Answer Key

Solar System B
2015 Katy Regional Tournament

1. E
2. D
3. C
4. B
5. C
6. E
7. G
8. A
9. B
10. F
11. D
12. A
13. G
14. B
15. B, C, and F
16. A
17. G
18. B*
19. D
20. H
21. I
22. C
23. F
24. J
25. E
26. J
27. K
28. O
29. MBCs are essentially asteroids that are only active at some point(s) in their orbit (i.e. an active asteroid) and have higher concentration of volatile substances compared to other asteroids. NEOs are bodies close to Earth but never exhibit anything that would resemble a comet, such as a tail
30. Three things (all or nothing):
    a. Orbit around the Sun
    b. Has sufficient mass to assume hydrostatic equilibrium (a nearly round shape)
    c. has "cleared the neighborhood " around its orbit
31. Pluto fits a. and b., but does not have enough mass to "clear the neighborhood"
32. Oort Cloud
33. It is the object with the largest known perihelion in the solar system
34. Ceres, Pluto, Haumea, Makemake, and Eris
35. The pressure on Mars is generally slightly lower than the triple point of water and/or it is too cold. Even when the pressure is high enough, it is generally not hot enough on Mars to be liquid
36. Any answer makes sense and has solid ice water and gaseous water in atmospheres of the most massive solar system bodies. Should also talk about the uncertainty surrounding subsurface conditions of other bodies.
37. Any answer between 85 and 99 degrees Celsius will be accepted, because it shows that the students is aware about the relationship present
38. gas

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39. Amorphous ice is where the molecules are arranged randomly, either due to cooling liquid water rapidly or by compressing crystalline ice. Crystalline ice is where the molecules are arranged in a lattice.
40. Each correct response is worth 0.5 pts each
    a. Galileo VIMS
    b. Castillo - mainly crystaline
    c. Ganymede - both
    d. Europa - mainly amorphous
41. true
42. false
43. false
44. false
45. true
46. Juno will be orbiting Jupiter inside of the orbits of the icy Galilean moons and will be studying Jupiter and its atmosphere, not the moons
47. During the summers on Mars, the CO_2 will sublimate. Since there are extremely large amounts of CO_2 in the polar ice caps of Mars, this adds a lot of gas to the atmosphere and greatly increases the atmospheric pressure. In the same manner, much of the CO_2 in the winter will deposit (go directly from gas to solid), lessening the atmospheric pressure****
48. Need at least one pro and one con
    a. Pros
        i. Have extremely long lifespans so life would have time to begin, evolve, and survive
        ii. Lots of red dwarfs
    b. Cons
        i. Since the habitable zone of red dwarfs are really close to the star itself, most planets in the habitable zone would be tidally locked. This would result in a planet of extremes, where one side is always lit while the other one is always dark (i.e. permanent day/night sides)
        ii. Low luminosity, and much of the light is in infrared, which carries less energy than something like visible light, which is what the Sun mostly emits, so photosynthesis would be more difficult. If plants were to exist they would probably look black when viewed in visible light because they would have to adapt so that they can get enough energy
        iii. Evolution of the Red Dwarf stars: as such stars have an extended pre-main sequence phase, their actual habitable zones were for around 1 Gyr in a zone where water wasn't liquid but in its gaseous state, so that terrestrial planets in the actual habitable zones, if provided with abundant surface water in their formation, would have been in runaway greenhouse for several hundred Myr. During such early runaway phase, photolysis of water vapor and hydrogen escape to space could lead to the loss of several Earth oceans of water, leaving then a thick abiotic O_2 atmospehere.
        iv. Extremely variable (e.g. sunspots to decrease brightness dramatically and solar flares that would increase brightness dramatically)
49. The main factor at play is irridation due to charged particles from Jupiter, which would convert crystalline ice to amorphous ice. Europa, being the closest Galilean moon to Jupiter, receives highest level of radiation and thus through irradiation has most amorphous ice. Callisto is furthest from Jupiter, receiving lowest radiation flux and therefore maintaining its crystalline ice.

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Ganymede, which lies between two, exhibits amorphous ice at high latitudes and crystalline ice at lower latitudes; because of moon's intrinsic magnetic field, which would funnel charged particles to higher latitudes and protect lower latitudes from irradiation.

50. Enceladus
51. Saturn
52. Coarser-grained ice
53. Cassini ISS
54. Farther from the planet
55. Iapetus
56. Saturn
57. Dark
58. Any of the following responses will be accepted:
    a. May be sweeping up particles from Phoebe; if that is case, then there will be a steady replenishing of dark surface because very few bright crater are detected within dark area.
    b. There may be ice-volcanism and hydrocarbons may have chemical reactions with solar wind/radiation and become dark.
    c. Thermal segregation: it has a very slow rotation, longer than 79 days. Such a slow rotation means that daily temperature cycle is very long, so long that dark material can absorb heat from sun and warm up. (The dark material absorbs more heat than bright icy material.) This heating will cause any volatile, or icy, species within dark material to sublime out, and retreat to colder regions on Iapetus. This sublimation of volatiles causes dark material to become even darker -- and causes neighboring bright, cold regions to become even brighter.
    d. May have experienced a (possibly small) influx of dark material from an external source, which could have warmed up and triggered this thermal segregation process.
59. Turgis Crater.
60. Image F
61. Conamara Chaos
62. Europa
63. Disruption of the icy crust of Europa. The region consists of rafts of ice that have moved around and rotated. Surrounding these plates is a lower matrix of jumbled ice blocks which may have been formed as water, slush, or warm ice rose up from below the surface.
64. This supports the Thin-Ice model of Europa, where there is frequent contact between the surface and the subsurface ocean
65. Any of the following are accepted:
    a. Thera/Thrace Macula
    b. Ridges
    c. Cycloids
    d. Plains
    e. Subsurface Ocean
    f. Plumes
66. True
67. Non-ice components. The red is seen around the ridges and near the dome-like structures where the surface may have been thermally altered. Thus, areas associated with internal geologic activity appear reddish

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68. Ejecta from Pwyll Crater. They are superimposed to the surrounding area indicating that they are extremely young
69. Old, icy plains
70. Galileo
71. Images E and G
72. Europa is geologically active and the surface appears to change frequently
73. Comet Shoemaker-Levy 9's impact with Jupiter
74. 1994
75. Utig
76. Equatorial Glaciers
77. Mars
78. SHARAD on Mars Reconnaissance Orbiter (MRO)
79. Vesta
80. Asteroid belt
81. Dawn
82. Ceres
83. Triton
84. Neptune
85. Retrogade orbit
86. Slidr and Tano Sulci
87. Cantaloupe Terrain
88. Comet
89. WILD-2
90. Stardust
91. Titan
92. Image D
93. Vortex at South Pole
94. Huygens
95. Mars, South Pole
96. Thickness CO_2 deposits on Mars South Polar Ice cap
97. SHARAD on Mars Reconnaissance Orbiter
98. Color coded and processed to enhance faint signals, making the contours and extent of the fainter, larger-scale component of the plume easier to see
99. E ring
100. Particles that come from plumes on Enceladus replenish the E Ring of Saturn
101. Enceladus has a much lower surface gravity (0.114 m/s^2) than Europa (1.314 m/s^2), so more particles escape from it. In contrast, The plumes material for Europa would fall back down to surface (high re-deposition rate of 3000kg/s) after going 100-300km high after being shot out at approximately 700 m/s
102. Gravity measurements mapped onto a reference ellipsoid showing anomaly from what it would be if Enceladus was a perfect sphere.
103. Subsurface Ocean around the south pole of Enceladus
104. As Cassini flies by Enceladus its velocity is perturbed by an amount that depends on variations in the gravity field that we're trying to measure. That change is measured by applying the Doppler effect because the change in velocity of Cassini is seen as a change in the frequency of the radio waves transmitted through space back to Earth. What was found is a negative mass anomaly, which means the area contains less mass than would be expected for a perfectly spherical body. Although a negative mass anomaly makes sense since Enceladus' south-polar region is depressed

by a depth of ~1 km, the observed negative mass anomaly turned out to the significantly smaller than expected. As a result, there must be “extra” mass beneath the surface to account for the smaller than expected negative mass anomaly. From these, calculations predict that the