Dynamic Planet Test:
Glaciers

School: _____ Number: _____

Names: _____ _____

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Instructions:

- The test is 8 pages long and comes with a 6 page answer sheet and a 7 page image sheet.
- There are 150 points on the test.
- Throughout the test, you may refer to the images.
- Please write all answers on the answer sheet. Anything written on the test itself will not be graded.
- Ties will be broken by the score on the multiple answer section, followed by the essay question, the interpretive section, and the identification section. If a tie still holds, time will be used.
- The test is long and difficult – please try to finish as much as you can and do not be dismayed.
- Enjoy!

Questions 1 – 24 are multiple answer. Please circle all appropriate choices on the answer sheet.

1. Which of the following are erosional features?
   a. Crescentic gouge
   b. Crescentic fracture
   c. Kame terrace
   d. Varves

2. Fjords and Fjards differ in that:
   a. Fjords have a much lower relief than Fjards
   b. Salt marshes are commonly found near Fjards, but not Fjords
   c. Flood plains are commonly found near Fjords, but not Fjards
   d. A Fjord can be a firth but a fjard cannot

3. Which of the following are true regarding Rogen moraines?
   a. They are only found in areas once covered by the Scandinavian and Laurentide ice sheets
   b. They are commonly found near hummocks
   c. They are transverse ridges
   d. They are usually straight, not curved

4. Which of the following are true regarding H, N, and R channels?
   a. They are all subglacial erosional channels
   b. R channels are more circular in shape, while H channels are flatter
   c. N channels signify a more stable and long-term flow of meltwater than H channels
   d. R channels are visible after the glacier melts, while N channels are not

5. Refer to image **1**. Which letters correspond to a depositional feature?
   a. A
   b. B
   c. C
   d. D

6. Which of the following are true regarding flutes, rock drumlins, and whalebacks?
   a. They are all drumlinoids
   b. They consist entirely of rock
   c. They are all erosional features
   d. They are all larger than Roche moutonnées

7. Which of the following are true regarding schrunds, rimayes, and cwms?
   a. Schrunds and rimayes are only found in cwms
   b. Schrunds form from tensile strain while rimaye form from melting
   c. Cwms always contain at least one rimaye
   d. Schrunds always penetrate to the bedrock while rimayes never do

8. Which of the following are true regarding pingos and palsas?
   a. Drunken trees can be caused by pingos but not by palsas
   b. Pingos are more cone-shaped while palsas are flatter
   c. Pingos form in groups while palsas do not
   d. Pingos require large hydrostatic pressure, while palsas do not

9. Refer to image **2**. Which of the following are true?
    a. Letter A refers to a Mackenzie-type pingo
    b. Letter B refers to a Segregationseis-type pingo
    c. Letter C refers to a Grönland-type pingo
    d. Letter D refers to a Offener-type pingo

10. Regolith found on periglacial plateaus can consist of:
    a. Clay
    b. Powdered grit
    c. Granular grit
    d. Blockfields

11. Which of the following are true regarding salinity?
    a. Salinity in the arctic regions is usually approximately 5 psu below that of the ocean average
    b. The freezing point of water decreases by approximately 0.1 degrees Celsius for every increase of 1 psu
    c. The salinity of an iceberg is approximately half that of the ocean average
    d. The salinity of an alpine glacier is approximately a fifth that of the ocean average

12. Which of the following are ways in which brine is expelled from sea ice?
    a. Tension in the ice break the brine pockets, releasing the brine
    b. Melt ponds melts through brine pockets, washing the brine away
    c. The brine increases in temperature, bursting out of the brine pockets and is washed away
    d. The brine increases in salinity and begins to melt the ice underneath, eventually escaping

13. Iceberg B-15 is the largest iceberg ever discovered. Which of the following is true regarding it?
    a. It can be found in the longitude range 90° - 180° E
    b. It can be classified as a growler iceberg
    c. It is a tabular iceberg
    d. The last remaining piece, B-15A, remained the largest iceberg intact five years later

14. In which of the following years was the average arctic ice cover less than that of 2008?
    a. 2007
    b. 2009
    c. 2010
    d. 2011

15. Refer to image **3**, which was taken on the Ward Hunt ice shelf. Note that the Ward Hunt ice shelf is located on Ellesmere Island next to the Disraeli Fiord. Which of the following is true?
    a. The image is taken on the third largest ice shelf in the Northern Hemisphere
    b. The ice is floating over an epishelf lake
    c. The pools of water are not frozen
    d. The undulations in the terrain are parallel to the shoreline

16. Which of the following are in chronological order?
    a. Nebraskan, Kansan, Caryan, Illinoian, Wisconsinan
    b. Andean-Saharan, Aftonian, Cryogenian, Sangamonian, Yarmouthian
    c. Huronian, Karoo, Riss, Mindel, Mankatoan, Würm
    d. Huronian, Illinoian, Iowan, Tazewellan, Bradyan

17. Which of the following are true?
    a. The Fedchenko glacier is the second longest glacier in the world's non-polar regions
    b. The Siachen glacier falls more than 2000 meters over its length
    c. The Lambert-Fisher glacier moves less than 2 meters a day
    d. The Jacobshavn glacier has a flow rate of more than 20,000,000,000 tons of ice per year

18. Refer to image **4**, a photograph of a waterfall in Yosemite National Park. Which of the following are present in the picture?
    a. Hanging U-shaped valley
    b. Misfit stream
    c. Kame terrace
    d. Trim line

19. Which of the following are true regarding séracs, penitentes, and cryoconites?
    a. Cryoconites and séracs are depressions, while penitentes are not
    b. Penitentes only form when the dew point is below freezing, while séracs can form whenever
    c. Séracs form from tension, while penitentes form from compression
    d. Cryoconites and penitentes require non-glacial material to form, while séracs do not

20. Which of the following are true regarding lochans, paternoster lakes, and ribbon lakes?
    a. Ribbon lakes can form in lochans, while paternoster lakes cannot
    b. Lochans can be part of a set of paternoster lakes
    c. All can be formed by moraine damming
    d. Ribbon lakes are a subset of lochans, while paternoster lakes are not

21. Refer to image **5**. Which of the following are present in the image? (At least is implied)
    a. 4 tarns
    b. 4 horns
    c. 4 arêtes
    d. 4 corries

22. Refer to image **6**, which shows a longitudinal profile. Which of the following are true?
    a. The valley drops more than the valley side
    b. The valley is an example of a through valley
    c. The rock basin is an example of overdeepening and may contain a ribbon lake
    d. The ice discharges slower in the rock basin than in the other areas of the valley

23. Which of the following are true regarding global warming and glacial melting?
    a. Since the 1960s, the arctic ice thickness has decreased by 40%
    b. Since 1985, the Larson B ice shelf in Antarctica has decreased in area by 40%
    c. Since 1600, the oceans have risen 4 feet in height
    d. Since 2007, the arctic ice has decreased in area by 40%

24. The Milankovitch cycles include:
    a. Apsidal precession that increases the period of pure equinoctial precession
    b. Orbital inclination that has a different period with respect to the current orbit and the invariable plane of the solar system
    c. Orbital forcing that varies the total insolation by up to 25%
    d. Changes in eccentricity with a period of 500,000 years

For questions 25 – 42, refer to image **7**, a topographic map of McMurdo Sound, Antarctica.

25. Mount Erebus is 3794 meters tall. What are the contour intervals on the map, in meters?
26. Between points A and B, what is the average gradient, in meters/meters, of the Ferrara glacier?
27. What is the elevation of the highest point shown on the map, in meters?
28. What do the shaded areas on the image indicate?
29. What does this say about the climate, hydrological and aeolian, of the area?
30. What glacial feature is indicated by letter C?
31. What is the depth of the Mackay glacier beneath the the southern valley wall at letter D, in meters?
32. Name two periglacial features found on the valley beds of the area.
33. The bed of the valley shown at letter E shows what erosional feature?
34. At point E lies Lake Vida, which is covered by ice. In 2005 and 2010, scientists drilled through the ice cover, identifying 32 species of bacteria living there, which were surprisingly high. What are the challenges of microbial life 'thriving' there?
35. Approximately how thick is the ice that covers the lake, in meters?
36. Describe the formation of Lake Vida.
37. In 2005, iceberg B-15A approached McMurdo sound. What were some of the effects it caused? Include whether this was harmful or helpful to penguins, with support.
38. What is the approximate area of the Erebus Ice Tongue, shown by letter F, in square kilometers?
39. In what season do the most icebergs calve off the ice tongue? Why?
40. What is the approximate length of the Erebus glacier, excluding the tongue, in kilometers?
41. Which mountain range are the mountains in the map part of?
42. The McMurdo station, indicated by letter G, is the largest Antarctic research station, supporting almost 2000 people. From 1962 – 1972, what was the primary energy source of the station?

For questions 43 – 49, refer to image **8**, a collection of data from an ice core in Antarctica.

43. From what Antarctic station was the core taken from?
44. What is the average delay, in years, between insolation levels and $\delta^{18}O$ levels?
45. Compare the shape and size of the fluctuations to Dansgaard-Oeschger events.
46. These fluctuations exhibit a roughly 100,000 year period. Which components of Milankovitch cycles have such a period?
47. Which depth in the ice core, in meters, corresponds to the Eemian period?
48. Which depth in the ice core, in meters, corresponds to the Hoxnian period?
49. Ice cores often have alternating dark and light bands. What do these layers indicate and how do they vary with depth?

For questions 50 – 59, refer to image **9**, a topographic map of the glacier shown on the cover page.

50. How long, in kilometers, is the glacier, excluding moraines?
51. What event occurred in 1937 and how much further did the glacier extend during that event?
52. What does this classify the glacier as?
53. Refer to the cover image. Which two features confirm that this classification is correct?
54. What is indicated by the letters A, B, and C?
55. Which glacial features are indicated by the letters D and E, respectively?
56. What instrument is indicated by letter F, and why is it used?
57. How many active tributaries of the glacier are there?
58. Which feature provides the general shape of the lower valley of the glacier?
59. What event (which actually occurred in 2002) can be caused by this feature? What effect would this have on the mass-balance of the glacier? Name two supraglacial features that would result from this.

For questions 60 – 66, refer to images **10**, a map of Long Island, and **11** and **12**, stratigraphical profiles of two different locations on Long Island, both in proximity to one of the two terminal moraines.

60. The older moraine is the Ronkonkoma moraine. Describe the formation of this moraine and the glacial processes surrounding it in detail.
61. The younger moraine is the Roanoke Point moraine. Describe the formation of this moraine and the glacial processes surrounding it in detail.
62. The two moraines seem to converge at the Western end of Long Island. Why does this happen?
63. What is present in the Dms material that is absent in the Dmm material (Ranco Quarry)?
64. What type of sediment is found in the Unit 6 layer of the Ranco Quarry stratigraphy?
65. What is the difference between the Fm and Sm sediments (Mattituck Falls)?
66. The main cross-sectional stratification of Units 2 and 3 of the Mattituck Falls stratigraphy are different in what respect?

For questions 67 – 70, refer to images **11**, a topographical map of Bench Glacier, and **12**, data from a gopher probe drilled into a borehole.

67. Draw a longitudinal profile of the surface of Bench Glacier. Make sure to include a proper scale with units. Mark the approximate location of the equilibrium line, the accumulation and ablation zones, where the glacier flows the fastest, where a randkluft may form, and the snout of the glacier on the profile.
68. How does turbidity approximately vary with temperature?
69. What occurs immediately before the spike in conductivity and turbidity?
70. What is counter-intuitive regarding this event?

Questions 71 – 90 are identification questions. Please refer to images **15** – **54**.

71. What glacial feature is indicated in image **15**? In image **16**?
72. What glacial feature is shown in image **17**? In image **18**?
73. What glacial feature is indicated in image **19**? In image **20**?
74. What glacial feature is shown in image **21**? In image **22**?
75. What glacial feature is indicated in image **23**? In image **24**?
76. What glacial feature is shown in image **25**? In image **26**?
77. What glacial feature is shown in image **27**? In image **28**?
78. What glacial feature is indicated in image **29**? In image **30**?
79. What glacial sediment is shown in image **31**? In image **32**?
80. What glacial feature is indicated in image **33**? In image **34**?
81. What glacial feature is shown in image **35**? In image **36**?
82. What type of glacier is shown in image **37**? In image **38**?
83. What glacial feature is shown in image **39**? In image **40**?
84. What periglacial feature is shown in image **41**? In image **42**?
85. What periglacial feature is shown in image **43**? In image **44**?
86. What periglacial feature is shown in image **45**? In image **46**?
87. What process created the feature shown in image **47**? In image **48**?
88. Which glacier is shown in image **49**? In image **50**?
89. What terrain feature is shown in image **51**? In image **52**?
90. Where is the glacier shown in image **53** located? In image **54**?

Question 91 is an essay question.

91. Please write a concise, persuasive, and substantiated (with data) essay in the space provided. You may write about your opinion of either:
    a. Are drumlins depositional or erosional? Be sure to include the different models of drumlin formation and their relative abundancies and/or characteristics.
    b. MIS stage 5 began approximately 10,000 years earlier than expected. Explain why this may have happened and include justification through calculations.
    c. What will happen with the current rapid global warming of the Earth? Is this just part of a glacial cycle or a D-O event? What is the fate of the glaciers?
    d. Did the two snowball Earth events actually cover the entire Earth? Be sure to include supporting evidence from till fabric analysis, etc..