1: MULTIPLE CHOICE (26 points)

Choose the correct answer from those provided for each question.

1. Which of the following descriptions does NOT apply to the following fault pattern:

   ( en echelon / right-stepping / left-stepping )

2. Which type of fault motion would most likely produce this fault pattern at the Earth’s surface?

   ( left-lateral / right-lateral / normal )

3. If a strike-slip fault has a right-lateral sense of motion and a left step along the fault, which of the following features is most likely to be found within this stepover zone?

   ( hill / lake / normal fault )

4. Which of the following years was NOT associated with a M~8 earthquake along the San Andreas fault?

   ( 1812 / 1857 / 1906 )

5. The type of fault that caused the M7.3 Borah Peak earthquake in Idaho in 1983:

   ( strike-slip / normal / reverse )
6. Which of the following earthquake segments ruptured most recently and is thus least likely to rupture in the immediate future?

( Salt Lake / Brigham City / Provo )

7. If the recurrence interval along the segment of the Lost River fault that produced the 1983 Borah Peak earthquake is 15,000 years, and if the slip rate is \( \text{\~0.3 mm/yr} \), about how many years from now should we expect the next big earthquake along this segment?

( \( 15,000 - 1983 \) / \( 15,000 + 1983 \) / 14,980 )

8. Which of the following subduction zone megathrusts can be found in the region of Japan?

( Aleutian / Nankai / Java-Sumatra )

9. Which of the following features associated with the 1964 Great Alaskan earthquake does not belong in the same category as the other two?

( marine terrace on Montague Island / drowned forests / earthquake-related uplift )

10. In which year did the last great subduction zone earthquake occur along the Cascadia subduction zone?

( 1500 / 1700 / 1900 )

11. Which of the following types of paleoseismic evidence does NOT fall within the “manifestation” category?

( stratigraphic / geomorphic / instantaneous )

12. The uppermost stratigraphic layer that exists at the exact instant that an earthquake occurs is referred to by paleoseismologists as the:

( event horizon / erosional surface / scarp )

13. Erosion of an earthquake scarp gradually produces a pile of debris at the base of the scarp slope, referred to as a:

( debris slope / colluvial wedge / geomorphic horizon )
2: FILL IN THE BLANKS (26 points)

1. The strike-slip fault that runs underneath Berkeley stadium and which is thought to have the highest current earthquake hazard in the Bay Area is the __________________________ fault. (2)

2. The region in central California where geologists incorrectly predicted a moderate sized earthquake would occur between 1988-1992 is __________________________. (2)

3. The fault that produced the 1999 Hector Mine earthquake (M7.1) in southern California was the __________________________ fault. (2)

4. The process by which a major earthquake along a fault causes a later earthquake along a nearby fault (sometimes years later) is called __________________________. (2)

5. The process by which a number of fault segments can “feel” each other (i.e., mechanically interact) and thus act like a “team” to share the slip along a fault zone as if it were one continuous fault is called __________________________. (2)

6. As a result of the above process in question 5, where along a segmented fault system would you expect to find the segment with the highest slip rate? __________________________. (2)

7. The greatest earthquake risk in the continental USA associated with an intracontinental rift zone occurs along the __________________________ fault system, producing a high hazard in the major urban area of __________________________ (name of city). (4)

8. In what country are you most likely to find (and maybe fall into) a feature called a gjá along a normal fault in a spreading center environment? __________________________. (2)

9. Reverse faults that do not extend all the way to the Earth’s surface and which do not produce surface ruptures are called __________________________. (2)

10. Which major city is at tremendous risk due to a seismic gap along the Himalayan décollement fault? __________________________. (2)

11. The two main controls on the magnitudes of subduction zone megathrust earthquakes are __________________________ and __________________________. (4)
i) The diagram below shows a cross section through a typical subduction zone. Label the elements of the subduction zone indicated by empty boxes.

ii) Indicate on the above diagram any FOUR locations where earthquakes may occur in a subduction zone setting, and explain below why earthquakes occur in those portions of the subduction zone.

iii) What are the two main types of subduction zones and what are the major differences between them?
1. Provide a definition for the following terms often used in paleoseismological studies: 

**aseismic:**
________________________________________________________________________

**nonseismic:**
________________________________________________________________________

**coseismic:**
________________________________________________________________________

2. In the trench cross-section below, indicate the location of the likely event horizon, and explain your reasoning for identifying it.

________________________________________________________________________
________________________________________________________________________

![Trench Cross-Section Image]

3. What are the two types of seismic hazard assessments?

________________________________________________________________________
________________________________________________________________________

4. Why is the concept of the maximum credible earthquake typically not very useful in an area in which a seismic hazard assessment is being undertaken?

________________________________________________________________________
________________________________________________________________________
5. The diagram below shows a probability density function that can be used to calculate the probability that an earthquake will occur along a particular fault at some point in the future.

![Diagram of probability density function](image)

i) Why is it necessary to know both the recurrence interval and the time since the last earthquake event in order to create one of these curves? (4)

ii) Why is the curve shaped the way it is? Or in other words, why can’t we say with certainty when the next earthquake will occur? (2)

iii) If we knew the recurrence interval with absolute precision, what would the probability density function look like? (2)

iv) How could you calculate the probability of an earthquake occurring during the time interval labeled $\Delta t$? (2)

v) Examine the attached map of earthquake probabilities in the San Francisco Bay area for the period 2002-2032. Based on the information provided, draw a rough probability density function graph underneath the map that shows the bell-shaped curve for both the Hayward fault and the San Gregorio fault on the same graph. Hint: the peaks of the curves will be in different places but assume that the height and width of each curve is the same. (4)

vi) Would the overall $M > 6.7$ earthquake probability for the entire region be around 27%? Explain your reasoning. (4)
Mark the above map (which shows typical world seismicity) with a circled number indicating the locations of the features listed below. Make sure your numbers are clearly legible!

1. The North Anatolian fault.
2. The Intermountain Seismic Zone.
3. A location where a mid-ocean ridge normal fault system is exposed on land.
4. The location of the Reelfoot Rift (which has been reactivated as a strike-slip fault system).
5. The location of the world’s largest (M>8) continental earthquakes (along a décollement).
6. The location of the largest earthquake ever recorded.
7. The location of the second-largest earthquake ever recorded.
8. The location of the world’s largest strike-slip fault earthquake ever recorded (Macquarie Ridge).
9. A country where four tectonic plates come together, producing frequent earthquakes.
10. A Mariana-type subduction zone.
11. The location of the only M>7 earthquakes recorded this semester (2 in the same spot).
12. The region containing the greatest concentration of M6-7 earthquakes this semester.
13. A region in the US where there have been numerous M<5 aftershocks this semester to a M6.5 earthquake that happened in December 2003.
14. A cluster of earthquakes this semester along the southern extent of the Alpine fault.
15. A cluster of ongoing aftershock activity this semester following the 2002 Denali fault earthquake.
16. A region of earthquakes this semester associated with the Hellenic subduction zone.
17. A region of strike-slip fault earthquakes this semester related to the collision of India with Asia.
18. Earthquakes in the northern portion of the Juan de Fuca plate this semester.
19. Location of intracontinental rift zone earthquake this semester.
20. The Strait of Gibraltar earthquake sequence this semester.

OPTIONAL BONUS QUESTION (5 POINTS)

The greatest concentration of earthquakes this semester has been around the circum-Pacific belt. Write a paragraph explaining why earthquakes are so prevalent in this region of the Earth. Be sure to include a discussion of the range of earthquake magnitudes in different parts of the circum-Pacific belt, and how this may be related to the tectonic environment in different parts of the belt.
SAN FRANCISCO BAY REGION EARTHQUAKE PROBABILITY

M≥6.7

Probability for one or more magnitude 6.7 or greater earthquakes from 2033 to 2032.

EXPLANATION
Probability in a 30-year period from 2033 to 2032

- >10%
- 4-10%
- 1-4%
- <1%

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