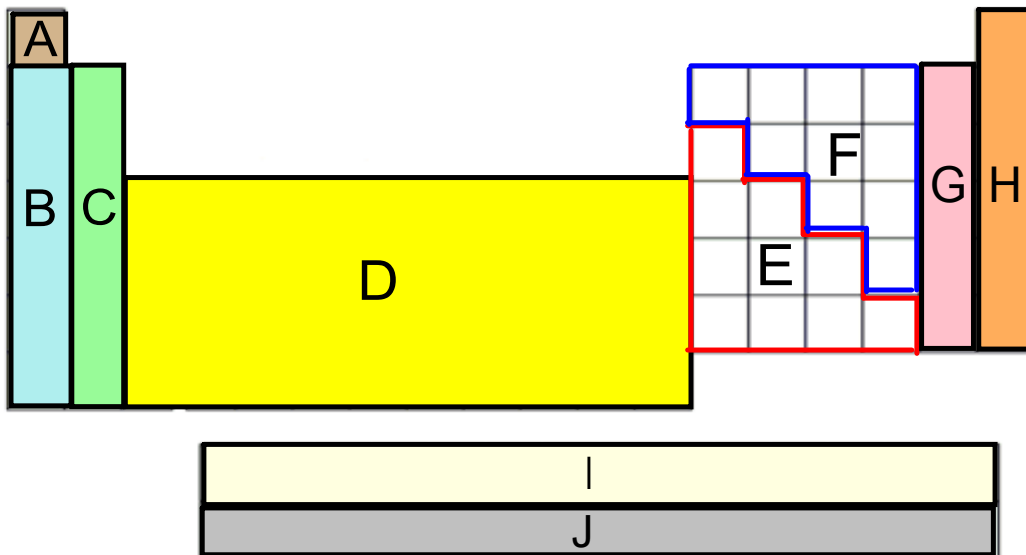


Pretest: Nuclear Technology (PSC - 4010)

1.



In which section(s) would you find:

a) the metals? _____

b) the nonmetals? _____

c) the halogens? _____

d) the actinides? _____

e) the alkaline earth metals? _____

f) the alkali metals? _____

g) the noble gases? _____

2. For each of the following statements, indicate the atomic model theory (i.e. Ancient Greeks, Dalton, Thomson, Rutherford, Bohr, or current simplified atomic model) to which it refers.

a) At the time of the Industrial Revolution, this man conducted experiments and made observations that allowed him to build on Democritus' atomic theory.

Ans: _____

b) The existence of electrons was confirmed through observations that cathode rays were deflected in magnetic fields.

Ans: _____

c) All of matter is made of four basic elements: earth, air, water, and fire.

Ans: _____

d) It concluded that the movement and distribution of electrons in atoms will affect how atoms react.

Ans: _____

e) Much thought was given in attempts to answer the question: "What is the nature of matter?"

Ans: _____

f) Gold foil was bombarded with helium nuclei, and this led to the conclusion that nuclei contain positively charged protons.

Ans: _____

3. Refer to the period table, and fill in the following chart:

Information on Bromine

Symbol: _____

Atomic number: _____

Atomic mass: _____

Number of protons: _____

Number of electrons: _____

Number of neutrons: _____

Group number: _____

Period number: _____

Number of energy levels: _____

Number of electrons in the outermost energy levels: _____

4. In a sample of pure neon gas:

- the mass number of 90.48% of the atoms is 20
- the mass number of 0.27% of the atoms is 21
- the mass number of 9.25% of the atoms is 22

Using the above information, calculate the average atomic mass of magnesium.

Show all steps in the solution.

5. For many years a variety of scientists made contributions towards developing our understanding of what an atom looks like.

a) What was Chadwick's contribution? That is, what did he add to Bohr's model in order that we would be left with the current simplified atomic model?

b) Identify three features of Bohr's model that remain in the simplified atomic model.

c) List two similarities between Thomson's model and Rutherford's model.

d) List three differences between Thomson's model and Rutherford's model.

6. Consider the following fictitious elements. They have been assigned the symbol "E" and identified using atomic notation.



- a) Which are isotopes of the same element?

- b) How many protons do these isotopes have?

- c) How many neutrons do these isotopes have?

7. Several different units are used to measure the intensity of radiation.

In the following table, match each definition with the corresponding unit of measurement.

Write the appropriate number in the parentheses after each definition.

Definition	Unit of Measurement
a) Smallest unit used to measure the number of disintegrations per second. ()	1. The becquerel
b) Largest unit used to measure the quantity of energy absorbed per kilogram of living tissue. ()	2. The sievert
c) Smallest unit used to measure the radiation dose resulting in biological damage when absorbed by the human body. ()	3. The curie
d) Largest unit used to measure the number of disintegrations per second ()	4. The rem
e) Smallest unit used to measure the quantity of energy absorbed per kilogram of living tissue. ()	5. The rad
f) Largest unit used to measure the radiation dose resulting in biological damage when absorbed by the human body. ()	6. The gray

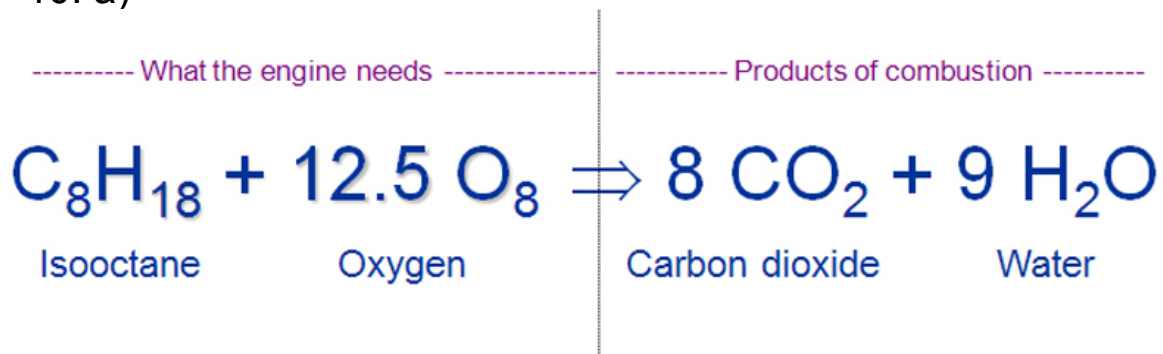
8. Complete the following sentences by choosing the correct missing word:

- a) The greater the mass defect the _____ (more or less) energy released during nucleus formation.
- b) The less nucleons in the nucleus the more _____ (stable or unstable) the nucleus.
- c) The more stable the nucleus the _____ (smaller or greater) the number of nucleons in the nucleus.
- d) The _____ (smaller or greater) the mass defect the more unstable the resulting atom.

9. Place a (P) for physical change, a (C) for chemical change, or an (N) for nuclear change in each of the spaces below.

- _____ When propane or any other gas is burned it is converted to steam and carbon dioxide (CO₂).
- _____ In a conventional thermal power plant, water in the boiler unit is converted into steam.
- _____ Since polonium is unstable it decays to lead.
- _____ When food is exposed to Co-60 its decay process is slowed.
- _____ Silver will turn greyish-black when it is placed in a bag with cooked egg white.
- _____ If iron filings are placed in a magnetic field, the iron filings themselves will turn into little magnets.

10. a)



The above equation shows what happens in a car engine. Explain why is this considered a chemical reaction.



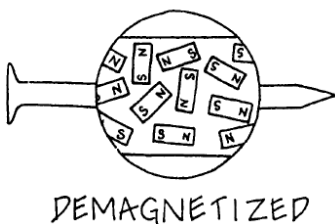
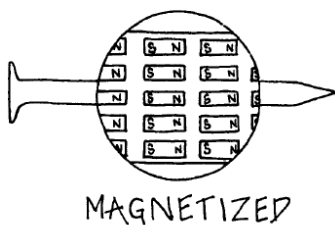
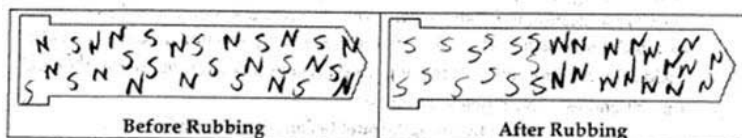
How do you know that the equation to the left represents a nuclear reaction?

Answer: _____

10. c) When regular iron nails are exposed to a magnetic field (e.g. rubbed with a magnet):



... The nails themselves become temporary magnets! :



... and then the nail can be used as a magnet to pick up substances which are made of magnetic metals (like iron, cobalt, and nickel)! :

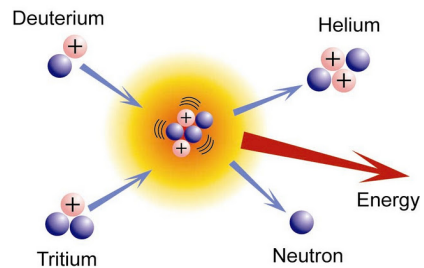


Explain the reason that this would be considered a physical change.

11. Indicate whether each of the following statements is true (T) or false (F):

a) Natural radioactivity is not emitted spontaneously. _____

b) The following represents a nuclear fusion reaction: _____



c) The fusion of a given quantity of matter produces more energy than the fission of the same quantity of matter. _____

d) The decay rate of a radioactive isotope will increase if the pressure is increased. _____

e) Radioactivity produced by artificial radioactive elements is not emitted spontaneously. _____

f) In a nuclear fusion reaction the total mass of the resulting atoms is slightly less than the total mass of the initial atoms. _____

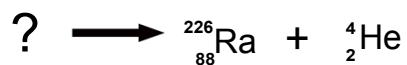
g) If the uranium is heated, then it will fission more quickly in a nuclear reactor. _____

12. A 10-kilogram sample of radioactive waste from a nuclear power plant contains 30 milligrams of radium-226. How much radium-226 will be left in this sample after 11 200 years? The half-life of radium-226 is 1600 years.

13. Check off the appropriate boxes:

Type of Radiation				
Statement	α	β	γ	x
It is the most penetrating type of radiation.				
It travels at the speed of light.				
It is not produced by radioactive elements.				
It consists of particles.				
It is not deflected by a magnetic field.				
It consists of electrons.				
It consists of helium nuclei.				
It can be stopped by a piece of wood.				

14. Given the following equation of a nuclear disintegration:



a) What type of radiation is emitted during this decay process?

b) Name the unknown element. Explain how you got your answer.

Unknown element: _____

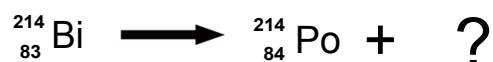
Explanation: _____

c) What is the mass number of this element? Explain your answer, based on the principle of conservation of mass.

Mass number: _____

Explanation: _____

15. The equation for the nuclear disintegration of bismuth-214 is the following:



a) What type of radiation is emitted during this decay process?

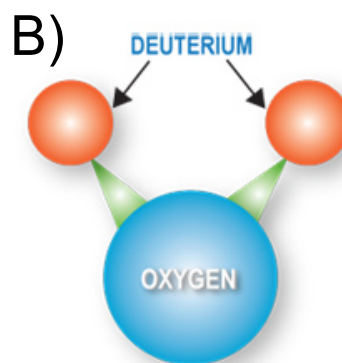
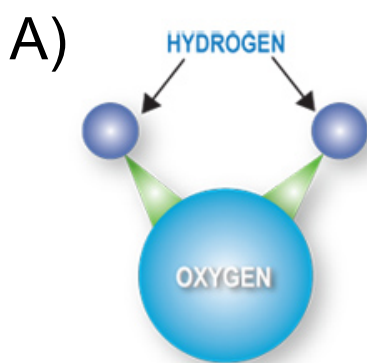
b) Using the principle of conservation of mass, explain why the mass number remains unchanged.

c) Explain why the atomic number increases from 83 to 84.

16. Indicate whether each of the following statements regarding the CANDU nuclear power reactor is true (T) or false (F).

- a) The same substance serves as a coolant and a moderator. _____
- b) Cadmium control rods speed up the neutrons. _____
- c) Coolant is converted into steam, and then it drives the turbine. _____
- d) The reactor does not need to be shut down when fuel bundles are changed. _____
- e) When electricity demand increases, the fission rate in the reactor can be increased to meet this demand. _____
- f) The coolant circulates in an open system. _____
- g) Cooling water is pumped into the condenser from a source outside the power station. _____
- h) Only one uranium isotope undergoes fission in the reactor core. _____
- i) The waste from the nuclear power station is not radioactive since fission reactions have stopped. _____

17. Differentiate between the two molecules below. For each, give one location where each is found in the CANDU nuclear power reactor.



Common name: _____

Common name: _____

Location found: _____

Location found: _____

18. Much research is being conducted in efforts to develop a nuclear power plant that uses fusion instead of fission as the energy source.

a) List two advantages of using fusion rather than fission as an energy source.

b) List two problems associated with using fusion as the energy source in a nuclear power plant.

19. **Canada was the world's largest uranium producer for many years, accounting for about 22% of world output, but in 2009 was overtaken by Kazakhstan. Production comes mainly from the McArthur River mine in northern Saskatchewan province, which is the largest in the world. Production is expected to increase significantly from 2013 as the new Cigar Lake mine comes into operation. With known uranium resources of 572,000 tonnes, as well as continuing exploration, Canada will have a significant role in meeting future world demand.**

a) List three ways that people living near a uranium mine can be exposed to radiation.

b) From an economic viewpoint, explain why Canada would continue to invest in uranium mining despite the health risks to Canadians.

20. A huge disadvantage of nuclear power plants is the problem of disposing of nuclear left-over waste.

There are about 270,000 tonnes of used fuel in storage, much of it at reactor sites. About 90% of this is in storage ponds, the balance in dry storage.

Explain why nuclear waste storage is a risk to the environment.

21. In spite of the fact that nuclear energy results in radioactive waste production, why is it said that "nuclear energy is a clean source of energy"?

22. *It doesn't take an accident* for a nuclear power plant to release radioactivity into our air, water and soil. All it takes is the plant's everyday routine operation, and federal regulations permit these radioactive releases.

Name one possible health effect that radioactive gas leakage may have on people living near the power station.

23. Accidents involving nuclear reactors such as Chernobyl (1986) have released strontium into the atmosphere, which ultimately settles to the earth's surface as fallout. Chernobyl contributed the largest worldwide burden of strontium-90 contamination, and a substantial portion of the strontium-90 released was deposited in the former Soviet Republics; with the rest being dispersed as fallout worldwide.

After settling into the earth, Sr-90 enters the food chain. It is present in the grass, in the bodies of animals that eat grass, and subsequently in the bodies of people who drink milk from infected cows, or who eat the meat of infected animals. What two kinds of cancer can be caused by the build-up of this harmful radioactive isotope in the body?

24. Radioactive isotopes like fluorine-18 (half life of 20 minutes) are used in medicine (specifically for PET scans). Give one reason that it is important that radioisotopes have a short half life.
-

25. In the space beside each statement below, place an "A" for atomic bomb or an "H" for hydrogen bomb.

- ___ a) This bomb is a thermonuclear bomb.
- ___ b) In this bomb, the fissile material is divided into two separate blocks, each with a mass lower than the critical mass.
- ___ c) This bomb involves nuclear fusion.
- ___ d) In theory, there is no limit to the explosive power of this bomb.
- ___ e) Plutonium can be used for this type of bomb.
- ___ f) This bomb produces less energy than the other type of bomb.
- ___ g) The other type of bomb is required to detonate this bomb.
- ___ h) A limited amount of material must be used to make this bomb.

26. The following statements pertain to one or more of the types of power stations that were covered in class. For each statement, write the corresponding letter in each of the boxes to which it applies. Each letter may need to be placed in more than one of the boxes!

- A) This type of power station has a coolant.
- B) Coal may be used as the fuel source in this type of power station.
- C) This type of power station has a condenser.
- D) This type of power station has a boiler.
- E) This type of power station produces waste or pollution.
- F) Pressurized steam drives the turbine in this type of power station.
- G) This type of power station uses the potential gravitational energy of water.

Hydroelectric Power Station	Conventional Thermal Power Station	Nuclear Power Station

27. Canada, Russia, and the United States vary in terms of the components used in their nuclear power plants.

Choose the correct answer from the list below and write it in the appropriate box.

	Reactor Components	Canada	Russia	United States
Plutonium, Natural Uranium, or Enriched Uranium	Type of Fuel			
Heavy Water, Ordinary Water, or Graphite	Moderator			
Heavy Water, Ordinary Water, or Pressurized Gas	Coolant			

28. List two ways in which irradiation prevents a potato from spoiling quickly.
