National Science Olympiad 2014
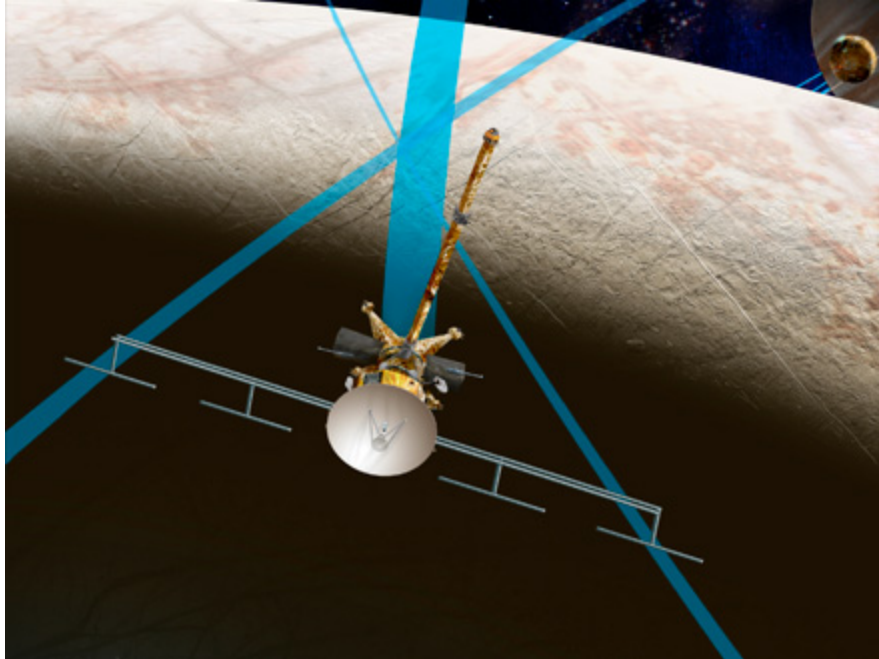## Division B: Solar System
May 17th 2014

Sponsored by the University of Texas Institute for Geophysics

Team Number: _____

Team Name: _____

Questions 1 - 24 refer to the images in Image Set 1

1. What is the **name** of the object shown in **Image A**?
2. What **type** of object is the object in **Image A**?
3. What other **image** shows **this object**?

4. What is the **name** of the **moon** shown in **Image B**?
5. What **image** shows the **planet** around which this object orbits?
6. What is the **name** of that **planet**?
7. What other **image** shows the surface of the same object as **Image B**?
8. What is the **name** of the arc-shaped **features** in that image (**Question 7**)?
9. What **type of force** is responsible for the creation of these **features**?

10. What is the **name** of the moon shown in **Image C**?
11. What **image** shows the **planet** around which this moon orbits?
12. What is the **name** of that **planet**?
13. What **image** shows the surface of this moon in **Infrared** wavelengths?
14. What **image** shows the surface of this moon in **Ultraviolet** wavelengths?
15. What **image** (other than Image C) shows this moon in **Visible** wavelengths?

16. What is the **name** of the **planet** in **Image O**?
17. What **other** image shows **this planet**?
18. What **portion** of the electromagnetic spectrum was used to produce this image (**Question 17**)?
19. What other **object** is shown in this image (**Question 17**)?

20. What object is shown in **Image D**?
21. What **image** shows the **planet** around which this object orbits?
22. What is the **name** of that **planet**?
23. What **image** shows the surface of the largest moon orbiting this planet (**Question 22**)?
24. What **spacecraft** produced this image (**Question 23**)?

Questions 25 - 57 refer to the images in Image Set 2

25. What **portion** of the electrometric spectrum (other than Visible) produced **Image P**?
26. What **object** is shown in this image (**Question 25**)?
27. What color **image** shows the surface of this object in **Radio** wavelengths?
28. Which **image** indicates the composition of the atmosphere of this object (**Question 25**)?
29. What **portion** of the electromagnetic spectrum was used to produce this image (**Question 28**)?

30. What **image** shows the object with the **feature** *Kraken Mare*?
31. Is the large dark feature shown in this image solid or liquid (**Question 30**)?
32. What is the **composition** of the large dark feature shown in this image (**Question 30**)?
33. What is the **name** of the **planet** around which this object orbits (**Question 30**)?
34. What **image** shows the surface of this object (**Question 30**) as observed by a lander?
35. What is the name of that lander?

36. What is the **name** of the moon of Saturn shown in **Image Q**?
37. What is the **name** for the blue features in this image (**Question 36**)?
38. What **image** indicates the temperature of these features (**Question 37**)?
39. What **portion** of the electromagnetic spectrum was used to measure this temperature (**Question 38**)?
40. What **image** shows jets coming out of these features?
41. What is the **composition** of these jets?
42. Do you think these jets produce snow on the surface of this object? Why or why not?

43. What is the **name** of the moon of Jupiter from which a similar jet was recently observed?
44. What **portion** of the electromagnetic spectrum was this observation (**Question 43**) made with?

45. What is the **name** of the moon with the "cantaloupe terrain" shown in **Image T**?
46. What other **image** shows the surface of this moon (**Question 45**)?
47. What is the **name** of the **spacecraft** that took this image (**Question 46**)?

48. What is the **name** of the object represented by **Image X**?
49. Which **region** in **Image U** shows the location of this object (**Question 48**)?
50. What is the **name** of this **region** (**Question 49**)?

51. What **type** of object is represented by **Image Z**?
52. What **area** in **Image Z** indicates the "coma" of this object?
53. What direction is the **Sun** compared to **Image Z**?
54. Which **region** in **Image U** shows the origin of the long-period variety of this object (**Question 51**)?
55. What is the **name** of this **region**?
56. What other **two images** indicate an object of this type (**Question 51**)?
57. What is the **name** of this **object** (**Question 56**)?

Questions 58 - 74 refer to the images in Image Set 3

58. What is the **name** of the **planet** shown in all of the **images** in Image Set 3 (except MM)?
59. What **image** shows at least half of the surface of this planet as mapped with a **laser altimeter**?
60. What **images** shows at least half of the surface of this planet as mapped in **infrared**?
61. What **two images** show **permafrost** on the surface observed by landers?
62. **Which** of these images (**Question 61**) was taken first?
63. What is the **name** of the lander that took this image (**Question 62**)?

64. Is the **feature** shown in **Image GG** in the Northern or Southern hemisphere of the planet?
65. Is the **feature** shown in **Image NN** in the Northern or Southern hemisphere of the planet?
66. What **image** shows the **feature** that includes the **layers** shown in **Image JJ**?
67. Which **set of layers** in **Image JJ** has "cleaner" ice?
68. Which image shows these layers (**Question 67**) in the **radio** portion of the electromagnetic spectrum?
69. What **type of instrument** produced this image (**Question 68**)?

70. Is the **feature** shown in **Image EE** located closer to the pole or the equator?
71. Which of the **areas** in **Image EE** has a composition with lowest ratio of ice to rock?

72. Is the **Southern** or **Northern** ice cap on this planet thicker?
73. Approximately **how thick** (in km) is the thickest part of this ice cap (**Question 72)**?
74. If the pressure at the base of this ice cap is 13 MPa, at what temperature (in K) would water ice melt?

Questions 75 - 88 refer to the images in Image Set 4

75. What is the **name** of the **moon** shown in all of the **images** in Image Set 4?
76. Is the **feature** in **Image OO** located in a region more like the one in **Image PP** or **Image QQ?**
77. Is the **feature** in **Image RR** located in a region more like the one in **Image PP** or **Image QQ?**
78. What is the **name** for the **type of feature** shown in **Image RR**?
79. Are the **features** in **Image SS** located in a region more like the one in **Image PP** or **Image QQ?**
80. What is the **name** of **feature xi** in **Image SS**?
81. Which **feature** has higher average surface roughness **xi** or **xii** (in **Image SS)**?
82. Which **image** shows a region with higher average surface roughness **Image PP** or **Image QQ**?
83. Which image shows an **illustration of the process** that may have formed the features in **Image SS**?
84. **Image TT** shows a model of subsurface ocean temperatures (with red areas being hotter). Does this model suggest areas like **Image QQ** should more abundant near the **poles** or **equator**?

85. Explain the difference between the models illustrated in **Image VV and Image WW**.

86. This moon (**Question 75**) is approximately 5 times further from the Sun than the Earth is. Is the amount of energy it receives (per unit surface area) from solar radiation **less than**, **greater than**, or **equal to** 1/5th the amount received by the Earth's surface?
87. Does this moon (**Question 75**) receive more energy from solar radiation or tidal forces?

88. Explain how the process shown illustrated in **Image UU** could be important for mixing chemicals on the surface into subsurface water and why that might matter for habitability.

Questions 89 - 93 refer to the images in Image Set 5

89. Of **features xxiii, xxiv and xxv** in **Image PPP**, which was formed **first**?
90. Of **features xxiii and xxiv** in **Image PPP**, which was formed **last**?
91. Of **features xxiv and xxv** in **Image PPP**, which was formed **last**?
92. Of **features xxix and xxv** in **Image PPP**, which was formed **first**?
93. Of **features xxvi and xxvii** in **Image PPP**, which was formed **last**?

Questions 94 - 110 refer to the images in Image Set 6

94. **Image XX** shows an illustration of a model for subsurface layers for the moon Titan where **layer xiv** is *low pressure ice* and **layer xvi** is *high pressure ice*. What is **layer xv**?
95. What **path** on **Image YY** best shows this model's state of water with increasing depth (**Question 94**)?

96. Of **Images AAA, BBB, and CCC,** which **image** shows the object with the **least** total water?
97. Of **Images AAA, BBB, and CCC,** which **image** shows the object with the **most** total water?

98. What is the **name** for the **green zone** in **Image DDD**?
99. Which of the **diagrams** in **Image DDD** correspond to a star **hotter** than the Sun?

100. **Image EEE** shows the fly-by tracks for a planned upcoming NASA led mission concept to explore the habitability of Europa. What is the **name** of this mission?
101. Which **image** shows a concept of the spacecraft for that mission?
102. Which **image** shows another planned mission that would observe Europa?
103. Explain the differences between a fly-by and an orbital mission. What are some reasons that a might a fly-by mission might be preferable?

104. Place the Mars lander missions **Images LLL, MMM,** and **NNN** in order from earliest to latest.
105. How many US Mars missions have been launched since the launch of the last mission to Europa?

106. **Image OOO** shows the radio-noise environment at Europa. For which of the following potential radar frequencies would you expect the least radio noise: **9 MHz, 15 MHz,** or **60 MHz**?

107. Explain the difference between detecting *evidence of life* and detecting *areas of habitability*.
108. Do you think that an instrument that measures chemical signatures is a better tool for detecting *evidence of life* or *areas of habitability*? Why?

109. Explain how a *gravity meter* could each be used to observe a subsurface ocean of an icy moon.
110. Explain how a *magnetometer* could each be used to observe a subsurface ocean of an icy moon.