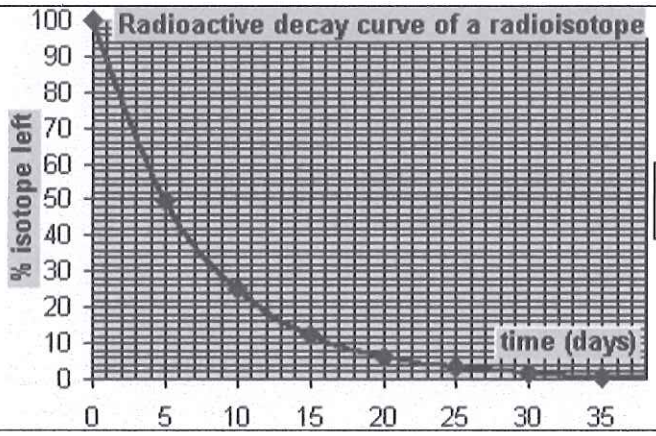
HS Energy Unit Study Guide

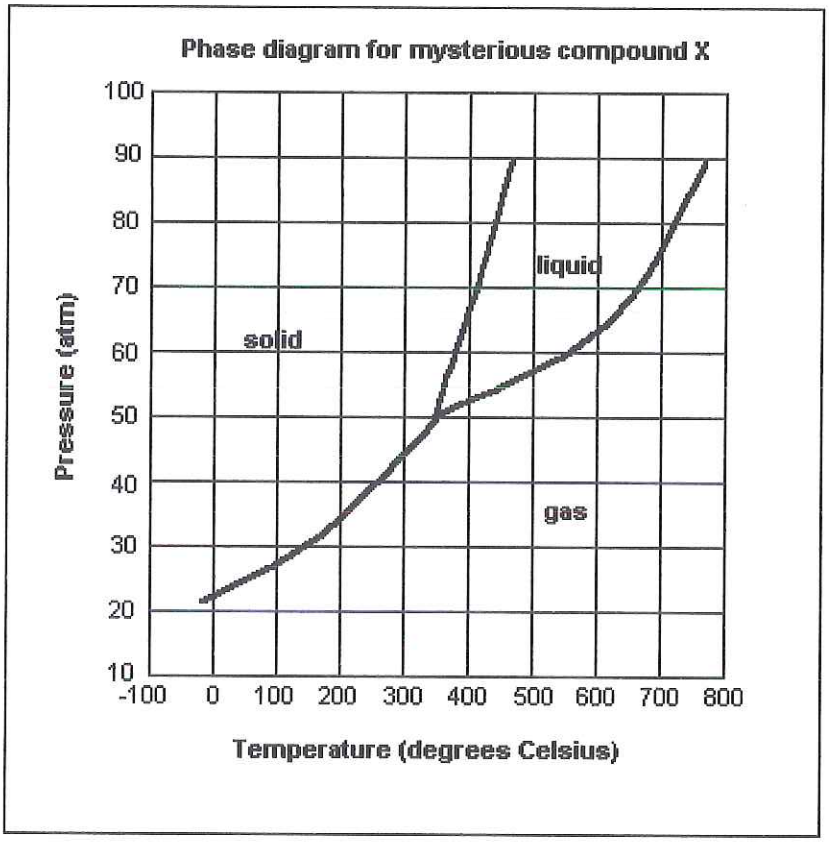
1. Define isotope.	
2. Write the isotope notation for Polonium-209 and label the atomic number and the mass number.	
3. Define radioactivity.	
4. Define radioisotope.	
5. What are the 3 types of radioactive decay?	
6.	A helium nucleus emitted by some radioactive substances
7.	A fast moving electron emitted by radioactive decay of substances.
8.	Electromagnetic radiation emitted during radioactive decay
9. Complete the chart about nuclear radiation	

Type of decay	Symbol		Charge	Mass	Can be stopped by

10. What force causes alpha decay? Explain How	
11. What force causes beta decay? Explain How	
12. Write the nuclear equations for the following radioactive decay series:	Uranium-235 goes through alpha decay Thorium-231 goes through gamma and beta decay Protactinium-231 goes through alpha and gamma decay Actinium-227 goes through beta decay Th-227 goes through alpha and gamma decay

13. Complete the following nuclear reactions:	What is the name of the product isotope formed when Radon-222 decays by alpha decay? What is the name of the product isotope formed when Thorium-234 decays by beta decay? Uranium-238 undergoes an alpha decay and produces 2 gamma rays
14. What is Nuclear Fission?	
15. Use the terms critical mass and chain reaction to diagram a Fission reaction	
16. What is Nuclear Fusion	
17. Identify two uses of nuclear fission	
18. Where does nuclear fusion does takes place? Why is it not used on Earth?	
19. List 2 advantages of nuclear energy.	1. 2.
20. List 1 disadvantage of nuclear energy	
21. Define Half-Life	
22. The half life of a radioisotope is 3 days. If you started with 600 mg of material, how much would be left in 15 days?	
23. You start with 800 grams of a radioisotope. In 36 hours, there are 100 grams left. What is the half-life of this radioisotope?	

24. What is the half-life of this substance?	 Half-Life = _____
25. Define energy	
26. What does the Law of Conservation of Energy state?	
27. What is Potential Energy?	
28. What is Kinetic Energy?	
29. Define the 8 forms of energy. *Circle Each Potential Energy*	a. Mechanical Energy _____ b. Electromagnetic Energy _____ c. Electrical energy _____ d. Chemical energy _____ e. Thermal Energy _____ f. Sound Energy _____ g. Gravitational Energy _____ h. Nuclear Energy _____
30. What is an energy transformation?	
31. Identify the energy transformation	a. The Sun b. Walking c. Solar Energy
32. Identify and define the 3 types of Heat Transfer	1. 2. 3.
33. How does heat move? Explain	
34. Identify the type of heat being transferred	1. Walking on hot sand _____ 2. Weather Patterns _____ 3. Warming hands next to a fire _____ 4. Hot air circulating around the house _____ 5. Boiling Water _____ 6. The Sun warming the Earth _____ 7. Shaking Hands _____ 8. Eggs frying in a pan _____
35. Define Specific Heat.	
36. What is the formula for specific heat? Label each variable	

37. When 3.0 kg of water is cooled from 80.0°C to 10.0°C, how much heat energy is lost?	Plug & Chug
38. How much heat is needed to raise a 0.30 kg piece of aluminum from 30.°C to 150°C?	Plug & Chug
39. A 15.75-g piece of iron absorbs 1086.75 joules of heat energy, and its temperature changes from 25°C to 175°C. Calculate the specific heat capacity of iron.	Plug & Chug
40. 100.0 mL of 4.0°C water is heated until its temperature is 37°C. If the specific heat of water is 4.18 J/g°C, calculate the amount of heat energy needed to cause this rise in temperature	Plug & Chug
41. For each of the questions on this worksheet, refer to the phase diagram for mysterious compound X. a. What is the critical temperature of compound X? _____ b. At what temperature and pressure will all three phases coexist? T= _____, P= _____ c. If I have a bottle of compound X at a pressure of 45 atm and temperature of 100^0 C, what will happen if I raise the temperature to 400^0 C? _____ d. What temperature will mystery X boil with a constant pressure of 70atm? _____ e. How much pressure will cause the substance to melt at 400°C? _____	

KEY

HS Energy Unit Study Guide

1. Define isotope. — 2 or more forms of the same element (Neutrons change)

2. Write the isotope notation for Polonium-209 and label the atomic number and the mass number. — Po-209 = $^{209}_{84}Po$

3. Define radioactivity. — Process of emitting charged particles

4. Define radioisotope. — Isotope w/ an unstable nucleus

5. What are the 3 types of radioactive decay? — Alpha, Beta, Gamma

6. Alpha — A helium nucleus emitted by some radioactive substances

7. Beta — A fast moving electron emitted by radioactive decay of substances.

8. Gamma — Electromagnetic radiation emitted during radioactive decay

9. Complete the chart about nuclear radiation

Type of decay	Symbol		Charge	Mass	Can be stopped by
Alpha	$^{4}_{2}\alpha$	$^{4}_{2}He$	2+	4 AMU	Paper
Beta	$^{0}_{-1}\beta$	$^{0}_{-1}e$	-1	0 AMU	Al ("paper")
Gamma	γ		0	0 AMU	9 inches of concrete

10. What force causes alpha decay? Explain How — Electromagnetism (Strong + repelling force)

11. What force causes beta decay? Explain How — Weak force (Turns a neutron into a proton → ejects an e^-)

12. Write the nuclear equations for the following radioactive decay series:

Uranium-235 goes through alpha decay

$$^{235}_{92}U \longrightarrow {}^{231}_{90}Th + {}^{4}_{2}\alpha$$

Thorium-231 goes through gamma and beta decay

$$^{231}_{90}Th \longrightarrow {}^{231}_{91}Pa + {}^{0}_{-1}e + \gamma$$

Protactinium-231 goes through alpha and gamma decay

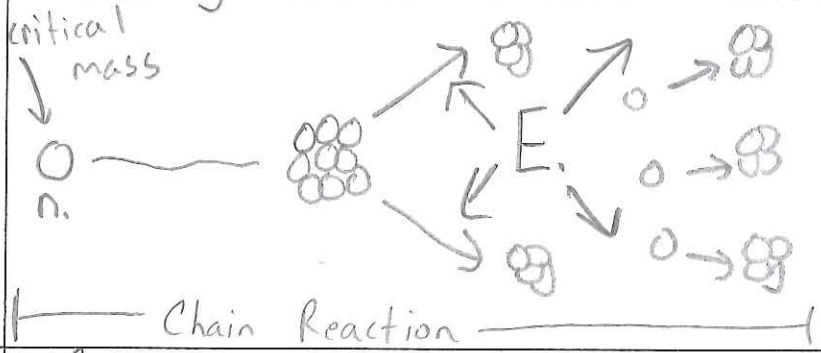
$$^{231}_{91}Pa \longrightarrow {}^{227}_{89}Ac + {}^{4}_{2}\alpha + \gamma$$

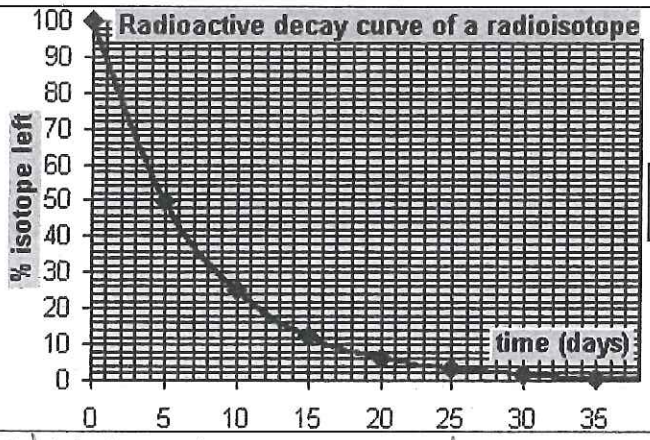
Actinium-227 goes through beta decay

$$^{227}_{89}Ac \longrightarrow {}^{227}_{90}Th + {}^{0}_{-1}e$$

Th-227 goes through alpha and gamma decay

$$^{227}_{90}Th \longrightarrow {}^{223}_{88}Ra + {}^{4}_{2}He + \gamma$$

13. Complete the following nuclear reactions:	What is the name of the product isotope formed when Radon-222 decays by alpha decay? $^{222}_{86}Rn \rightarrow {}^{218}_{84}Po + {}^{4}_{2}\alpha$ What is the name of the product isotope formed when Thorium-234 decays by beta decay? $^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}e$ Uranium-238 undergoes an alpha decay and produces 2 gamma rays $^{238}_{92}U \rightarrow {}^{4}_{2}He + {}^{234}_{90}Th + 2\gamma$
14. What is Nuclear Fission?	Splitting of an atomic nuclei
15. Use the terms critical mass and chain reaction to diagram a Fission reaction	
16. What is Nuclear Fusion	Combining of 2 atoms to make 1
17. Identify two uses of nuclear fission	1) Nuclear E. 2) Weapons
18. Where does nuclear fusion ~~does~~ takes place? Why is it not used on Earth?	SUN (Can't control heat + pressure — YET! :)
19. List 2 advantages of nuclear energy.	1. Efficient 2. Clean
20. List 1 disadvantage of nuclear energy	Where do we store nuclear waste?
21. Define Half-Life	Time it takes for ½ of the mass of a radio isotope to decay
22. The half life of a radioisotope is 3 days. If you started with 600 mg of material, how much would be left in 15 days?	600 (3 days) → 300 (6 days) → 150 (9 days) → 75 (12 days) → 37.5 1st ½ 2nd ½ 3rd ½ 4th ½ (15 days) 18.75 5th ½
23. You start with 800 grams of a radioisotope. In 36 hours, there are 100 grams left. What is the half-life of this radioisotope?	800 (12) → 400 (24) → 200 (36 hrs.) → 100 Total 1st 2ND 3rd

24. What is the half-life of this substance?	 Half-Life = 5 days
25. Define energy	ability to cause change or do work
26. What does the Law of Conservation of Energy state?	E. cannot be created or destroyed
27. What is Potential Energy?	Stored E.
28. What is Kinetic Energy?	Moving E.
29. Define the 8 forms of energy. *Circle Each Potential Energy* "N C G"	a. Mechanical Energy — MOVING b. Electromagnetic Energy — Light c. Electrical energy — Moving Electrons (d.) Chemical energy — Stored in bonds blw atoms e. Thermal Energy — Heat f. Sound Energy — Vibrating Matter (g.) Gravitational Energy — Ability to "Fall" (h.) Nuclear Energy — Within the nucleus
30. What is an energy transformation?	E. changes from 1 form to another
31. Identify the energy transformation	a. The Sun: N (T) → Em b. Walking: C (T) → M c. Solar Energy: Em (T) → E
32. Identify and define the 3 types of Heat Transfer	1. Radiation (Empty Space) 2. Conduction (Direct Contact) 3) Convection (Moving Fluid)
33. How does heat move? Explain	Hot → Cold
34. Identify the type of heat being transferred	1. Walking on hot sand — Conduction 2. Weather Patterns — Convection 3. Warming hands next to a fire — Radiation 4. Hot air circulating around the house — Convection 5. Boiling Water — Convection 6. The Sun warming the Earth — Radiation 7. Shaking Hands — Conduction 8. Eggs frying in a pan — Conduction
35. Define Specific Heat.	amount of heat necessary to raise 1 g of a substance by 1°C
36. What is the formula for specific heat? Label each variable	Heat Absorbed → $Q = m \times C \times \Delta T$ ← Change in temp. C = specific Heat m = Mass

$Q = m \times C \times \Delta T$

Remember: 1 mL = 1 g

37. When 3.0 kg of water is cooled from 80.0°C to 10.0°C, how much heat energy is lost?

Plug & Chug

$Q = 3 \times 4.18 \times 70^\circ$ $\quad Q = 877.8\ J$

38. How much heat is needed to raise a 0.30 kg piece of aluminum from 30.°C to 150°C?

Plug & Chug

$Q = .3 \times .9 \times 120^\circ$ $\quad C = .9$

$Q = 32.4\ J$

39. A 15.75-g piece of iron absorbs 1086.75 joules of heat energy, and its temperature changes from 25°C to 175°C. Calculate the specific heat capacity of iron.

Plug & Chug

$\frac{1086.75}{15.75 \times 150} = \frac{15.75 \times C \times 150^\circ}{15.75 \times 150^\circ}$

$\frac{1086.75}{2362.5} = .4\ J/g \cdot °C$

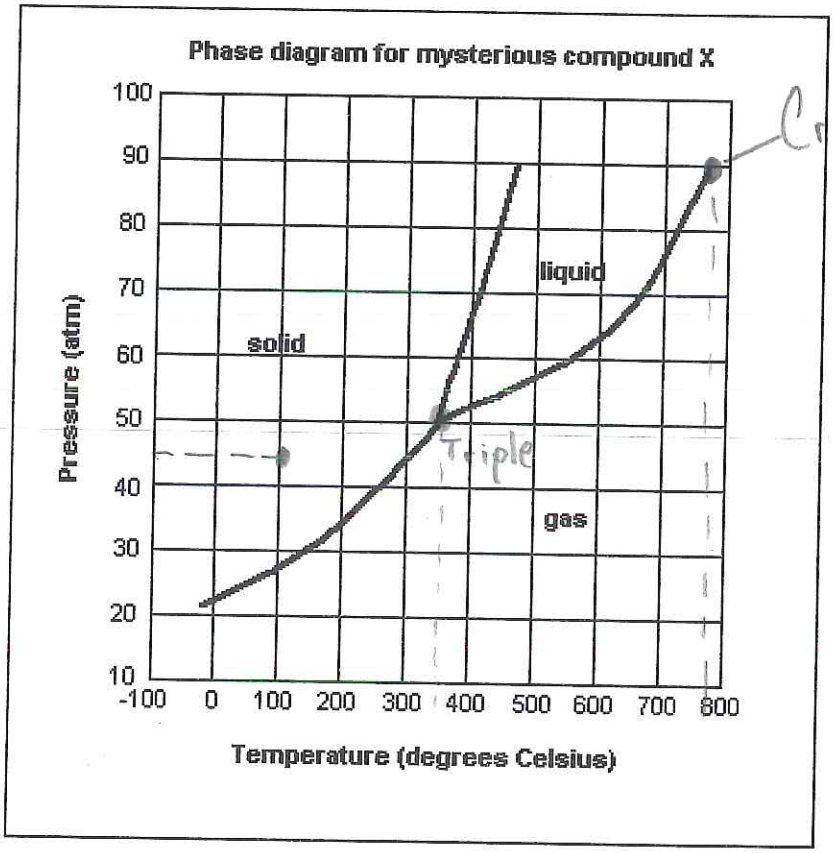
40. 100.0 mL of 4.0°C water is heated until its temperature is 37°C. If the specific heat of water is 4.18 J/g°C, calculate the amount of heat energy needed to cause this rise in temperature

Plug & Chug

$Q = 100 \times 4.18 \times 33^\circ$

$Q = 13{,}794\ J$

41. For each of the questions on this worksheet, refer to the phase diagram for mysterious compound X.



a. What is the critical temperature of compound X? 780°

b. At what temperature and pressure will all three phases coexist? T= 350°C P= 50 atm

c. If I have a bottle of compound X at a pressure of 45 atm and temperature of 100° C, what will happen if I raise the temperature to 400° C? Sublimation

d. What temperature will mystery X boil with a constant pressure of 70atm? 660°C

e. How much pressure will cause the substance to melt at 400°C? 67 atm