UNIT 6: RADIOACTIVITY AND NUCLEAR CHEMISTRY

WASHINGTON LATIN PUBLIC CHARTER SCHOOL

HONORS CHEMISTRY 2019-20

UNIT 6 TEST – RADIOACTIVITY AND NUCLEAR REACTIONS

Answer all questions

Recommended time = 25 minutes

You will need a Periodic Table and a calculator

Name:	
Score (open response)	/15
Score (multiple choice)	/5
Bonus (Submits quiz on time and in correct format)	/20
Total:	/40

UNIT 6: RADIOACTIVITY AND NUCLEAR CHEMISTRY

SECTION A - OPEN RESPONSE

Fill in all green cells

1.	Radon is a monatomic gas released naturally by most rocks. All of its isotopes are radioactive; its most abundant isotope, radon-222, is an alpha emitter.		
	(a)	Write an equation to show the decay of radon-222. (Use this template: $^{A}_{Z}E$)	2
		$^{222}_{?}Rn \rightarrow {}^{?}_{?}? + {}^{4}_{2}\alpha$	
	(b)	The radioactivity of radon-222 falls to 3.125% of its initial intensity after 19 days. Calculate the half-life of radon-222.	2
		3.125% = how many half-lives? Start at 100% - keep dividing by 2 until you get 3.125% Then use $t_{1/2} = \frac{t}{n}$	
	(c)	Radon eventually decays (via several other isotopes) into lead-210. How many alpha particles and how many beta particles must be emitted to convert radon-222 into lead-210? Explain your answer.	2
		- beta emission does not change A, so any change in A must come from alpha emission. So how many alpha particles must be emitted? - then figure out what the new Z would be if only alpha particles had been emitted - then figure out how many beta particles must also have been emitted, given that each beta emission increases Z by 1	
	(d)	Suggest why it is important to monitor the rate at which different rocks emit radon gas.	2
		Radon is a gas and an alpha emitter. Why is this a bad combination?	
		TOTAL	8

UNIT 6: RADIOACTIVITY AND NUCLEAR CHEMISTRY

2.	The sun's energy comes from fusing the nuclei of $^{1}_{1}\mathrm{H}$ and $^{2}_{1}\mathrm{H}$ to make $^{4}_{2}\mathrm{He}$. Nuclear energy on earth is generated by the fission of large atoms such as thorium-232.		
	(a)	Explain why the fusion of of $^{1}_{1}\mathrm{H}$ and $^{2}_{1}\mathrm{H}$ releases so much energy.	
		The more stable the new nucleus, the greater the quantity of energy is released. Which of the atoms in the equation has the most stable nucleus?	1
	(b)	Explain why extremely high temperatures and pressures are needed to get this fusion reaction started.	
		Why is it so difficult to get two nuclei to fuse? (think of the charges in a nucleus)	1
	(c)	State how most fission reactions are started.	
		There is only one way to start a fission reaction – look it up!	1
	(d)	The fission of thorium-232 produces xenon-137, two neutrons and one other product. Identify the other product and write a nuclear equation for the fission reaction. (Use this template: $^{A}_{Z}\mathrm{E} \rightarrow$)	
		$^{232}_{?}\mathrm{Th} \rightarrow {}^{137}_{?}\mathrm{Xe} + {}^{?}_{?}? + 2{}^{1}_{0}\mathrm{n}$	2
	(e)	Explain why this reaction needs to be controlled, and explain how it is controlled.	
		Why can this reaction easily become a chain reaction? How do you stop this happening?	2
	TOTAL		7

UNIT 6: RADIOACTIVITY AND NUCLEAR CHEMISTRY

SECTION B - MULTIPLE CHOICE

Do not answer these questions on this sheet
Make a note of your answers and enter them in the answer sheet.

3.	It is possible to monitor blood circulation by using a radioactive tracer. What type of radioactive material should be used? The radioactive particles are inside the body – so what type of half-life is best? The detector is outside the body – so what type of radiation is needed?	
	A	An alpha emitter with a long half-life
	B	An alpha emitter with a short half-life
	C	A gamma emitter with a long half-life
	D	A gamma emitter with a short half-life
	E	A beta emitter with a medium half-life
		1

4.	Which atom could turn into sulfur-32 by emitting a beta particle? Beta emission increases Z by 1 but has no effect on A	
	A	Sulfur-33
	B	Phosphorus-32
	C	Chlorine-32
	D	Phosphorus-31
	E	Chlorine-31
		1

UNIT 6: RADIOACTIVITY AND NUCLEAR CHEMISTRY

5.	A skeleton of a mammoth was analysed and found to contain 21.2% of the carbon-14 found in living bone. The half-life of carbon-14 is 5730 years. What is the most likely year of the mammoth's death? Use $\log(\frac{N_i}{N}) = \frac{t\log 2}{t_{1/2}}$ $\frac{N_i}{N} = \frac{100}{21.2}$, $t_{1/2}$ = 5730 years; hence find t This year – t = year of death	
	A	10,800 BC
	B	11,800 BC
	C	12,800 BC
	D	13,800 BC
	E	14,800 BC
		1

6.	Which of the following statements is not true?	
	A	Hydrogen-3 is a beta emitter Beta emitters have too many neutrons
	B	All of the isotopes of astatine (At) are radioactive All atoms with Z > 82 are radioactive
	C	Gamma radiation is most likely to be emitted alongside alpha or beta radiation if the mass defect is small. The larger the mass defect, the greater the decrease in potential energy
	D	The emission of an alpha particle and then a beta particle from neptunium-237 produces uranium-233 Alpha emission reduces A by 4 and Z by 2. Beta emission increases Z by 1
	E	Copper is unlikely to undergo fission or fusion reactions, even in stars Iron-56 is the most stable nucleus; fission and fusion reacts will occur in stars only if the products are closer in size to iron-56 than the reactants
		1

7.	The fusion of helium-3 with nitrogen-14 would produce oxygen-16 and $^{3}_{?}\mathrm{He} + {}^{14}_{?}\mathrm{N} \rightarrow {}^{16}_{?}\mathrm{O} + ?$	
	A	A proton $(^{1}_{1}\mathrm{H})$
	B	A neutron $(^{1}_{0}\mathrm{n})$
	C	An alpha particle $(^{4}_{2}\mathrm{He})$
	D	A beta particle $(^{0}_{-1}\mathrm{e})$
	E	Nothing else (oxygen-16 would be the only product)
		1

End of Test

Answer sheet and exit ticket