



Welcome to Geologic Mapping! I'm Aidan York, the supervisor and writer for this test. Some of you may know me as Giantpants on scioly.org or Discord. If we've met before, awesome! If not, it's nice to meet you!

Please make sure you read ALL DIRECTIONS before beginning the test!!!

The test is a combination of multiple choice and short answer/math questions. Unlike most Geologic Mapping tests, there won't be any drawing questions on here, since I obviously can't collect and grade those... But I tried to make the test a good difficulty level for both our level of competition today and our point in this season, so I hope you like it!

For math and short answer questions, even if you have absolutely no idea what to write, at least come up with something so that I can maybe potentially give you a point, rather than no chance of anything.

You'll have 50 minutes to complete the test, during which you'll only be allowed to use resources enclosed in your binders (which each of you can have one of!). Don't like, cheat, or anything like that. That would be severely uncool and dishonest... So yeah, just don't, and everyone will have a better time. Remember, as per BEARSO's rules, you can only communicate with your partner through Scilympiad's built in chat feature, not by other means of texting or calling.

I tried to make the test as long as I could to account for the immense number of teams, as to keep the distribution as spaced out as possible, I will be giving partial credit on most written section problems.

Even so, I understand there will likely still be ties. Ties will be broken by specific questions, which are very clearly labeled as tiebreakers. Tiebreaker 1 will break the first ties, if both teams get that right, then tiebreaker 2, then if teams get that right, then 3, etc.

Lastly, since there are a good deal of written questions, **please only give full sentence answers when I ask for an explanation or something like that**. If a question is asking for a specific thing like a math problem, giving a shorter answer will help me grade these quicker, and be overall easier for me, since there are so many teams participating!

That's it for now! Have fun and enjoy the test!

- 1. (1.00 pts)** Before we begin the test, do you confirm that you and your team will follow all of BEARSO's rules and guidelines while taking this test?
By selecting "I confirm," you are affirming your commitment to honesty and integrity in Science Olympiad!
DO NOT SUBMIT UNTIL SELECTING "I confirm." (if you do, you're forfeiting a free point!)

☐ A) I confirm.

2. (1.00 pts) What do you call the surface of a rock that has been flattened and smoothed by movement along a fault?

- ☐ A) Fault scarp
- ☐ B) Striatite
- ☐ C) Slickenline
- ☐ D) Slickenside

3. (1.00 pts) Which rock is most likely to be found containing a fossil?

- ☐ A) Basalt
- ☐ B) Shale
- ☐ C) Gabbro
- ☐ D) Slate

4. (1.00 pts) What is the minute series of the national topographic series released by the USGS?

- ☐ A) 15
- ☐ B) 7.5
- ☐ C) 60
- ☐ D) 5.0

5. (1.00 pts) What kind of fault exhibits a dip that decreases with depth?

- ☐ A) Abnormal fault
- ☐ B) Listric fault
- ☐ C) Transcurrent fault
- ☐ D) Oblique-slip fault

6. (1.00 pts) Which drainage pattern are you most likely to see when water flows down from a mountain?

- ☐ A) Radial
- ☐ B) Centripetal
- ☐ C) Trellis
- ☐ D) Dendritic

7. (1.00 pts) The mineral most resistant to weathering is found where on Bowen's Reaction Series?

- ☐ A) Top (highest crystallization temperature)
- ☐ B) Bottom (lowest crystallization temperature)
- ☐ C) Along the continuous series
- ☐ D) Along the continuous series

8. (1.00 pts) Who is credited with coming up with the Laws of Stratigraphy?

- ☐ A) James Hutton

- ☐ B) Hermann Necke
- ☐ C) Nicholas Steno
- ☐ D) Will Smith

9. (1.00 pts) The opening and closing of ocean basins is a process modelled in the _____ Cycle.

- ☐ A) Ocean Basin
- ☐ B) Wilson
- ☐ C) Louie
- ☐ D) Supercontinent

10. (2.00 pts) Which type of folding deforms preexisting foliations, commonly seen in rocks like schist and phyllite?

- ☐ A) Banded folding
- ☐ B) Chevron folding
- ☐ C) Fold folding
- ☐ D) Kink folding

11. (2.00 pts) A geologic cross section depicts a layer of sandstone lying directly above an eroded layer of gabbro. What kind of unconformity is this?

- ☐ A) Angular unconformity
- ☐ B) Disconformity
- ☐ C) Nonconformity
- ☐ D) Paraconformity

12. (2.00 pts) What is the name for a rock that has been pervaded by cleavage, foliation, or lineation?

- ☐ A) Fragmitite
- ☐ B) Sandslabs
- ☐ C) Mudstones
- ☐ D) Tectonites

13. (2.00 pts) In a fold, the shape of the fold can be generated by moving the _____ parallel to itself through space.

- ☐ A) Hinge line
- ☐ B) Hinge zone
- ☐ C) Fold axis
- ☐ D) Croke axis

14. (2.00 pts) When rotating a plane around the vertical axis of a stereonet, how do the properties of the plane change?

- ☐ A) It goes from a great circle to a small circle.
- ☐ B) The strike changes, but the dip is the same.
- ☐ C) Both the strike and the dip of the plane change.
- ☐ D) The dip changes, but the strike stays the same.

15. (2.00 pts) When calling a grouping of rock a sedimentary facies, what commonality do the sediments of the rocks share?

- ☐ A) The sediments were deposited at the same time.
- ☐ B) The sediments were deposited at similar energy levels.
- ☐ C) The sediments share the same depositional environment.
- ☐ D) The sediments are roughly of the same composition.

16. (2.00 pts) Saltation is characteristic of what kind(s) of sedimentary transports? (Choose all that apply!)

(Mark **ALL** correct answers)

- ☐ A) Aeolian
- ☐ B) Lagoonal
- ☐ C) Lacustrine
- ☐ D) Fluvial

17. (2.00 pts) In which type of channel would a stream flow fastest? (Hint! Think about the perimeter of water in contact with the stream bedding at any given time.)

- ☐ A) A broad, shallow channel
- ☐ B) A semicircular channel
- ☐ C) A narrow, deep channel
- ☐ D) They should all flow at roughly the same speed.

18. (2.00 pts) Which of the following can be thought of as a record of paleocurrents?

- ☐ A) Cross-bedding in sedimentary rocks
- ☐ B) Orders of parasequences
- ☐ C) The amount of Carbon-14 in an organism
- ☐ D) Turbidity current contents

19. (2.00 pts) How can you tell whether a sedimentary sequence was formed in a marine transgression or regression? (Choose all that apply!) (**Tiebreaker #6**)

(Mark **ALL** correct answers)

- ☐ A) In a regressive sequence, onlap will be prevalent.
- ☐ B) In a transgressive sequence, onlap will be prevalent.
- ☐ C) In a regressive sequence, rocks typically found in deep marine environments will be at the bottom of the sequence.
- ☐ D) In a transgressive sequence, rocks typically found in deep marine environments will be at the bottom of the sequence.

20. (2.00 pts) Which of the following is a possible ratio of deposition to accommodation for a progradational parasequence set?

- ☐ A) 0
- ☐ B) 0.5
- ☐ C) 1
- ☐ D) 1.5

21. (2.00 pts)

Parasequences of _____ sediments become finer as elevation increases, while parasequences of _____ sediments become coarser as elevation increases.

- ☐ A) alluvial, glacial
- ☐ B) lacustrine, aeolian
- ☐ C) glacial, marine
- ☐ D) fluvial, lacustrine

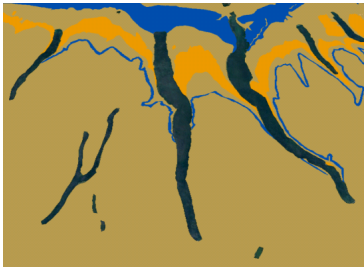
22. (2.00 pts)

What happens in a stream when the Froude number goes from less than 1 to greater than 1?

- ☐ A) The bottom of the bed goes from smooth to rocky.
- ☐ B) The stream begins producing ripples on the bottom of the bed.
- ☐ C) The stream progresses from tranquil to rapid flow.
- ☐ D) The stream officially becomes classified as unsafe to swim in.

23. (2.00 pts)

These long lakes in upstate New York are features left behind by which type of weathering?



- ☐ A) Fluvial
- ☐ B) Aeolian
- ☐ C) Marine
- ☐ D) Glacial

24. (2.00 pts)

What does a coarse grained sedimentary rock, such as sandstone, reveal about where it was deposited?

- ☐ A) The sediments were deposited at a higher elevation.
- ☐ B) The sediments were deposited in a relatively high energy environment.
- ☐ C) The sediments were deposited in a relatively low energy environment.
- ☐ D) The sandstone was formed in a place free of torches, since torches can be used to quickly harvest falling sand, given that sand breaks when it falls on a torch.

25. (2.00 pts)

According to Anderson's Theory of Faulting, how many directions of stress are there, and how many must be parallel to the earth to cause faulting?

- ☐ A) Two directions, two must be parallel
- ☐ B) Three directions, two must be parallel
- ☐ C) Three directions, three must be parallel
- ☐ D) Four directions, two must be parallel

26. (2.00 pts)

According to Anderson's Theory of Faulting, what is the ideal angle for a hypothetical normal fault to form at?

- ☐ A) 30 degrees

- ☐ B) 45 degrees
- ☐ C) 60 degrees
- ☐ D) 75 degrees
- ☐ E) 90 degrees

27. (2.00 pts) Boudins are structures that form as a result of different types of what kind of stress?

- ☐ A) Compressional
- ☐ B) Tensional
- ☐ C) Shear
- ☐ D) Distress

28. (2.00 pts) Which of the following can not be used as a shear sense indicator?

- ☐ A) Mica fish
- ☐ B) S-C fabrics
- ☐ C) Foliation markers
- ☐ D) Offset markers
- ☐ E) Shear bands
- ☐ F) They can all be used as shear sense indicators!

29. (2.00 pts) Which kind of fold has its youngest rocks in its core, but has been overturned and deformed?

- ☐ A) Antiformal syncline
- ☐ B) Antiformal anticline
- ☐ C) Synformal syncline
- ☐ D) Synformal anticline

30. (2.00 pts) The seismic shadow zone results from what? (Choose all that apply!)

(Mark **ALL** correct answers)

- ☐ A) Refraction of P-waves due to the liquid outer core
- ☐ B) Stopping of P-waves at the liquid inner core
- ☐ C) Stopping of S-waves at the liquid mantle
- ☐ D) Stopping of S-waves at the liquid outer core
- ☐ E) Refraction of S waves through the inner core

31. (2.00 pts)

When trying to find the dip-slip movement of a fault, we can use the Pythagorean theorem. Using the dip-slip movement as the hypotenuse, which values function as the legs of the right triangle? (**Tiebreaker #7**)

- ☐ A) Strike and dip
- ☐ B) Heave and throw
- ☐ C) Dip and slip
- ☐ D) Trend and plunge

32. (2.00 pts) When a ductile material is strained beyond its maximum strength, what process does it undergo before fracture?

- ☐ A) Necking
- ☐ B) Faltering
- ☐ C) Hardening
- ☐ D) Lacking

33. (2.00 pts) How many UTM zones are there in the world?

- ☐ A) 24
- ☐ B) 36
- ☐ C) 60
- ☐ D) 87

34. (2.00 pts) If you see this symbol on a geologic map, where can you expect the oldest rocks in the fold to be found?



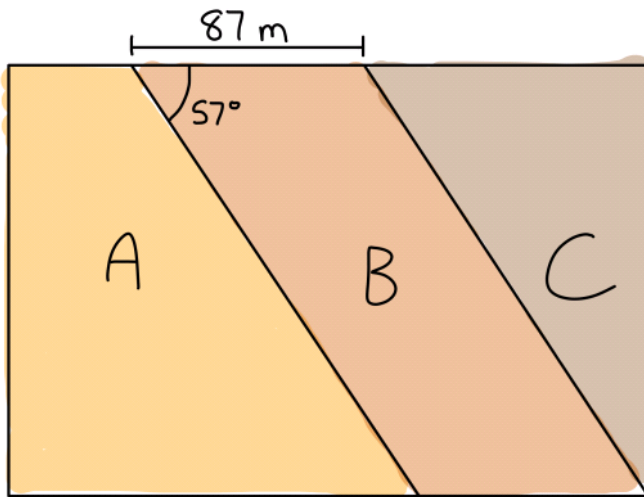
- ☐ A) In the center of the fold
- ☐ B) On the outside of the fold
- ☐ C) All rocks in the fold are the same age

35. (2.00 pts) Which of the following are equal-area map projections? (Choose all that apply!)

(Mark **ALL** correct answers)

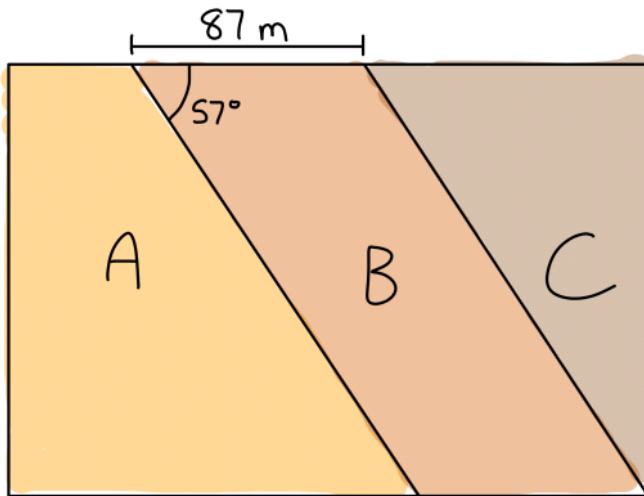
- ☐ A) Mollweide Projection
- ☐ B) Cassini Projection
- ☐ C) Albers Projection
- ☐ D) Lambert Azimuthal Projection
- ☐ E) Fuller Projection

36. (2.00 pts) What is true thickness of the bedding labelled "B" if the outcrop width is 87 meters and the dip is 57 degrees?



- ☐ A) 38.0 meters
- ☐ B) 73.0 meters
- ☐ C) 4.6 meters
- ☐ D) 103.7 meters

37. (1.00 pts) Which bedding is the youngest? (assuming no overturning, erosion, or folding)



- ☐ A) A
- ☐ B) B
- ☐ C) C

38. (2.00 pts) A _____ is a sheet of rock formed when a thrust fault forces it over another layer of rock.

- ☐ A) Inlier
- ☐ B) Megasheet
- ☐ C) Klippe
- ☐ D) Nappe

39. (2.00 pts) In which class of folds do dip isogons converge downwards towards an axial surface while maintaining constant layer thickness? **(Tiebreaker #8)**

- ☐ A) Class 1B
- ☐ B) Class 2C
- ☐ C) Class 3
- ☐ D) Class 3C

40. (2.00 pts) Where would you be likely to find a forearc basin? (Choose all that apply!)

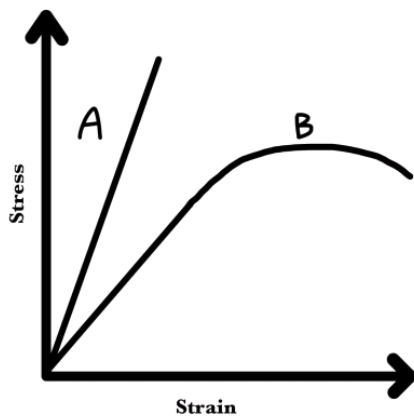
(Mark **ALL** correct answers)

- ☐ A) Near the Mariana Trench
- ☐ B) At the Mid-Atlantic Ridge
- ☐ C) Near a subduction zone
- ☐ D) Off the western coast of the United States
- ☐ E) At a divergent plate boundary

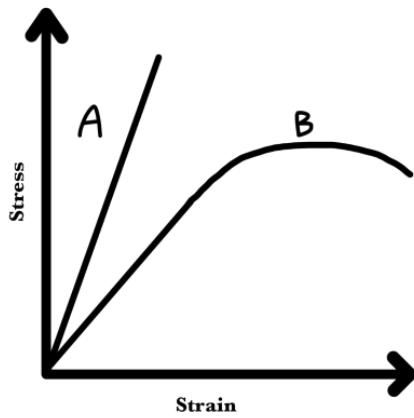
41. (2.00 pts) What law predicts the stress conditions under which faults form? **(Tiebreaker #9)**

- ☐ A) Frank's law of lacking
- ☐ B) Lyell's law of fracture
- ☐ C) Wilson's law of breaking
- ☐ D) Coulomb's law of failure

42. (1.50 pts) Does the line labelled A represent a brittle or ductile material? Does this better represent the lithosphere or the asthenosphere? (0.75 for each part)



43. (1.50 pts) Does the line labelled B represent a brittle or ductile material? Does this better represent the lithosphere or the asthenosphere? (0.75 for each part)



44. (4.00 pts) Briefly explain Walther's Law, how it can be used to explain the geologic past, as well as two geologic events which result in what this law describes.

45. (1.00 pts) What might invalidate an application of Walther's Law?

46. (3.00 pts)

While preparing for a walk in an area with lots of super cool geologic structures, you take out your geologic map of the region to see what you may encounter. Unfortunately, your map is slightly faded, making most markings challenging to read. No matter! Since you're familiar with your USGS map colors and what they represent, this won't be a problem. You notice a circular structure, the outer rim of which is colored blue on your map. The inside of the circle is colored grayish purple. Knowing this, what structure is this?

47. (3.00 pts)

Beyond that structure on the map, some of the markings once again become legible, and you see another circular structure. This time you can read the labels of the rocks! You can clearly see a "K" labelled over the outer ring of the structure on the map, and an "S." What is this second structure?

48. (5.00 pts)

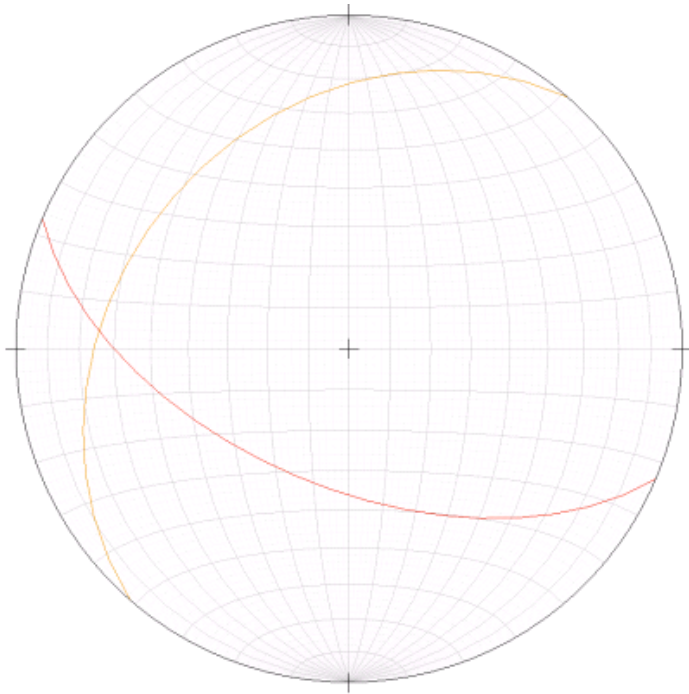
Describe the procedure of taking the strike and dip of a bedding using a geologic (Brunton) compass. (Remember to try to keep your answers concise!) **(Tiebreaker #10)**

49. (5.00 pts)

What are the strikes and dips of these two planes? (You can give the answers in either order, just make sure that the proper strikes and dips are paired up!)

I'll accept values within 20 degrees for the strike, and within 5 for the dip, and don't worry about decimals, whole numbers are good. Each value is worth one point, plus an extra point if you get them all correct! **(Tiebreaker #5)**

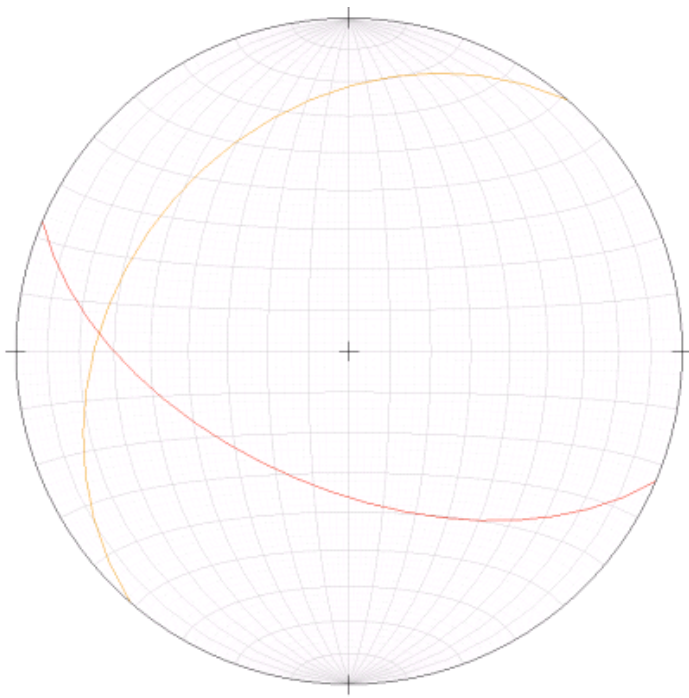
(The acceptable range is so large to account for the difficulty of doing this on a computer!)



50. (5.00 pts)

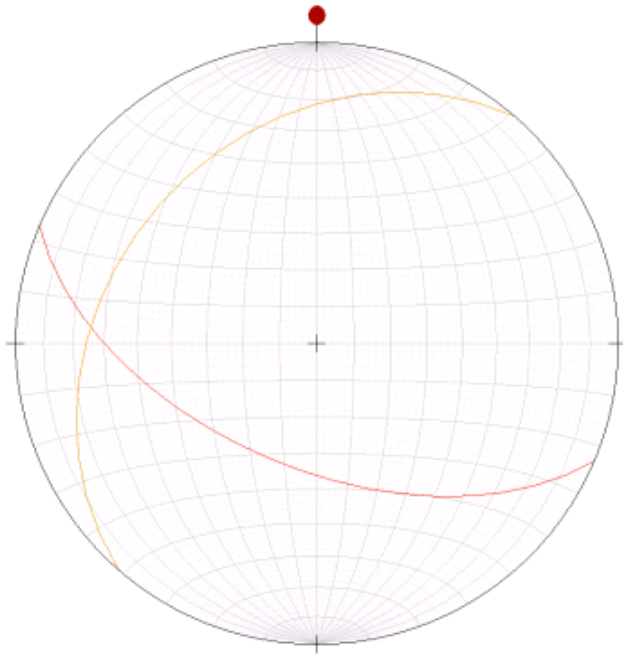
What are the trends and plunges of the poles of these planes? (Again, list give your answers in any order you want, just make sure your trends and plunges are paired properly!)

I'll accept the same range of values as the last question (within 20 for trend, within 5 for plunge)

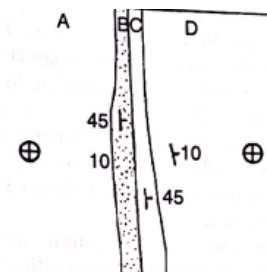


51. (2.00 pts) What is the trend and plunge of the intersection of these two planes?

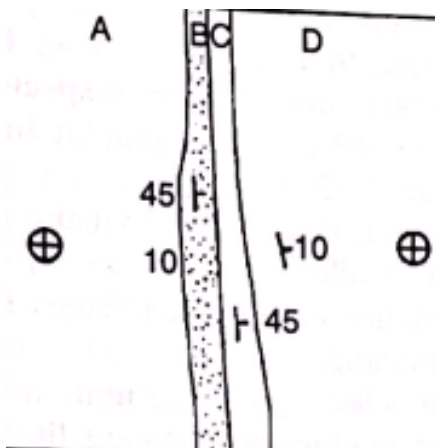
Same range is acceptable as last time!



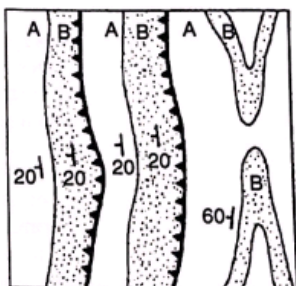
52. (2.00 pts) What structure is depicted here?



53. (2.00 pts) Give a value of the strike and dip for the the bedding labeled "D." For the dip, just a number will be sufficient.



54. (2.00 pts) What kind of faults are depicted here?



55. (3.00 pts)

Pete finds the outcrop width of a bedding to measure 78 meters from the lower to the upper contact. He also finds the true dip of the bed to be 27.4 degrees, and the ground the bed is angled 9 degrees in the opposite direction of the dip. Pete took a shot at finding the true thickness of the bedding, and didn't even come close. Can you help him by finding the true thickness? **(Tiebreaker #2)**

56. (2.00 pts)

Pete's friend, Patrick, did his own study of the bedding, and found the apparent dip to be 32.1 degrees. Assuming Pete's value for the dip is correct, why must Patrick's be wrong?

57. (3.00 pts)

Their friend, Joe, encounters another bedding. This bedding has an outcrop width of 131 meters, has a true dip of 49 degrees, and lies on ground with a slope of 15 degrees in the same direction as the dip. With a smile on his face, Joe calculates the true thickness of the bedding, but he accidentally drops the piece of paper with his answer on it... Oops. The paper with all his data and work is now well concealed underneath a giant rock. Can you help Joe out by finding the true thickness of this bedding?

58. (3.00 pts)

Andy has a map of a region which shows strike lines of a number of beddings. If he finds the distance between two strike lines of a bedding to be 39 meters, and the elevation difference is 50 meters, what is the dip of this bedding?

59. (7.00 pts)

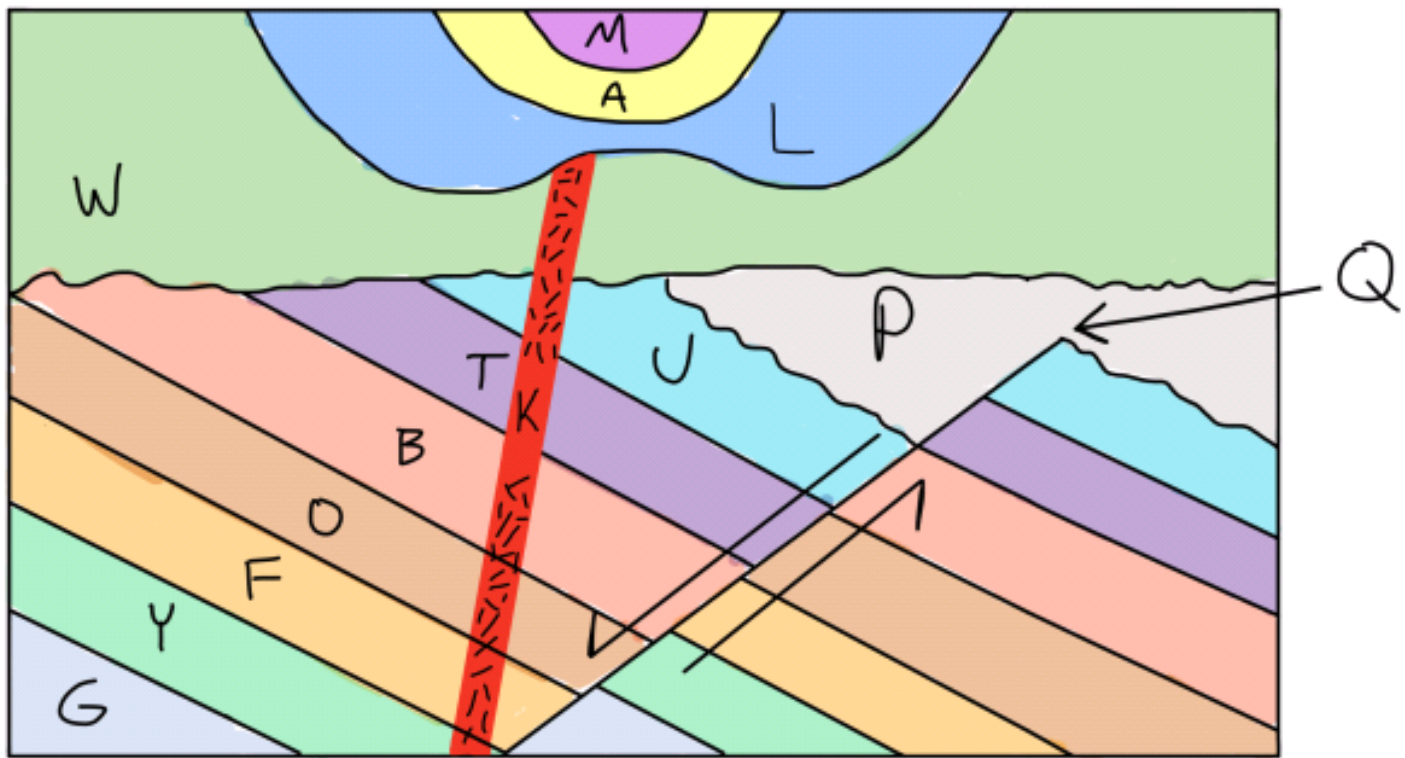
Yep, y'all know what this is.

Order the features on this geologic cross section in order of **oldest to youngest!**

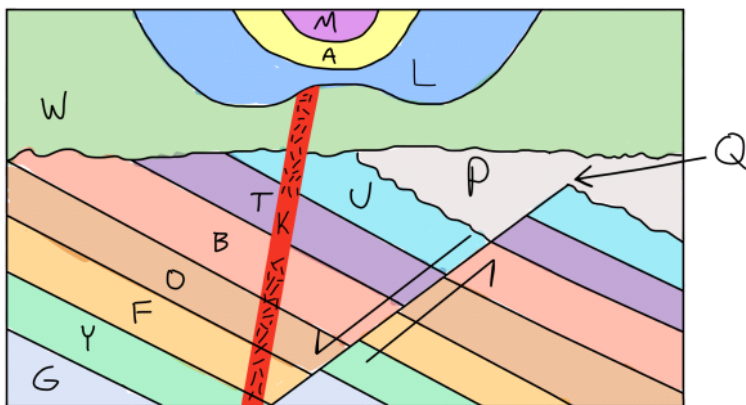
You can write your answers separated by a space (Example A B C D E) Each correct letter will be worth 0.5 points!

(and don't worry about the minor coloration overlaps/errors, I did this all by hand on my iPad and colored each layer without lifting my finger up, coloring by hand is relatively challenging haha)

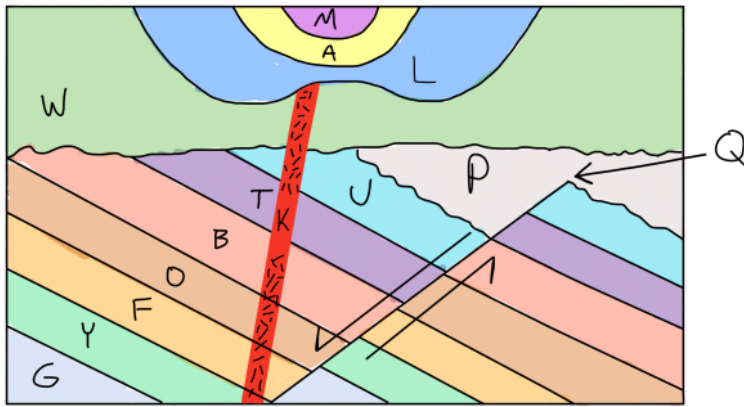
(Q is referring to the fault!)



60. (1.00 pts) What kind of fault is Q?

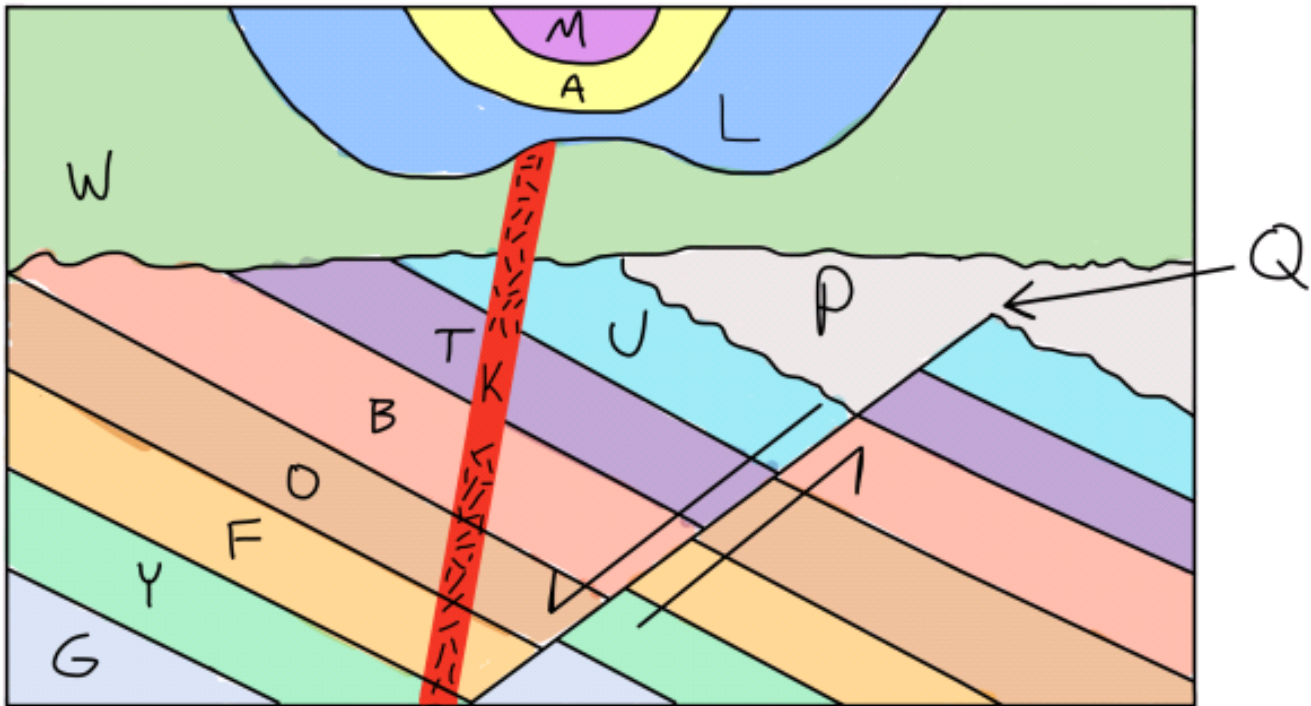


61. (1.00 pts) Is the igneous intrusion K concordant or discordant?



62. (1.50 pts)

There used to be an igneous intrusion in layer W, responsible for the indentation in layer L. What kind of intrusion is this? Is this type of intrusion concordant or discordant?



63. (2.00 pts)

Before reading a book, Yuri always bends the book into an antiform for some reason. While shaped like an antiform, what relationship to the hinge of the fold does the direction of relative slip of the pages have? (**Tiebreaker #3**)

- ☐ A) It is parallel.

- ☐ B) It is perpendicular.
- ☐ C) It is equal.
- ☐ D) It is adjacent.

64. (4.00 pts)

One day, her friend Monika notices this, and, tired of writing poems, decides to take up an interest in geology. She goes out and finds a random antitline. Measuring the thickness of a point on the folded layer to be 4.4 meters, and the inclination of the top of the folded layer to be 24 degrees, what value does Monika find for the slip of the point? **(Tiebreaker #1)**

65. (4.00 pts)

Bored of the anticline, Monika finds a bedding of rock on a hillside which trends at N47E. The bedding strikes east to west, and she measures the bedding's apparent dip to be 21.4 degrees. Can you help her find the true dip?

(If you don't know how to do this with math, but can figure it out by drawing, then you can describe the drawing by which you figured it out! That will be worth full credit too.)

66. (1.50 pts)

The next three questions refer to a map, which you can look at here via Google Drive (<https://drive.google.com/file/d/1RUGbek2dfJ2kwvKFHLpgS4GfxtqS8J1l/view?usp=sharing>) or here via Imgur (<https://imgur.com/a/4q9kvLJ>). Is an anticline or syncline depicted at point #1?

67. (1.50 pts) Is an anticline or syncline depicted at point #2?

68. (2.00 pts) Point #3 is an example of what structure?

69. (2.50 pts) What are isopach maps and what do they measure? Give two potential uses for such a map.

70. (3.00 pts) List and briefly explain four properties of a material that affect its behavior when subjected to deformation.

71. (1.00 pts)

The next set of questions relates to the the lower half of a geologic/topographic map of the Hawley Gulch Quadrangle, Bonneville, and Madison Counties in Idaho.

Since the image was impossible to insert into the question and still be legible, I have uploaded the image to Imgur (<https://imgur.com/a/jUVP4d7>), as well as a PDF to this Google Drive link (https://drive.google.com/file/d/1wmU2K7PdTv0egR_k1j5ycvOrcNybKwq/view?usp=sharing) and an image to this Google Drive link (https://drive.google.com/file/d/11Cj8fXP3YR4vzCBM5OhQVHJgp-wzL9_e/view?usp=sharing). All of the links will open in a new tab. Feel free to open any/all (if you go on Imgur you can open the image in a new tab) to allow you to zoom in on it even more. I think the PDF link may be the clearest if you zoom in, but it is really up to you. If you have any issues viewing it, let me know.

That being said, take a close look at the map. You probably expected this question, so yeah, here it comes. What is the contour interval on this map? It may be a little hard to see, but it should be doable.

- ☐ A) 15 feet
- ☐ B) 20 feet
- ☐ C) 25 feet
- ☐ D) 50 feet

72. (1.00 pts) If we say this map has a scale of 1:24,000, what does that mean?

- ☐ A) 1 inch on the map is equivalent to 24,000 inches on the earth's surface.
- ☐ B) You can lay a maximum of 24,000 copies of the map across the area depicted in the map.
- ☐ C) The amount of land you can move your eyes over in 1 minute on the map would take you 24,000 seconds to do in real life.
- ☐ D) 1 inch on the map is equal to 24,000 feet on the earth's surface.

73. (3.00 pts) Which faults are depicted in the bottom right of the image? What about the bottom left side?

74. (3.00 pts) What depositional environment was the layer "Qas" deposited in? How can you tell?

75. (1.00 pts) The bedding labelled "Qaf" is an example of what depositional feature?

76. (3.00 pts) What is an example of a potential geologic hazard that might occur in this region? Can you find any indication that it has already occurred? **(Tiebreaker #4)**

(Mark **ALL** correct answers)

- ☐ A) Anticlines
- ☐ B) Enticlines
- ☐ C) Monoclines
- ☐ D) Synclines

78. (1.00 pts) What do the letters labels of rock units on a geologic map mean?

- ☐ A) Capital letters - depositional environment
Lowercase letters - formation method
- ☐ B) Capital letters - color
Lowercase letters - texture
- ☐ C) Capital letters - rock type
Lowercase letters - age
- ☐ D) Capital letters - age
Lowercase letters - rock type/description

79. (2.00 pts) The rock labelled Qyh is rhyolitic ignimbrite. Which words describe this type of rock?

- ☐ A) Pyroclastic, felsic, plutonic
- ☐ B) Pyroclastic, mafic, volcanic
- ☐ C) Pyroclastic, felsic, volcanic
- ☐ D) Clastic, mafic, plutonic
- ☐ E) Clastic, felsic, plutonic
- ☐ F) Clastic, mafic, volcanic

80. (1.00 pts) On what landform is the highest elevation on line A? What is the highest possible whole number elevation on this line?

Thanks for participating in Geologic Mapping! I hope you liked the test!

REMINDER: If you are taking this test in the first iteration of Block 3 (your time slot began at 13:00 EDT, 12:00 CDT, 11:00 MDT, 10:00 PDT, 9:00 AKDT), DO NOT PUBLICLY DISCUSS THE TEST! This includes on forums, Discord servers, or large group chats. There are still participants in the HST time block that need to take the test. You are free to publicly discuss the test after the second iteration of Block 3 has concluded. (at 14:00 HDT, or 20:00 EDT, 19:00 CDT, 18:00 MDT, 17:00 PDT, 16:00 AKDT)

If you have any concerns about the test, you can feel free to message me on Discord (Giantpants#6460) or on scioly.org (Giantpants) or email me (my addresses are included in the link below)! I'll be happy to do my best to help with any questions you have about the test. (Although to maximize fairness, I won't be answering any messages about the test until the HDT teams have finished their block!)

If you are interested in leaving feedback, you are welcome to do so at this Google Form. (<https://forms.gle/R8XohTJLefoJZkuo6>) (anonymous if you so choose!) I would **really** love to know what you think of the exam!

(If you don't have time to fill it out now, I've also linked the form on my scioly.org Userpage (<https://scioly.org/wiki/index.php/User:Giantpants#Supervising>), which is accessible at anytime by simply googling "Giantpants scioly.")

Thanks again!

Aidan

(PS: It's Geologic, not GeoLogic... smh I'll never understand why they are trying to turn a single word into some sort of pun lol)