UNIT 2 PROJECT

The Anatomy of an Explosion

Background

The wreck of the *Imo* in Halifax harbour is a stark reminder of the aftermath of technology gone terribly wrong. Even more frightening is that the *Mont Blanc*, the ship that collided with the *Imo*, totally disintegrated in the 1917 Halifax explosion that followed the seemingly minor collision of the two ships! In an instant, the unleashing of megaforces and the momentum of flying objects devastated Halifax and Dartmouth. We still remember with awe that the barrel of one of *Mont Blanc's* cannons was found 6 kilometres from the centre of the blast. A 500 kilogram piece of its anchor flew 3 kilometres in the opposite direction, and windows were shattered up to 80 kilometres away.

Disasters such as the Halifax explosion often lead to a scientific analysis of the event. They also lead to considerations of economic, social and technological changes to prevent or at the very least minimize future disasters.

Challenge

Organize your class into small working groups to develop scientific explanations for the damage caused by the Halifax explosion, and to analyse new structural technologies that were used in the rebuilding of Halifax and Dartmouth. Each group will be designated to prepare a presentation or display on one of the following.

A Simulate the Physics

The Collision

Design and build a working model of the collision between the two ships to illustrate how the *Mont Blanc* came to rest against the dock of the Shipyards. The model is to involve floating objects with masses proportionate to the actual ships. Your presentation is to include

- calculations and scale diagrams showing the momentum before and after the collision, using the best available information of the actual event
- a discussion of the forces involved and an explanation of why even slow moving ships require long distances to stop

The Explosion

Incredibly, the mass destruction caused by the explosion was due only in part to the momentum carried by the flying metal of the *Mont Blanc*. In addition, the explosion set off, simultaneously, several chain reactions similar to three naturally occurring destructive events — earthquakes, hurricane force winds, and a tidal wave. Several groups are to be assigned to build working models or simulations to explain each of these.

CAUTION Do not use chemical explosions in the working models or simulations for these challenges. "Explosions" can be created using everyday physics equipment such as springs, dynamics carts, ripple tank vibrators or rolling steel balls. All designs for simulating explosions are to be authorized by your teacher before you begin construction.

1. **Impulse-Momentum of Objects**
   Design and build a demonstration of the explosion of the *Mont Blanc* to demonstrate how pieces of a variety of masses radiate out from the epicentre of a blast. The group presentation is to include
   - a discussion of the total momentum of the ship's component masses before and after the explosion
   - a reasoned prediction, using the impulse-momentum theorem, of the the magnitude of impulse that blasted off the *Mont Blanc's* anchor shaft and its cannon barrel in opposite directions. The prediction is to be based on actual known facts and estimations of other data necessary for making the calculations. Assume the cannon barrel and the anchor shaft were next to each other the instant before the explosion
2. **An Earthquake**
   Design and build a display of how the explosion was the epicentre of an earthquake. The display is to include
   - descriptions of the interaction of forces and the conservation of momentum as the earthquake spread
   - illustrations, based on topographical maps, seismic reports and data of the underlying ground strata surrounding Halifax, to explain the extent of the area affected by the earthquake
   - a discussion of how the magnitude of earthquakes and explosions is registered. Use the best available data to calculate, in kg·m/s, the size of the **impulse** created by the Halifax explosion.
3. **Winds and a Tidal Wave**
   Design and build, in a ripple tank, aquarium or large washtub, a topographical model of Halifax harbour and surrounding lands. Use this model to illustrate and explain
   - the areas most affected by the hurricane force winds and tidal wave created by the explosion
   - the areas protected from the winds and tidal wave by natural landforms
   - the path of the original tidal wave as it headed out to sea
   - the characteristics of secondary waves that resulted from the reflection of the original waves off landforms around the harbour.

   The group presentation is to include illustrations of
   - the forces involved in creating winds and waves
   - the forces involved in dissipating winds and waves
   - the area over which the effects of the tidal wave were detected

B. Analyse the Building Structures

The positive side, if one exists, of most disasters is that communities and governments are forced into action to seek solutions for long-standing problems. Whole subdivisions are rebuilt employing up-to-date building standards. Safeguards are put into place to prevent or minimize future disasters of a similar nature.

The challenge for groups examining aspects of the rebuilding Halifax and Dartmouth is to research either the technological advances used during the redevelopment that took place in 1917 or present day structural designs of buildings that have been developed to minimize the damage resulting from natural or technological disasters. Presentations are to include a combination of the following:

- model buildings that illustrate structural features that absorb the impact of winds, waves, earthquakes and flying objects
- an explanation, using the impulse-momentum theory, of the theory upon which the development of the structural features is based
- illustrations and maps of the placement of new buildings using the topography of the land to minimize the effect of a disaster
- an account of the safeguards put into place as a result the Halifax explosion and an overview of the social changes that took place as a result of building new communities

Safety Precautions

- Have all designs for simulating the explosion approved by your teacher before beginning the construct of models.
- Wear eye protection when experimenting with moving objects.
- Wear eye protection when using power tools.
- Ensure that electrical equipment is properly grounded.
- Do not use power tools in the immediate area around sinks or water tanks.
- Take appropriate precautions when using knives, saws, and other sharp tools.
- Set up appropriate safety shields around demonstrations of colliding objects.
- Ensure that spectators are wearing protective eyewear and are cautioned about the safety issues related to the observation of the collision of objects.

Project Criteria

As a class, prior to commencing the challenges

A. Research, review and discuss literature and scientific studies that provide factual accounts of the Halifax explosion.

B. Decide on the criteria to be used for evaluating the quality of the models to be made and the degree to which they exemplify the physics involved in the specific challenge.

C. Set parameters for the size of the models to be made and cost limits for the material to be used. Consider an evaluation scheme that awards marks inversely proportional to the amount of money spent on the project.

D. List the safety procedures to be followed during the design, construction and demonstration of working models.

E. Decide on a format and an evaluation scheme for the presentations.

Each group is to prepare a written report that includes

- an appropriate title and the identification of group members
- a two page executive summary of the development of the project, problems encountered, and subsequent solutions
- an overview of the physics involved that includes a discussion and sketches of the forces involved and a discussion of how the impulse-momentum theorem applies to the situation
- a summary of how an understanding of the physics involved in the situation that you studied led to economic, societal,

environmental and technological changes in the rebuilding of Halifax or other similar disaster sites

- an outline of ideas for further study that includes reflections on how the completed study could be refined.

Action Plan

1. Work in groups of two to four.
2. Establish time lines for the design, construction, testing and evaluation phases of the overall project.
3. Set aside one or two class periods about two thirds of the way through the project for peer collaboration. By this point, each group is to have prepared a prototype of their model. Groups will be paired for collaboration on refinements to be made for the final model.
4. Construct final model and prepare for presentation.
5. Make presentation and submit final report.

Evaluate

1. Review the criteria for your group's challenge. Record your assessment of your project and the feedback that you received from your collaborating group.
2. Recommend specific refinements to your model to improve its ability to simulate the actual events.
3. Make recommendations on refining the class project to better attain its intended outcomes of analysing the physics of an explosion and the societal changes that most often follow such a disaster.

Web Link

www.mcgrawhill.ca/links/atlphysics

To begin your research into the Halifax explosion, go to the Internet site above and click on **Web Links**.