

Introductory Physics: Calculus-Based**Name:**

Homework 03.10: Nuclear Physics: Homeworks are due as posted on the course web site. Multiple-choice questions will **NOT** be marked, but some of them will appear on exams. One or more full-answer questions may be marked as time allows for the grader. Hand-in the full-answer questions on other sheets of paper: i.e., not crammed onto the downloaded question sheets. Make the full-answer solutions sufficiently detailed that the grader can follow your reasoning, but you do **NOT** be verbose. Solutions will be posted eventually after the due date. The solutions are intended to be (but not necessarily are) super-perfect and often go beyond a fully correct answer.

Multiple Choice Questions:

022 qmult 00200 1 1 2 easy memory: nuclei made of protons, neutrons

Extra keywords: Sun-question

1. Atomic nuclei are made up of:

- a) protons and electrons. b) protons and neutrons. c) positrons and electrons.
 d) positrons and neutrals. e) ponytrons and nuggets.

SUGGESTED ANSWER: (b)**Wrong answers:**

- c) A positron is the antiparticle of an electron: i.e., its the antielectron.
 e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

022 qmult 00210 1 1 2 easy memory: nucleus small and massive

Extra keywords: Sun-question

2. The nucleus occupies _____ of the volume of an atom and has _____ of the atomic mass.

- a) a small part; none b) a small part; almost all c) most; almost all d) most; none
 e) most; half

SUGGESTED ANSWER: (b)**Wrong answers:**

- e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01

022 qmult 00220 1 1 2 easy memory: isotopes defined

Extra keywords: Sun-question

3. Nuclei with the same number of protons, but different number of neutrons are _____ of each other.

- a) isochrones b) isotopes c) isobars d) isotropics e) Isoldes

SUGGESTED ANSWER: (b)**Wrong answers:**

- a) Contours of the same time.
 b) Contours of the same pressure.
 d) Contours of the same tropics.
 e) Isolde or Iseult is the heroine of the Arthurian romance of Tristan and Isolde:

Nay, order him!

Pray understand it!

I command it.

I Isolde.

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022 qmult 00230 1 4 4 easy deducto-memory: deuteron and triton

Extra keywords: Sun-question

4. “Let’s play *Jeopardy!* For \$100, the answer is: These isotopes of hydrogen have 1 and 2 neutrons, respectively.”

What are _____, Alex?

- a) uranium-235 (${}_{92}^{235}\text{U}$) and uranium-238 (${}_{92}^{238}\text{U}$) b) helium-3 (${}^3_2\text{He}$) and helium-4 (${}^4_2\text{He}$)
 c) the deuteron (D or ${}^2_1\text{H}$) and tritium (T or ${}^3_1\text{H}$) d) the deuteron (D or ${}^2_1\text{H}$) and triton (T or ${}^3_1\text{H}$)
 e) carbon (${}^{12}_6\text{C}$) and oxygen (${}^{16}_8\text{O}$)

SUGGESTED ANSWER: (d)

Wrong answers:

- b) Helium-3 fraction of terrestrial helium is 1.37×10^{-6} by number??? (see Wikipedia: Helium-3).
 c) Deuteronomy is the 5th book of the Pentateuch and is a second statement of the Mosaic law.
 It’s about where most would-be-whole Bible readers languish.

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022 qmult 00240 1 1 2 easy memory: strong nuclear force binds nuclei

Extra keywords: Sun-question

5. Nuclei are bound together by:

- a) gravity. b) the strong nuclear force. c) the electromagnetic force.
 d) the centrifugal force. e) the weak nuclear force.

SUGGESTED ANSWER: (b)

Wrong answers:

- d) As Lurch would say: “Aaaarh.” This not an ordinary force, but rather the tendency of objects in a rotating frame to try to go in a straight line. It is an inertial force.

Redaction: Jeffery, 2001jan01

022 qmult 00250 1 1 2 easy memory: nuclear fusion defined

Extra keywords: CK-261,266 Sun-question

6. Nuclear fusion is the _____ bonding of nuclei to form _____ nuclei.

- a) chemical; larger b) nuclear; larger c) nuclear; smaller d) chemical; smaller
 e) gravitational; smaller

SUGGESTED ANSWER: (b)

Wrong answers:

- e) This is fission, not fusion.

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022 qmult 00270 2 4 3 moderate deducto-memory: H fusion mass loss

Extra keywords: Sun-question

7. In stellar hydrogen fusion to helium, the rest mass energy of the products is _____ less than that of the reactants. The missing rest mass energy went mostly into _____.

- a) 70 %; heat energy b) 170 %; magnetic field energy c) 0.7 %; heat energy d) 70 %; magnetic field energy
 e) 0 %; chemical binding energy

SUGGESTED ANSWER: (c)

Wrong answers:

- e) As Lurch would say: “Aaaarh.”

Redaction: Jeffery, 2001jan01

022 qmult 00280 1 3 2 easy math: $E=mc^2$ calculation 1 kg

Extra keywords: Sun-question

8. A mass of 1 kg is equivalent to about how much energy? Recall that the speed of light is 3.00×10^8 m/s.

- a) 8×10^{16} J. b) 9×10^{16} J. c) 9×10^8 J. d) 3×10^8 J. e) 2×10^8 J.

SUGGESTED ANSWER: (b)

Everyone must remember $E = mc^2$. We note that 1 megaton TNT yields 4.16×10^{15} J explosion energy (WP-A-20) which I suppose counts both heat and macroscopic kinetic energy. Thus, if one could transform 1 kg of matter into explosive energy one would have a 20 megaton bomb. Fortunately, this reaction though energetically allowed is forbidden by other rules. We would, of course, like to change rest mass energy into useful energy in a controlled manner: i.e., controlled fusion.

Wrong answers:

- d) You forgot to square c .

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022 qmult 00300 1 1 2 easy memory: MS hydrogen burning 1

Extra keywords: Sun-question

9. The energy emitted as electromagnetic energy from main sequence stars is supplied by the:

- a) nuclear burning of helium to hydrogen. b) nuclear burning of hydrogen to helium.
c) nuclear burning of hydrogen to carbon. d) nuclear burning of helium to carbon.
e) chemical burning of hydrogen to carbon.

SUGGESTED ANSWER: (b)

Wrong answers:

- a) Wrong way around.

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022 qmult 00320 1 1 3 easy memory: thermonuclear reactions in star cores

Extra keywords: CK-267-12 Sun-question

10. Thermonuclear reactions happen only in a star's core (which for the Sun is the region within about 0.25 solar radii of the Sun's center) because only there is it _____ enough.

- a) cold and dilute b) hot and dilute c) hot and dense d) cold and opaque
e) fissionable

SUGGESTED ANSWER: (c) See CK-263 and Cox-342.

Wrong answers:

- e) Fusion, not fission goes on in stars.

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022 qmult 00330 1 1 1 easy memory: nuclear burning on star surface 1

Extra keywords: CK-322-4 Sun-question

11. Why don't thermonuclear reactions happen on the surface of main sequence stars?

- a) Not hot and not dense enough. b) Too hot and too dense. c) Too green. d) Too bad.
e) Too late.

SUGGESTED ANSWER: (a)

Wrong answers:

- e) As Lurch would say: "Aaaarh."

Redaction: Jeffery, 2001jan01