National Association of Rocketry
Level 2 ("J"/"K"/"L") Certification Test Question Pool

Questions with bold numbers are not effective until 1 June, 1999

Section A - Applicable Regulations (11 questions)

A1) Which of the following National Fire Protection Association standards provides a code for high power rocketry?

A) NFPA 1122
B) NFPA 1127
C) NFPA 1123
D) NFPA 1124

The answer is "B". NFPA 1127 is the Code for High Power Rocketry. NFPA 1122 is the Code for Model Rocketry; NFPA 1123 is the Code for Outside Display of Fireworks; NFPA 1124 is the Code for the Manufacture, Transportation, and Storage of Fireworks.

A2) What part of the Federal Aviation Administration Federal Aviation regulations govern rocket activity?

A) Part 95
B) Part 97
C) Part 101
D) Part 125

The answer is "C". Rocket activity is codified in Part 101, Moored Balloons, Kites, Unmanned Rockets, and Unmanned Free Balloons.

A3) What is the maximum launch weight allowable for a rocket which does not require FAA notification or waiver?

A) 4 ounces (113 grams)
B) 4.4 ounces (125 grams)
C) 1 pound (453 grams)
D) 3.3 pounds (1500 grams)

The answer is "C". Part 101 does not govern the operation of model rockets weighing under 16 ounces (1 pound).

A4) What is the maximum propellant weight allowable for a rocket which does not require FAA notification or waiver?

A) 4 ounces (113 grams)
B) 4.4 ounces (125 grams)
C) 1 pound (453 grams)
D) 3.3 pounds (1500 grams)

The answer is "A". Part 101 does not govern the operation of model rockets using not more than 4 ounces of propellant.

A5) What is the maximum total impulse allowable for a rocket which does not require FAA notification or waiver?

A) 80 Newton seconds
B) 160 Newton seconds
C) 320 Newton seconds
D) There is no impulse limit.

The answer is "D". Part 101 does not specify any impulse limits.

A6) What is the maximum launch weight allowable for a rocket when complying with the FAA notification requirements?

A) 4 ounces (113 grams)
B) 4.4 ounces (125 grams)
C) 1 pound (453 grams)
D) 3.3 pounds (1500 grams)

The answer is "D". Part S101.22 allows operation of rockets weighing no more than 1500 grams (3.3 pounds) provided an individual complies with the notification requirements in part S101.25.

A7) What is the maximum propellant weight allowable for a rocket when complying with the FAA notification requirements?

A) 4 ounces (113 grams)
B) 4.4 ounces (125 grams)
C) 1 pound (453 grams)
D) 3.3 pounds (1500 grams)

The answer is "B". Part S101.22 allows operation of rockets using not more than 125 grams (4.4 ounces) of propellant provided an individual

complies with the notification requirements in part S101.25.

A8a) High power rocket motors, motor reloading kits, and pyrotechnic modules shall be stored at least ____ away from smoking, open flames, and other sources of heat.

A) 10 feet
B) 25 feet
C) 50 feet
D) 75 feet

The answer is "B". Refer to paragraph 2-18.1 of NFPA 1127, 1998 edition.

A9a) Which of the following is a requirement for high power certification:

A) The ability to understand written English instructions
B) A minimum of 18 years of age
C) A citizen of the United States of America
D) No felony convictions

The answer is "B". Refer to paragraph 5-4.1 of NFPA 1127, 1998 edition.

A10) Deleted

A11) What is the maximum total impulse permitted in a high power rocket per NFPA 1127?

A) 81920 Newton seconds
B) 40960 Newton seconds
C) 20480 Newton seconds
D) There is no limit provided the FAA altitude waiver requirements are not exceeded.

The answer is "B". Refer to paragraph 2-8.2 of NFPA 1127, 1998 edition.

A12) What is the maximum allowable weight for a high power rocket permitted per NFPA 1127?

A) 30 pounds
B) 60 pounds
C) 120 pounds
D) There is no limit provided the rocket weighs less than the rocket motor manufacturer's recommended liftoff weight for the rocket motor(s) used for flight.

The answer is "D". Refer to NFPA 1127, 1998 edition paragraph 2-8.1.

A13) What is the minimum age for user certification?

A) 16 years old
B) 18 years old
C) 21 years old
D) 25 years old

The answer is "B". Refer to NFPA 1127, 1998 edition, paragraph 5-4.1.

A14) Which of the following is <u>not</u> a required feature of a rocket motor ignition system?

A) A removable interlock device is in series with the launch switch.
B) The system is electrically operated.
C) The launching switch will return to the "off" position when released.
D) An audible or visual indicator shows continuity through the rocket motor ignitor.

The answer is "D". Refer to NFPA 1127, 1998 edition, paragraphs 2-12.1 and 2-12.2.

A15) Which of the following statements are true concerning the definition of a High Power Rocket Motor?

A) Total impulse is more than 160 Newton seconds
B) The motor uses a "composite" propellant
C) Both A and B above
D) The motor must use either fiberglass or metal case materials

The answer is "A". Refer to NFPA 1127, 1998 edition, paragraph 1-3, for the definition of a high power rocket motor.

A16) Which of the following is (are) true of a complex high power rocket per NFPA 1127?

A) The rocket is multi-staged or propelled by a cluster of rocket motors
B) The rocket contains electrical or electronic devices intended for control of the rockets functions, e.g. staging, recovery initiation
C) The rocket uses other than parachute or streamer recovery, e.g. helicopter or glide recovery
D) Both "A" and "B" above

The answer is "A". Refer to NFPA 1127, 1998 edition, paragraph 1-3, Definitions.

A17) A launch site is defined as containing areas for which of the following activities?

A) Launching
B) Recovery
C) Parking
D) All of the above

The answer is "D". Refer to NFPA 1127, 1998 edition, paragraph 1-3, for the definition of a launch site.

A18) A person shall fly a high power rocket only in compliance with:

A) NFPA 1127
B) Federal Aviation Administration Regulations, Part 101
C) State, and local laws, rules, regulations, statutes, and ordinances
D) All of the above

The answer is "D". Refer to NFPA 1127, 1998 edition, paragraph 2-2.

A19) Which of the following statements is always true concerning the definition of a hybrid rocket motor?

A) The fuel component is composed of either paper or plastic.
B) The fuel is in a different physical state (solid, liquid, or gaseous) than the oxidizer.
C) The oxidizer component is nitrous oxide.
D) Both "A" and "C" above"

The answer is "B". Refer to NFPA 1127, 1998 edition, paragraph 1-3, for the definition of a hybrid rocket motor.

A20) Per the ATF-Explosives Law and Regulation (Orange Book) what kind of explosive material is Thermalite fuse:

A) High Explosive
B) Low Explosive
C) Blasting Agent
D) Non-explosive

The answer is "B". Refer to section 55.202 (b) of the ATF-Explosives Law and Regulation, 6/90 revision.

A21) LEUP stands for:

A) Legal Entitity User Permit
B) Liability Evaluation/Uniform Process
C) Low Explosive User Permit
D) Low Explosive Uniform Process

The answer is "C".

A22) The minimum age for an explosive permits applications is:

A) 16 years or older
B) 18 years or older
C) 21 years or older
D) 25 years or older

The answer is "C". Refer to ATF-Explosives Law and Regulation (Orange Book), Sections 843 (b) (1) and 842 (d) (1).

A23) Which of the following statements are true concerning the definition of a High Power Rocket Motor?

A) Total impulse is less than 81920 Newton seconds
B) The total impulse is more than 160 Newton-seconds
C) Both A and B above
D) The motor must use either fiberglass or metal case materials

The answer is "B". Refer to NFPA 1127, 1998 edition, paragraph 1-3, for the definition of a high power rocket motor.

A24) Which of the following are prohibited activities for participants prepping or launching high power rockets?

A) Consumption of alcohol
B) Use of medication that could affect judgement, movement, or stability
C) Both "A" and "B" above
D) None of the above

The answer is "C". Refer to NFPA 1127, 1998 edition, paragraph 6-1 "l".

A25) Which of the following are prohibited activities for spectators in high power rocket prepping areas ?

A) Consumption of alcohol
B) Use of medication that could affect judgement, movement, or stability
C) Both "A" and "B" above
D) None of the above

The answer is "C". Refer to NFPA 1127, 1998 edition, paragraph6-1 "l".

A26) An certified individual wants to purchase a "L" motor reload kit at a launch in a state other than his residence. Which of the following is true?

A) He must possess a Low Explosives User's Permit.
B) He does not require a Low Explosives User's Permit.
C) He must pay in advance for the motor purchase.
D) He must use the reload kit on the same day as purchase.

The answer is "A". Refer to NFPA 1127, 1998 edition, paragraph 5-2 "a".

A27) An certified individual wants to purchase a "L" motor reloadable casing at a launch in a state other than his residence. Which of the following is true?

A) He must possess a Low Explosives User's Permit.
B) He does not require a Low Explosives User's Permit.
C) He must pay in advance for the motor purchase.
D) He must use the reload kit on the same day as purchase.

The answer is "B". Refer to NFPA 1127, 1998 edition, paragraph 5-2 "a". Note the difference from question A26 (casing versus reload kit).

Section B - Storage Requirements (2 questions)

B1) What is the maximum net propellant weight that may be stored in a indoor Type 3 or Type 4 magazine?

A) 10 pounds
B) 25 pounds
C) 50 pounds
D) 100 pounds

The answer is "C". Refer to NFPA 1127, 1998 edition, paragraph 2-18.2.

B2) Which type of storage magazine is referred to as a "day-box"?

A) Type 1
B) Type 2
C) Type 3
D) Type 4

The answer is "C". A Type 3 magazine is a "day-box" or other portable magazine per page 51 of the ATF - Explosives Law and Regulations (6/90).

B3) Which of the following are requirements for Type 3 magazine construction?

A) Steel structure
B) Wood lined
C) Lockable
D) All of the above

The answer is "D". A Type 3 magazine is constructed from steel, no thinner than 12 gauge, and lined with 1/2" thick plywood or

hardboard. Provisions for 1 lock, no hood, are required.

B4) Which of the following is not a requirement for an indoor magazine?

A) The magazine will be painted red.
B) The magazine will bear the words "EXPLOSIVES-KEEP FIRE AWAY".
C) The magazine will bear the words "EXPLOSIVES-50 POUND MAXIMUM"
D) The words "EXPLOSIVES-..." are printed in white letters at least 3 inches high.

The answer is "C". Refer to NFPA 1127, 1998 edition, paragraph 2-18.2.

B5) In which of the following locations can a Type 3 or Type 4 magazine be properly located?

A) In the attached garage of a single family residence
B) In the utility or laundry room of a multi-family residence
C) In the bedroom closet for a non-smoker resident
D) Anywhere inside the house at least 10 feet away from flame producing appliances (stove, water heater, etc.)

The answer is "A". Refer to NFPA 1127, 1998 edition, paragraph 2-18.2.3.

B6) In which of the following locations can a Type 3 or Type 4 magazine be properly located?

A) In the utility or laundry room of a multi-family residence
B) In the attached garage of a multi- family residence if the garage is surrounded on all sides by a 1 hour fire rated barrier
C) In the bedroom closet for a non-smoker resident
D) Anywhere inside the house at least 10 feet away from flame producing appliances (stove, water heater, etc.)

The answer is "B". Refer to NFPA 1127, 1998 edition, paragraph 2-18.2.4.

B7) In which of the following locations can a Type 3 or Type 4 magazine be properly located?

A) In the bedroom closet for a non-smoker resident
B) In the attached garage of a multi- family residence
C) In a detached garage substantially removed or segregated from any residence.
D) Anywhere inside the house at least 10 feet away from flame producing appliances (stove, water heater, etc.)

The answer is "C". Refer to NFPA 1127, 1998 edition, paragraph 2-18.2.2.

Section C - Range and Safety Practices (15 questions)

C1) What is the maximum launch angle, measured from the vertical, for a high power rocket?

A) 10 degrees
B) 20 degrees
C) 30 degrees
D) 40 degrees

The answer is "B". Refer to section 15 of the NAR High Power Rocket Safety Code.

C2) What is the maximum wind velocity allowable for launch operations?

A) 20 miles per hour
B) 25 miles per hour
C) 15 miles per hour
D) 30 miles per hour

The answer is "A". Refer to section 13 of the NAR High Power Rocket Safety Code.

C3) The minimum launch site dimension for rockets having a maximum installed impulse of 320.00 Newton seconds is 1500 feet. What is the minimum distance between the launch site boundary and the launcher?

A) 150 feet
B) 375 feet
C) 750 feet
D) The launcher may be located anywhere on the launch site to compensate for wind.

The answer is "C". A person shall not locate a launcher closer to the edge of the launch site than one half (1/2) the minimum launch site dimension. Refer to section 9 of the NAR High Power Rocket Safety Code (revision 7/95).

C4) The minimum launch site dimension for rockets having a maximum installed impulse of 2560.00 Newton seconds is 5280 feet. Flights to 10500 feet are anticipated. What is the minimum distance between the launch site boundary and the launcher?

A) Approximately 660 feet
B) Approximately 1320 feet
C) Approximately 2600 feet
D) The launcher may be located anywhere on the launch site to compensate for wind.

The answer is "C". A person shall not locate a launcher closer to the edge of the launch site than one half (1/2) the minimum launch site dimension. Refer to NFPA 1127, 1998 edition, paragraph 2-14.2 and section 9 of the NAR High Power Rocket Safety Code (revision 7/95). The anticipated altitude is important because the launch site dimensions may also be determined to be 1/2 of the maximum altitude expected (see NFPA paragraph 2-13.4). In this case 1/2 of 10500 feet is 5250 feet or about the same as specified in the safety code launch site table.

C5) The FAA has granted a waiver for high power rocket flight to 18000 feet for your event. Flights up to that altitude are expected. What are the minimum launch site dimensions?

A) 1800 feet
B) 4500 feet
C) 9000 feet
D) 18000 feet

The answer is "C". The size of the launch site may also be calculated as no less than one half (1/2) of the maximum altitude expected, calculated, simulated, or granted (by FAA waiver/authority having jurisdiction). Note that the minimum launch site dimensions may even be even greater depending upon the total impulse flown. For example, "L" powered models require a minimum launch site dimension of 10560 feet. Refer to NFPA 1127, 1998 edition, para 2-13.2 and to section 9 of the NAR High Power Rocket Safety Code (revision 7/95).

C6) The FAA has granted a waiver for high power rocket flight to 2500 feet for your event. What are the minimum launch site dimensions?

A) 250 feet
B) 500 feet
C) 1250 feet
D) 1500 feet

The answer is "D". The size of the launch site may also be calculated as no less than one half (1/2) of the maximum altitude expected, calculated, simulated, or granted (by FAA waiver/authority having jurisdiction), however, in no case shall the minimum launch site dimension be less than 1500 feet. Note that the minimum launch site dimensions may even be even greater depending upon the total impulse flown. Refer to NFPA 1127, 1998 edition, paragraph 2-13.3 and to section 9 of the NAR High Power Rocket Safety Code (revision 7/95).

C7) In no case shall the minimum launch site dimension be less than _____ the estimated altitude of the high power rocket or _____ .

A) 1/4, 1500 feet
B) 1/2, 1500 feet
C) 1/4, 2500 feet
D) 1/2, 2500 feet

The answer is "B". Refer to NFPA 1127, 1998 edition, paragraphs 2-13.2 and 2-13.3.

C8) Your launch site borders on an interstate freeway. What is the minimum distance allowable for location of a high power launch site from the interstate freeway?

A) 750 feet
B) 1500 feet
C) 3000 feet
D) 5280 feet (1 mile)

The correct answer is "B". Refer to NFPA 1127, 1998 edition, paragraph 2-14.2.

C9) Your launch site's owner's house is located in the middle of your site. What is the minimum distance allowable for location of a high power launch site from the owner's house?

A) 750 feet
B) 1500 feet
C) 3000 feet
D) The launch site shall contain no occupied buildings; you cannot launch unless the house is empty.

The answer is "D". Paragraph 2-14.2 of NFPA 1127, 1998 edition, states that when occupied structures or busy roads border the launch site, a 1500 foot minimum separation is required between the launcher and the road or building.

C10) What is the minimum safe distance from a high power rocket containing a single "I" motor?

A) 200 feet
B) 100 feet
C) 75 feet
D) 50 feet

The answer is "B". Refer to Table 2-15 .3 of NFPA 1127, 1998 edition, and the safe distance table in the NAR High Power Rocket safety code (revised 7/95).

C11) What is the minimum safe distance from a high power rocket containing two "H" motors?

A) 200 feet
B) 100 feet
C) 75 feet
D) 50 feet

The answer is "A". Refer to Table 2-15.3 of NFPA 1127, 1998 edition, and the safe distance table in the NAR High Power Rocket safety code (revised 7/95).

C12) What is the minimum safe distance from a high power rocket containing two "K" motors?

A) 50 feet
B) 100 feet
C) 300 feet
D) 500 feet

The answer is "D". Refer to the NAR High Power Rocket Safety Code and Table 2-15.3 of NFPA 1127, 1998 edition.

C13) Which of the following igniters may be ignited by the continuity test of some launch controllers?

A) Nichrome wire
B) Flashbulbs
C) Electric match
D) Both "b" and "c" above

The answer is "D". Refer to the "Handbook of Model Rocketry" by G. Harry Stine, 6th edition, Chapter 6 on "Ignition and Ignition Systems". Look at page 94.

C14) In the event of a misfire how long should you wait before approaching the launch pad?

A) 15 seconds
B) 60 seconds
C) 5 minutes
D) No wait is required

The answer is "B". Refer to paragraph 12 of the NAR High Power Rocket Safety Code.

C15) Which of the following is most likely to cause catastrophic failure of a black powder rocket motor?

A) Temperature cycling
B) Electromagnetic fields
C) Vibration
D) High altitude

The answer is "A". Temperature cycling is the primary cause of black powder rocket motor catastrophic failure. Temperature cycling cause expansion and contraction of the black powder grain and motor casing causing delaminations between the case and propellant grain and cracks within the grain. These delaminations and cracks expose additional burning surface that increases combustion pressures. The result is a motor failure. Note that shock or vibration can also damage a black powder rocket motor, however thermal cycling is the most likely cause of failure. Refer to the May and June 1992 issue of American Spacemodeling magazine, page 10, the article "A Theoretical Analysis of Why Black Powder Model Rocket Motors Fail".

C16) Igniters for clustered rocket motors should be wired together in:

A) Series
B) Parallel
C) Short Circuit
D) Open Circuit

The answer is "B". If the igniters are wired in series the first igniter to burn out opens the circuit preventing any other igniters from receiving electrical power. Parallel connections allow all of the igniters to independently receive electrical power.

C17) When should igniters installed in rocket motors be checked for continuity?

A) Any time
B) Only in an enclosed shelter
C) Only on the launch pad when ready for launch
D) Igniters should never be checked for continuity while installed in a rocket motor.

The answer is "C". Continuity is typically checked by the launch controller when the rocket is placed on the launch pad. This is considered safe practice because the number of personnel around the model is at a minimum and the model is pointed skyward which minimizes the hazard in the event of inadvertent ignition.

C18) Which of the following is the preferred method for attaching fins to a high power rocket?

A) Tube surface mounting
B) "Wedge" mount
C) "Though the wall" mounting
D) All fin mounting methods are all equally strong; it does not matter

The answer is "C". Through the wall mounting is stronger because the model is supported and attached to the rocket at two locations. The fins are attached to the motor tube and the body tube. In cases where through the wall mounting is not usable "wedge" mounting may be possible. Wedge mounting places the fin at the junction of two tubes; this mounting is typically used in cluster models. Surface mounting, like that used in most model rocket kits, is not recommended for high power rockets.

C19) Which of the following adhesives should not be used on rubber (or elastic) shock cord components?

A) Epoxy adhesives
B) Cyanoacrylate glues (super glue)
C) Aliphatic resin based glues
D) White "Elmer's" glue

The answer is "B". Cyanoacrylate glues will chemically attack rubber or elastic shock cord components allowing them to break when stretched.

C20) Which of the following adhesives is most likely to be weakened under humid or wet weather conditions?

A) Epoxy adhesives
B) Cyanoacrylate glues (super glue)
C) Aliphatic resin based glues
D) White "Elmer's" glue

The answer is "D". White glues are weakened under high humidity conditions. Use aliphatic base (wood or carpenter's) glues instead of white glue.

C21) Which of the following adhesives is the best choice for engine mount construction?

A) Epoxy adhesives
B) Cyanoacrylate glues (super glue)
C) Aliphatic resin based glues
D) "Hot melt" adhesives

The answer is "A". Epoxies can be used to easily form fillets at the bond joints which provides an increase in strength. Epoxies also bridge gaps in loose fitting parts to improve bond strength. One caution when using epoxies is that they are relatively heavy; they can reduce model stability by making the model tail heavy. Cyanoacrylate glues are not recommended for engine mount construction because they tend to soak into paper/cardboard body tube materials and are poor gap fillers. Hot melt adhesives should never be used for engine mount applications because they weaken with heat.

C22) The centering rings provided with your high power kit are a loose fit around the motor tube. Which of the following adhesives is the best choice for a strong joint?

A) Epoxy adhesives
B) Cyanoacrylate glues (super glue)
C) Aliphatic resin based glues
D) "Hot melt" adhesives

The answer is "A". Epoxies can be used to easily form fillets at the bond joints which provides an increase in strength. Epoxies also bridge gaps in loose fitting parts to improve bond strength. One caution when using epoxies is that they are relatively heavy; they can reduce model stability by making the model tail heavy. Cyanoacrylate glues are not recommended for engine mount construction because they tend to soak into paper/cardboard body tube materials and are poor gap fillers. Hot melt adhesives should never be used for engine mount applications because they weaken with heat.

C23) A small hole is typically recommended near the top, but below the nosecone or payload section shoulder, of a high power rocket's booster section. Why?

A) This hole allows excessive ejection charge pressures to vent to reduce shock cord stress.
B) The hole is used to give air pressure readings for on board altimeters.
C) The hole vents internal air pressure as the rocket gains altitude to prevent internal air pressure from prematurely separating the model.
D) The hole allows easy verification that a parachute is installed.

The answer is "C". Air pressure external to the rocket decreases as the rocket ascends. Trapped pressure within the model can prematurely separate the model. The hole vents this internal air pressure to prevent separation. Note that the hole size is dependent on model size; larger models require larger holes. Use caution in locating the hole such that the nosecone (or stage coupler) does not block the hole. Also, position the hole such that ejection charge pressure is not vented before ejecting the recovery system from the body tube.

C24) When clustering combinations of black powder and composite motors, which type of rocket motor should be ignited first?

A) Composite rocket motors should be ignited first
B) Black powder rocket motors should be ignited first
C) It does not matter which motors are ignited first
D) Clusters should never mix composite and black powder motors

The answer is "A". Composite rocket motors are harder to ignite than black powder motors. The concern is that the model will leave the launch pad before the composite motor has ignited.

C25) Why should composite motors be ignited first in a mixed composite and black powder cluster?

A) Composite motors are more difficult and take longer to ignite.
B) Composite motors are more likely to "cato" than black powder motors
C) The exhaust products from black powder motors prevent composite motor ignition.
D) Composite rocket motors are more powerful than black powder motors

The answer is "A". Composite rocket motors are harder to ignite than black powder motors. The concern is that the model will leave the launch pad before the composite motor has ignited.

C26) If individual igniters are used for igniting a clustered model's motors which of the following statements is typically true:

A) The launch control must have an audible as well as visual indication of igniter continuity.
B) The launch control must provide additional current to ignite the additional igniters.
C) The launch control must provide higher voltage to ignite the additional igniters.
D) The launch control must use a car battery as a power source

The answer is "B". Parallel wiring used in cluster ignition models "shares" the current among all the igniters. If the ignition circuit is marginal those igniters which are slightly more sensitive will ignite before their mates. The model may leave the launcher prior to full ignition of the cluster. Common practice is to use a battery which can deliver higher currents than dry cells; automotive, motorcycle, and "gell cell" batteries are common. Increased voltage will not significantly improve cluster ignition reliability. House voltage, 110 volts AC, should never be used for ignition systems.

C27) What is (are) the advantages of using a "relay" type launch control?

A) It is cheaper than a non-relay launch control
B) The relay allows a better indication of igniter continuity
C) It can deliver more power to the rocket motor igniters
D) Both "B" and "C" above

The answer is "C". A relay launch system uses a relay to switch the power needed for rocket motor ignition. The battery is usually placed adjacent to the launch pad which allows for shorter power wires. The shorter power wires minimize the normal loss of power that occurs over long wire lengths (remember that several hundred feet of wire may be required to reach a high power launch pad). The wires going to the launch officer only carry the power required to operate the relay; this power is typically much less than that required by an igniter.

C28) Petroleum based lubricants should not be used with the oxygen or nitrous oxide systems used in hybrids. Why?

A) They thicken when exposed to oxygen or nitrous oxide.
B) They lose their lubricating properties when exposed to oxygen or nitrous oxide.
C) There is a risk of spontaneous ignition or explosion.
D) The lubricant can promote corrosion of the metal components in the presence oxygen or nitrous oxide.

The answer is "C". Petroleum lubricants are a fuel. Oxygen rich environments are more likely to promote combustion.

C29) Which of the following safety hazards may be associated with hybrid rocket motors?

A) High pressure gas, low temperatures (frostbite)
B) Low temperatures (frostbite)
C) Corrosive materials
D) High pressure gas

The answer is "A". The pressure within a nitrous oxide cylinder used with hybrid rocket motors is approximately 750 psi. When filling or venting the nitrous oxide cylinder individuals need to use caution to avoid having high pressure gas or liquid impinge on skin or eyes. Oxidizer cylinders need to be inspected after crashes for damage that may compromise their structural integrity.

Nitrous oxide boils at -127 ^{o}F. Partially filling and allowing the liquid to drain (boil-off) from a nitrous oxide cylinder is a technique used to pre-chill the nitrous oxide cylinder in some motor applications (called shock chilling). The low temperatures achievable through this method may present a hazard to exposed skin.

C30) The range safety officer says that your model is unsafe to fly. Who has the authority to overturn this ruling:

A) The Launch Control Officer (LCO)
B) The individual who "checked-in" the model
C) Three certified high power fliers who agree the model is safe
D) The safety monitor's (RSO) decision cannot be overturned by anybody

The answer is "D". The range safety officer's decision is final. If the flier can produce additional information which shows the safety of the model, e.g. simulations, previous flight data, then the flier should present the information to the range safety officer.

C31) Parachute ejection systems that sense barometric pressure for activation need a outside hole in their compartment because:

A) This hole allows excessive ejection charge pressures to vent
B) The hole is used to give outside air pressure readings
C) The hole vents internal air pressure as the rocket gains altitude to prevent internal air pressure from prematurely separating the model.
D) The hole allows easy verification that the battery is installed

The answer is "B". Air pressure external to the rocket decreases as the rocket ascends. Most barometric ejection systems trigger after detecting a minimal change in the outside barometric pressure (which happens near apogee). The hole allows the sensor to "see" the outside pressure. Use caution in locating the hole such that the nosecone (or stage coupler) does not block the hole.

C32) Which of the following individuals has the final authority in permitting a high power rocket to fly?

A) The launch control officer (LCO)
B) The range safety officer (RSO)
C) The check-in officer
D) The rocket owner

The answer is "B". The range safety officer's decision is final.

C33) Which of the following individuals has the ultimate responsibility to ensure that the rocket was built in a safe manner?

A) The launch control officer (LCO)
B) The safety monitor (range safety officer or RSO)
C) The rocket owner/builder
D) All of the above

The answer is "C". Range personnel can do inspections to catch lapses in construction quality or rocket design errors but the owner/builder bears all responsibility for the "goodness" and safety of the model.

C34) Parachute ejection systems that sense barometric pressure can malfunction during supersonic flight because:

A) Aerodynamic heating changes the values of electronic components
B) The outside pressure distribution is not continuous around the model
C) Static discharges will "zap" sensitive electronic components
D) Both answers "A" and "B" are correct

The answer is "B". During supersonic flight shock waves are generated off various model features. The pressure distribution across the shock wave is not continuous. The pressure change across the shock wave may fool the ejection system logic causing a premature ejection.

C35) Your rocket was returned from its flight with "zipper" damage where the shock cord tore through the model. What is the possible cause:

A) Parachute ejection occurred too soon after motor burnout
B) Parachute ejection occurred too late after apogee
C) Parachute ejection occurred at apogee
D) Both "A" and "B"

The answer is "D". "Zippers" are caused when the model is moving too quickly during parachute deployment. Ejection too soon after burnout does not allow the model to slow down. Ejection too late after apogee allows the model to gain velocity. Ejection at apogee is best because the model velocity is lowest.

C36) Your payload section, with heavy payload, separated from your model immediately after motor burnout. What might be the cause?

A) The center of pressure at burnout was behind the center of gravity for the model
B) The payload shoulder was too loose in the body tube
C) The rocket motor had a failure of its delay system
D) Both "B" and "C" are correct.

The answer is "D". Delay train failures do happen and can cause this problem. More often, though, "drag separation" causes this problem and is mistaken for a motor failure. Drag separation is caused by the drag on the aft section of the model being higher than the drag of the forward section. The difference in drag causes the aft section to be pulled away from the forward section. This problem is more pronounced with heavier forward sections because the momentum of the forward section tends to carry it away. Preflight inspection should confirm that the forward section cannot separate under its own weight. More sophisticated models

will use some form of positive retention, e.g. shear pins, to prevent premature separation.

C37) What is the distance around a launcher with a "J" powered model that must be cleared of easy to burn material?

A) 10 feet
B) 30 feet
C) 50 feet
D) 75 feet

The answer is "C". Refer to paragraph 2-14.1 of NFPA 1127, 1998 edition.

C38) What is the distance around a launcher with a 2 "J" engine cluster powered model that must be cleared of easy to burn material?

A) 10 feet
B) 30 feet
C) 50 feet
D) 75 feet

The answer is "D". Refer to paragraph 2-14.1 of NFPA 1127, 1998 edition.

Section D - Rocket Stability (3 questions)

D1a) For a rocket to be stable which of the following statements is true?

A) The center of pressure (CP) must be behind the center of gravity (CG).
B) The center of pressure (CP) must be in front of the center of gravity (CG).
C) The rocket must have fins.
D) The length of the body tube must be at least 5 times the model diameter.

The answer is "A". Refer to the "Handbook of Model Rocketry" by G. Harry Stine, 6th edition, Chapter 9 on "Stability". Note references on pages 137 and 138.

D2) An unstable rocket can be made stable by:

A) Adding weight to the nosecone
B) Removing weight from the nosecone
C) Moving the fins forward towards the nosecone
D) Making the rocket shorter

The answer is "A". To make the rocket stable the center of gravity (C.G.) must be moved forward of the center of pressure (C.P.). Adding weight to the nosecone moves the C.G. forward. Removing weight from the nosecone moves the C.G. aft which is incorrect. Moving the fins forward towards the nosecone moves the C.P. forward which is also incorrect. Finally, making the rocket shorter reduces the correcting moments produced by the aerodynamic forces at the C.P.; the reduced moment makes the rocket less stable.

D3) Rocket stability can be estimated by:

A) Center of pressure "Barrowman" equations
B) "Cardboard cutout" method
C) Determining the relative positions of the center of pressure and center of gravity
D) Stability cannot be estimated before a test flight.

The answer is "C". Refer to the "Handbook of Model Rocketry" by G. Harry Stine, 6th edition, Chapter 9 on "Stability". Note Figure 9-6 on page 138. Center of pressure equations and the cardboard cutout method only allow you to determine the center of pressure of the model; the center of gravity location must also be known to determine stability.

D4) A high power rocket's center of pressure can be estimated by:

A) The "Barrowman" method
B) Finding the point where the model balances
C) Center of pressure equations
D) Both "A" and "C" above

The answer is "D". The "Barrowman" method is a set of equations developed by J. Barrowman for estimating model

rocket stability. More sophisticated methods are available to cover conditions not covered by the Barrowman method, e.g. supersonic flight. Refer to the "Handbook of Model Rocketry" by G. Harry Stine, 6th edition, Chapter 9 on "Stability". Note references on pages 140 and 14, Appendix II, and Appendix IV.

D5) An unstable rocket can usually be made more stable by:

A) Using a shorter nosecone
B) Increasing the size of the aft fins
C) Using a larger, heavier rocket motor
D) Increasing the rocket diameter

The answer is "B". To make the rocket stable the center of pressure (C.P.) must be moved aft of the center of gravity (C.G.). Adding larger fins on the aft portion of the model moves the center of pressure aft. A shorter nosecone removes weight from the nose moving the C.G. aft which is incorrect. A larger, heavier rocket motor has the same affect of moving the C.G. aft. Finally, increasing the rocket diameter has essentially no effect on its stability.

D6) During boost a rocket powered by a solid rocket motor tends to become:

A) Less stable in flight
B) More stable in flight
C) No change in stability
D) Unstable

The answer is "B". During powered flight the solid rocket motor consumes its fuel causing the aft end of the rocket to become lighter. This moves the C.G. forward and enhances stability. This can be seen in instances where a unstable rocket becomes stable partway during the rocket motor burn; this is also particularly dangerous because the now stable rocket may be pointed in any direction.

D7) Which of the following is true of an unstable rocket?

A) The center of pressure (CP) is behind the center of gravity (CG).
B) The center of pressure (CP) is in front of the center of gravity (CG).
C) The rocket has more than 6 fins.
D) The length of the body tube is less than 5 times the model diameter.

The answer is "B". Refer to the "Handbook of Model Rocketry" by G. Harry Stine, 6th edition, Chapter 9 on "Stability". Note references on pages 137 and 138.

D8) As a rule of thumb, how far should the center of pressure be from the center of gravity?

A) The center of pressure should be at the same location as the center of gravity.
B) The center of pressure should be at least 1.0 body tube diameters behind the center of gravity.
C) The center of pressure should be at least 1.0 body tube diameters ahead of the center of gravity.
D) The center of pressure should be 1.0 body tube diameters ahead of the fin leading edge; the center of gravity does not matter.

The answer is "B". Refer to the "Handbook of Model Rocketry" by G. Harry Stine, 6th edition, Chapter 9 on "Stability". Note references on pages 141 through 146.

Section E - Rocket Motor Designations (2 questions)

E1) What does the "H" in the motor designation H100-5 stand for?

A) It is the first letter in the manufacturer's name.
B) It indicates the total power range or impulse range of the rocket motor.
C) It indicates the total thrust of the rocket motor.
D) It indicates that the motor uses black powder as a propellant.

The answer is "B". In a rocket motor designation the alphabetic character indicates the total impulse (or total power) for the rocket motor. High power rocket motors are rated as follows:

"H" 160.01 to 320.00 Newton-seconds
"I" 320.01 to 640.00 Newton-seconds
"J" 640.01 to 1280.00 Newton-seconds
"K" 1280.01 to 2560.00 Newton-seconds
"L" 2560.01 to 5120.00 Newton-seconds
"M" 5120.01 to 10240.00 Newton-seconds
"N" 10240.01 to 20480.00 Newton-seconds
"O" 20480.01 to 40960.00 Newton-seconds

Note that the total allowable impulse doubles with each letter class.

E2) What does the "100" in the motor designation H100-5 stand for?

A) It is the peak thrust in pounds of the rocket motor.
B) It is the rocket motor burn time in seconds.
C) It is the average thrust in Newtons of the rocket motor.
D) It is the manufacturer's retail price code.

The answer is "C". In a rocket motor designation the number before the dash is the average thrust in Newtons of the rocket motor. Divide this number by 4.45 for the average thrust in pounds.

E3) What does the "5" in the motor designation H100-5 stand for?

A) It is the rocket motor burn time.
B) It is the peak thrust (in kilograms) of the rocket motor.
C) It is the average thrust of the rocket motor.
D) It is the ejection charge delay time.

The answer is "D". In the standard designation system for rocket motors the number after the dash indicates the delay in seconds between rocket motor burnout and ejection charge operation. Note that a "0" (zero) delay indicates a booster rocket motor; the propellant grain is exposed and no delay or ejection charge is used. A "P" may also be used; this indicates that the end of the motor where the ejection charge and delay train normally reside is plugged.

E4) What are the units of measurement for the "100" in the motor designation H100-5?

A) Newtons per second
B) Newtons
C) Newton-seconds
D) feet per second

The answer is "B". In a rocket motor designation the number before the dash is the average thrust in Newtons of the rocket motor. Divide this number by 4.45 for the average thrust in pounds.

E5) What is the maximum total impulse for a "J" rocket motor?

A) 320.00 Newton-seconds
B) 640.00 Newton-seconds
C) 1280.00 Newton-seconds
D) 2560.00 Newton-seconds

The answer is "C". In a rocket motor designation the alphabetic character indicates the total impulse (or total power) for the rocket motor. High power rocket motors are rated as follows:

"H" 160.01 to 320.00 Newton-seconds
"I" 320.01 to 640.00 Newton-seconds
"J" 640.01 to 1280.00 Newton-seconds
"K" 1280.01 to 2560.00 Newton-seconds
"L" 2560.01 to 5120.00 Newton-seconds
"M" 5120.01 to 10240.00 Newton-seconds
"N" 10240.01 to 20480.00 Newton-seconds
"O" 20480.01 to 40960.00 Newton-seconds

E6) Assuming that each motor has the full allowable impulse, how many "H" motors have the same total impulse as a single "J" motor?

A) 3
B) 1
C) 2
D) 4

The answer is "D". An "H" motor has a maximum allowable total impulse of 320.00 Newton-seconds and a "J" motor has a maximum total impulse of 1280.00 Newton-seconds thus it takes 4 "H's" to equal 1 "J".

E7) The Department of Transportation explosives classification "EXPLOSIVES B" indicates what type of hazard?

A) Mass detonating type explosive
B) Mass fire and hot gas production
C) Shrapnel or projectiles resulting from detonation
D) Limited fire, hot gas production

The answer is "B". Classification "EXPLOSIVES A" indicates a mass detonation hazard; this class has no use in high power rocketry. Classification "EXPLOSIVES B" indicates the production of large amounts of fire and hot gas; this is the classification typically given to high power expendable rocket motors and large (54mm or greater) reloadable motors. Classification "EXPLOSIVES C" indicates the production of limited amounts of fire or hot gas; Class "C" devices typically contain limited amounts of Class "A" or Class "B" materials. Model rocket motors are sometimes classified as Class "C" devices.

E8) What classification in the United Nations (UN) system is similar to the Department of Transportation classification "EXPLOSIVES B"?

A) UN Division 1.1
B) UN Division 1.2
C) UN Division 1.3
D) UN Division 1.4

The answer is "C". UN Division 1.1 is similar to the DOT "EXPLOSIVES A" classification. UN Division 1.4 is similar to the DOT "EXPLOSIVES C" classification. UN Division 1.3 is similar to the DOT "EXPLOSIVES B" classification. (As a note UN Division 1.2 is shrapnel producing; Division 1.1 usually is applied instead.)

E9) You have an H64-8 rocket motor which has been certified to have a total impulse of 320.00 Newton seconds. What is the approximate burn time for this motor?

A) 3 seconds
B) 5 seconds
C) 8 seconds
D) 10 seconds

The answer is "B". Divide the total impulse by the average thrust to determine the motor burn time.

$$\frac{320 \text{ (Newton-seconds)}}{64 \text{ (Newtons)}} = 5 \text{ (seconds)}$$

E10) The manufacturer's test data shows a total impulse of 680 Newton-seconds for your motor. What impulse class does your motor represent?

A) "H"
B) "I"
C) "J"
D) "K"

The answer is "C". Refer to the answer for question E5 above

E11) The manufacturer's test data shows an average thrust of 100 Newtons for 6 seconds for your motor. What impulse class does your motor represent?

A) "H"
B) "I"
C) "J"
D) "K"

The answer is "B". The total impulse is calculated by multiplying the average thrust by time. In this case the total impulse is 600 Newton seconds. Refer to question E5 above for the letter versus total impulse class table.