StellarXplorers IV Quarterfinals Round (Qtr) Question Bank - DRAFT
Answer Key

1. An *apparent solar day* is the time between the Sun's successive passages above a certain point (such as a location's longitude). Because the Earth's orbit is slightly elliptical, an *apparent solar day* varies a bit throughout the year. In practice, we take the average over the year to get a *mean solar day*, which is 24 hours. For orbits and launch windows, we need one day to actually equal 360^0 of Earth's rotation. We call this a *sidereal day*. A solar day is _____________ a sidereal day. [Section 9.1]

    a. Always shorter than
    b. Always longer than
    c. Sometimes shorter than and sometimes longer than
    d. Equal to (at the vernal equinox)

2. Kennedy Space Center is located at a latitude (L_0) of 28.5^0. A satellite's planned orbit has an inclination (i) of 53^0. How many launch windows are available each day? [Section 9.2]

    a. 0
    b. 1
    c. 2
    d. 4

3. During liftoff from Earth, a launch vehicle goes through four distinct phases on its way from the launch pad into orbit. During which phase is the launch vehicle attempting to gain velocity without exceeding dynamic pressure constraints? [Section 9.3]

    a. Vertical Phase
    b. Pitch Over
    c. Gravity Turn
    d. Vacuum Phase

4. Due to the Earth's rotation, a launch site has a tangential velocity in the eastward direction, it gives a launch vehicle a "head start" (assist) for launches in the easterly direction—into direct (prograde) orbits. The closer a launch site is to the equator, the greater assist the launch vehicle gets when launching eastward. The European Space Agency's launch site at Kourou is located at 5^0 N latitude while Kennedy Space Center is located at 28.5^0 latitude. For satellites going to geostationary orbit, launching from Kourou needs about ____________ less ΔV to get to GEO compared to launching from Kennedy Space Center. [Section 9.3]

    a. 10%
    b. 20%
    c. 30%
    d. 40%

5. The velocity the launch vehicle must deliver to reach the desired orbit is called _____________. [Section 9.3]

   a. Burnout Velocity (V_{bo})
   b. Design Velocity (ΔV_{design})
   c. Velocity Needed (ΔV_{needed})
   d. Velocity Launch Site ($V_{launch\ site}$)

6. Force applied to an object over time produces _________________. [Section 14.1]

   a. Momentum
   b. Impulse
   c. Effective Exhaust Velocity
   d. Mass Flow Rate

7. ___________________________ represents rocket efficiency, which equals the ratio of momentum change to the amount of propellant spent. [Section 14.1]

   a. Specific Impulse
   b. Effective Exhaust Velocity
   c. Specific Momentum
   d. Thrust Coefficient

8. Thermodynamic rockets develop thrust using thermodynamic energy (heat and/or pressure) to accelerate as gas through a nozzle. The air in a balloon (under pressure) is one simple example. The air in the balloon behaves as a "perfect gas," so we can relate the pressure, density, and temperature of the air using the perfect-gas law ($P = \rho RT$) where *P* = pressure, ρ = density, *R* = Specific Gas Constant, and *T* = Temperature. A "perfect gas" has certain properties and one of them says there is no heat transfer into or out of the fluid. This property is called ____________________________. [Section 14.1]

   a. Steady Flow
   b. Adiabatic Flow
   c. Frozen Flow
   d. Reversible Flow

9. For supersonic flow, such as typical thermodynamic rocket engines, a divergent nozzle expands the exiting gasses which causes the exit velocity to increase. The longer the divergent nozzle, the higher the exit velocity. If the length of the nozzle results in the pressure at the nozzle exit being greater than the atmosphere surrounding the nozzle ($P_{exit} > P_{atmosphere}$), this is called an _________________ nozzle. [Section 14.1]

   a. Over expanded
   b. Ideally expanded
   c. Under expanded
   d. Exit

10. Electrostatic rockets use electric and magnetic fields to accelerate charged particles in a propellant. To create more thrust from an electrodynamic rocket, we need ___________________________________. [Section 14.1]

    a. A higher exhaust velocity
    b. A higher charge density
    c. A stronger electric field
    d. All of the other three answers

11. For a launch vehicle, the primary disadvantage of a pressure-fed propellant delivery system compared to a pump-fed pressure system is ________________________. [Section 14.2]

    a. Complexity
    b. Weight
    c. Requirement for cryogenic propellants
    d. Nozzle configuration

12. An electromechanical device that measures the pressure at various points in the propellant system is called a(n) _________________. [Section 14.2]

    a. Pressure Transducer
    b. Injector
    c. Pressure Controller
    d. Pressure Regulator

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13. Hypergolic propellants do not require a separate means of ignition system to start the combustion process. Which of these is an example of a hypergolic propellant? [Section 14.2]

    a. Kerosene and Liquid Oxygen
    b. Liquid Hydrogen and Hydrogen Peroxide
    c. Hydrazine and Nitrogen Tetroxide
    d. Kerosene and Ammonium Perchlorate

14. In a solid-rocket motor, this mass flow rate depends on the propellant's burn rate (m/s) and the burning surface area (m^2). The large solid rocket motors on the Space Shuttle, for example, used a star-shaped core, specifically tailored so the thrust decreased 55 seconds into the flight to reduce acceleration and the effects of aerodynamic forces as the vehicle passes through the sound barrier. There is a Figure in Section 14.2 of the textbook called Solid Propellant Grain Designs. Which grain design shows the star-shaped core? [Section 14.2]

    a. Figure #1
    b. Figure #2
    c. Figure #5
    d. Figure #6

15. Which of the following is an example of a solid-rocket propellant? [Section 14.2]

    a. Hydrazine
    b. Ammonium perchlorate
    c. Hydrogen Peroxide
    d. Nitrogen Tetroxide

16. Which rocket type has a very high efficiency (I_{sp} ~ 1000 s with H_2) and high thrust (~ 10^6 N). [Section 14.2]

    a. Resistojet
    b. Arcjet
    c. Electro-thermal
    d. Nuclear-thermal

17. Teflon is used as a propellant on what type of propulsion system? [Section 14.2]

    a. Solar-Thermal
    b. Electro-Static
    c. Hall Effect Thruster
    d. Pulsed Plasma Thruster

18. One “exotic” means of propulsion is use of a tether. A small payload is attached to a satellite in a circular orbit at the end of a very long tether. The payload is deployed upward (away from Earth). When the tether is cut, the payload will enter an elliptical orbit with more energy than the satellite’s circular orbit. The new apogee altitude for the payload elliptical orbit would be higher than the carrier’s original circular orbit by _____ times the length of the tether. [Section 14.2]

    a. 2
    b. 4
    c. 7
    d. 10

19. For a launch vehicle, the external pressure on the first stage engines decreases from sea level (101.3 kPA = 14.7 psi) to near zero (vacuum) in just a few minutes. Ideally, the nozzle should increase its expansion ratio throughout the trajectory to change the exit pressure as atmospheric pressure decreases. Unfortunately, with current technology, the hardware to do this weighs too much to be affordable to implement. Instead, the nozzle is typically designed to reach ideal expansion approximately _________ of the way from the altitude of engine ignition to the altitude of engine cutoff. [Section 14.3]

    a. 1/3
    b. 1/2
    c. 2/3
    d. 3/4

20. According to the textbook, over _________% of a typical launch vehicle’s lift-off mass is propellant. [Section 14.3]

    a. 25
    b. 40
    c. 60
    d. 80