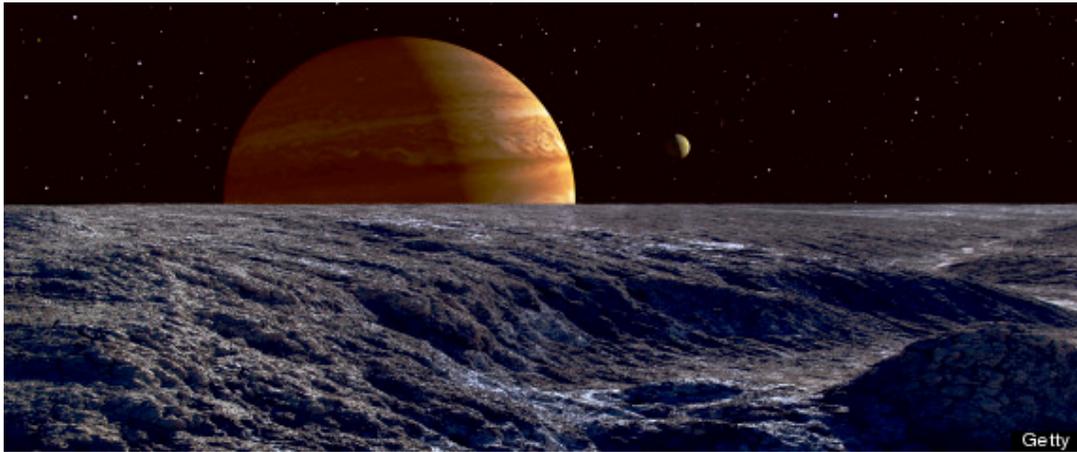


# SOLAR SYSTEM

## B Division

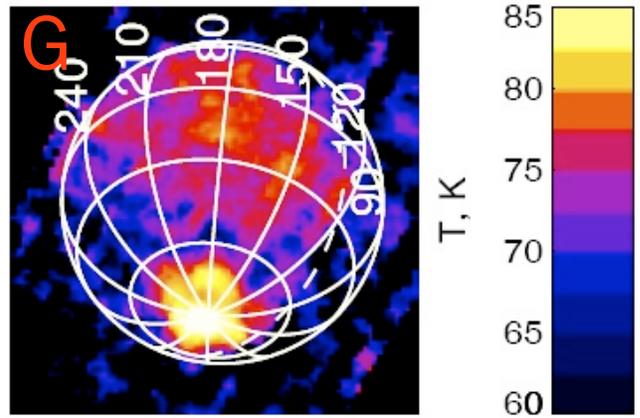
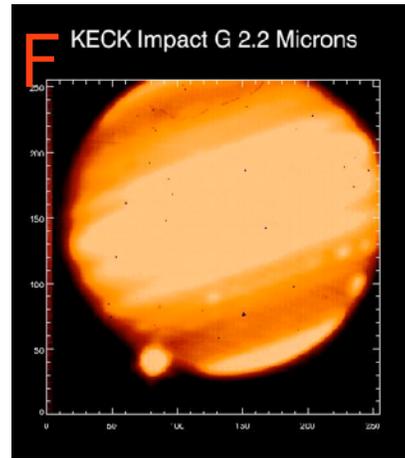
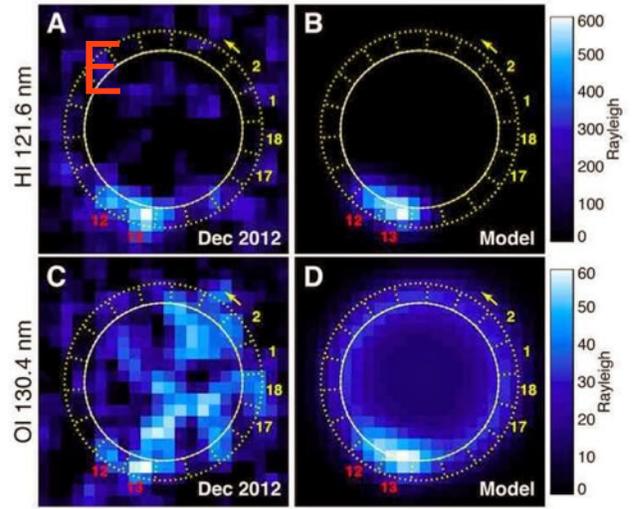
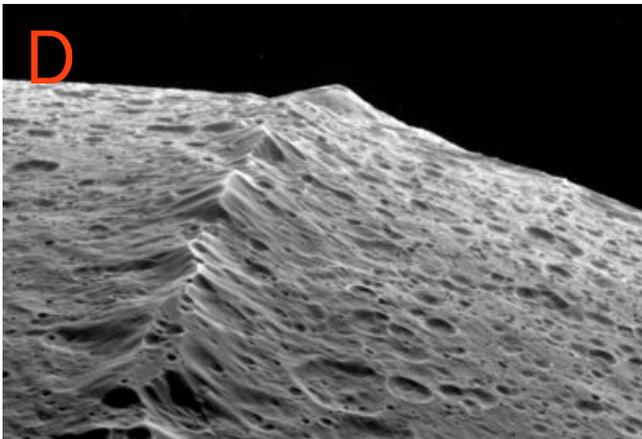
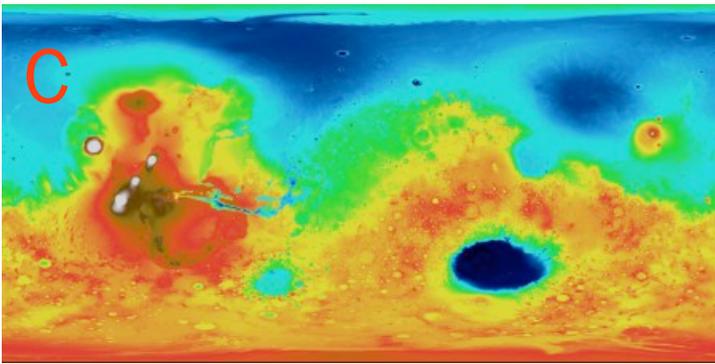
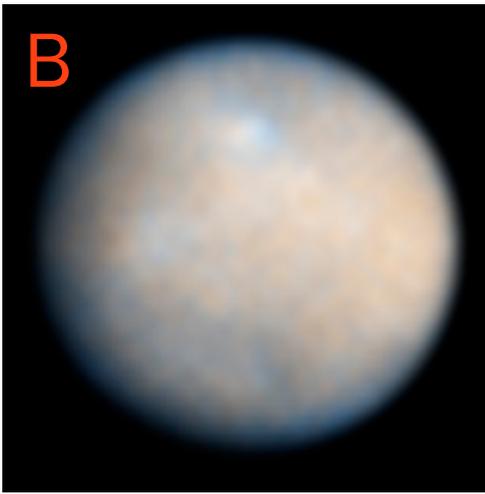
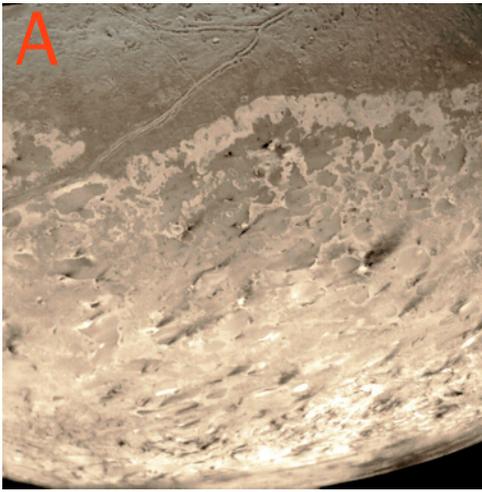


Team Name: \_\_\_\_\_

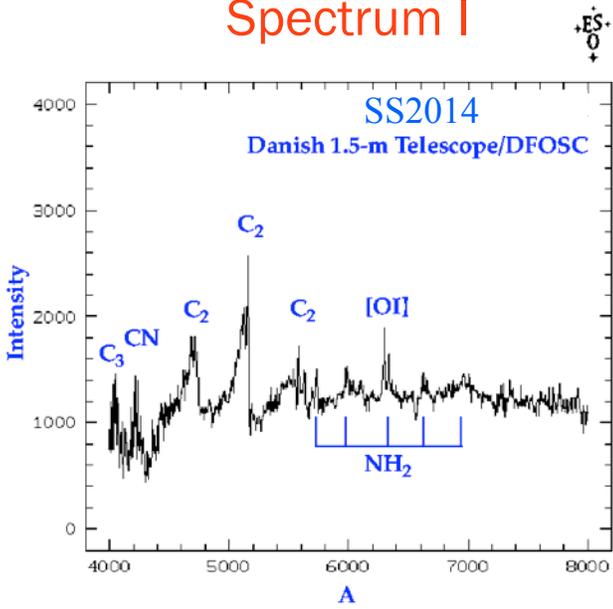
Team #: \_\_\_\_\_

Student Names: \_\_\_\_\_  
\_\_\_\_\_

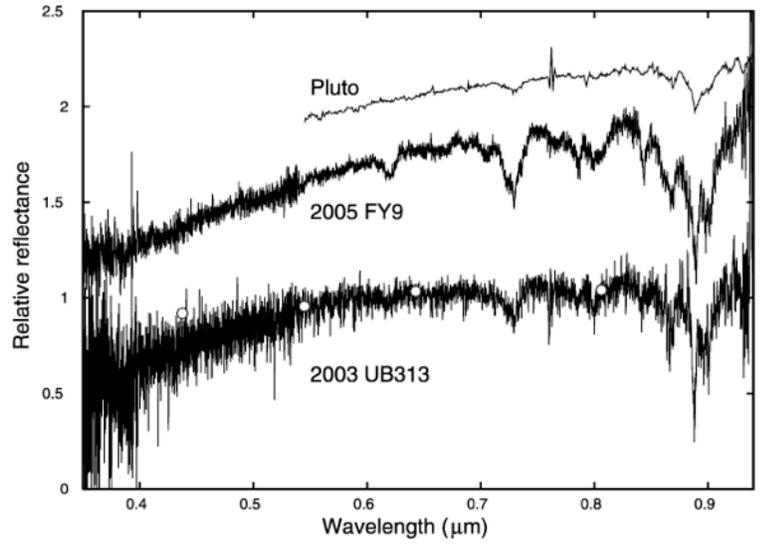
# IMAGE SHEET



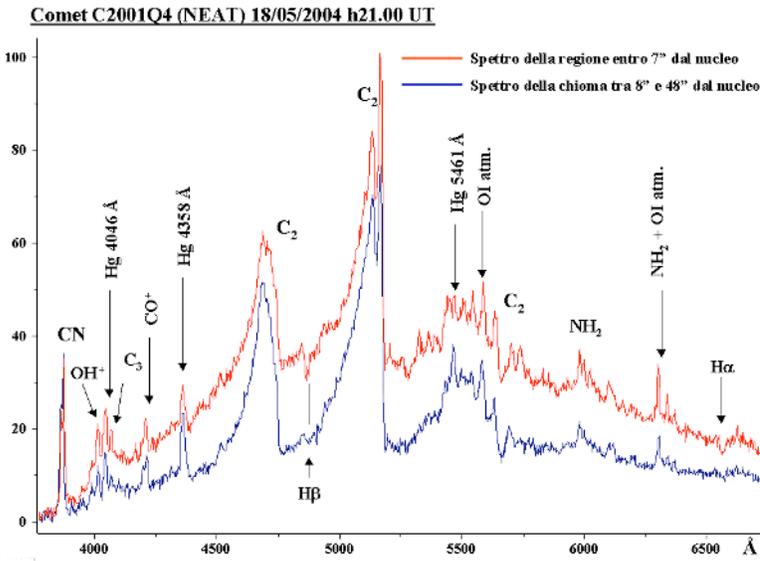
### Spectrum I



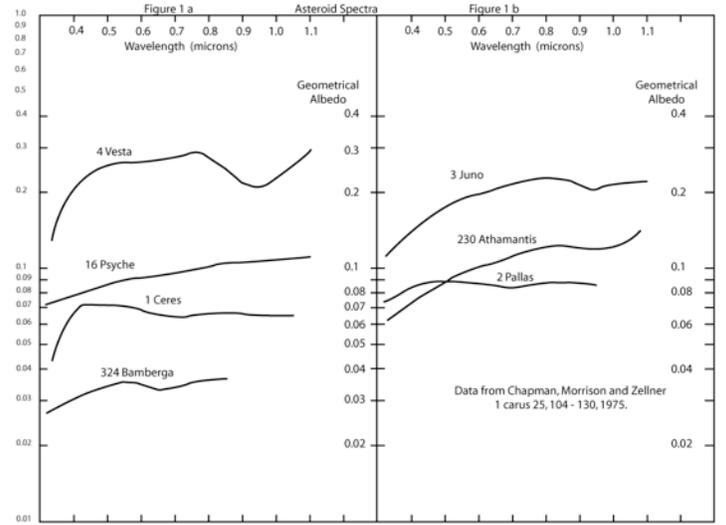
### Spectrum II



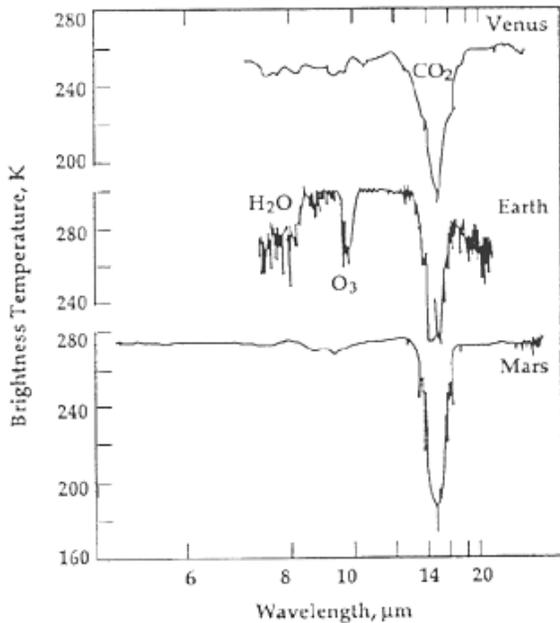
### Spectrum III



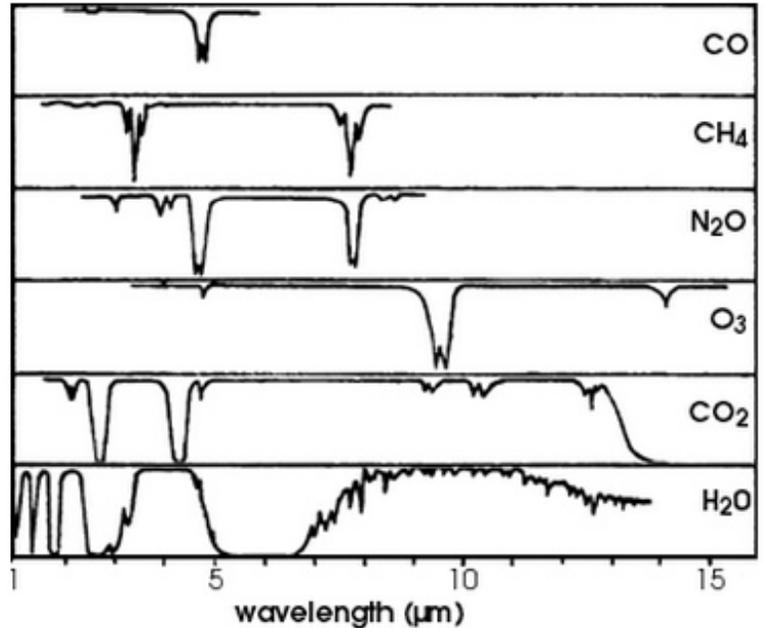
### Spectrum IV



### Spectrum V



### Spectrum VI



1. A. What satellite is pictured in Image A?  
B. What object does this satellite orbit?  
C. What other satellites in the solar system are larger in volume?  
D. What is different about this satellite's orbit compared to other satellites?  
E. What spacecraft took this image?
2. A. What object is pictured in Image B?  
B. What spacecraft took this image?  
C. Why are no higher resolution images of this object available? When might they first be available and why?  
D. Is this object denser or less dense than water? What does that tell scientists about its composition?
3. A. What object is pictured in Image C?  
B. What instrument took this image?  
C. This specific instrument was a part of what spacecraft?  
D. What do the different colors in this image indicate? What is the name of the contrast between the northern and southern hemispheres of this object?
4. A. What is the name of the feature pictured in Image D?  
B. What spacecraft took this image?  
C. What is the leading hypothesis for the formation of this feature?
5. A. What object is pictured in Image E?  
B. What spacecraft took this image?  
C. What discovery was supported by the data in these images?
6. A. What is happening in Image F?  
B. What did scientists learn about Jupiter from this event?
7. A. Based on the scale in Image G, which object is pictured in Image G?  
B. Explain the distribution of temperature on this object.
8. A. What is pictured in Image H?  
B. On which object was this image taken?
9. What is the typical sequence of mission types used by NASA to explore a planetary body?  
Use these terms: Lander, Probe, Flyby, Sample Return Mission, Orbiter, Rover
10. On which objects in the solar system is there evidence of tectonic activity currently or in the past? Give an example of a feature on each object that supports the hypothesis that tectonic activity existed there.
11. A. Which object in the solar system has the strongest magnetic field?  
B. Which planet in the solar system has the weakest magnetic field?  
C. Which satellite in the solar system has the strongest magnetic field?

12. What is the difference between a Near Earth Asteroid and a Main Belt Comet?
13. Comets and some planets and satellites have different layers. How are the different layers of comets formed compared to the different layers of planets and satellites? What is this process called in planets and satellites?
14. Is the majority of the water in the solar system in liquid, gas, or solid form? Use a phase diagram to help explain your answer.
15. You have discovered an object orbiting a star that is not the Sun. Compare the spectrum (Spectrum I) of this object, SS2014, to the spectrum of
- II. Pluto, 2005 FY9 (Makemake), 2003 UB313 (Eris)
  - III. Comet C2001G4 NEAT
  - IV. Several large Asteroids
  - V. Venus, Earth, and Mars
  - VI. common molecules

Based on this information, what kind of object (in our solar system do you think SS2014 is comparable to?

16. BONUS: What is VP113?

# ANSWER SHEET PAGE 1

Score:	
Total Points Possible:	67
% Correct:	
RANK:	

TEAM NAME \_\_\_\_\_ TEAM NUMBER \_\_\_\_\_

STUDENT NAMES: \_\_\_\_\_  
\_\_\_\_\_

1. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_ (1)  
C. \_\_\_\_\_ (1)  
D. \_\_\_\_\_ (1)  
E. \_\_\_\_\_ (1)
2. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_ (1)  
C. \_\_\_\_\_  
D. \_\_\_\_\_ (2)  
\_\_\_\_\_ (2)
3. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_ (1)  
C. \_\_\_\_\_ (1)  
D. \_\_\_\_\_  
\_\_\_\_\_ (2)
4. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_ (1)  
C. \_\_\_\_\_  
\_\_\_\_\_ (2)
5. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_ (1)  
C. \_\_\_\_\_  
\_\_\_\_\_ (2)
6. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_  
\_\_\_\_\_ (2)
7. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_  
\_\_\_\_\_ (2)
8. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_ (1)

ANSWER SHEET PAGE 2

TEAM NAME \_\_\_\_\_ TEAM NUMBER \_\_\_\_\_

STUDENT NAMES: \_\_\_\_\_  
\_\_\_\_\_

9. \_\_\_\_\_ (6)

10. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (4)

11. A. \_\_\_\_\_ (1)  
B. \_\_\_\_\_ (1)  
C. \_\_\_\_\_ (1)

12. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (4)

13. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (6)

14. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (4)

15. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (6)

16. \_\_\_\_\_  
\_\_\_\_\_ (2)

# ANSWER KEY PAGE 1

Score:	67
Total Points Possible:	67
% Correct:	100
RANK:	

TEAM NAME \_\_\_\_\_ TEAM NUMBER \_\_\_\_\_

STUDENT NAMES: \_\_\_\_\_  
\_\_\_\_\_

1. A. Triton (1)  
B. Neptune (1)  
C. Ganymede, Titan, Callisto, Io, Moon, Europa (1)  
D. Retrograde Orbit around Neptune (1)  
E. Voyager 2 (1)
  
2. A. Ceres (1)  
B. Hubble Space Telescope (1)  
C. No missions to the asteroid belt or other Solar System objects have passed Ceres closely enough to take any higher resolution photographs. Ceres is one of the primary targets of the Dawn mission, expected to reach Ceres in 2015. (2)  
D. Ceres has a density of about  $2.077 \text{ g/cm}^3$ , suggesting that it has a rocky, perhaps even differentiated, core beneath its apparent icy mantle. (2)
  
3. A. Mars (1)  
B. Mars Orbiter Laser Altimeter (1)  
C. Mars Global Surveyor (1)  
D. Differences in color show differences in elevation, the difference between the Southern and Northern Hemispheres is called the Mars Dichotomy. (2)
  
4. A. Equatorial Ridge (1)  
B. Cassini (1)  
C. The leading hypothesis for the formation of Iapetus's equatorial ridge suggests that at one point Iapetus had its own small satellite, either a gravitationally captured object or a large piece of Iapetus blasted off from an impact with another object. Over time, this object's gravitationally unstable orbit brought it closer to Iapetus and it was eventually torn apart and settled into rings around Iapetus's equatorial plane. Eventually these rings settled to form the ridge. (2)
  
5. A. Europa (1)  
B. Hubble Space Telescope (1)  
C. Plumes of water from Europa's South Pole (2)
  
6. A. Comet Shoemaker-Levy 9 is colliding with Jupiter (1)  
B. Jupiter's atmosphere had less  $\text{H}_2\text{O}$  and  $\text{O}_2$  and far more  $\text{S}_2$  and  $\text{CS}_2$  than previously thought, suggesting that Jupiter's large mass had allowed it to accrete the majority of heavier elements present in only trace amounts in other gas giants. (2)
  
7. A. Enceladus (1)  
B. Highest surface temperatures are present at Enceladus's South Pole, where subsurface liquid water jets out and active surface ice formation and melt-through is occurring. Other areas of Enceladus are comparatively cold and stable. (2)

## ANSWER KEY PAGE 2

TEAM NAME \_\_\_\_\_ TEAM NUMBER \_\_\_\_\_

STUDENT NAMES: \_\_\_\_\_  
\_\_\_\_\_

8. A. **Martian Blueberries (Hematite Spherules) (1)**  
B. **Mars (1)**
9. **Flyby, Orbiter, Probe, Lander, Rover, Sample Return Mission (6)**
10. **Earth- volcanoes and earthquakes indicate active tectonic plate boundaries**  
**Europa- Ice subduction zones indicated by boundaries of ice of different temperature and density and gradual shift of surface ice as new ice is formed**  
**Mars- evidence for ancient tectonic activity, Valles Marineris may be the divergent boundary between two large Martian tectonic plates (4)**
11. A. **The Sun (1)**  
B. **Venus (1)**  
C. **Ganymede (1)**
12. **Main belt comets are more accurately called “active asteroids” because they are asteroids with higher than average amounts of ice and exhibit comet-like activity only during part of their orbit. However, Near Earth Asteroids are objects that orbit close to the Earth and never exhibit a tail or coma in any part of their orbit. (4)**
13. **In planets and satellites, the process of formation of different layers is called “differentiation.” Differentiation occurs early in formation when planets and satellites are hot enough that materials differentiate based on density, so the heaviest elements compose the core and the layers settle as the object cools. The layers of comets are formed as the rock/ice nucleus of the comet accretes ice and dust outer layers as it moves through the Kuiper Belt. This outer ice is partially melted as the comet approaches the sun and forms an icy glaze over the nucleus.(6)**
14. **Accept answers using data from phase diagram to explain that most solar system conditions allow for solid ice water and gaseous water in atmospheres of the most massive solar system bodies. Students should explain that lack of data about subsurface conditions on some objects leaves uncertainty about the nature of subsurface water reserves. (4)**
15. **SS2014 appears to be an object analogous to a comet orbiting the Sun. The spectrum of SS2014 shows prominent peaks indicating abundances of CN, C<sub>2</sub>, and OI. These peaks are also prominent in Spectrum III and 2005FY9 in Spectrum II, indicating a comparable Kuiper Belt origin of this object. Closer comparison shows a closer match with Comet C2001G4 NEAT. (6)**
16. **VP113 is the furthest known object from the Sun in the solar system, orbiting twice as far as Pluto at perihelion with a highly eccentric orbit. It is thought to be a dwarf planet. (2)**