Exam						
Name	2					
MUL	TIPLE CHOIC	CE. Choose the one alterna	ative that best compl	etes the statement o	r answers the quest	ion.
	A) Tho B) Lan C) All D) An cor	te of the following statement of the following statement of nucleus is held together rege nuclei are denser than leading the san nuclei have nearly the san nucleus containing 20 nucleontaining 10 nucleons.  The average of the following statement of the following s	nostly by the electrica ight nuclei. ne density. eons will have approx	l and gravitational f		1)
		'a" contains 5 protons and 5 ntains 35 protons and 45 ne		dius $R$ . The radius of	f nucleus "b",	2)
	A) 8R	B) R	C) 2R	D) 1.4R	E) 4R	
		y rate of an isotope is initia f the <i>next</i> half-life, the deca	• 0	ılf-life has gone by, t	he rate is $R_0/2$ . At	3)
	A) 0	B) R/4	C) <i>R/e</i>	D) R/2	E) $R/e^2$	
box h	as a half-life o	ach start out containing 100 of 1.00 hr, while the isotope ate and both are beta-minught.	in the other box has a	mples and contain n half-life of 2.00 hr.	Both isotope sample	es have the
		on 43.1, after 4.00 hr have $\epsilon$ le reading of the 1.00–hr is	•	· ·	he 2.00-hr isotope	4)
	A) 2	B) 16	C) 1	D) 4	E) 8	
	the decay	on 43.1, after 4.00 hr have $\epsilon$	will be closest to:	•	•	5)
	A) 1	B) 2	C) 4	D) 16	E) 8	
	6) The follow	wing masses are known:				6)
	$\frac{1}{0}$ n	1.008665 u				
	<sup>1</sup> H 1	1.007825 u				

The binding energy of  $\begin{array}{ccc} 7 \text{ Li, in MeV, is closest to:} \\ 3 \end{array}$ B) 56 C) 39

7.016004 u

A) 48

<sup>7</sup> Li

D) 52

E) 43

7) The binding energy per nucleon for  $^{60}$  Co, calculated from the liquid drop model, in MeV, is

closest to:

A) 8.4

B) 8.8

C) 8.0

D) 8.6

E) 8.2

8) A proton is projected at a stationary  $\frac{62}{20}$  Ni aluminum target. The proton momentarily comes to a

halt at a distance from the center of an aluminum nucleus, equal to twice the nuclear radius. Assume that the nucleus retains its spherical shape and that the nuclear force on the proton is negligible. The initial kinetic energy of the proton, in MeV, is closest to:

A) 5.8

B) 12

E) 8.6

9) Rubidium <sup>87</sup> Rb is a naturally occurring nuclide that undergoes beta-minus decay. The nuclide,

9)

which is the product of the decay, is:

A)  $\frac{87}{38}$  Kr

B)  $\frac{88}{37}$  Rb C)  $\frac{87}{36}$  Kr D)  $\frac{87}{38}$  Sr E)  $\frac{87}{36}$  Sr  $\frac{87}{36}$  Sr

10) Naturally occurring tellurium,  $\frac{123}{52}$  Te, transforms by electron capture, according to the reaction

$$^{123}_{52}$$
 Te + e<sup>-</sup>  $\to X + v_e$ 

The product nuclide, denoted by X, is:

A) <sup>123</sup> I <sub>53</sub> I

B)  ${}^{123}_{53}$  Sb C)  ${}^{123}_{52}$  Te D)  ${}^{123}_{51}$  Sb E)  ${}^{123}_{51}$  I

11) Neodymium <sup>144</sup>Nd is a nuclide that undergoes alpha decay. The nuclide that is the product of the decay is:

11)

A)  $\frac{148}{62}$  Sm

E)  $^{146}_{64}$  Gd

12) Scandium <sup>44</sup>Sc decays by emitting a positron. The nuclide that is the product of the decay is:

A) 44 Ti

B)  $\frac{43}{21}$  Sc C)  $\frac{44}{20}$  Ca D)  $\frac{45}{21}$  Sc

E) 43 Ca 21

13) Neptunium  $^{239}$  Np has a decay constant of 3.40  $\times$ 10<sup>-6</sup> s<sup>-1</sup>. A 3.0-mg sample of Np-239 is

13)

prepared. The activity of the Np-239 sample, in Ci, is closest to:

A) 70

B) 220

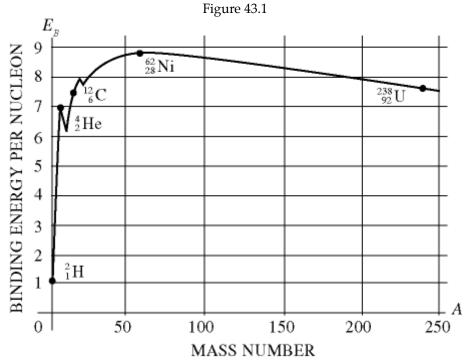
C) 700

D) 2200

E) 22

14) <i>A</i>	(4) A radioactive source of a single nuclide emits 2.4-MeV neutrons at the rate of 9200 neutrons per						
S	econd. The number o	-			-		
C	elosest to: A) 250	B) 920	C) 2500	D) 92	E) 25		
15) <i>A</i>	A radioactive source o	f a single nuclide em	nits 2.4-MeV neutro	ns at the rate of 3200	neutrons per	15)	
	econd. The number of or:	f atoms in the source	e is $5.3 \times 10^9$ . The me	an lifetime of the nu	clide is closest		
	A) $2.0 \times 10^6$	B) $2.3 \times 10^6$	C) $2.7 \times 10^6$	D) $1.3 \times 10^6$	E) $1.7 \times 10^6$		
	The decay constant of ninutes, is closest to:	a radioactive nuclid	e is $2.5 \times 10^{-3}  \text{s}^{-1}$ . Th	e half-life of the nuc	clide, in	16)	
	A) 6.7	B) 3.6	C) 2.6	D) 4.6	E) 5.6		
s	The decay constant of specimen of the nuclid s closest to:			0	•	17)	
	A) 95 s	B) 88 s	C) 80 s	D) 73 s	E) 100 s		
	The decay constant of			· ·		18)	
	atoms of the radioactive after a time interval of A) 1.38 ×10 <sup>11</sup>			atoms of the nuclide	that remain		
	D) 4 04 4011						

- B)  $1.04 \times 10^{11}$
- C) 1.14 ×10<sup>11</sup>
- D) 1.26 ×10<sup>11</sup>
- E) 1.52 ×10<sup>11</sup>



- 19) In Fig. 43.1, the curve graphed here helps us to understand
  - A) the nature of the process called beta decay.
  - B) why scintillation counters are used in nuclear physics.
  - C) why eventually the universe will be entirely composed of heavy elements like uranium.
  - D) how radioactive dating is accomplished.
  - E) how energy is generated in a nuclear reactor.
- 20) Which of the following is not true of the nuclear force?
  - A) For two protons in close proximity, the nuclear force and the electric force have comparable magnitudes.
  - B) The nuclear force has a short range, of the order of nuclear dimensions.
  - C) A nucleon in a large nucleus interacts via the nuclear force only with nearby nucleons, not with ones far away in the nucleus.
  - D) The nuclear force does not depend on charge.
  - E) The nuclear force favors binding of pairs of protons or neutrons with opposite spin angular momenta.

19) \_\_\_\_

20)

21) The stability of  ${}^{11}_6$  C with respect to alpha, beta-plus, and beta-minus decay is to be determined.

d. 21) \_\_\_\_\_

Do not consider the possibility of decay by electron capture. The following atomic masses are known:

The  $\frac{11}{6}$  C nuclide is:

- A) subject to alpha decay only
- B) subject to beta-minus decay only
- C) not subject to alpha, beta-plus, or beta-minus decay
- D) subject to beta-plus or beta-minus decay, but not to alpha decay
- E) subject to beta-plus decay only

22) The stability of  ${}^{36}_{17}$  Cl with respect to alpha, beta-plus, and beta-minus decay is to be

22) \_\_\_\_\_

determined. Do not consider the possibility of decay by electron capture. The following atomic masses are known:

The  $\frac{36}{17}$  Cl nuclide is:

- A) subject to beta-plus decay only
- B) subject to beta-minus decay only
- C) subject to alpha decay only
- D) not subject to alpha, beta-plus, or beta-minus decay
- E) subject to beta-plus or beta-minus decay, but not to alpha decay

determined. Do not consider the possibility of decay by electron capture. The following atomic masses are known:

The  $\frac{47}{21}$  Sc nuclide is:

- A) subject to beta-minus decay only
- B) not subject to alpha, beta-plus, or beta-minus decay
- C) subject to beta-plus or beta-minus decay, but not to alpha decay
- D) subject to alpha decay only
- E) subject to beta-plus decay only

24) The stability of 
$$^{56}_{26}$$
 Fe with respect to alpha, beta-plus, and beta-minus decay is to be

24)

determined. Do not consider the possibility of decay by electron capture. The following atomic masses are known:

The  $\frac{56}{26}$  Fe nuclide is:

- A) subject to alpha decay only
- B) subject to beta-plus or beta-minus decay, but not to alpha decay
- C) subject to beta-minus decay only
- D) subject to beta-plus decay only
- E) not subject to alpha, beta-plus, or beta-minus decay

25) Bismuth	<sup>212</sup> Bi is kno	wn to be radioac	tive. The stability of	<sup>212</sup> Bi with respect t	o alpha,	25)
beta-plı	ıs, and beta-n		be determined. Do n	00		
<sup>4</sup> He	4.002603					
<sup>208</sup> Tl	207.981998					
<sup>212</sup> <sub>82</sub> Pb	211.991871					
<sup>212</sup> <sub>83</sub> Bi	211.991255					
<sup>212</sup> <sub>84</sub> Po	211.988842					
The <sup>212</sup> <sub>83</sub>	Bi nuclide is:					
A) sı	ıbject to beta-	plus decay only				
	*	minus decay onl	y			
C) sı	ıbject to alpha	decay only	•			
D) st	ıbject to alpha	or beta-plus de	cay, but not beta-mir	us decay		
E) al	pha or beta-n	ninus decay, but	not beta-plus decay			
			lose for occupational			26)
_			1 mJ of 0.7-MeV gan	•	•	
0	•	_	rays is 1.00. The ratio	•	osage received by	
the tech A) 0.		naxımum permis B) 0.13	ssible equivalent dosa C) 0.14	D) 0.15	E) 0.18	
Α) 0.	17	D) 0.13	C) 0.14	D) 0.13	E) 0.16	
27) The may	amum permis	ssible workday d	lose for occupational	exposure to radiatio	on is 12 mrem A	27)
		•	9 mJ of 0.5-MeV gan			
_	-		rays is 1.00. The num	-	•	
_	-	workday is close		, , , , , , , , , , , , , , , , , , ,	•	
A) <sub>1</sub>	× 10 <sup>8</sup>	B) $_{4 \times 10^9}$	C) $4 \times 10^8$	D) $1 \times 10^9$	E) $_{4 \times 10}$ 10	
			eutrons in a work day	0,		28)
MeV. Th	e relative bio	logical efficiency	(RBE) for fast neutro	ns is 10. The equiva	lent dosage of the	

C) 13

D) 1.3

E) 4.3

radiation exposure, in mrem, is closest to: A) 43 B) 2.7

29)	A beryllium-	-8 atom	at rest	undergoe	s double	alpha	decay	as follows:

29) \_\_\_\_\_

$${8 \atop 4}$$
 Be  $\rightarrow {4 \atop 2}$  He  $+ {4 \atop 2}$  He

The atomic masses are:

- <sup>4</sup><sub>2</sub> He 4.002603
- <sup>8</sup>/<sub>4</sub> Be 8.005305

The kinetic energy of each departing alpha particle, in keV, is closest to:

- A) 92
- B) 180
- C) 65
- D) 46
- E) 130

30) One of the fusion reactions that occurs in the sun is:

30) \_\_\_\_\_

$${}^3_2\text{He} + {}^3_2\text{He} \rightarrow {}^4_2\text{He} + {}^1_1\text{H} + {}^1_1\text{H}$$

The following atomic masses are known:

- $^{1}_{1}$  H 1.007825
- <sup>3</sup> He 3.016029
- $\frac{4}{2}$  He 4.002603

The reaction energy, in MeV, is closest to:

- A) 17
- B) 19
- C) 11
- D) 13

E) 15

Situation 43.2

An excited  $\frac{236}{92}$  U\* nucleus undergoes fission into two fragments.

$$^{236}_{92} \text{ U}^* \rightarrow ^{144}_{56} \text{ Ba} + ^{92}_{36} \text{ Kr}$$

The following atomic masses are known:

31) In Situation 43.2, the reaction energy, in MeV, is closest to:

- A) 150
- B) 180
- C) 170
- D) 190
- E) 160

32) In Situation 43.2,	assume, at a given i	nstant, that the two	fragments are spher	ical and barely in	32)
contact. At that ir	nstant, the electrosta	tic interaction energ	gy of the two fragmen	nts, in MeV, is	
closest to:					
A) 240	B) 250	C) 270	D) 260	E) 230	

**Table 43.1** 

Time (days)	0	2	6	11	19	30
Counts per Minute	1000	899	726	556	556	200

- 33) In Table 43.1, in a laboratory accident a work area is contaminated with radioactive material. Health physicists monitor the area during a 30-day period and obtain the data shown here. The accident occurred at t = 0. They determine that it will not be safe for workers to enter the area until the radioactivity level has dropped to 133 counts per minute. Of the choices listed, which is the earliest time that workers could safely return?
  - A) 50 days
- B) 32 days
- D) 38 days
- E) 24 days
- 34) The radioactive nuclei  $^{60}$ Co is widely used in medical applications. It undergoes beta decay, and the total energy of the decay process is 2.82 MeV per decay event. The half-life of this nucleus is 272 days. Suppose that a patient is given a dose of 6.9 microCurie of 60Co. If all of this material decayed while in the patient's body, what would be the total energy deposited there? (
  - 1 Ci =  $3.70 \times 10^{10}$  decays/sec.)
    - A) 11 J
    - B)  $4.15 \times 10^6$  J
    - C) 3.9 I
    - D)  $8.63 \times 10^{12}$  J
    - E) 24 J
- 35) In the nuclear reaction here, which of the following is the missing nuclear product?
- 35)

33)

$${}^{10}_{5} \, {\rm B} + {}^{4}_{2} \, {\rm He} \rightarrow {}^{1}_{1} \, {\rm H} + ?$$

- A)  $^{21}_{7}$  N B)  $^{13}_{6}$  C C)  $^{14}_{7}$  N D)  $^{13}_{7}$  N E)  $^{12}_{9}$  F

## SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 36) If the radius of a nucleus is given by  $R = R_0 A^{1/3}$  where  $R_0 = 1.20 \times 10^{-15}$  m, calculate the density of a nucleus that has A = 136. The mass of a nucleon (proton or neutron) is  $1.67 \times 10^{-27}$  kg.
- 36) \_\_\_\_\_
- 37) The unstable isotope  $^{234}$ Th decays by  $\beta$  emission with a half-life of 24.5 days.
- 37) \_\_\_\_\_
- (a) What mass of  $^{234}$ Th will produce  $9.9 \times 10^{13}$  decays per second? (Note:

$$1u = 1.66 \times 10^{-27} \text{ kg.}$$

(b) If the initial decay rate of the sample is  $9.9 \times 10^{13}$  decays per second, what is the decay rate after 68 days?

38) Consider the fusion reaction:

$${}^{2}_{1}H + {}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{1}H + {}^{1}_{0}n$$

The atomic masses are:

 $^2_1$  H, 2.01410 u;  $^4_2$  He, 4.00260 u;  $^1_1$  H, 1.00783 u and  $^1_0$  n, 1.008665 u, where 1u = 1.6606 ×

What mass of deuterium  $\{{}^2_1H\}$  fuel is used up in producing  $8.2 \times 10^{13}$  J of energy by this reaction?

39) A hypothetical particle has mass  $512 \, \text{MeV/c}^2$ . If such a particle at rest decays into two gamma-ray photons, what is the wavelength of each photon?

(Note: 
$$e = 1.602 \times 10^{-19}$$
 C,  $c = 2.998 \times 10^8$  m/s, and  $h = 6.626 \times 10^{-34}$  J·s.)

40) What initial kinetic energy must a proton have in order to initiate a nuclear reaction with 40) \_\_\_\_\_ a  $^{62}$  Ni nucleus? Express your answer in MeV. (R  $_{0}$  = 1.2 ×10<sup>-15</sup> m)

41) A certain isotope has a half-life of 32.4 hr and a relative biological effectiveness of 3.50. A sample of this isotope initially delivers an equivalent dose of 24.0 rad to 250 g of tissue.



- (a) What was the initial equivalent dose to the tissue in rem?
- (b) How many joules of energy did the 250-g sample initially receive from the isotope?
- (c) How long would it take before this isotope would deliver only 5.00 rad to the 250-g piece of tissue?

## Answer Key

Testname: UNTITLED1

- 1) C
- 2) C
- 3) B
- 4) C
- 5) C
- 6) C
- 7) B
- 8) A
- 9) D
- 10) D
- 11) D
- 12) B
- 13) C
- 14) A
- 15) E
- 16) D
- 17) D
- 18) B
- 19) E
- 20) A
- 21) E
- 22) E
- 23) A
- 24) E
- 25) E
- 26) B
- 27) E
- 28) E
- 29) D
- 30) D
- 31) B
- 32) B
- 33) D
- 34) C
- 35) B
- 36)  $2.31 \times 10^{17} \text{ kg/m}^3$
- 37) (a)  $1.2 \times 10^{-4}$  kg
  - (b)  $1.4 \times 10^{13}$  decays per second
- 38)  $2.4 \times 10^{-1} \text{ kg}$
- 39)  $4.84 \times 10^{-15}$  m
- 40) 19 MeV
- 41) (a) 84 rem (b) 0.060 J (c) 73.3 hr