Physics 30 Worksheet #22: *Cathode Ray Tubes*

1. An electron enters a magnetic field in a CRT at a speed of 5.00×10^{5} m/s and is deflected with a radius of 7.00×10^{-3} m. Calculate the strength of the magnetic field present.

2. The strength of the magnetic field in a CRT is 8.00×10^{-1} T. If the speed of a cathode ray in this magnetic field is 5.50×10^{5} m/s, what is the radius of the cathode ray's path?

3. Calculate the charge to mass ratio of a particle that passes through a magnetic field of 7.20×10^{-2} T with a speed of 5.00×10^{5} m/s while deflecting with a radius of 3.70×10^{-3} m.

4. A cathode ray passes undeflected through an electric field of strength 6.00×10^{3} V/m and a magnetic field of strength 6.50×10^{-3} T. Calculate the speed of the cathode ray.

5. A cathode ray passes undeflected through an electric field of 5.00×10^{3} N/C and a magnetic field of 7.00×10^{-3} T. Calculate the kinetic energy of the cathode ray. An electron traveling at a speed of 6.00×10^{5} m/s passes through an electric field of 5.00×10^{3} N/C and a magnetic field of an unknown strength. If the electron passes through undeflected, what is the strength of the magnetic field?

6. An electron is accelerated across a potential difference in a cathode ray tube to a speed of 2.00×10^{6} m/s. What is the value of the potential difference across which the electrons were accelerated?

7. A cathode ray travels undeflected through an electric field of 6.00×10^{3} V/m and a magnetic field of 7.00×10^{-3} T. The cathode ray then enters only a magnetic field of 7.00×10^{-1} T. Calculate the radius of the path followed by the cathode ray.

8. An electron passes through an electric field of 3.00×10^{3} N/C and a magnetic field of 5.00×10^{-3} T undeflected. The electric field is removed, leaving only the magnetic field. Calculate the radius of the electron's path when the electric field is removed.

9. Electrons in a cathode ray tube are accelerated from rest though a potential difference of 1.30×10^{3} V. The electrons enter a magnetic field of 2.50×10^{-2} T. Calculate the maximum radius of the electron's path.

10. A cathode ray travels through a magnetic field of 2.00×10^{-2} T and follow a path of radius 5.60×10^{-3} m. What value of electric field would need to be added to make these cathode rays pass through undeflected?

Physics 30 Worksheet #23: *Millikan Oil Drop Experiment*

1. An oil drop with a mass of 4.80 x 10^{-16} kg is suspended between plates that are 6.00 cm apart. The potential difference between the plates is 5.90 x 10^{2} V. What is the charge of the oil drop?

2. An oil drop has a mass of 7.20 x 10^{-16} kg and is suspended between two plates in a Millikan experiment. The electric field between the plates is 2.20 x 10^{4} V/m. Calculate the charge on the oil drop. How many excess electrons are present on the oil drop?

3. What potential difference would be necessary to balance an oil drop with five excess electrons on it, when the mass of the oil drop is 4.89 x 10^{-15} kg and the plates are 5.00 cm apart?

4. An particular oil drop has a mass of 5.70 x 10^{-16} kg and accelerates upward at a rate of 2.90 m/s^{2}. The potential difference between the plates is 7.92 x 10^{2} V and the distance between the plates is 0.0350 m. Calculate the charge on the oil drop. Calculate the number of excess electrons on the oil drop.

5. An oil drop with a mass of 3.50 x 10^{-15} kg accelerates downward at a rate of 2.50 m/s^{2}. Calculate the charge on the oil drop if the distance between the plates is 10.0 mm and the potential difference between the plates is 5.38 x 10^{2} V.

Physics 30 Worksheet #24: *Transmutation Equations*

Instructions: *Fill in the unknown quantities and identify whether the equation is alpha decay, beta decay, or an artificial transmutation.*

1. $^{238}_{92}U \rightarrow ^{234}_{90}Th + \_\_\_\_$
2. $^{222}_{86} \rightarrow ^{4}_{2}\alpha + \_\_\_\_$
3. $^{214}_{82}Pb \rightarrow ^{214}_{83}Bi + \_\_\_\_$
4. $^{234}_{92}U \rightarrow ^{4}_{2}\alpha + \_\_\_\_$
5. $^{210}_{81}Tl \rightarrow ^{0}_{-1}\beta + \_\_\_\_$
6. $^{208}_{82}Pb + \_\_\_\_ \rightarrow ^{265}_{108}Hs + ^{1}_{0}n$
7. $^{234}_{91}Pa \rightarrow ^{234}_{92}U + \_\_\_\_$
8. $^{214}_{83}Bi \rightarrow ^{214}_{84}Po + \_\_\_\_$
9. $^{214}_{84}Po \rightarrow ^{210}_{80}Pb + \_\_\_\_$
10. $^{9}_{4}Be + ^{1}_{1}H \rightarrow ^{6}_{3}Li + \_\_\_\_$
11. $^{230}_{90}Th \rightarrow ^{226}_{88}Ra + \_\_\_\_$
12. $^{226}_{88}Ra \rightarrow ^{4}_{2}\alpha + \_\_\_\_$
13. $^{210}_{80}Hg \rightarrow ^{0}_{-1}\beta + \_\_\_\_$
14. $^{14}_{7}N + ^{4}_{2}\alpha \rightarrow ^{17}_{8}O + \_\_\_\_$

Physics 30 Worksheet # 25: *Half-Life*

1. The half life of polonium-210 is 138 days. How much of a 20.0 kg sample of polonium-210 will remain after:

   a. 1.0 half life?

   b. 2.0 half lives?

   c. 3.6 half lives?

2. The half life of a particular radioactive sample is 10.0 years. How much of a 10.0 kg sample will remain after:

   d. 10.0 years?

   e. 20.0 years?

   f. 30.0 years?

   g. 35.0 years?

3. The original activity of polonium-210 is 100 Bq. What is the activity after 2.00 years have elapsed?

4. The half life of carbon-14 is 5730 years. What percentage of carbon-14 remains after:

   h. 1000 years?

   i. 3000 years?

   j. 5730 years?

   k. 100000 years?

5. The activity of carbon-14 is 20.0 Bq. What was the original activity if 3.0 half lives have elapsed?

6. The activity of carbon-14 is 100 Bq. What was the original activity if 2000 years have elapsed?

7. Find the ratio of current activity to original activity of carbon-14 after 11460 years have elapsed.

8. The half life of a radioactive sample is 5.0 days. How would the activity of this sample after 17 days compare to its original activity?

9. How many half lives would it take for 10.0 g of a radioactive sample to decay to 1.25 grams?

10. How many half lives would it take for a radioactive sample to decay to 25% of its original activity?

11. How many years would it take for 20 g of carbon-14 to decay to:

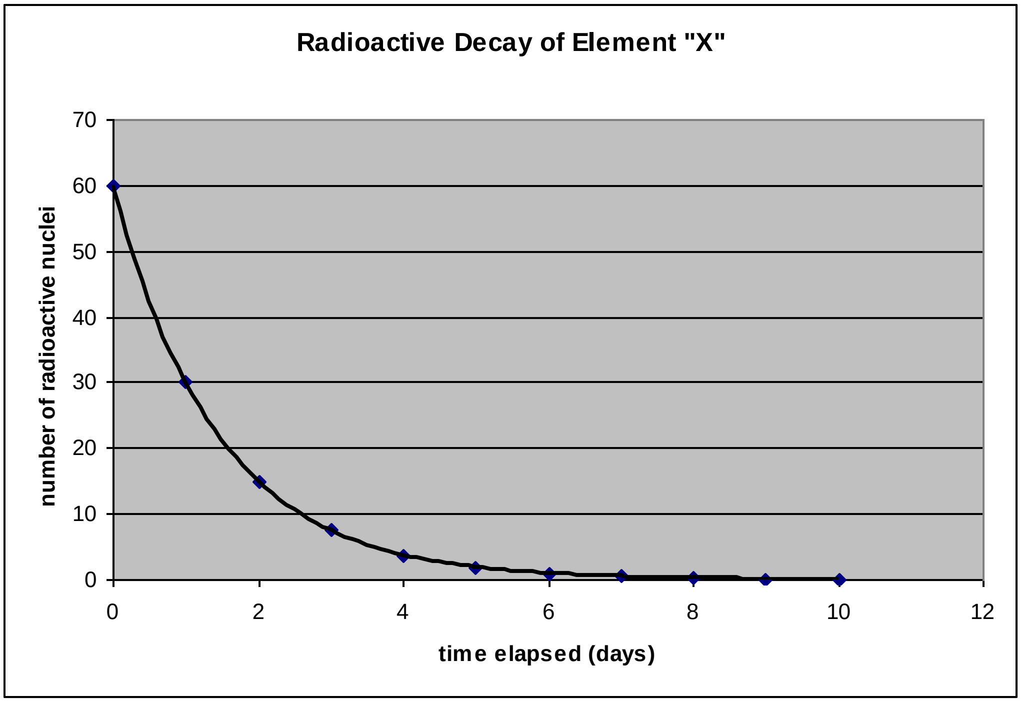
    l. 10 g?

    m. 2.5 g?

    n. 1.25 g?

    o. 0.625 g?

12. Use the following graph to answer the questions:



a. What is the half life of element “X”?

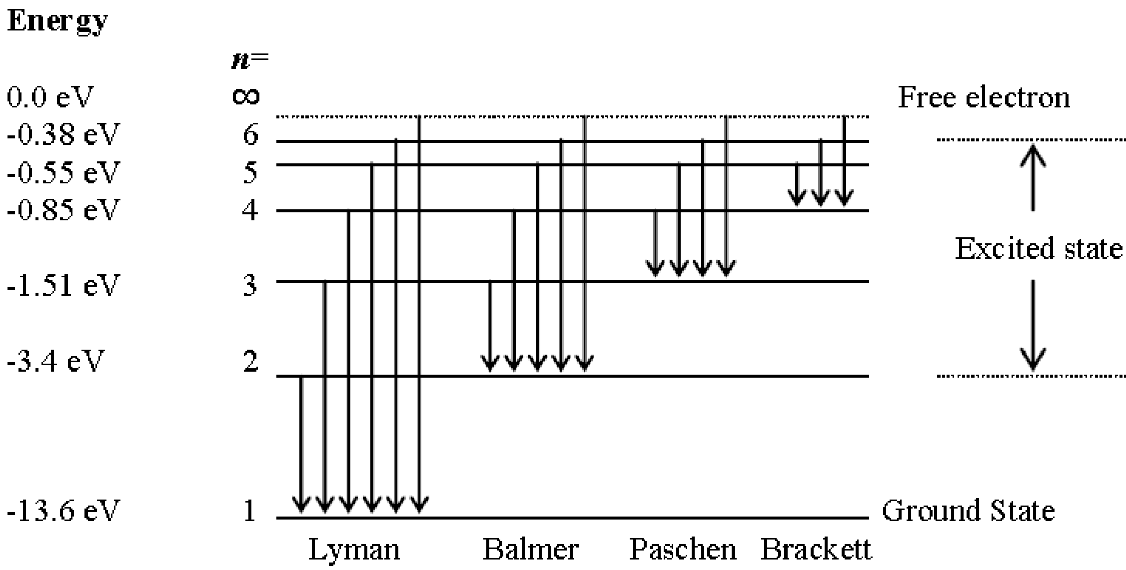
b. How much of element “X” will remain after 2 days?

c. How much of element “X” will remain after 3 half lives?

d. How long will it take element “X” to decay from its original amount to 10 nuclei remaining?

Physics 30 Worksheet # 26: *Electron Levels and Transitions*

Use the electron level diagram for Hydrogen below to answer the questions.



1. Calculate the wavelength of EMR involved when an electron in a hydrogen atom makes a transition from the third level to the first level. Calculate the frequency of this EMR. Calculate the energy of this EMR. What type of EMR is this? Is the EMR absorbed or emitted?

2. Calculate the wavelength of EMR involved when an electron in a hydrogen atom makes a transition from the first level to the third level. Calculate the frequency of this EMR. Calculate the energy of this EMR. What type of EMR is this? Is the EMR absorbed or emitted?

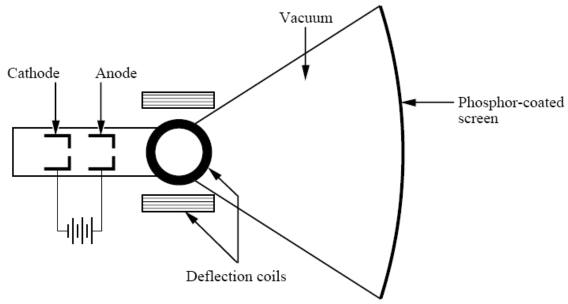
3. Calculate the frequency of EMR involved when an electron in a hydrogen atom makes a transition from the third level to the fifth level. Calculate the frequency of this EMR. Calculate the energy of this EMR. What type of EMR is this? Is the EMR absorbed or emitted?

Diploma Exam Review Questions

<u>Cathode Ray Tube / Mass Spectrometer</u>

Use the following information to answer the next question.

Cathode-ray tubes (CRTs) are used for television and computer screens. They are set up as shown below.



Electrons are "boiled off" the surface of the cathode and are accelerated toward the anode. The cathode is 4.5 cm from the anode. A potential difference of 2.5×10^3 V exists between the cathode and the anode. The electrons are deflected both side to side and up and down by pairs of magnetic deflection coils mounted on the neck of the tube.

146. An electron hits the screen at a speed of

A. 1.0×10^7 m/s
B. 1.5×10^7 m/s
C. 3.0×10^7 m/s
D. 8.8×10^{14} m/s

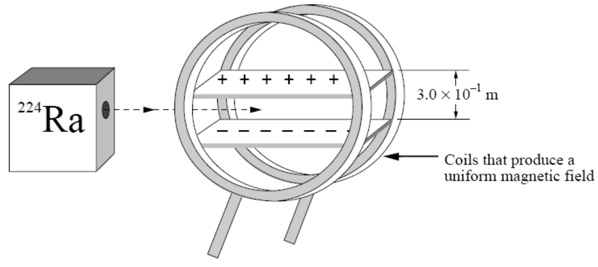
----

147. J. J. Thomson's experiments indicated that cathode rays are

A. photons
B. electromagnetic radiation
C. positively charged particles
D. negatively charged particles

Use the following information to answer the next two questions.

A scientist places a 10 g sample of ^{224}Ra, which has a half-life of 3.66 d, into a shielded box that allows a stream of high energy particles to escape. The scientist then applies a potential difference of 5.3×10^5 V across horizontal plates that are 3.0×10^{-1} m apart and a perpendicular magnetic field of 0.70 T. She observes that the particle beam passes through the apparatus undeflected. When the electric field is eliminated, the magnetic field causes the particles to orbit in a circle with a radius of 7.5×10^{-2} m. Note: The entire apparatus is in a vacuum.



148. The particles in the undeflected beam are moving at a speed of ***a.b*** x 10^c m/s. The values of ***a, b,*** and ***c,*** are, respectively, ____, ____, and ____ .

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

149. Using the charge-to-mass ratio of the particles, the scientist determines the particles to be

A. protons
B. neutrons
C. electrons
D. alpha particles

Millikan Oil Drop Experiment

150. Two scientists who conducted experiments that led to the determination of the mass of an electron were

A. Planck and Einstein
B. Rutherford and Bohr
C. Thomson and Millikan
D. Compton and de Broglie

Isotope Notation

151. Polonium has more isotopes than any other element, and they are all radioactive. The isotope $^{218}_{84}Po$

A. 218 protons and 84 neutrons
B. 84 protons and 218 neutrons
C. 134 protons and 84 neutrons
D. 84 protons and 134 neutrons

Radioactivity (Qualitative)

152. Nuclear radiation exists in several different forms. Listed from greatest to least in their ability to penetrate human tissue, the order of three of these forms is

A. alpha, beta, gamma
B. gamma, beta, alpha
C. gamma, alpha, beta
D. alpha, gamma, beta

153. When a neutral meson particle ($\pi°$) decays, it produces an electron (e^-). In this process, it is **most likely** that

A. nothing else is produced
B. a gamma ray is also produced
C. a negative particle is also produced
D. a positive particle is also produced

Use the following information to answer the next question.

A student obtains samples of pure quantities of two radioactive isotopes: X and Y. The samples contain equal numbers of atoms. The half-life of each isotope is given below.

Half-life of radioactive isotope X: 120 days
Half-life of radioactive isotope Y: 15.2 days

Both isotopes undergo beta decay.

154. Which of the following situations would result in a person experiencing the **most** exposure to radioactivity?

A. Being exposed to isotope X at a distance of two metres for two hours
B. Being exposed to isotope X at a distance of one metre for two hours
C. Being exposed to isotope Y at a distance of two metres for two hours
D. Being exposed to isotope Y at a distance of one metre for two hours

Transmutation Equations

Use the following information to answer the next question.

A Transmutation Reaction

$^{12}_{7}N$ + alpha particle → unstable nucleus → proton + $^{A}_{Z}X$

155. In the transmutation reaction above, an alpha particle is absorbed by a nitrogen nucleus. An unstable nucleus that decays by producing a proton and an unidentified nucleus $^{A}_{Z}X$ is produced. The values of A and Z are, respectively,

A. 16 and 9
B. 15 and 8
C. 11 and 6
D. 8 and 15

Use the following information to answer the next question.

Mass spectrometers are used in archeological studies to help date ancient artifacts. The relative amounts of carbon-12 and carbon-14 isotopes in a sample of organic material may be used to determine the age of the sample. Carbon-14 is a radioactive isotope that undergoes beta decay and has a half-life of 5 730 years.

156. The product of the carbon-14 decay is

A. $^{14}_{7}N$
B. $^{14}_{8}O$
C. $^{10}_{4}Be$
D. $^{12}_{6}C$

Use the following information to answer the next question.

Some smoke detectors use the radioactive source americium-243 to ionize the air between two electric plates in a detection chamber. A 9.0 V battery in the detector causes a continuous current to flow between the plates. When smoke particles enter the chamber, they neutralize the ionized air molecules, which decreases the current and triggers an alarm.

157. If the air is ionized by alpha particles produced by the americium-243, what immediate byproduct would one expect to find?

A. Curium-243
B. Plutonium-243
C. Berkelium-247
D. Neptunium-239

Use the following information to answer the next question.

When a neutron is captured by a nucleus of uranium-238, the event shown below occurs.

$$^{238}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{239}_{92}\text{U}$$

The uranium-239 then undergoes a series of decays:

$$^{239}_{92}\text{U} \xrightarrow{\text{decay I}} ^{239}_{93}\text{Np} \xrightarrow{\text{decay II}} ^{239}_{94}\text{Pu}$$

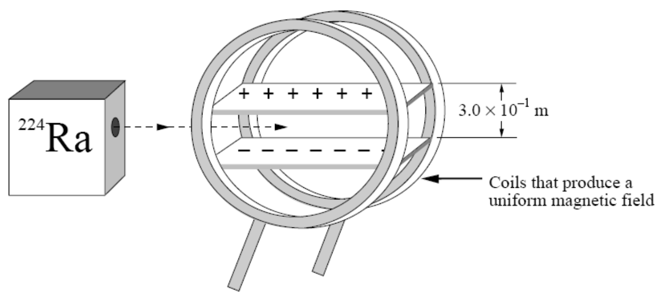
158. In both decays I and II, the type of emitted particle is

A. an alpha particle
B. an electron
C. a neutron
D. a proton

Half-Life Problems

Use the following information to answer the next question.

A scientist places a 10 g sample of ^{224}Ra, which has a half-life of 3.66 d, into a shielded box that allows a stream of high energy particles to escape. The scientist then applies a potential difference of 5.3×10^5 V across horizontal plates that are 3.0×10^{-1} m apart and a perpendicular magnetic field of 0.70 T. She observes that the particle beam passes through the apparatus undeflected. When the electric field is eliminated, the magnetic field causes the particles to orbit in a circle with a radius of 7.5×10^{-2} m. Note: The entire apparatus is in a vacuum.



159. The mass of 224 Ra remaining after 22 days is

A. 0.16 g
B. 0.31 g
C. 2.7 g
D. 3.7 g

Use the following information to answer the next question.

Mass spectrometers are used in archeological studies to help date ancient artifacts. The relative amounts of carbon-12 and carbon-14 isotopes in a sample of organic material may be used to determine the age of the sample. Carbon-14 is a radioactive isotope that undergoes beta decay and has a half-life of 5 730 years.

160. An archeological sample is dated using the carbon-14 dating process and is found to be 2 865 years old. What percentage of the original carbon-14 remains?

A. 25.0%
B. 29.3%
C. 70.7%
D. 75.0%

----

161. For a 768 g sample of an unknown radioactive element, 48.0 g remain after 10.2 h. The half-life of the element is __________ h.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

In medical diagnosis, a patient may be injected with a radioactive isotope. As the isotope decays, the gamma ray emissions are detected and a computer builds images of the patient's blood flow and organs.

A radioactive isotope commonly used in medical diagnosis is technetium-99. This isotope has a half-life of 6.00 h and decays to a stable isotope by gamma ray emission.

162. If the biological processes that might eliminate some of the technetium-99 from the body are ignored, the maximum percentage of radioactive technetium-99 that could still be present in a patient's system 24.0 h after injection is

A. 12.5%
B. 6.25%
C. 2.00%
D. 0.841%

Use the following information to answer the next question.

Some smoke detectors use the radioactive source americium-243 to ionize the air between two electric plates in a detection chamber. A 9.0 V battery in the detector causes a continuous current to flow between the plates. When smoke particles enter the chamber, they neutralize the ionized air molecules, which decreases the current and triggers an alarm.

163. Americium-243 has a half-life of approximately 7 000 years. If a detector containing 20 mg of this isotope were discarded and then rediscovered 70 years later, approximately how much americium-243 would remain?

A. 20 mg
B. 0.20 mg
C. 2.0×10^{-7} mg
D. No measurable amount would remain.

Fission / Fusion

Use the following information to answer the next two questions.

A particular nuclear fission reaction of uranium-235 is represented by

$${}^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{141}_{55}\text{Cs} + {}^{ab}_{cd}X + 3\,{}^{1}_{0}\text{n},$$

where element X is unknown.

164. The value of ***cd*** in the above reaction can be identified using the Law of Conservation of

A. Mass
B. Energy
C. Charge
D. Momentum

165. The fission product in this reaction is represented by ${}^{ab}_{cd}X$. The values of ***a***, ***b***, ***c***, and ***d*** are _____ , _____ , _____ , and _____ .

(Record your **four-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next three questions.

In 1939, four German scientists, Otto Hahn, Lise Meitner, Fritz Strassmann, and Otto Frisch, made an important discovery that ushered in the atomic age. They found that a uranium nucleus, after absorbing a neutron, splits into two fragments that each have a smaller mass than the original nucleus. This process is known as nuclear fission.

There are many possible fission reactions that can occur, two of which are shown below.

I ${}^{1}_{0}\text{n} + {}^{235}_{92}\text{U} \rightarrow {}^{236}_{92}\text{U} \rightarrow {}^{141}_{56}\text{Ba} + {}^{92}_{36}\text{Kr} + 3\,{}^{1}_{0}\text{n} + \text{energy}$

II ${}^{1}_{0}\text{n} + {}^{235}_{92}\text{U} \rightarrow {}^{236}_{92}\text{U} \rightarrow {}^{140}_{54}\text{Xe} + {}^{92}_{38}\text{Sr} + x\,{}^{1}_{0}\text{n} + \text{energy}$

166. The value of ***x*** in reaction II is

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

Use the following additional information to answer the next two questions.

The measurements given below indicate that the uranium-235 nucleus has a smaller mass than the mass of a corresponding number of free protons and neutrons. This difference in mass is called the mass defect.

Einstein's concept of mass-energy equivalence, $E = mc^2$, can be used to predict the energy that binds a nucleus together by using the mass defect.

mass of uranium-235 nucleus = 3.9021×10^{-25} kg
mass of proton = 1.6726×10^{-27} kg
mass of neutron = 1.6749×10^{-27} kg

167. The mass defect of uranium-235, expressed in scientific notation, is $\boldsymbol{b} \times 10^{-w}$ kg. The value of ***b*** is __________.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

168. The nuclear binding energy of uranium-235, expressed in scientific notation, is $\boldsymbol{b} \times 10^{w}$ eV. The value of ***b*** is __________.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

A particular nuclear fission reaction of uranium-235 is represented by

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{141}_{55}\text{Cs} + ^{ab}_{cd}\boldsymbol{X} + 3^{1}_{0}\text{n},$$

where element ***X*** is unknown.

169. In the above fission reaction, the mass of the reactants is 236.05 atomic mass units, and the mass of the products is 235.86 atomic mass units. Which of the following explanations **best** describes the change in mass that occurs in this nuclear fission reaction?

A. Mass and energy are equivalent, and energy has been converted into mass in this reaction.
B. Mass and energy are equivalent, and mass has been converted into energy in this reaction.
C. Mass and energy are equivalent, and the missing mass is due to inaccurate laboratory measuring equipment.
D. Neutrinos that are given off in the fission reaction are undetectable, which accounts for the differences in mass of the detectable components of the reaction.

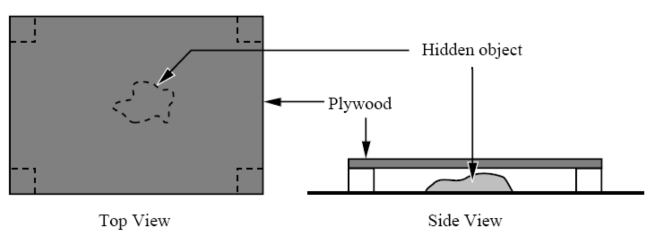
<u>Rutherford Gold Foil Experiment and the Planetary Model of the Atom</u>

170. In certain scattering experiments, alpha particles bounce backward from a thin metal target. This observation led to the hypothesis that

A. alpha particles carry electric charges
B. charge is uniformly distributed throughout the atom
C. alpha particles' kinetic energy cannot be converted to potential energy
D. the centre of the atom is very small, charged, and contains most of the atom's mass

Use the following information to answer the next question.

Students attempt to determine the nature of an object that is hidden beneath a sheet of plywood by rolling marbles under the plywood.



171. This exercise would help students appreciate the difficulties encountered by

A. Compton in his work on wave–particle theory
B. Einstein in his work on the photoelectric effect
C. Rutherford in his work on the nucleus of the atom
D. Thomson in his work on cathode rays

Bohr Model of the Atom (Qualitative)

172. When white light passes through a cool gas and then into a spectroscope, the spectrum produced is

A. a continuous spectrum
B. an absorption spectrum
C. a bright-line spectrum
D. an emission spectrum

Bohr Model of the Atom Problems

Use the following information to answer the next question.

Selected Energy Levels of a Mercury Atom

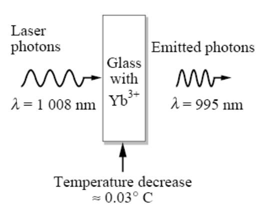
Level	Energies (eV)
∞	0
.	.
.	.
.	.
Z	–1.6
Y	–3.7
X	–5.5
W	–10.4

173. What frequency of electromagnetic radiation is required to excite mercury atoms from energy level W to energy level Z?

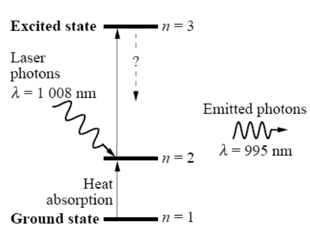
A. 2.1×10^{15} Hz
B. 2.5×10^{15} Hz
C. 2.9×10^{15} Hz
D. 3.1×10^{15} Hz

Use the following information to answer the next question.

Physicists have produced "optical cooling" by shining a laser onto glass that contains ytterbium ions (Yb^{3+}). The glass with ytterbium ions absorbs the laser photons and radiates photons with a shorter wavelength, as shown below. This process decreases the temperature of the glass with ytterbium ions.



One theory suggests that the cooling occurs because of electron movement between energy levels in the ytterbium ions, as shown below. If a ground state electron in an ytterbium ion absorbs a small amount of thermal energy, it moves to the second energy level ($n = 2$). The ion then absorbs the laser photon, which moves the electron to the excited state ($n = 3$). The cooling occurs when the ytterbium ion emits a photon.



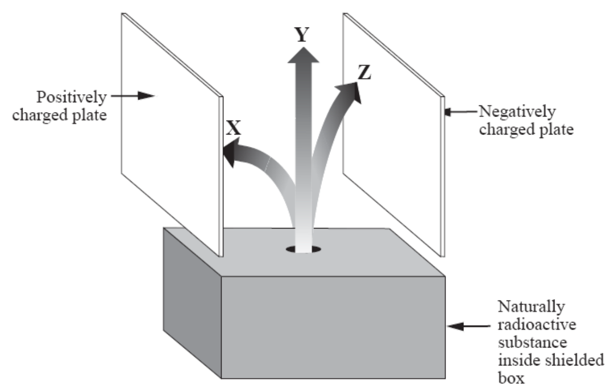
174. When the glass cools, the ions lose both the thermal energy and the energy that was absorbed from the laser photons. The electron energy level transition that occurs is from energy level

A. $n = 3$ to $n = 2$
B. $n = 3$ to $n = 1$
C. $n = 2$ to $n = 1$
D. $n = 2$ to $n = 3$

Unit 4 Review Questions

Use the following information to answer the next question.

Three types of radiation pass through an electric field along the paths shown below.



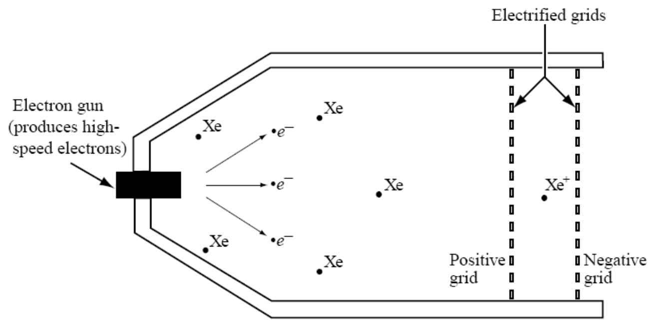
175. The types of radiation taking paths X, Y, and Z are, respectively,

A. beta, alpha, and gamma
B. beta, gamma, and alpha
C. gamma, alpha, and beta
D. alpha, gamma, and beta

Use the following information to answer the next three questions.

The Deep Space 1 mission (DS1) uses a ion propulsion system (IPS) on the DS1 capsule. The IPS involves ionizing atoms of xenon, accelerating them through an electric field produced by electrified grids, and ejecting the ions into space behind the capsule.

IPS Chamber of the DS1 Capsule



In the IPS chamber, high-speed electrons collide with xenon atoms. These collisions can ionize xenon atoms. The electric field then accelerates the ions and ejects them from the IPS chamber, which propels the DS1 capsule forward.

IPS Operating Specifications for DS1

propellant ions	Xe^{+}
total mass of propellant	81.5 kg
mass of DS1 capsule (without propellant)	489.5 kg
energy required to ionize a xenon atom	12.1 eV
mass of a single xenon atom	2.18×10^{-25} kg
exit speed of xenon ions	43.0 km/s

176. As xenon ions in the exhaust stream behind the DS1 capsule interact with other charged particles in space, the xenon ions become neutral atoms, and in the process, emit photons. The maximum frequency of these photons, expressed in scientific notation, is $\boldsymbol{b} \times 10^{w}$ Hz. The value of ***b*** is __________.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Use the following additional information to answer the next two questions.

One isotope of xenon, xenon-133, is an unstable isotope that undergoes beta decay and has a half-life of 5.24 days.

177. If the IPS uses 81.5 kg of xenon-133 as a propellant and the launch is delayed by 26.2 days, the amount of xenon 133 that would remain is __________ kg.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

178. The decay equation for xenon-133 is

A. ${}^{133}_{54}\text{Xe} \rightarrow {}^{133}_{54}\text{Xe} + \gamma$

B. ${}^{133}_{54}\text{Xe} \rightarrow {}^{129}_{52}\text{Te} + {}^{4}_{2}\alpha$

C. ${}^{133}_{54}\text{Xe} \rightarrow {}^{133}_{55}\text{Cs} + {}^{0}_{-1}\beta$

D. ${}^{133}_{54}\text{Xe} \rightarrow {}^{133}_{53}\text{I} + {}^{0}_{-1}\beta$

Use the following information to answer the next two questions.

The different colours seen in exploding fireworks are produced using different elements.

Element	**Predominant Colour**
Strontium	Red
Barium	Green
Copper	Blue-Green
Sodium	Yellow-Orange

179. Given the information above, the element that emits the lowest energy photon of visible light is

A. strontium
B. barium
C. copper
D. sodium

180. The colours are emitted by electrons that are

A. undergoing transitions to higher energy levels
B. undergoing transitions to lower energy levels
C. oscillating between energy levels
D. emitted by the nucleus

----

181. An experiment starts with 1.45 kg of iodine-131. After 32.2 days, 90.6 g are left. The half-life of iodine-131 is

A. 32.2 days
B. 16.1 days
C. 8.05 days
D. 4.04 days

Use the following information to answer the next four questions.

Fusion Research

Interest in nuclear fusion is growing because of the amount of energy available from nuclear reactions. A major difficulty in producing a nuclear fusion reaction is that in order for nuclei to fuse, the nuclei must possess a large amount of kinetic energy. Under most circumstances, 0.25 MeV per nucleus is sufficient. At such high energies, the nuclear fuel is called a plasma.

The average kinetic energy of a nucleus within a plasma can be found using

$$E_k = \frac{3}{2}bT$$

where T is the temperature of the plasma, in Kelvin, and b is a physical constant equal to 1.4×10^{-23} J/K.

One method of obtaining the temperatures necessary for fusion is to use a high-intensity laser to heat a small cluster of nuclei. One such laser emits a 1.0×10^{15} W pulse of ultraviolet radiation that lasts for 1.0×10^{-12} s. The wavelength of this laser is 280 nm.

A Fusion Reaction Equation

$${}^{2}_{1}\text{H} + {}^{3}_{1}\text{H} \rightarrow \underline{\;X\;} + \text{neutron}$$

182. The missing product, X, in the fusion reaction given above is

A. ${}^{5}_{2}He$
B. ${}^{4}_{2}He$
C. ${}^{4}_{1}H$
D. ${}^{3}_{2}He$

183. The main reason that the nuclei need to have such large kinetic energies is that

A. fusion releases large amounts of energy
B. fission must occur before fusion can occur
C. this kinetic energy is converted into nuclear energy
D. the nuclei must overcome a strong electrostatic repulsion

184. When the average kinetic energy of the nuclei in a plasma is 0.25 MeV, then the temperature is

A. 1.9×10^{9} K
B. 2.9×10^{9} K
C. 4.3×10^{9} K
D. 1.2×10^{28} K

185. The energy of a single photon of the ultraviolet laser is

A. 7.1×10^{-19} J
B. 1.0×10^{-27} J
C. 7.1×10^{-28} J
D. 1.9×10^{-40} J

----

186. The absorption spectrum of hydrogen is produced when electrons

A. emit radio frequency photons
B. emit short wavelength photons
C. jump from a higher orbital to a lower orbital
D. jump from a lower orbital to a higher orbital

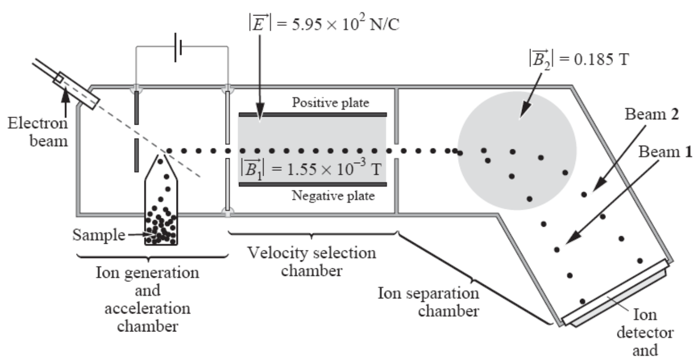
187. An accelerated electron with 8.77 eV of energy strikes a mercury atom and leaves the collision with 2.10 eV of energy. The maximum frequency of light that can be emitted by the mercury atom is

A. 1.01×10^{14} Hz
B. 5.07×10^{14} Hz
C. 1.61×10^{15} Hz
D. 2.12×10^{15} Hz

Use the following information to answer the next two questions.

A Mass Spectrometer

A particular lithium sample contains two isotopes. These isotopes are singly charged in an ion generation and acceleration chamber. Since individual atoms are ionized at different points in the acceleration chamber, their speeds vary when they enter the velocity selection chamber. In the velocity selection chamber, the electric field strength is 5.95×10^2 N/C and the magnetic field strength is 1.55×10^{-3} T. The velocity selection chamber allows ions of a certain speed to pass through undeflected. The beam of undeflected ions then enters the ion separation chamber where the magnetic field of 0.185 T splits the beam into two beams. Beam 1 curves through a radius of 0.131 m.



188. The speed of the undeflected ionized lithium ions, Li + , as they leave the velocity selection chamber is

A. 4.25×10^4 m/s
B. 3.84×10^5 m/s
C. 8.63×10^6 m/s
D. 7.22×10^7 m/s

189. The mass of a lithium ion in beam 1, expressed in scientific notation, is ***b*** x 10^{-w} kg. The value of ***b*** is __________.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

Bill notices that the picture on his television screen is distorted when a strong magnet is placed near it.

Note: This distortion can be permanent.

190. This distortion occurs because of the magnetic force acting on the

A. visible wavelengths of EMR
B. television circuits
C. moving electrons
D. gamma radiation

----

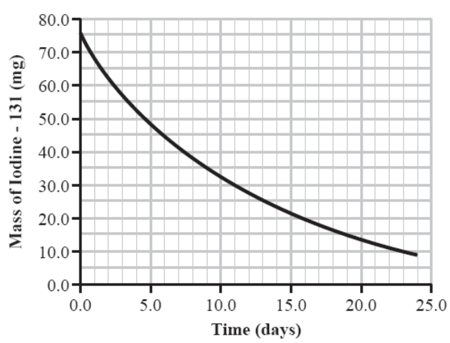
191. Which of the following types of radiation can be deflected by both electric fields and magnetic fields?

A. X-rays
B. Cathode rays
C. Photon beams
D. Electromagnetic waves

Use the following information to answer the next six questions.

A sample of iodine-131 has an initial mass of 76.0 mg. The activity of the sample is measured and the amount of iodine-131 remaining in the sample is determined. The following graph was obtained.

Mass of Iodine-131 Versus Elapsed Time



A particular nucleus of iodine-131 decays by emitting a beta particle that travels at 2.34×10^5 m/s and gamma radiation that has a wavelength of 5.36×10^{-12} m. Extra momentum and kinetic energy are carried off by a neutrino.

192. The half-life of iodine-131 is

A. 8.0 days
B. 12.0 days
C. 16.0 days
D. 24.0 days

193. After 48.0 days the amount of iodine-131 that remains in the sample is __________ mg.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

194. The energy emitted as gamma radiation during the transmutation of an iodine-131 nucleus is

A. 3.55×10^{-45} J
B. 2.68×10^{-27} J
C. 1.24×10^{-22} J
D. 3.71×10^{-14} J

Use the following additional information to answer the next question.

The momentum of the gamma ray photon and the beta particle can be calculated. The momentum of a gamma ray photon *(γ)* is determined by the equation $$p = \frac{h}{\lambda}$$

195. For the decay of iodine-131, the relationship between the magnitude of the momentum of the gamma ray photon (ρ_γ) and the magnitude of the momentum of the beta particle (ρ_β) can be represented by the equation

A. $p_\gamma = -p_\beta$

B. $p_\gamma = p_\beta$

C. $p_\gamma = (1.72 \times 10^{-3}) \times p_\beta$

D. $p_\gamma = (5.80 \times 10^{2}) \times p_\beta$

196. The equation for this radioactive decay is

A. ${}^{131}_{53}\text{I} \rightarrow {}^{127}_{51}\text{Sb} + \text{beta} + \text{gamma} + \text{neutrino}$

B. ${}^{131}_{53}\text{I} \rightarrow {}^{132}_{54}\text{Xe} + \text{beta} + \text{gamma} + \text{neutrino}$

C. ${}^{131}_{53}\text{I} \rightarrow {}^{132}_{53}\text{I} + \text{beta} + \text{gamma} + \text{neturino}$

D. ${}^{131}_{53}\text{I} \rightarrow {}^{131}_{54}\text{Xe} + \text{beta} + \text{gamma} + \text{neutrino}$

197. To protect lab technicians from harmful radiation, the equipment used in this experiment should be shielded with

A. lead to stop the γ radiation
B. paper to stop the β particles
C. an electric field to stop the γ radiation
D. a magnetic field to stop the β particles

----

198. The voltage required to stop an alpha particle with an initial speed of 5.34×10^4 m/s is __________ V.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Atomic Physics MC Answers

146	C										
147	D										
148	256										
149	D										
150	C	160	C	170	D	180	B	190	C		
151	D	161	2.55	171	C	181	C	191	A		
152	B	162	B	172	B	182	B	192	A		
153	D	162	A	173	A	183	D	193	1.19		
154	D	164	C	174	B	184	A	194	D		
155	B	165	2937	175	B	185	A	195	D		
156	A	166	A	176	2.92	186	D	196	D		
157	D	167	3.18	177	2.55	187	C	197	A		
158	B	168	1.79	178	C	188	B	198	29.6		
159	A	169	B	179	A	189	1.01				