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Title:	**Quiz1**
Started:	September 10, 2010 4:03 PM
Submitted:	September 10, 2010 6:20 PM
Time spent:	02:16:40
Total score:	**18.86/24 = 78.5833%** | Total score adjusted by 0.0 | Maximum possible score: 24

Completed

1.

The proportion of metals in a planet or moon increases the closer that body is to the Sun. That is because:

	Student Response	Value	Correct Answer	Feedback
1.	the gas/dust disk from which the bodies in the solar system formed had a compositional gradient away from the Sun in order to conserve angular momentum. The amount of metals decreased away from the Sun.			
2.	many metals and metal compounds could condense at the high temperatures		☑	

	Student Response	Value	Correct Answer	Feedback
	quite close to the Sun; other materials could not.			
	3. many metals and metal compounds can only condense at the high temperatures close to the Sun, they could not condense as easily further from the Sun.			
	4. gravity caused more collisions closer to the Sun, resulting in high accretion rates.			
	5. all of the above	0%		

Score: 0/1

2.

A significant part of our bodies, our planet, and the universe is made up of atoms. [A cosmologist may want to get into a discussion about dark matter and subatomic particles here, but lets just stay with atoms].

Which of the following statements about atoms are true (several are correct):

	Student Response	Value	Correct Answer	Feedback
	A. Hydrogen	34%	✓	Yup. Check out the proportions in the notes and

	Student Response	Value	Correct Answer	Feedback
	(H) and Helium (He) are by far the most common atoms in the universe.			text.
B.	Young stars are almost entirely made up of hydrogen and helium atoms.	33%	✓	Yep. They will produce heavier atoms over their lifespan and will produce (fuse together) heavy atoms (heavier than iron atoms) when they finally explode in a supernova.
C.	With the exception of the hydrogen, pretty much all of the atoms in your computer, mp3 player, shoes, toothpaste, underwear, and the food you ate today were formed within our Sun.			
D.	Stars can produce atoms as large as iron (Fe) by their normal	33%	✓	True. Note that all of these heavier atoms that are important in our planet and our lives were not formed BY or IN our Sun - but rather were formed by other stars that are now extinct. Hence the quote you've probably seen, 'we are all stardust'. Just not our own star's dust.

	Student Response	Value	Correct Answer	Feedback
	fusion processes. (Iron has 26 protons and usually about 30 neutrons). Larger atoms require more energy to form than a normal star posesses.			
E.	Stars can produce all the larger atoms by their normal fusion processes. For example, Uranium (which has 92 protons and around 136 neutrons)			

Score: 2/2

3.

Several of these are true. Which ones? (penalty for wrong answers).

The tail that streams out from a comet nucleus:

	Student Response	Value	Correct Answer	Feedback
A.	Is present no matter where the comet is in it's orbit around the Sun.	0%		can precede the comet (be ahead of it).
B.	are the dust and gas freed from the frozen comet nucleus by sublimation	33%	✓	
C.	point away from the Sun, essentially blown by the solar wind.	34%	✓	
D.	always streams out behind the comet.			
E.	would never contain water vapour.			

	Student Response	Value	Correct Answer	Feedback
F.	actually has two components, a dust tail and an ion tail.	33%	✓	

Score: 1.5/1.5

4.

Why is the process by which the Earth (and many other of the larger bodies in the solar system) became layered called the "iron catastrophe"?

	Student Response	Value	Correct Answer	Feedback
A.	Temperature rose to the point where iron compounds melted. The molten iron sank, generating more heat. That caused the catstrophic, complete melting of the Earth.	100%	✓	
B.	The formation of the Moon claimed most of the Earth's iron compounds, leaving the depleted Earth in an iron catastrophe.			
C.	Iron melted preferentially due to its			

	Student Response	Value	Correct Answer	Feedback
	conductive properties. Melting released heat-producing radioactive elements that subsequently caused a catastrophic, complete melting of the Earth.			
D.	Iron and iron compounds make up an extremely small proportion of the Earth. But when they melted their motion triggered a catastrophic, complete melting of the Earth.			

General Feedback: Temeprature rose to the point where iron compounds melted. The molten iron sank, generating more heat. That caused the catstrophic, complete melting of the Earth. The key is that things became layered based on their compound density.

Score: 1/1

5.

Which is FALSE? The iron catastrophe of the Earth resulted in_____.

	Student Response	Value	Correct Answer	Feedback
A.	the Earth's lower mantle and core being enriched with	100%	✓	FALSE (and therefore the right answer) Most of the heavy radioactive atoms actually bound with lighter atoms to form quite light compounds that floated up in the felsic rock - so they are now dominantly found in the

	Student Response	Value	Correct Answer	Feedback
	radioactive atoms.			continental crust.
B.	the Moon's compositional differences from the Earth.			
C.	a concentrically layered planet, with the layers ordered by compound density			
D.	an early atmosphere was created due to release of volatile gases from the melting.			
E.	the planet cooling more quickly because the radioactive atoms were concentrated in the Earth's crust.			

General Feedback: *the Earth's lower mantle and core being enriched with radioactive atoms.*
FALSE (and therefore the right answer) Most of the heavy radioactive atoms actually bound with lighter atoms to form quite light compounds that floated up in the felsic rock - so they are now dominantly found in the continental crust.

the planet cooling more quickly because the radioactive atoms were concentrated in the Earth's crust.
Yes! The Earth may still be molten inside had this not occurred!

an early atmosphere was created due to release of volatile gases from the melting.
This is also true, although there are strong arguments that suggest that the accretion of comets after the iron catastrophe could have brought a significant component to our ocean/atmosphere system.

a concentrically layered planet, with the layers ordered by compound density
Also true. Had the Earth not already have been differentiated (or layered), the Moon would have had a more similar composition to the Earth in that it would have had more metallic composition. Or in otherwords, it would have had a larger core.

Score: 1/1

6.

Having just won another Nobel prize, you decide to change fields and go into astronomy. Operating on a hunch, you discover yet another dwarf planet in an orbit just a bit further out than Pluto.

Knowing what you do about the theories of condensation and accretion for the formation of our solar system, would you expect it to have:

	Student Response	Value	Correct Answer	Feedback
A.	a metallic core about the same proportion as the Earth's core to the entire Earth (the core's radius is about 1/2 the Earth's radius).			
B.	an extremely large metallic core (comprising most of the interior of the dwarf planet)			
C.	a very small metallic core	100%	✓	Possible, but why?

	Student Response	Value	Correct Answer	Feedback
	compared to the size of the dwarf planet			
D.	no metallic core		☑	

General Feedback: We'll talk about this one more after the Assignment...

Score: 2/2

7.

The proportion of metals in a planet or moon increases the closer that body is to the Sun. That is because (one answer):

	Student Response	Value	Correct Answer	Feedback
A.	Metals could condense at the high temperatures quite close to the Sun; other materials could not.		☑	
B.	Gravity caused more collisions closer to the Sun, resulting in high accretion rates.			
C.	All of the above.	0%		
D.	Metals could condense at the high temperatures close to the			

	Student Response	Value	Correct Answer	Feedback
	Sun, but they could not condense as easily further from the Sun.			
E.	The gas/dust disk from which the bodies in the solar system formed had a compositional gradient away from the Sun in order to conserve angular momentum. The amount of metals decreased away from the Sun.			

Score: 0/0

8.

The time it took our solar system to form appears to be astoundingly short. We have age dates for the oldest rocks on Earth, rocks from the Moon, and asteroids that have fallen to Earth as meteorites. Those dates give some bounds on when those rocks were last molten. To come up with dates beyond that, we have to rely on the physics behind models of the formation process. Match the dates with the events below.

Depending on where you look, you may find slightly different numbers. Just choose the best answers - consider the sequence.

Dates can only be used once...

Statement	Response	Value	Correct Match
~0 years ago	Youngest known rocks from Earth (most recent magmatism)	9.09%	Youngest known rocks from Earth (most recent magmatism)

Statement	Response	Value	Correct Match
~200 Ma (million years ago)	Oldest oceanic crust on Earth	9.09%	Oldest oceanic crust on Earth
~3.2 Ga (billion years ago)	Youngest known rocks from Moon (most recent magmatism)	9.09%	Youngest known rocks from Moon (most recent magmatism)
~4.022 Ga (billion years ago)	Oldest known rocks (rocks not mineral grains) from Earth	9.09%	Oldest known rocks (rocks not mineral grains) from Earth
~4.44 Ga (billion years ago)	Oldest known rocks from Moon	9.09%	Oldest known rocks from Moon
~4.56 Ga (billion years ago)	Age of majority of meteorites (asteroid fragments)	9.09%	Age of majority of meteorites (asteroid fragments)
~4.6 Ga (billion years ago)	Approximate age for Moon formation	9.09%	Approximate age for Moon formation
~4.7 Ga (billion years ago)	Planetary system pretty much formed	9.09%	Planetary system pretty much formed
~4.98 Ga (billion years ago)	Our young sun goes into T-Tauri phase, blowing most gas from solar system	9.09%	Our young sun goes into T-Tauri phase, blowing most gas from solar system
~4.999 Ga (billion years ago)	Nebula has collapsed into a spinning, flattened disk	9.09%	Nebula has collapsed into a spinning, flattened disk
~5 Ga (billion years ago)	Nebula begins to collapse and rotate	9.1%	Nebula begins to collapse and rotate

General Feedback: Note that the further we go back in time, the larger the errors/uncertainties. Therefore, some of the oldest dates are based on some observations, and on models (constrained by the physics).

However, you should be able to answer the question by the relative order. Asteroids that fall to Earth as meteorites are generally dated at around 4.563 Ga. They should be slightly older than the oldest dated Moon rocks since, as smaller bodies, asteroids should cool quite quickly. The Moon, considered to have formed in a late major collision, should provide slightly younger ages since it would have taken more time to cool/solidify (as it is layered, meaning it was molten in its early formation stages). And, the oldest surface rocks on the Earth should be a bit younger than the Moon since the Earth (also remelted due to that big collision), would have taken a bit longer to cool than the Moon... The measured dates fit. For this question, you could have looked things up, or simply use logic for almost all of the answers.

Youngest known rocks: well, there are rocks on Mt. Baker that erupted less than 100 years ago. Volcanoes are erupting every day - and the igneous rocks formed from that cooled magma would start out with an age of "0". Brand new.

The 200 Ma date is a typical date given for the breakup of Pangea. It is also a good date for the oldest known oceanic crust on the planet. So oceanic crust would range

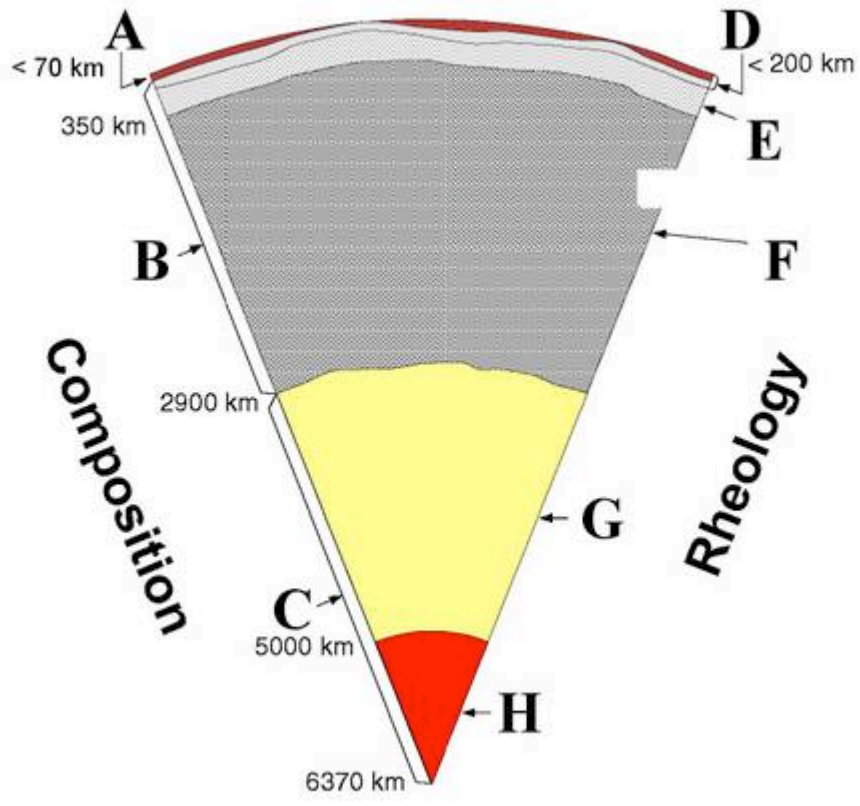
from 0 years old (where it is being formed at the ridgecrest) to 180-200 My old at the furthest distance away in the northwest Pacific ocean basin (the widest ocean basin). Rocks on an oceanic plate should be (unless there was other volcanism on the plate) the oldest the furthest distance away from the ridge that created that crust. As it glides away from the ridge, time passes - so it gets older!

Score: 2.5/2.5

9.

The basic layered structure of the Earth (and other planets) can be described or defined in different ways. It can be described in terms of the general composition of the layers (chemically different materials). Or, it be described in terms of the rheology of the layers (how the materials deform under pressure. Each method is useful.

This question is to ensure you know the different layers as we'll be using them throughout the course.



Statement	Response	Value	Correct Match

Statement	Response	Value	Correct Match
A	crust	12.5%	crust
B	mantle	12.5%	mantle
C	core	12.5%	core
D	lithosphere	12.5%	lithosphere
E	asthenosphere	12.5%	asthenosphere
F	lower mantle	12.5%	lower mantle
G	outer core	12.5%	outer core
H	inner core	12.5%	inner core

Score: 1/1

10.

The Earth is a layered planet. The composition of the different layers can be divided in general terms into types of rock (ultramafic, mafic, intermediate, felsic) and metal (primarily iron and nickel). Match the layer names on the left with the correct compositional term on the right. You can use some of the terms several times if you need to.

Statement	Response	Value	Correct Match
oceanic crust	mafic rock (and some ultramafic)	25.0%	mafic rock (and some ultramafic)
continental crust	intermediate rock	0.0%	mafic, intermediate, and felsic rock (and some ultramafic)
mantle	ultramafic rock	25.0%	ultramafic rock
core	metal (mostly iron and nickel)	25.0%	metal (mostly iron and nickel)

Score: 1.5/2

11.

Match the rock types to the descriptions of how they form on the right.

Statement	Response	Value	Correct Match
igneous	crystallization of molten rock	33.33%	crystallization of molten rock
metamorphic	solid state changes due to changes in temperature and/or pressure	33.33%	solid state changes due to changes in temperature and/or pressure
sedimentary	precipitation of minerals or lithification (rock formation) or sediments	33.34%	precipitation of minerals or lithification (rock formation) or sediments

Score: 1/1

12.

Which one of the following is **false**?

An intrusive rock:

	Student Response	Value	Correct Answer	Feedback
A.	can be igneous			
B.	can be felsic			
C.	can be sedimentary	100%	✓	
D.	solidifies beneath the Earth's surface			
E.	can be mafic			

Score: 1/1

13.

If you were hiking or skiing near the peak of Mt. Baker (an active volcano just southeast of Vancouver) and stopped on some rocks for a lunch break, what statement below best describes the rock you were sitting on?

	Student Response	Value	Correct Answer	Feedback
A.	The rock is very likely to be igneous			
B.	The rock may be metamorphic			
C.	The rock's composition could range from mafic to felsic.			
D.	The rock is likely to be extrusive			

	Student Response	Value	Correct Answer	Feedback
E.	All of the answers are true.	100%	✓	

General Feedback: It's a volcano. So, it is very likely the rock is igneous, but it could be metamorphic too. If it is igneous, you are on the surface - so it would likely be extrusive. We'll look at compositions in much more detail in the volcanism section later in the course. However... continental volcanoes can have a very broad range of composition that ranges from felsic all the way to mafic.

Score: 1/1

14.

If you were looking for a sedimentary rock here near Vancouver, a very good place to look would be _____.

	Student Response	Value	Correct Answer	Feedback
A.	several hundred metres beneath (down) Delta (or Richmond or Surrey or in similar places in the lower mainland)		✓	
B.	next to the pier down at Jericho beach (near UBC, Vancouver on English Bay)			
C.	All of the answers are correct.			
D.	on top of Mt. Baker or Mt. Garibaldi (volcanoes close to Vancouver)			
E.	at the bottom of the Fraser River (running through the Fraser Valley and exiting into Georgia Strait through Vancouver/Richmond /Surrey)	0%		You'd likely just find sand or clays (sediment) at the bottom of the river. You'd have to drill down or excavate 10s or 100s of meters to get to sedimentary rock.

General Feedback: So, you would look in a place where sediments are deposited, but not right at the surface since that would be sediment and not sedimentary rock. A little deeper and the pressure (and heat) would help lithify the sediments.

Score: 0/1

15.

You have read about the general characteristics and components of the Earth's crust (continental and oceanic) and how different rock types are formed. Which of the following rock types is by far the **least** abundant in the Earth's crust?

	Student Response	Value	Correct Answer	Feedback
	A. Igneous			
	B. Igneous, sedimentary, and metamorphic are all equally abundant			
☑	C. Sedimentary	100%	☑	but we so see a lot of sedimentary rock on or close the surface....
	D. Metamorphic			

Score: 1/1

16.

Many things control the speed that P and S waves travel within the Earth.
In general, wave speeds gradually increase as they travel deeper in the Earth but in some places there are abrupt increases or decreases in wave speed.

Which of the following (there may be more than one right answer) would likely cause an abrupt change in wave speed?

	Student Response	Value	Correct Answer	Feedback
☑	A. a change in crystal structure (mineral phase)	33%	☑	again, this could cause an abrupt change in wave speed. For example the two transition zones in the Earth's mantle
☑	B. a change in composition	33%	☑	Changes in composition will usually result in a change in wavespeed. The abruptness can

	Student Response	Value	Correct Answer	Feedback
	(e.g., from sandstone to granite, or from crust to mantle or from mantle to core)			depend on different factors (how sharp the transition is from one material to another and on the wavelength of the seismic wave), but the changes can be quite significant. The crust-mantle boundary and the mantle-core boundaries represent quite major changes in composition and therefore result in quite large and abrupt changes in wave speed.
C.	an increase in pressure with depth			
D.	a change from liquid to solid (or vice versa)		☑	

Score: 0.66/1

17.

Information obtained from seismic waves show that there is a 'transition zone' in the mantle with a major transition at roughly 410 km depth, and another major transition (at the base of the 'transition zone') at roughly 660 km depth. The depth to these varies slightly, but they are present all around the planet.

Both of these transitions are thought to represent _____. (one answer)

	Student Response	Value	Correct Answer	Feedback
A.	Sharp temperature changes (thermal boundaries) due to convective processes			
B.	Concentrations of lots and lots of diamonds			
C.	Rheological change at the top and			

	Student Response	Value	Correct Answer	Feedback
	bottom of the fluid asthenosphere.			
D.	Changes of rock composition as the amount of iron and nickel increases	0%		The general composition stays the same - but the crystal form changes.
E.	metamorphic changes in the mantle rocks as pressure increases		✓	

Score: 0/1

18.

You are swimming underwater and hear a strange, curious, 'clack-clack-clack' noise. What could it be?
You turn around and, oh dear, there is an extremely large Great White Shark chomping its jaws as it closes in on you.

The first question that pops into your mind is, 'Hm, what type of waves are my ears detecting?' *(one answer)*

	Student Response	Value	Correct Answer	Feedback
A.	surface waves			
B.	Love waves			
C.	gravity waves	0%		
D.	S-waves			
E.	P-waves		✓	

General Feedback: P-wave can travel through liquids. S-waves cannot. Surface waves can travel along an interface - like the top of the water. And they do extend down into the material (even liquids). But it is unlikely you would hear these.

Score: 0/1

19.

The speed that P and S waves travel through rock _____.

[More than one answer may be correct. And, even worse, one of them is a trick (heh heh). Penalty for incorrect answers except for the tricky one.]

	Student Response	Value	Correct Answer	Feedback
A.	depends on the composition of the rock	30%	☑	Yes, wave speed can help constrain the type of rock. It can't really perfectly determine it, but it can bound the general range of rocks that are in the area sampled by the waves.
B.	decreases in partially molten rock		☑	
C.	generally increases as the waves move deeper into the Earth	40%	☑	In general, wave speed increases with depth. Waves travel faster in the mantle than in the crust. Waves travel faster in the deep mantle than in the shallow mantle. Waves travel faster in the core than in the mantle. (see some of the figures in the pdf files that show wave speed).
D.	increases with the density of the rock	0%		Tricky tricky. Seems to make sense. Many textbooks even say this is true. But take a look at the equation in the pdf file. As density increases, speed decreases! Hm. It's a little bit of a trick though. Speed does increase as the rocks get 'stiffer' (less bendable, less compressible). As you go deeper in the Earth (higher pressure), rocks get stiffer and denser. It turns out they get stiffer more quickly than their density increases. So - wave speed increases with depth... but that's because of the increase in stiffness, NOT because of the increase in density.
E.	decreases as the stiffness of the rock increases			

General Feedback: This is a good example of a false correlation. It appears that speed increases as density increases. After all, wave speed generally increases with depth in the Earth and density increases with depth (pressure increases, squeezing the rock and making it more dense). Many textbooks even say speed increases due to increasing density. But take a look at the equation in the pdf file. As density increases, speed decreases! Hm. It's a little bit of a trick though. The equation describes that wave speed does

increase as the rocks get 'stiffer'. As you go deeper in the Earth (higher pressure), rocks get stiffer (less bendable, less compressible) AND denser. It turns out they get stiffer more quickly than their density increases. So - wave speed increases with depth... but that's because of the increase in stiffness, NOT because of the increase in density.

Score: 0.7/1

20.

An example of *convection* dominating the transfer of heat is when you pour a hot cup of tea and _____.

	Student Response	Value	Correct Answer	Feedback
A.	your hand gets warm as you spill the tea			
B.	the tea cools faster as you blow across the top of the cup			
C.	your hand gets warm as you hold your hand above (but not touching) the cup	100%	☑	yup. convection of the air heated by the tea below (taking heat away from the tea more rapidly than if the air didn't move). Radiation would also contribute, but to a lesser degree.
D.	your hand gets warm as you hold the cup			
E.	your hand gets warm as you hold your hand bon the side			

Student Response	Value	Correct Answer	Feedback
(but not touching) the cup			

Score: 1/1

Completed