Most of the questions on this exam require short answers. Therefore, be accurate, but also BE BRIEF. Correct rambling answers will get you no more credit than correct concise answers.

1. **(20 points)** For each of the following phenomena,
   a) define it (One sentence or phrase only)
   b) state whether you'd be more likely to find it at
      • a volcanic arc above a subduction zone, or
      • a Hawaiian volcano, or
      • a mid-ocean ridge
   c) give an example of a volcano or specific eruption exhibiting it.

   Lahar

   Shield volcano

   Rhyolitic dome

   Composite volcanic cone

   Pyroclastic flow
2. (9 points)
a) Given the following diagrams, indicate the type of fault (reverse, normal, right-lateral strike slip, left-lateral strike slip)

1.          2.          3.

b) For each fault type in part a, state the type of plate boundary for which it is most characteristic.

c) For each plate boundary in part b, give an example from somewhere in the world.
3. **(20 points)** Do either A or B **(not both)!**. Use diagrams or sketches if they help.

**A)** Explain, being sure to discuss wavelength, amplitude, and velocity,
   i) how tsunamis are generated
   ii) what tsunamis look like in the open ocean
   iii) how tsunamis change as they approach land

**OR**

**B)** Describe how earthquake epicenters and magnitudes can be determined from seismograms.
4) **(4 points)** A magnitude 7 earthquake releases 30 times as much energy as a magnitude 6 earthquake. How much more energy does a magnitude 8 earthquake release, compared with a magnitude 6 earthquake? (You do not need an equation or calculator to answer this question!)

5. **(6 points)**
   a) Of the following circumstances, circle all that lower the viscosity of magma:
      - Increased temperature
      - Decreased temperature
      - Increased dissolved water content
      - Decreased dissolved water content
      - Higher silica content
      - Lower silica content

   b) For ONE of the items you circled, explained WHY it lowers the viscosity of magma.

6. **(5 points)** Pick one of the following and in 3 sentences or less explain his or her significance. (If you do more than one, only the first will be graded.)

   - Brian Brady
   - James Hutton
   - Eben Browning
   - Thorbjorn Sigurgeirsson

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Multiple choice (2 points each)

1. The Richter scale is somewhat less widely used today than in the past because:
   a) Dr. Charles Richter, who developed the Richter scale and advocated its use, died.
   b) Mercalli intensity is now the preferred measure of earthquake size.
   c) The Richter scale doesn't differentiate the sizes of large earthquakes very well.
   d) The Richter scale was developed for use with a specific type of seismometer that is no longer in use.
   e) Scientists and the media got lazy and dropped the phrase "on the Richter scale" when reporting earthquake magnitude, but actually the reported magnitudes are still Richter magnitudes.
   f) One can't assess the size of prehistoric earthquakes using the Richter scale.
   g) All of the above.
   h) None of the above.

2. Which of the following is true?
   a) The rate of radioactive decay depends on the mineral in which the radioactive element resides.
   b) The half-life for radioactive decay depends on the quantity of radioactive element present.
   c) The rate of radioactive decay depends on the quantity of radioactive element present.
   d) The rate of radioactive decay depends on temperature---the hotter the rock, the faster the decay.
   e) all of the above
   f) none of the above

3. If I start with 16 billion ($1.6 \times 10^{10}$) atoms of pure $^{238}$U (uranium-238) in a closed box (no atoms can enter or escape), after 4 half lives I have approximately:
   a) 2 billion $^{238}$U, 2 billion $^{206}$Pb ($^{206}$Pb = lead-206)
   b) 4 billion $^{238}$U, 12 billion $^{206}$Pb
   c) 4 billion $^{238}$U, 4 billion $^{206}$Pb
   d) no $^{238}$U, 16 billion $^{206}$Pb
   e) 2 billion $^{238}$U, 14 billion $^{206}$Pb
   f) 12 billion $^{238}$U, 4 billion $^{206}$Pb
   g) none of the above
4. Magma is found at mid-ocean ridges because
   
   a) The mantle under ridges is more silica-rich than other parts of the mantle, so melts at temperatures at which other parts of the mantle are still solid.
   
   b) Convection cells and mantle plumes bring magma up from molten regions near the core-mantle boundary. The cracks and faults at divergent plate boundaries permit the magma to leak up to the earth's surface.
   
   c) Hot rising rock under mid-ocean ridges mixes with seawater that has percolated downwards. The mixing lowers the rock's melting point sufficiently that the rock melts.
   
   d) Mantle rock wells up to fill the gap left by the diverging plates. As this rock rises towards the surface, the pressure on it diminishes; reduction of pressure makes the rock melt.
   
   e) Other (give a reason)

5. Which of the following is true?
   
   a) Normal faults are so-called because they normally slip in one direction only, rarely reversing direction.
   
   b) Thrust faults are so-called because motion across them accelerates the long-term rate of plate motion (provides thrust).
   
   c) A right-lateral strike-slip fault is so-called because if you were to stand straddling the fault with one foot on each side of it, your right foot would move forward during an earthquake.
   
   d) A dip-slip fault is so called because it dips (is inclined rather than being vertical or horizontal)
   
   e) All of the above
   
   f) None of the above

6. A volcanic risk might be:
   
   a) pyroclastic flows
   
   b) lahars
   
   c) poisonous gases
   
   d) all of the above
   
   e) a 1% chance in the next 500 years of having more than $1000 damage to your house due to ash fall
   
   f) none of the above

7. The VAN method of earthquake prediction relies on:
   
   a) quiescence along the fault prior to an earthquake
   
   b) changes in the earth's geo-electric field
   
   c) unusual weather patterns and animal behavior
   
   d) changes in groundwater levels and radon gas emissions

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8. You are on an Earth Sciences field trip to Parkfield, California, attempting to determine geodetically whether there has been recent movement across the San Andreas Fault. Using the Earth Sciences department's distance measuring equipment, you determine that the distance between two benchmarks on either side of the fault is 478 m. At the same time, using far superior equipment, the US Geological Survey determines that the distance between the two benchmarks is actually 477.9352 m. Compared to the USGS data, your data are:

   a) Accurate and precise.
   b) Accurate, but not precise.
   c) Precise, but not accurate.
   d) Neither precise nor accurate.

9. The compositional units of the earth are the

   a) crust, mantle, core
   b) crust, lithosphere, asthenosphere, core
   c) lithosphere, Moho, asthenosphere, core
   d) atmosphere, hydrosphere, crust, mantle, core
   e) atmosphere, hydrosphere, lithosphere, asthenosphere, mesosphere

10. The ________ is the distance between wave crests; the __________ is half of the height between the crest and trough; and the ________ is the time interval between successive crests or successive troughs.

    a) amplitude, wavelength, velocity
    b) amplitude, magnitude, period
    c) wavelength, amplitude, period
    d) magnitude, wavelength, frequency
    e) period, amplitude, frequency
    f) wavelength, magnitude, frequency

11. Magma with high silica content and high concentrations of dissolved gases is generally associated with:

    a) steep-sided volcanoes with explosive eruptions
    b) gently sloping volcanoes with explosive eruptions
    c) steep-side volcanoes with Hawaiian-style eruptions
    d) gently sloping volcanoes with Hawaiian-style eruptions

EXAM CONTINUED ON NEXT PAGE
12. Three types of tephra include
   a) lava, smoke, ash
   b) 'a'a, pahoehoe, pyroclastics
   c) ash, cinders, lahar
   d) bombs, lapilli, ash

13. Large stratovolcanoes typically have ____________ eruptions.
   a) Plinian
   b) Flood basalt
   c) Hawaiian
   d) Phreatomagmatic

14. Uniformitarianism is a way of thinking about earth processes that proposes:
   a) The layers of the Earth have exactly the same thickness everywhere around the globe
   b) The most important geological processes are the ones that happen very quickly
   c) The Earth has been shaped by slow-gradual processes occurring over long time periods.
   d) The Earth’s lithosphere is divided into movable plates
   e) The Earth’s age is infinite.
   f) The Earth’s age is approximately 4.55 billion years.
   g) All of the above
   h) None of the above

15. The silica tetrahedron is
   a) An ultra-sensitive component of a seismometer.
   b) A characteristic grouping of atoms found in most rock-forming minerals and magmas.
   c) The area in California most at risk for earthquakes.
   d) The mantle source region for most magmas extruded onto Earth’s surface.
   e) An ancient Egyptian version of a pendulum-based seismoscope.
   f) The device used by psychics to predict earthquakes.
   g) None of the above

16. Metamorphic rocks:
   a) Consist only of quartz and quartz-related minerals.
   b) Form when hot magma flows onto the Earth’s surface and cools.
   c) Form when rocks are subjected to extreme heat and pressure.
   d) Are present only in the inner and outer core.
   e) None of the above.
   f) All of the above

EXAM CONTINUED ON NEXT PAGE
17. Tsunamis may be triggered by (circle all that apply)

   a) Underwater earthquakes
   b) Underwater volcanic eruptions
   c) Meteorite impacts
   d) Tides
   e) Underwater landslides
   f) Hurricanes
   g) None of the above

18. Which of the following are products of non-explosive eruptions? (Circle all that apply)

   a) Pillow lava
   b) A`a
   c) Pahoehoe
   d) Lava tubes
   e) Flood basalts
   f) All of the above
   g) None of the above
Extra Credit: Volcanic phenomenon or delicious food?

Mark the following choices “V” for volcanic phenomenon, or “F” for delicious food. Write a short definition for each volcanic hazard. (Delicious foods need not be defined.)

[1 point for correct identification of all hazards vs. foods. 0.5 point for each correct definition. Total possible extra credit: 4.5 points]

___ Fumarole:
___ Guacamole:
___ Ravioli
___ Mahi mahi:
___ Pahoehoe:
___ Calzone
___ Strombolian:
___ Boboli
___ Funnel cake:
___ Spatter cone:
___ Waffle cone
____Crème brulée
___ Nuée ardente:
___ Crêpe flambée:
____Halvah
___ Lahar:
___ Falafel:
___ Lapilli:
___ Taboulli:
___ Cannoli

END OF EXAM