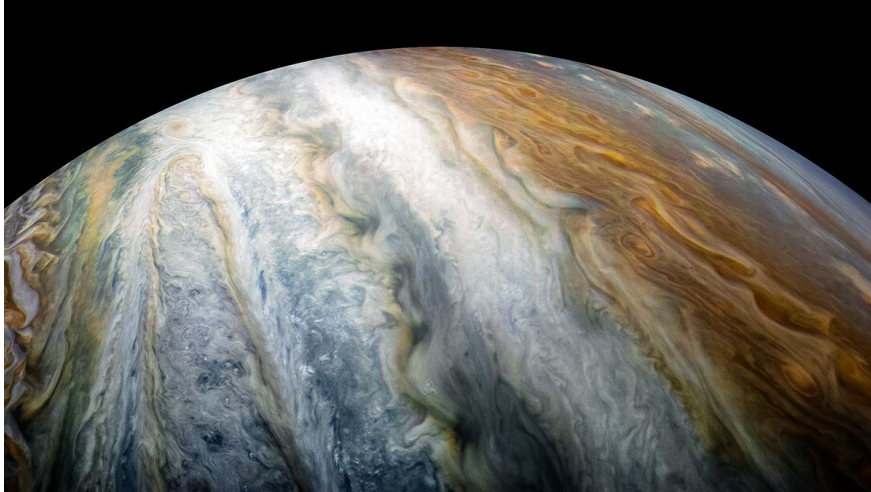


UT Invitational, Fall 2018

Solar System B



Competitors: _____

School Name: _____

Team Number: _____

This test contains 3 sections totalling 200 points. You can complete the questions in the order that best suits your team's strengths. **Make sure to write all your answers in the answer sheet!**

As always, you'll have 50 minutes to complete the test. You may separate the pages; be sure to put your team number at the top of every page. Don't feel obligated to write in complete sentences; your priority is to get all your ideas on paper quickly. Two note sheets allowed, don't cheat, etc. Tiebreaker: first question missed.

Good Luck, Have Fun! And always remember: The Eyes of Texas Are Upon You!

Written by: Aditya Shah, adityashah108@gmail.com

Part I: Matching

2 points each. Each choice will be used exactly once.

A	Albedo	B	Asteroid belt	C	Ceres
D	Charon	E	Dawn	F	Eris
G	Haumea	H	Herschel	I	Juno
J	Kuiper Belt	K	Lucy	L	Makemake
M	Mimas	N	New Horizons	O	Nix
P	Oumuamua	Q	Phoebe	R	Pluto
S	The Moon	T	Trojans		

- _____ The region beyond Neptune where Pluto lives.
- _____ A dwarf planet discovered by Clyde Tombaugh.
- _____ The fourth object to be recognized as a dwarf planet.
- _____ The family of rocks between Mars and Jupiter.
- _____ The closest dwarf planet to Earth.
- _____ Is mainly responsible for tides on Earth.
- _____ The first interstellar rock we have ever observed.
- _____ The first mission to Pluto.
- _____ A family of asteroids which share the orbit of Jupiter.
- _____ A mission to Ceres.
- _____ A moon marked by a giant crater whose diameter is 1/4 the moon's.
- _____ The most ellipsoidal dwarf planet.
- _____ A moon that is half the diameter of its planet.
- _____ A mission to Jupiter.
- _____ The most massive dwarf planet.
- _____ A moon of Saturn thought to have been captured well after Saturn's formation.
- _____ The discoverer of Mimas.
- _____ One of Pluto's irregularly shaped (nonspherical) moons.
- _____ A measure of the reflectiveness of an object.
- _____ A mission to the Trojans.

Part II: Multiple Choice

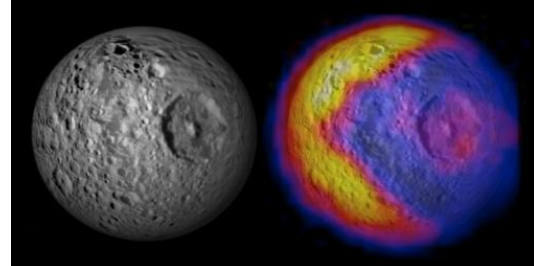
2 points each.

The next 5 questions refer to the image below.



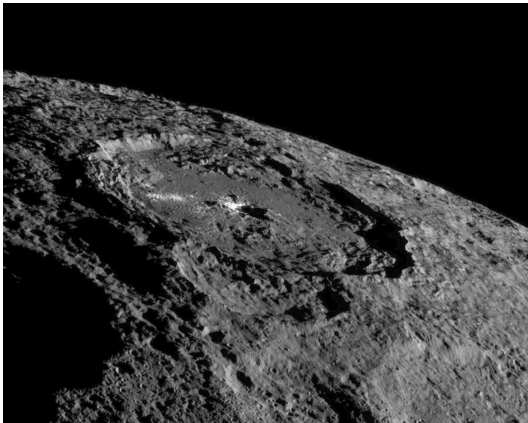
21. What object is pictured?
 - A. Phoebe
 - B. Ceres
 - C. Mimas
 - D. Pluto
22. Which best describes the location of the object?
 - A. Oort Cloud
 - B. Saturn's ring system
 - C. Asteroid Belt
 - D. Kuiper Belt
23. Which spacecraft took this image?
 - A. Dawn
 - B. Voyager 2
 - C. New Horizons
 - D. Cassini
24. What instrument on the spacecraft mentioned above was used to take the image?
 - A. Infrared Feature Detector (IRD)
 - B. Landsat Thematic Mapper (LTM)
 - C. Long Range Reconnaissance Imager (LORRI)
 - D. Subsonic Radar Spectrometry Emissator (SRSE)
25. What is the name of the prominent dark spot at the bottom?
 - A. Ahuna Mons
 - B. Krun Macula
 - C. Planitia Sputnik
 - D. Herschel

The next 4 questions refer to the image below, of temperature patterns on a moon.



26. What moon is this?
 - A. Phoebe
 - B. Charon
 - C. Mimas
 - D. Earth's moon
27. What spacecraft collected this data?
 - A. Cassini
 - B. New Horizons
 - C. Lucy
 - D. Dawn
28. Based on this data, which side of the moon (in this view) is hotter?
 - A. Left
 - B. Right
 - C. Top
 - D. Bottom
29. Would the hotter side consist of a material with a higher or lower thermal conductivity?
 - A. Higher
 - B. Lower
 - C. Same conductivity
 - D. Can't tell

The next 5 questions refer to the image below.



30. What object is pictured?
- Pluto
 - Haumea
 - Makemake
 - Ceres
31. What is the name of the crater in the picture?
- Ahuna Mons
 - Occator Crater
 - Sputnik Planitia
 - Herschel
32. Which spacecraft took this image?
- Lucy
 - Curiosity
 - Voyager 2
 - Dawn
33. Before imaging the object in this picture, where did the aforementioned spacecraft visit?
- Ganymede
 - Mimas
 - Halley's Comet
 - Vesta
34. What type of propulsion does this spacecraft use?
- Antimatter thrusters
 - Solid Rocket Booster
 - Warp engine
 - Ion propulsion

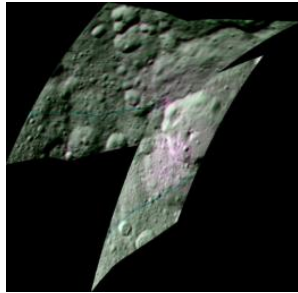
The next 4 questions refer to the image below.



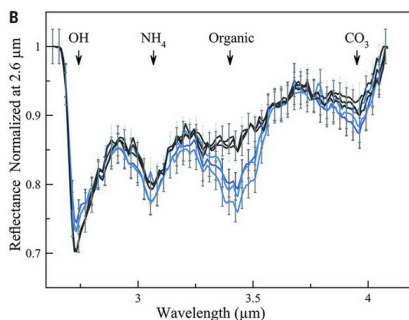
35. What object is pictured?
- Makemake
 - 'Oumuamua
 - Eris
 - Haumea
36. What shape best describes the orbit of this object?
- Parabola
 - Ellipse
 - Circle
 - Hyperbola
37. What kind of rotational motion does this object have?
- Axial rotation
 - Gyroscopic rotation
 - Non-principal axis rotation
 - It doesn't rotate.
38. What does this object's light curve¹ look like?
- Constant
 - Periodic and sinusoidal
 - Periodic but not sinusoidal
 - Aperiodic (i.e. chaotic)

¹Here, I'm talking about the commonly accepted 'theoretical' light curve

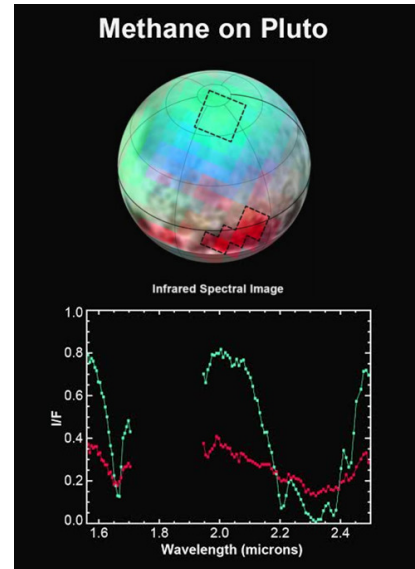
The next 4 questions refer to the image below, of the region around the Ernutet crater.



39. Which object is this crater a part of?
 - A. Mimas
 - B. Phoebe
 - C. Pluto
 - D. Ceres
40. What instrument took this image?
 - A. Ultraviolet Sensor (UVS)
 - B. Visible and Infrared Mapping Spectrometer (VIR)
 - C. Multiband Reflectance Bolometer (MRB)
 - D. Gravitational Wave Detector (GWD)
41. The pink areas signify areas that are thought to be
 - A. Rich in inorganic compounds
 - B. Rich in organic compounds
 - C. Rich in precious metals
 - D. Rich in radioactive compounds
42. The image below shows example spectra of this crater, taken from De Sanctis et al. (2017). Which color line shows the spectra for an area rich with organic compounds? (Only two answer choices)
 - A. Black
 - B. Blue



The next 4 questions refer to the image below, of spectra of Pluto's surface in infrared light. The two areas outlined on Pluto show where Ralph observations obtained two spectral traces shown.



43. Can humans naturally see infrared light?
 - A. Yes
 - B. No
 - C. About 20% of humans can; the rest cannot
 - D. About 20% of human cannot; the rest can
44. Infrared light has a ___ wavelength compared to visible light.
 - A. Longer
 - B. Shorter
 - C. Equal
 - D. Infrared light cannot be described as a wave.
45. What part of the Ralph instrument took the data represented in this image?
 - A. Multiband Reflectance Bolometer (MRB)
 - B. Subsonic Radar Spectrometry Emissator (SRSE)
 - C. Linear Etalon Imaging Spectral Array (LEISA)
 - D. Chandra Deep-Field Imager (CDFI)
46. What does the green represent on the picture? (Only two answer choices)
 - A. A channel where methane ice absorbs light very well
 - B. A channel where methane ice does not absorb light well

Part III: Free Response

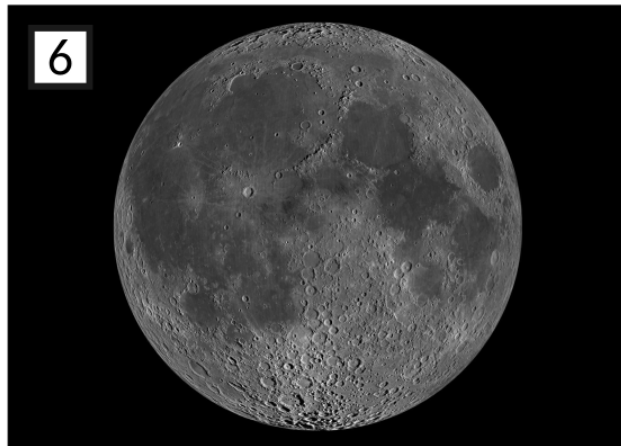
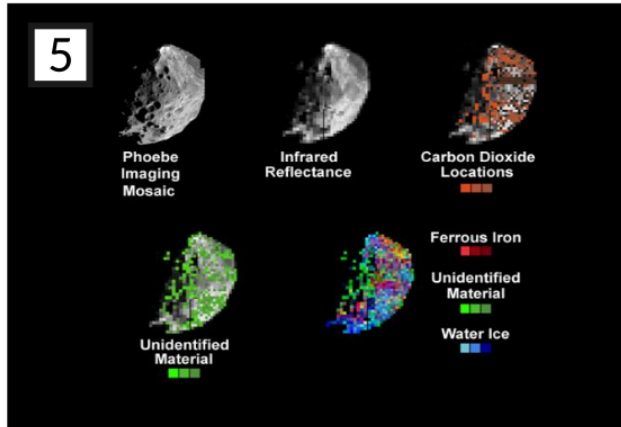
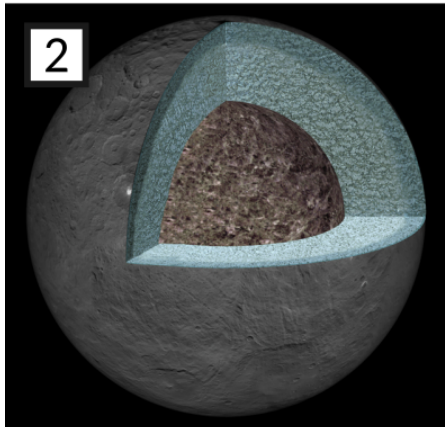
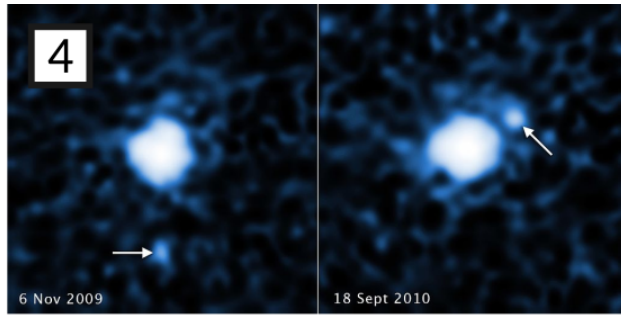
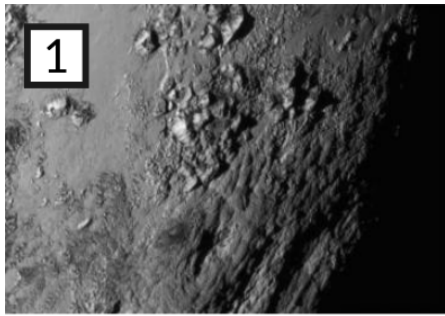
Each sub-part is worth 3 points. These are not necessarily ordered by difficulty.

47. Image 1 shows a mountain range on Pluto!
- These mountains appear to be relatively young - only on the order of 100 million years old. What is one clue this image provides which could help scientists estimate this age?
 - Pluto has an abundance of ices for numerous different compounds, ranging from methane to nitrogen. However, scientists suspect that these mountains are made from water ice. Why do scientists rule out the other materials?
 - Some icy moons around giant planets have similar mountainous structures. Scientists think that some form of heating is necessary to build these mountain ranges. How are these icy moons around giant planets heated? Could Pluto be heated the same way?
 - In what year was Pluto demoted² to dwarf planet?
48. An artist's rendition of the internal structure of Ceres is shown in Image 2.
- What does the term "differentiated" mean with regard to the internal structure of an object? Based on this image, would you say that Ceres is "differentiated"?
 - What do scientists think Ceres's outer layer mainly consists of?
 - One challenge scientists face is determining the thickness of the middle layer; for now, they simply say "it extends down at least 100 kilometers". Why can't they give a more definite answer?
49. Image 3 shows artist depictions of the largest known Kuiper Belt Objects (KBOs) when the image was made in 2011. Since then, a number of these objects have been renamed or given additional names.
- Pluto is shown to have 3 moons in this image. The largest one is Charon - what are the names of the other 2? (keep in mind that these two had to be known in 2011; since then we've discovered additional moons around Pluto)
 - What is 2003 UB313 more commonly known as nowadays?
 - Why was the discovery of 2003 UB313 notable for determining if Pluto should remain a planet?
 - In this image, what is the name given to the object we more commonly call "Haumea"? Hint: think about Haumea's shape!
 - Telescope measurements are able to constrain the radius (size) of Sedna, but it's impossible for scientists to get an accurate measurement of its mass. Why is this so?
 - 2005 FY9, also known as Makemake, is relatively bright for a Kuiper Belt Object and not unusually far away. However, it was relatively difficult to discover. What property of its orbit was the reason for this?
 - Quaoar is a cubewano. What are cubewanos? What is the difference between "hot" and "cold" cubewanos?
50. Take a look at image 4.
- What object is shown?
 - In what year was it discovered?
 - This object came to perihelion in 1857, at a distance of 33 AU from the sun. Approximately how many times farther was this object than the earth was from the sun?
 - This object is currently 88 AU from the sun. Your friend concludes that this object is therefore an interstellar visitor which is now leaving the Solar System. Is this a reasonable conclusion? Why or why not?
 - What are the arrows in the image pointing to?
 - Which telescope took this image?
 - Although this object was initially nicknamed the "Snow White", it's actually one of the reddest known objects. What do scientists think is the cause for this object's extreme redness?

²sad react :-(

51. Image 5 shows the location and distribution of water ice, ferric iron, carbon dioxide and an unidentified material on Phoebe, a moon in the outer solar system.
- (a) Around what planet does Phoebe orbit?
 - (b) A bit of trivia: craters on this moon are named after which Greek band of heroes?
 - (c) Which spacecraft took all of these images?
 - (d) Which instrument on the spacecraft mentioned in part (c) took the image labeled “Phoebe Imaging Mosaic” in the top left?
 - (e) Scientists think that Phoebe is a captured object; that is, it formed outside of the Saturnian system and joined it later. Gives two reasons why scientists believe this.
 - (f) Scientists have ruled out the asteroid belt as a possible origin of Phoebe, based on one of the substances shown in this image. What is their reasoning?
 - (g) Is water ice more prevalent on brighter or darker regions of Phoebe?
52. The (hopefully) easiest object to identify is shown in Image 6.
- (a) What object is shown in the image above?
 - (b) Around which planet does this object orbit?
 - (c) What spacecraft took this image?
 - (d) What are the dark regions called?
 - (e) What is the primary component of the regolith of this object?
 - (f) What fraction of the Earth’s surface gravity is this object’s surface gravity?
 - (g) What colloquial unit of time is named after the object? (Hint: it’s related to the object’s revolution period.)
 - (h) This object is tidally locked, but we can see slightly more than 50% of its surface (the best estimates put it at about 59%). What is the name of this effect/phenomenon?

Images



You may do scratch work here.

Answer Sheet

Part I: Matching

- | | | | | |
|----------|----------|-----------|-----------|-----------|
| 1. _____ | 5. _____ | 9. _____ | 13. _____ | 17. _____ |
| 2. _____ | 6. _____ | 10. _____ | 14. _____ | 18. _____ |
| 3. _____ | 7. _____ | 11. _____ | 15. _____ | 19. _____ |
| 4. _____ | 8. _____ | 12. _____ | 16. _____ | 20. _____ |

Part II: Multiple Choice

- | | | | | |
|-----------|-----------|-----------|-----------|-----------|
| 21. _____ | 27. _____ | 33. _____ | 39. _____ | 45. _____ |
| 22. _____ | 28. _____ | 34. _____ | 40. _____ | 46. _____ |
| 23. _____ | 29. _____ | 35. _____ | 41. _____ | |
| 24. _____ | 30. _____ | 36. _____ | 42. _____ | |
| 25. _____ | 31. _____ | 37. _____ | 43. _____ | |
| 26. _____ | 32. _____ | 38. _____ | 44. _____ | |

Part III: Free Response

47.a.

47.b.

47.c.

47.d.

48.a.

48.b.

48.c.

49.a.

49.b.

49.c.

49.d.

49.e.

49.f.

49.g.

50.a.

50.b.

50.c.

50.d.

50.e.

50.f.

50.g.

51.a.

51.b.

51.c.

51.d.

51.e.

51.f.

51.g.

52.a.

52.b.

52.c.

52.d.

52.e.

52.f.

52.g.

52.h.
