**ROYAL CANADIAN AIR CADETS**

**PROFICIENCY LEVEL THREE**

**INSTRUCTIONAL GUIDE**

**SECTION 8**

**EO C340.06 – LAUNCH A WATER ROCKET**

| | |
|---|---|
| Total Time: | 90 min |

## PREPARATION

### PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-803/PG-001, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Construct a launching pad as shown at Annex W.

Prepare a string guidance system as shown at Annex X.

Photocopy Annex Y for each cadet.

### PRE-LESSON ASSIGNMENT

N/A.

### APPROACH

A practical activity was chosen for TPs 1 and 2 as it is an interactive way to introduce cadets to water rockets. This activity contributes to the understanding of rocketry in a fun and challenging setting.

A group discussion was chosen for TP 3 as it allows the cadets to interact with their peers and share their knowledge, experiences, opinions, and feelings about water rockets.

## INTRODUCTION

### REVIEW

N/A.

### OBJECTIVES

By the end of this lesson the cadet, as a member of a group, shall have constructed and launched a water rocket.



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**IMPORTANCE**

It is important for cadets to launch a water rocket so that they can experience the difference that a higher exhaust pressure makes in rocket flight, compared with using an effervescing tablet for power as was done in EO M140.01 (Build and Launch a Model Rocket, A-CR-CCP-801/PF-001, Chapter 13, Section 1).

**Teaching point 1** **Supervise the Cadets constructing a Water Rocket**

Time: 20 min Method: Practical Activity




Supervise the cadets as they construct a water rocket, to include:

(1) fuselage,

(2) stabilizing fins,

(3) nose cone,

(4) centre of gravity trimming, and

(5) decorations.

**ACTIVITY**

**OBJECTIVE**

The object of this activity is to have the cadets construct a water rocket, which will fly under its own self-contained power.

**RESOURCES**

- One-litre plastic pop bottles with caps removed,
- Construction paper,
- Scissors,
- Glue,
- Putty or modelling clay,
- Packing tape, and
- Instructions for constructing a water rocket.

**ACTIVITY LAYOUT**

Cadets shall be organized in groups of no more than four, working together at one table, with all the resources required to build a water rocket.

**ACTIVITY INSTRUCTIONS**

1. Give each cadet a copy of Annex Y.
2. Explain the instructions located at Annex Y.
3. Each group will construct a water rocket in the manner depicted in Figure 15Y-1.



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**SAFETY**

N/A.

**CONFIRMATION OF TEACHING POINT 1**

The cadets' participation in the activity will serve as the confirmation of this TP.

**Teaching point 2** **Supervise the Cadets Launching a Water Rocket**

Time: 50 min Method: Practical Activity

**ACTIVITY**

**OBJECTIVE**

The objective of this activity is to have each group of cadets launch a water rocket constructed in TP 1 and experimentally determine its flight characteristics.

**RESOURCES**

- Water rockets constructed in TP 1,
- Air pump with pressure gauge,
- Launch pad,
- Drinking straws,
- Packing tape,
- 3-mm string, and
- Safety glasses.

**ACTIVITY LAYOUT**

1. The CO shall select an outdoor area with controlled access for this training, at least 10 m by 20 m.
2. The string guidance system shall be secured to a suitable tower and the launch pad.
3. Place the launch pad in the centre of the launch area.
4. Anchor the launch pad securely in place.

**ACTIVITY INSTRUCTIONS**

1. Have one group of cadets place their water rocket, quarter filled with water, on the launch pad.
2. Ensure other cadets stand back 5 m; if necessary, rope off the launch site.
3. After the water rocket is attached to the launcher, have one cadet pump air into the rocket to more than 344 kPa (50 psi) pressure.
4. When pressurization is complete, all cadets shall stand behind the launch control officer.
5. Before conducting the countdown, ensure that the guidance system area is clear.
6. Have one cadet launch the water rocket by pulling the launch release cord.



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7. Repeat this process for each group.

8. When all water rockets have been launched, have the cadets retrieve their water rockets.

**SAFETY**

- Safety glasses must be worn by all cadets and staff during this activity.
- In case of a misfire, the instructor shall ensure that no one approaches the launch pad until the instructor has removed the misfired water rocket.

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**CONFIRMATION OF TEACHING POINT 2**

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The cadets' participation in launching a water rocket will serve as the confirmation of this TP.

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**Teaching point 3** **Conduct an Activity Debriefing**

Time: 10 min Method: Group Discussion

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**BACKGROUND KNOWLEDGE**

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The point of the group discussion is to draw the following information from the group using the tips for answering/facilitating discussion and the suggested questions provided.

**Characteristics of the Successful Launches**

The forces acting upon the cadets' water rockets in flight are those acting upon any aircraft:

- gravity,
- thrust,
- drag, and
- lift, which is minimal in this case unless the water rocket is provided with an airfoil.

Drag and lift are atmospheric forces that result from air coming in contact with the body of the water rocket.

There are many propellants used in rocketry, resulting in a variety of exhaust pressures and velocities. The greater the exhaust pressure, the higher the exhaust velocity. The rocket's power is increased as exhaust velocity of the propellant increases.

When launching a water rocket, there is a difference that a higher exhaust pressure makes in rocket flight, compared with using an effervescing tablet for power as was done in EO M140.01 (Build and Launch a Model Rocket, A-CR-CCP-801/PF-001, Chapter 13, Section 1). Since the water rocket launched in this lesson is heavier when filled with propellant, it may start slower, but the greater mass of the propellant may allow it to attain even greater speeds and distances.

**Rocket Behaviour Under Newton's Laws**

**First Law**. Every object in motion tends to remain in motion until an external force is applied to it.



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**Second Law**. The direction of acceleration is the same as the direction of the force. Therefore, since the reactive force pushes upwards against the bottle as the water is directed downwards, the force acting upon the water rocket is also directed upwards.

**Third Law**. For every action there is an equal and opposite reaction. Therefore, matter such as water particles escaping outward from the rear nozzle will push upon the body of the water rocket.

## GROUP DISCUSSION




### TIPS FOR ANSWERING/FACILITATING DISCUSSION

- Establish ground rules for discussion, eg, everyone should listen respectfully; don't interrupt; only one person speaks at a time; no one's ideas should be made fun of; you can disagree with ideas but not with the person; try to understand others as much as you hope they understand you; etc.
- Sit the group in a circle, making sure all cadets can be seen by everyone else.
- Ask questions that will provoke thought; in other words avoid questions with yes or no answers.
- Manage time by ensuring the cadets stay on topic.
- Listen and respond in a way that indicates you have heard and understood the cadet. This can be done by paraphrasing their ideas.
- Give the cadets time to respond to your questions.
- Ensure every cadet has an opportunity to participate. One option is to go around the group and have each cadet answer the question with a short answer. Cadets must also have the option to pass if they wish.
- Additional questions should be prepared ahead of time.

### SUGGESTED QUESTIONS

Q1. Which rocket was heavier? The water rocket or the film canister rocket in Proficiency Level One?

Q2. Which rocket flew further?

Q3. Which rocket flew faster?

Q4. How might increased pressure or an increased volume of propellant affect the rocket?




Other questions and answers will develop throughout the group discussion. The group discussion should not be limited to only those suggested.




Reinforce those answers given and comments made during the group discussion, ensuring the teaching point has been covered.



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## CONFIRMATION OF TEACHING POINT 3

The cadets' participation in the group discussion will serve as the confirmation of this TP.

## END OF LESSON CONFIRMATION

The cadets' participation in launching the water rocket and in the group discussion will serve as the confirmation of this lesson.

## CONCLUSION

### HOMEWORK/READING/PRACTICE

N/A.

### METHOD OF EVALUATION

N/A.

### CLOSING STATEMENT

There are many propellants used in rocketry, resulting in a variety of exhaust pressures and velocities. The greater the exhaust pressure, the higher the exhaust velocity. The rocket's power is increased as exhaust velocity of the propellant increases.

### INSTRUCTOR NOTES/REMARKS

Prior to this lesson, instructors shall prepare a launching platform and guidance system as shown at Annexes W and X or reference C3-016.

The launching pad should be saved for future training.

Each group shall be allowed a number of attempts to achieve a successful launch.

If a suitable location for this launching water rockets is not available at the squadron's LHQ, that part of the lesson can be carried out as part of a field exercise.

## REFERENCES

C3-016 EG-2003-01-108-HQ NASA. (2003). *Rockets: A Teacher's Guide With Activities in Science, Mathematics, and Technology*. Washington, DC: NASA.



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