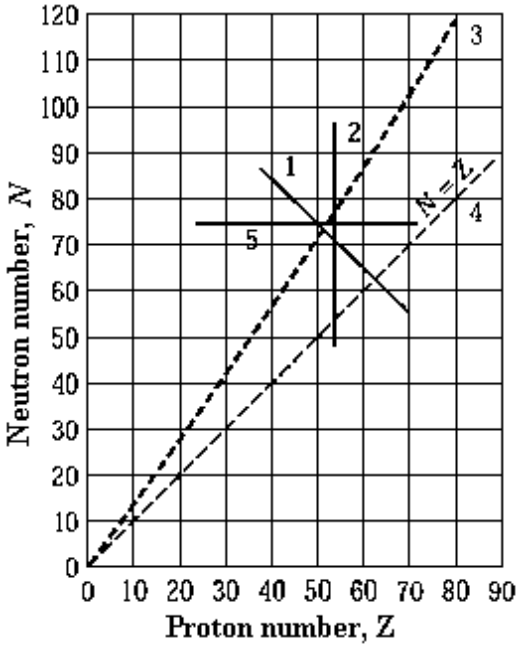
18. According to Hubble's law, the age of the universe is **(Read sect 41-8, especially p1329)**

a) approximately 6000 years.
b) less than 6000 years.
c) roughly 1 billion years.
d) too great to estimate.
e) between 10 and 15 billion years. ←

19. The reaction $\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$ conserves **(Read sect 41-3)**

a) muon lepton number but not electron lepton number.
b) electron lepton number but not muon lepton number.
c) neither muon lepton nor electron lepton number.
d) both muon and electron lepton numbers. ←
e) None of these is correct.

20.



Two nuclides that are isotopes could lie on curve is **(Read sect 40-1)**

a) 1
b) 2 ←
c) 3
d) 4
e) 5

21. The conservation law violated by the reaction $p \rightarrow \pi^0 + e^+$ is the conservation of **(Read sect 41-3)**

a) charge.
b) energy.
c) linear momentum.
d) lepton number and baryon number. ←
e) angular momentum.

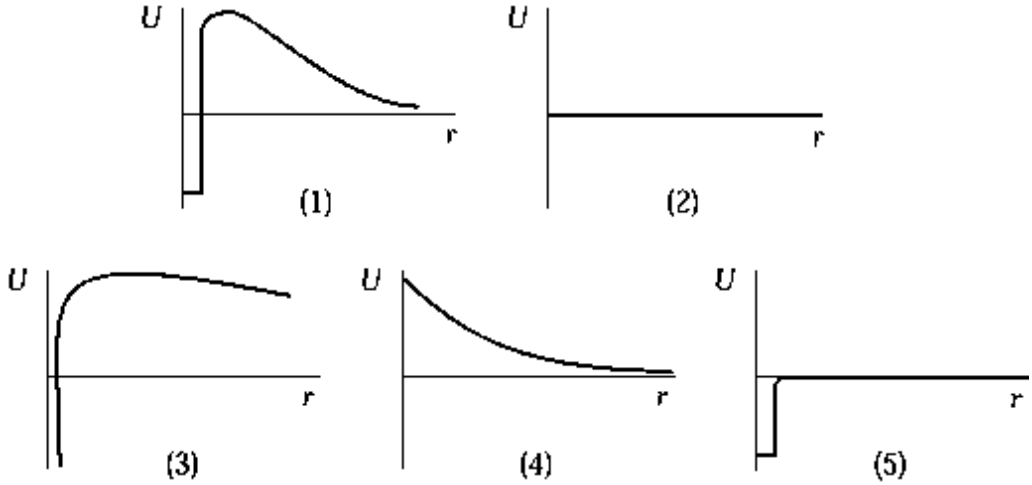
22. Which of the following choices lists the four known types of forces in nature in order of decreasing strength? **(Study table 41-5)**

a) strong nuclear, electromagnetic, weak nuclear, gravitational ←
b) electromagnetic, strong nuclear, weak nuclear, gravitational
c) strong nuclear, gravitational, weak nuclear, electromagnetic
d) strong nuclear, weak nuclear, electromagnetic, gravitational
e) strong nuclear, electromagnetic, gravitational, weak nuclear

23. The nuclear radius of $^{27}_{13}\mathrm{Al}$ is approximately is **(Use eqn 40-1)**

a) 1.05 fm
b) 4.50 fm ←
c) 0.350 fm
d) 11.2 fm
e) 1.85 fm

24. **(Look at Fig 40-7 and think about differences between an α particle & a neutron)**



The graph that represents the interaction of the proton and neutron is

a) 1
b) 2
c) 3
d) 4
e) 5 ←

25. Particles that participate in the strong nuclear interaction are called **(Read sect 41-7)**
- **a)** neutrinos
- **b)** hadrons ←
- **c)** leptons
- **d)** electrons
- **e)** photons

26. Current thought is that all matter is composed of is **(Read sect 41-4, study table 41-3)**
- **a)** six quarks.
- **b)** four quarks and four leptons.
- **c)** six leptons.
- **d)** six quarks and four leptons.
- **e)** six quarks and six leptons. ←

27. The fact that the binding energy per nucleon is roughly a constant over most of the range of stable nuclei is a consequence of the fact that the nuclear force is **(Read sect 40-1, especially p1288)**
- **a)** short range. ←
- **b)** long range.
- **c)** weak.
- **d)** strong.
- **e)** repulsive.

28. A particle moves in such a way that its kinetic energy just equals its rest energy. The velocity of this particle is **(Use Eqn 39-23)**
- **a)** $0.866c$ ←
- **b)** $c/4$
- **c)** c
- **d)** $0.707c$
- **e)** $c/2$

29. The total yearly world consumption of energy is approximately 4.0×10^{20} J. How much mass would have to be completely converted into energy to provide this amount of energy? **(Use $E=mc^2$)**
- **a)** 4.4×10^3 kg
- **b)** 1.3×10^{12} kg
- **c)** 1.3×10^4 kg ←
- **d)** 4.4×10^5 kg
- **e)** 2.2×10^4 kg

30. Rutherford's experiments, in which he bombarded a very thin gold foil with alpha particles, showed that is **(Read sect 37-1)**

a) all of the α particles passed through the foil without significant deflection.
b) none of the α particles were able to penetrate the foil.
c) all of the α particles passed through the foil and were deflected through large angles.
d) most of the α particles passed through the foil with negligible deflection but some were deflected through large angles. ←
e) the α particles were linearly polarized after passing through the foil.

31. The interaction that describes the forces among nucleons that hold nuclei together is is **(Read sect 40-1)**

a) the strong nuclear (hadronic) interaction. ←
b) the electromagnetic interaction.
c) the weak nuclear interaction.
d) the gravitational interaction.
e) None of these is correct.

32. The following fusion reaction occurs in the sun: is **(Read sect 40-3, study exam. 40-5)**

$$^{3}_{2}\mathrm{He} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{7}_{4}\mathrm{Be}$$

The masses of the nuclei are

^{3}He = 3.016 049 u
^{4}He = 4.002 604 u
^{7}Be = 7.016 930 u

The energy released or absorbed by the reaction is

a) 920 MeV, absorbed
b) 1.6 MeV, absorbed ←
c) 920 MeV, released
d) 1.6 MeV, released
e) 270 MeV, released