Go Direct® Projectile Launcher
(Order Code GDX-PL)



The Go Direct Projectile Launcher allows students to investigate important concepts in two-dimensional kinematics.

Sample experiments include

- Investigate projectile range as a function of launch angle.
- Measure the launch speed of a projectile.
- Predict the ball landing point from the initial speed of a horizontally launched ball.
- Predict the ball landing point from the initial launch speed and angle.
- Attempt to hit a target.

Note: Vernier products are designed for educational use. Our products are not designed nor are they recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

What's Included
- Go Direct Projectile Launcher
- 6 Steel balls
- Hand pump
- 2 Pairs of safety goggles
- Level
- Roll of waxed marking paper
- Micro USB Cable

Compatible Software
See **www.vernier.com/manuals/gdx-pl** for a list of software compatible with Go Direct Projectile Launcher.

Quick Start: Vernier Graphical Analysis® and Bluetooth®
1. Charge your sensor for at least 2 hours before first use.
2. Turn on your sensor. The LED will blink red.
3. Launch Graphical Analysis, then click **Sensor Data Collection**.
4. Select your sensor from the list. The sensor ID is located on the sensor label near the bar code. **Note**: If you don't see a list of available sensors, click **WIRELESS**. After selecting your sensor, click **Pair**.
5. Click **DONE**. You are now ready to collect data.

Note: Be sure to always load the ball into the chamber before starting data collection, as your fingers will pass through the arms of the photogates.

Using other Vernier data-collection apps or want to connect via USB?
Visit **www.vernier.com/start-go-direct**

Note: This sensor also works with LabQuest 2 and LabQuest 3; it does not work with the original LabQuest.

Powering the Sensor
Connect the unit to a USB device such as a USB port on a computer or Chromebook, a USB wall outlet, or USB power brick. External power is required even if you are using the device with a wireless data connection. When connected to a USB port with adequate power, the unit will automatically wake up.

Connecting the Sensor
See the following link for up-to-date connection information:

www.vernier.com/start/gdx-pl

Connecting via Bluetooth Wireless Technology

Ready to connect	Red LED flashes when sensor is powered and ready to connect.
Connected	Green LED flashes when sensor is connected via Bluetooth wireless technology.

Connecting via USB

Connected via USB, data-collection software is not running	Red LED flashes when sensor is powered and ready to connect.
Connected via USB, data-collection software is running	Green LED is solid when connected to the software via USB.

Identifying the Sensor
Use the Identify feature to flash the LED on the sensor that is connected via Bluetooth wireless technology. In Graphical Analysis, Identify is accessed from Sensor Information. In LabQuest App, Identify is accessed by tapping the sensor meter, then tapping Go Direct.

Using the Product
Follow these steps when using the Go Direct Projectile Launcher when performing basic launch experiments.

1. Place the launcher on a flat surface and secure. We recommend placing the launcher on a sturdy table and securing the launcher to the table with table clamps (not included).
2. Connect the hand pump to the launcher.

3. Connect the sensor following the steps in the Getting Started section of this user manual.
4. Loosen the knob on the back of the unit, rotate the launch chamber to the desired launch angle, then secure the knob.
5. Set the release pressure by adjusting the range knob. Turn clockwise for higher pressure and higher muzzle velocity and counter-clockwise for lower pressure and lower muzzle velocity.
6. Insert one steel ball into the launch chamber. This is most easily done by inserting the ball into the launch chamber with your index finger, guiding the ball into the launch chamber. The ball should seat all the way to the back of the launch chamber.
7. Pump the hand pump until the pressure stabilizes. You should hear a small release sound when that pressure is reached. We recommend listening for at least three small release sounds and then waiting for five seconds to ensure the pressure has fully stabilized.
8. Start data collection.
9. Press and hold the Arm button. While still pressing the Arm button, press the Launch button to launch the steel ball.
10. Observe the range of the ball and position the waxed tape along the line of sight for subsequent data collection.

Channels

The Go Direct Projectile Launcher has two measurement channels, both of which are active when the sensor is connected. The channel names are

- Launch Speed
- Launch Angle

Note: The two embedded photogates and the accessory port are logically linked together to provide a single-channel output from these sensors, reported as Gate State. The gate state data is used to determine the launch speed of the projectile.

Calibrating the Sensor

Angle

The Angle sensor channel is factory calibrated before the sensor is shipped. It is possible to apply a single-point calibration offset if the displayed angle is off compared to a known angle (as determined by using a level).

To set the angle calibration offset, complete the following steps:

1. Click or tap the angle channel meter to view sensor options.
2. Select Calibrate.
3. Adjust the launch barrel to the desired position.
4. Enter the known angle and click or tap Keep.
5. Click or tap Apply to store the calibration offset to the sensor.

To remove the offset and restore the factory calibration, complete the following steps:

1. Click or tap the angle channel meter and choose Calibrate.
2. Click or tap Reset to Defaults to restore the factory calibration.

Note: The embedded photogates do not require calibration.

Specifications

Launch angle	0–90 degrees
Launch speed	0–6 m/s
Initial launch height	146 mm
Maximum launch distance	2.5 m
Internal photogate interval	50 mm
Steel ball diameter	17.46 mm
Steel ball mass	21.8 g
Maximum pressure (pressurizing chamber)	100 PSI

Safety

Two pairs of safety goggles are included for safety. We recommend students and instructors wear the goggles at all times while using this product, including anyone in the vicinity of the projectile launch and landing areas. If needed, additional safety goggles can be purchased from Vernier (see Accessories/Replacement Parts).

The launching system requires simultaneous engagement of the “Arm” and “Launch” buttons to prevent accidental launches. Do not attempt to override or disable this feature.

Other safety considerations

- Do not put your face, hands, or other body parts near the end of the launch chamber while launching.
- Do not aim the launcher at a person or animal.
- Do not attempt to remove the ball from the launch chamber by hand while the chamber is pressurized.
- Only apply pressure to the chamber using the pump provided.
- **Important**: Do not exceed 100 PSI when pressurizing the chamber.

Care and Maintenance

Storing the launcher

Do not store the launcher while pressurized. Fire the launcher several times before removing power, or use the release button located on the pump, below the pressure gauge, to release residual pressure. Remove the pump from the launcher.

Storing the projectiles

The balls are not stainless steel and can corrode over time when exposed to warm, humid environments. To reduce the likelihood of corrosion, keep the balls sealed in an airtight container such as a zipper-closure bag. In very humid environments, consider including a desiccant packet in with the balls.

If the balls do corrode, they will need to be replaced. Do not use any kind of oil on the balls in an attempt to remove the corrosion, as oil will damage the launcher.

Cleaning the projectiles and launcher

Over time, the projectiles (balls) may transfer some dirt to the inner surface of the launch chamber. The design of the launcher depends on a close fit between the ball and the launch chamber, so any additional material will cause friction and launch irregularities.

Occasional cleaning of the projectiles with a clean rag and a commercial solvent such as Goo Gone® or Goof Off® will help keep dirt out of the launch chamber. Isopropyl alcohol is not recommended for this purpose since it will not remove wax, a common source of the dirt.

If dirt does get into the launch chamber, use compressed air to remove any loose debris from the chamber. If necessary, wipe the inside of the launch chamber with a clean rag and solvent as noted above. If the solvent does not remove enough material, wipe the inside of the launch chamber near the lip with 1500 grit sandpaper. It is important to use very fine sand paper; if a coarser grit is used, the inner dimension of the launch chamber may change too much, damaging the launcher.

Water Resistance

Go Direct Projectile Launcher is not water resistant and should never be immersed in water or used in wet environments.

If water gets into the device, immediately disconnect the USB cable from the unit. Allow the device to dry thoroughly before attempting to use the device again. Do not attempt to dry using an external heat source.

How the Sensor Works

The Go Direct Projectile Launcher is used to investigate important concepts in two-dimensional kinematics. A steel ball placed in the launch chamber can be projected with different launch speeds and at different launch angles. A unique pneumatic launching system provides excellent repeatability at angles between 0 and 70 degrees and up to a distance of 2.5 m. **Note:** As launch angle increases above 70 degrees, the trajectory may deviate from the expected direction of parallel to the vertical plane of the back of the launcher.

The included hand pump is designed for generating the necessary pressure for the pneumatic launching system. The Range turn-knob controls the maximum pressure of the chamber, allowing for different projectile ranges given a constant launch angle. The pump includes a pressure gauge in order to return to an approximate launch speed used earlier. Note that a constant chamber pressure does not guarantee a constant launch speed at different launch angles.

Internal accelerometers are used to determine the angle of the launch chamber with respect to gravity. An angle of 0° indicates the launch chamber is horizontal, an angle of 90° indicates the launch chamber is vertical. (Negative launch angles should be avoided as the ball will not remain seated in the launcher during a launch.) Launch angle is reported by the software.

The launching system requires simultaneous engagement of the “Arm” and “Launch” buttons to initiate a launch. This allows the ball to be launched quickly and easily, while ensuring students’ safety. For more details on the launch procedure, see Using the Product.

Two photogates positioned within the launch chamber allow for precise determination of the ball’s launch speed using Vernier’s software applications. To do this, the software records the time when the ball initially blocks each gate then calculates the difference, known as the pulse time. The launch speed of the ball is then determined from the ratio of the separation distance of the photogates and the pulse time. Alternatively, the software can be configured to record the duration the first gate is blocked, known as the gate time. With this configuration, the average speed of the ball is determined from the ratio of the ball’s diameter (0.0174625 m or 11/16 in) and the gate time.

When using the optional Time of Flight Pad accessory, the time between the initial blocking of the first gate and the projectile striking the Time of Flight Pad is used to determine time of flight. **Note:** The Time of Flight Pad connects to the Go Direct Projectile Launcher accessory port.

Sample Experiments

There are a variety of experiments that can be performed with this Projectile Launcher. Below you will find several detailed examples. You might want to try them out to learn more about the equipment.

Investigate Projectile Range as a Function of Launch Angle

As a preliminary inquiry activity prior to the study of two-dimensional kinematics, have the students measure the launch range as a function of launch angle.

1. Follow the basic launch procedure for a launch angle of 5°.
2. Launch the ball such that it strikes the tape.
3. Increase the angle 5° for the second trial.
4. Repeat Step 3 up to a launch angle of 70°.
5. Examine the relationship between launch angle and range. Determine which launch angle produces the maximum range. Note any launch angles that appear to have the same range.

Measure the Launch Speed

Most of the experiments involving the projectile launcher require measurement of the initial launch speed.

1. Follow the basic launch procedure for a horizontal launch angle (0°), but do not perform the test launch.
2. Position an empty box standing vertically about 50 cm in front of the launcher to catch the ball.
3. Launch the ball into the box.
4. Record the launch speed.
5. Collect nine more readings.
6. Determine the average launch speed and its standard deviation.

Predict the Landing Point from the Launch Speed

Once the launch speed of the projectile is known, students can use their knowledge of two-dimensional kinematics to predict where the projectile will land. This activity can be especially challenging if the students use the technique noted above of catching the ball in a box shortly after it leaves the launcher. This approach prevents the students from visually estimating where the ball will land.

1. Determine the launch speed as described in the section above.
2. Move the setup such that the ball will be launched from the end of a table.
3. Use kinematics to calculate the landing spot.
4. Place one or two pieces of the waxed marking paper at that location.
5. Test your predictions.

Extension 1 – Change the launch speed and repeat Steps 1–5 above.

Extension 2 – Collect nine more readings. Calculate the range spread and the lateral spread from your prediction.

Predict the Landing Point from the Launch Speed and Angle

Perform the same steps as in the previous experiment, but this time launch the ball at various angles.

Attempt to Hit a Target

Challenge your students to launch a ball at a particular target and hit the target on their first trial. For example, challenge them to launch the ball horizontally from a tabletop into an empty soup can. Prior to their only trial, allow them to make as many measurements as needed to best determine the launch speed. In measuring the launch speed, do not allow them to actually project it off the table. Rather, specify that the ball be "caught" by an object such as an open box.

Troubleshooting

For troubleshooting and FAQs, see **www.vernier.com/til/4196**

Repair Information

If you have followed the troubleshooting steps and are still having trouble with your Go Direct Projectile Launcher, contact Vernier Technical Support at support@vernier.com or call 888-837-6437. Support specialists will work with you to determine if the unit needs to be sent in for repair. At that time, a Return Merchandise Authorization (RMA) number will be issued and instructions will be communicated on how to return the unit for repair.

Accessories/Replacements

Accessory	Order Code
Time of Flight Pad	TOF-VPL
Independence of Motion Accessory	IOM-VPL
Projectile Stop	PS-VPL
Micro USB to USB-C Cable	CB-USB-C-MICRO

Replacement Part	Order Code
Micro USB Cable	CB-USB-MICRO
Wax Tape (300 feet)	WXT-VPL
Steel Balls (Set of 6)	STB-VPL
Goggles (Set of 2)	GGL-VPL
Hand Air Pump	PUMP-VPL

Warranty

Warranty information for this product can be found on the Support tab at **www.vernier.com/gdx-pl**

General warranty information can be found at **www.vernier.com/warranty**

Disposal

When disposing of this electronic product, do not treat it as household waste. Its disposal is subject to regulations that vary by country and region. This item should be given to an applicable collection point for the recycling of electrical and electronic equipment. By ensuring that this product is disposed of correctly, you help prevent potential negative consequences on human health or on the environment. The recycling of materials will help to conserve natural resources. For more detailed information about recycling this product, contact your local city office or your disposal service.

The symbol, shown here, indicates that this product must not be disposed of in a standard waste container.

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

FCC Caution

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference and

(2) this device must accept any interference received, including interference that may cause undesired operation

RF Exposure Warning

The equipment complies with RF exposure limits set forth for an uncontrolled environment. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. You are cautioned that changes or modifications not expressly approved by the party responsible for compliance could void your authority to operate the equipment.

IC Statement

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

(1) this device may not cause interference, and

(2) this device must accept any interference, including interference that may cause undesired operation of the device.

Industry Canada - Class B This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the interference-causing equipment standard entitled “Digital Apparatus,” ICES-003 of Industry Canada. Operation is subject to the following two conditions: (1) this device may not cause interference, and

(2) this device must accept any interference, including interference that may cause undesired operation of the device.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

RF exposure warning: The equipment complies with RF exposure limits set forth for an uncontrolled environment. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Le présent appareil est conforme aux CNR d’Industrie Canada applicables aux appareils radio exempts de licence. L’exploitation est autorisée aux deux conditions suivantes :

(1) l’appareil ne doit pas produire de brouillage, et

(2) l’appareil doit accepter tout interférence radioélectrique, même si cela résulte à un brouillage susceptible d’en compromettre le fonctionnement.

Cet appareil numérique respecte les limites de bruits radioélectriques applicables aux appareils numériques de Classe B prescrites dans la norme sur le matériel interférant-brouilleur: “Appareils Numériques,” NMB-003 édictée par industrie Canada. L’utilisation est soumise aux deux conditions suivantes:

(1) cet appareil ne peut causer d’interférences, et

(2) cet appareil doit accepter toutes interférences, y comprises celles susceptibles de provoquer un disfonctionnement du dispositif.

Afin de réduire les interférences radio potentielles pour les autres utilisateurs, le type d’antenne et son gain doivent être choisie de telle façon que l’équivalent de puissance isotrope émis (e.i.r.p) n’est pas plus grand que celui permis pour une communication établie.

Avertissement d’exposition RF: L’équipement est conforme aux limites d’exposition aux RF établies pour un environnement non supervisé. L’antenne (s) utilisée pour ce transmetteur ne doit pas être jumelés ou fonctionner en conjonction avec toute autre antenne ou transmetteur.

Note: This product is a sensitive measurement device. For best results, use the cables that were provided. Keep the device away from electromagnetic noise sources, such as microwaves, monitors, electric motors, and appliances.

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Rev. 1/12/2026

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