

Appendix D - Hazard and Risk Analysis Checklist: Completed Example

Pre-Lab Hazard Analysis & Risk Assessment Checklist

This checklist is designed to help educators fulfill their professional "duty of care" by systematically analyzing hazards, assessing risks, and documenting safety actions for every science investigation or engineering design challenge.

Activity Assessed: Make a Planetary Exploration Balloon

Source: NASA Jet Propulsion Laboratory Education Lesson

(<https://www.jpl.nasa.gov/edu/resources/lesson-plan/make-a-planetary-exploration-balloon/>)

I. Analyze the Potential Hazards

A hazard is a source of harm. Evaluate potential hazards within the following categories before instruction begins. Hazards may include physical impact hazards (labware such as ring stand rod and meter sticks), chemical hazards (corrosives and toxins), and biological hazards (mold and bacteria)

- **Materials & Equipment:**

- **Helium-filled balloons.** A balloon can rupture and send fragments toward faces or eyes, and the sudden sound may startle students. Uninflated or broken balloon pieces can obstruct an airway if placed in the mouth. The balloon material must be identified because natural-rubber latex can cause allergic reactions.
- **Helium source, if balloons are filled on site.** A compressed-gas cylinder presents high-pressure, tip-over, valve-damage, rapid-gas-release, cold-burn, and oxygen-displacement hazards. This assessment does not authorize student handling of a helium cylinder.
- **String or ribbon.** The approximately 1-meter lengths specified in the lesson can become tangled around fingers, hair, clothing, or the neck, and loose lengths can create snag or trip hazards.
- **Gondola or container and tape.** Cracked, cut, or rough cup edges may scratch. Weak joints or poorly secured tape may fail and allow the gondola or ballast to fall. Adhesives may irritate sensitive skin or damage classroom surfaces.

- **Ballast objects.** Plastic beads, metal washers, and other small objects may be swallowed, scattered, stepped on, or dropped from height. Heavy, sharp, rusty, brittle, or irregular objects increase impact or cut risk.
- **Measurement tools.** Meter sticks and rulers can poke or strike; retractable measuring tapes can recoil; and a measuring strip or meter stick can fall if it is not secured flat to the wall.
- **Optional scales and timing devices.** A hanging-scale hook may pinch or scratch. Scales, smartphones, or other timing devices can be dropped or struck by a moving balloon-gondola system.
- **Moving balloon-gondola system.** The apparatus may swing, rise, or descend unpredictably; the payload may fall; and an escaped balloon may contact ceiling fans, lights, sprinklers, detectors, vents, or hot fixtures.
- **The Learner:**
 - **Allergy or respiratory sensitivity.** A learner may have a known or previously unrecognized latex sensitivity or may experience skin, eye, nasal, or breathing symptoms after exposure. A student may also have a sensory response to a balloon popping.
 - **Mouthing or ingestion.** Students may place balloon material, string, beads, washers, or other small parts in the mouth, creating choking or ingestion hazards.
 - **Intentional helium inhalation.** A learner may attempt to inhale helium for a voice effect. This behavior can reduce oxygen intake and must be explicitly prohibited.
 - **Entanglement and misuse.** Students may wrap string around the neck or body, snap or throw ribbon, throw ballast, intentionally pop balloons, or use rulers and meter sticks unsafely.
 - **Reaching, chasing, or climbing.** A learner may run after an escaping balloon, reach above others, or climb on furniture to retrieve it, increasing collision and fall risk.
 - **Crowding the test area.** Students may stand below the gondola or place faces and hands in its travel path, increasing the chance of being struck by the apparatus or falling ballast.
 - **Access and supervision needs.** Learners with visual, mobility, attention, behavioral, or sensory needs may require adjusted roles, clearer boundaries, additional adult support, or an alternate way to

participate.

- **The Environment:**

- **Balloon release and pollution.** The lesson should remain indoors so balloons do not escape and become ground or water pollution. Released balloons, ribbon, and fragments can also create wildlife entanglement or ingestion hazards.
- **Overhead building systems.** An untethered balloon may become caught in a ceiling fan, light, sprinkler head, smoke detector, vent, or other fixture, potentially damaging equipment or creating a secondary hazard.
- **Floor and walkway hazards.** Loose string, ribbon, ballast, tape backing, and balloon fragments can create trip, slip, or puncture hazards and can obstruct accessible routes or exits.
- **Surface and equipment damage.** Tape may pull paint or leave residue; falling metal ballast may damage floors, furniture, scales, or electronic devices.
- **Room configuration.** Crowded tables, open doors or windows, hot fixtures, and insufficient vertical clearance can make controlled ascent, descent, and retrieval unsafe.

II. Assess the Risks

Risk is the probability of harm to humans and the environment. Evaluate the likelihood and severity of the identified hazards, including factors such as duration or frequency of possible exposure, and the severity of potential injury or damage.

- **Safety Data Sheet (SDS) Review:**

- **The NASA lesson provides a materials list but does not include Safety Data Sheets.** No chemicals are intentionally mixed in the investigation.
- **Balloon product information.** Confirm whether balloons contain natural-rubber latex and review package warnings before purchase and use. Use a non-latex alternative when required by a student or staff health plan or when latex exposure cannot be safely managed.
- **Helium SDS, only if a cylinder is present on site.** Maintain the current supplier SDS and follow applicable compressed-gas procedures. Helium in a cylinder is gas under pressure; a release can displace oxygen, and rapidly expanding gas can cause cold injury. The cylinder must remain upright, secured, ventilated, and under trained-

adult control.

- **Other products.** Use classroom tape, cups, ballast, and scales only as intended and according to manufacturer labels. Obtain and review an SDS for any substituted adhesive, coating, cleaning product, or other material when required by local policy.

- **Critical Assessment Questions:**

These questions are designed to help move beyond simply identifying hazards to evaluating the actual level of danger and the feasibility of a specific activity. This evaluation helps determine if the instructional value of a lab justifies the remaining risk after safety controls are applied. (For example: What is the worst-case scenario? Is this activity for instruction or entertainment? Is the space appropriate for this activity?)

- **What is the worst-case credible scenario?** A severe allergic reaction, airway obstruction from balloon material, loss of consciousness from helium inhalation or oxygen displacement, a cylinder tip-over or valve failure, an eye or head injury from falling ballast, or contact with a fan or sprinkler system.
- **Is the activity instructionally justified?** Yes. It directly supports engineering design, buoyancy and force concepts, measurement, prediction, testing, and rate calculations rather than serving only as entertainment.
- **Is balloon inflation by students necessary?** No. Balloons should be obtained pre-inflated or inflated by a trained adult outside the student work area. Students should not blow up balloons by mouth or handle a helium cylinder.
- **Can safer materials meet the same learning goal?** Yes. Use non-latex balloons when needed, large smooth ballast instead of tiny beads, lightweight containers, pre-cut string, and a second retrieval tether. A teacher demonstration or video/data-analysis alternative can be used if risks cannot be adequately controlled.
- **Is the room appropriate?** Only if it provides clear vertical and horizontal space, controlled doors and windows, unobstructed exits and accessible routes, and separation from fans, sprinklers, detectors, vents, hot lights, and fragile equipment.
- **Are the materials developmentally appropriate?** Use larger, countable ballast and closer supervision whenever students may mouth objects or have difficulty following handling rules. Do not use sharp, rusty, brittle, or excessively heavy ballast.
- **Is supervision adequate?** The teacher must be able to observe all

groups, control the test area, and stop unsafe behavior immediately. One group should test at a time unless separate, adequately supervised test zones are available.

- **Are health and emergency needs addressed?** Review known allergies and health plans before class, identify the school response for allergic reaction or breathing difficulty, and ensure the teacher can promptly contact the nurse or emergency services.
- **Can environmental release and cleanup be verified?** Yes, if every balloon remains tethered; the work is conducted indoors; balloons and ballast are counted; and all fragments, ribbon, tape backing, and spilled objects are collected before dismissal.
- **Does the instructional benefit justify the residual risk?** Yes, only when all controls are in place. If a required control cannot be implemented, modify the activity or use a teacher-led or non-balloon alternative.

III. Determine & Document Safety Actions

Identify the controls needed to reduce risk. If risks cannot be managed, the activity must be modified or eliminated.

- **Hierarchy of Controls:**

- Elimination and substitution:
 - Eliminate student access to helium cylinders and eliminate all mouth inflation or helium inhalation. Obtain balloons pre-inflated or have a trained adult inflate them before students enter.
 - Substitute non-latex balloons whenever required by a known allergy or health plan, or when latex exposure cannot be confidently managed.
 - Replace small beads and sharp or heavy metal items with larger, smooth, lightweight, countable ballast whenever possible. Do not use rusty, brittle, or irregular objects.
 - Use lightweight cups or containers with smooth edges; pre-cut string or ribbon so cutting tools are not needed during the investigation.
 - When space, supervision, allergy controls, or material controls are inadequate, replace the hands-on test with a teacher demonstration, tethered tabletop model, or video/data analysis.

- Engineering controls:
 - Conduct the activity indoors in a designated test zone with fans turned off and clear separation from sprinklers, detectors, vents, hot lights, windows, doors, breakable equipment, and electrical fixtures.
 - Keep every balloon tethered at all times. Use a teacher-controlled retrieval line longer than the planned test distance so an escaped system can be brought down without climbing.
 - Mark a maximum test height below all overhead fixtures. Secure the meter stick or measurement strip flat to a wall; do not place rigid measuring tools across a walkway.
 - Secure the gondola to the balloon at multiple points and contain ballast in a lightweight cup, small sealable bag, or other system that prevents pieces from spilling during normal motion.
 - Remove chairs, backpacks, cords, and other trip hazards from the test zone. Keep doors, exits, and accessible routes unobstructed.
- Administrative controls and work practices:
 - The teacher should pre-test the activity with the actual balloons, container, ballast, ceiling height, and measuring setup to determine a safe mass range and maximum travel distance.
 - Review student health information and applicable allergy or emergency plans before bringing balloon materials into the room. Coordinate with the school nurse or designated health staff when needed.
 - Provide a pre-lab briefing: no helium inhalation; no balloon or balloon fragment in the mouth; no string around the neck or body; no intentional popping; no throwing ballast; no running, chasing, or climbing; and no one standing directly below the gondola.
 - Assign roles such as launcher, timer, measurer, recorder, and safety observer. Permit one group at a time in each test zone and keep observers behind a marked boundary.
 - Inspect knots, tape joints, the gondola, ballast, and retrieval tether before every trial. Add or remove ballast at table height, in small increments, and release the system only on the teacher signal.

- Stop work immediately for unsafe behavior, a leaking or damaged balloon, a failing attachment, uncontrolled swinging, a crowded test zone, or any student health concern.
- Immediately collect and discard every popped-balloon fragment. Count balloons and ballast before and after class, and sweep or inspect the floor before students leave.
- Place scales and timing devices on stable surfaces outside the flight path. Use student devices only under the school's normal technology and privacy procedures.
- Personal protective equipment and personal preparation:
 - Wear impact-rated safety glasses during construction and all flight testing to reduce the chance of eye injury from a balloon fragment or falling ballast.
 - Wear closed-toe shoes. Tie back long hair and secure loose clothing, lanyards, jewelry, or other items that could catch in string or the apparatus.
 - Provide an alternate role or hearing/sensory accommodation for a learner who may be distressed by a balloon pop. PPE does not replace the engineering and administrative controls above.
- Emergency and stop-work actions:
 - For a popped balloon, stop movement in the area, collect all fragments immediately, check for injury, and replace the balloon only after the test area is reset.
 - For suspected allergic reaction, follow the student's health plan and school emergency procedures and obtain immediate medical assistance for breathing difficulty or other severe symptoms.
 - For dizziness, collapse, or suspected helium exposure, move the person to fresh air without entering an unsafe area, activate the school emergency response, and call emergency services as indicated.
 - For a cylinder leak, tip-over, damaged valve, or uncontrolled release, evacuate students, prevent reentry, and contact trained facility or emergency personnel. Students must not approach or attempt to correct the condition.
 - Document injuries, exposures, property damage, and near

misses according to local requirements before the activity is repeated.

- **Documentation:**

- **Completed assessment.** Retain this activity-specific hazard and risk assessment with the educator name, date, class or course, room, and final local approval or modification decision.
- **Lesson and materials record.** Retain the NASA lesson, the final materials list, and any substitutions or procedural changes used for the class.
- **Product safety information.** Retain balloon packaging or product information and the current helium SDS and cylinder procedures if a cylinder is present anywhere on site for this activity.
- **Student health and accommodations.** Document that known allergies, health plans, accessibility needs, and required accommodations were reviewed and addressed, without placing confidential details in the general lab record.
- **Teacher pre-test and equipment check.** Record the date of the pre-test, safe mass range, maximum test height, room inspection, balloon material, and confirmation that tethers and measuring equipment were secure.
- **Student safety communication.** Document the pre-lab briefing, group roles, and any student safety acknowledgment required by local policy.
- **Cleanup and incident records.** Record balloon and ballast counts, disposal of fragments, and any injury, exposure, property damage, or near miss, including changes required before repeating the activity.

Critical Note: If the room lacks the necessary engineering controls or the required personal protective equipment is unavailable, the lab activity should not be conducted.

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