WEIZMANN UK

SUPPORTING THE WEIZMANN INSTITUTE OF SCIENCE

SCIENCE FOR THE BENEFIT OF HUMANITY

Get Cracking

Physics Tournament Handbook
2022/23

Competition

MILESTONES

DON'T MISS OUT!

FRIDAY 23 SEPTEMBER 2022
Registration Closes

MONDAY 10 OCTOBER 2022
Checkpoint 1: Initial design deadline (Designs sent before this deadline will receive feedback sooner)

FRIDAY 11 NOVEMBER 2022
Checkpoint 2: Progress check - You must have sent your revised ideas to your team coordinator and begun building your safe ready for the 'heats'

FRIDAY 5 DECEMBER 2022
Checkpoint 3: 'Heats' – *All teams need to submit a video of their safe and how it works and the physics principles they are using. The safe may not yet be physically built but we require a detailed explanation of the next steps.*

FRIDAY 16 DECEMBER 2022
Checkpoint 4: Your team must demonstrate to your coordinator any changes to your safe in preparation for the final

SUNDAY 8 JANUARY 2023
Checkpoint 5: Virtual Judging Competition TBC - Online judging of all safes.

WEEK BEGINNING 16 JANUARY 2023
Checkpoint 6: Final checkpoint with your physics coordinator

SUNDAY 5 FEBRUARY 2023
UK Physics Tournament

MARCH/APRIL 2023
The UK winning team participate in the International Physics Tournament 2023 (including a day of special events at the Weizmann Institute)

Let's get

Cracking

THE CHALLENGE

Teams of five students, from Year 12 physics classes, design and build a safe with two locking-mechanisms which are based on the principles of physics.

The safes should be opened in less than 5 minutes by their creators but must keep opponents stumped for at least 10 minutes!

At the UK tournament, teams swap and attempt to crack each other's safes, solving the physics riddles which are keeping them locked.

WHAT'S THE PRIZE?

The winning team will be awarded travel grants covering flights and accommodation to enable them to travel to Rehovot, Israel, and participate in the Weizmann Institute of Science International Tournament.

This prize is subject to terms and conditions. Please see page 04 for further information. Teams coming 2nd and 3rd will receive a trophy.

SCORING CRITERIA

Originality and elegance of the riddle

Aesthetics and durability of the safe design

Points awarded based on peer vote

The UK Competition

DESIGN AND BUILD

CHECKPOINT 1

Monday 10 October 2022

Initial designs to be sent for feedback.*
Your initial designs will be reviewed by your physics coordinator who will give you feedback. You will then be able to develop your ideas further, try out some of the mechanisms and be ready for checkpoint 2.

**This should be done via the Safe Concept form online.*

CHECKPOINT 2

Friday 11 November 2022

Based on your feedback from Checkpoint 1 you need to send your revised ideas to your team coordinator and begin building your safe ready for making of your video!

CHECKPOINT 3

Friday 5 December 2022

Heats' – All teams need to submit a video of their safe and how it works and the physics principles they are using. The safe may not yet be physically built but we require a detailed explanation of the next steps.

CHECKPOINT 4

Friday 16 December 2022

Your team must demonstrate to your coordinator any changes to your safe in preparation for the final.

CHECKPOINT 5

Sunday 8 January 2023

Virtual Judging Competition TBC - online judging of all safes.

CHECKPOINT 6

Week beginning 16 January 2023

Safe progress check with your physics coordinator to show that you will be ready for the UK Tournament.

Remember

Keep your physics coordinator up to date, and ask questions, as you develop your safe.

COMPETITION DAY!

UK COMPETITION DAY

Sunday 5 February 2023 TBC
Dulwich College, SE21 7LD

Cracking
Teams will participate in rounds of safe cracking; breaking into each other's safes and to test how hard your safe is to crack.

Exhibition
While the judges calculate your scores, there will be a safe exhibition where we invite other teachers, parents/guardians and special guests to come and see your safes.

Winners
After the exhibition there will be a presentation and the winners will be announced.

Please note:

- Teams are responsible for getting to and from the competition with their safe.
- All teams will need to be accompanied by at least one teacher, who will be required to act as a timekeeper for the competition.
- The tournament takes place between 9:00am-4:30pm, you will likely need to arrive early. Lunch and refreshments provided.

FAQs

Can my team have more than five people?

No. due to an increase in interest in the completion from around the world the Weizmann Institute of Science will only permit a maximum of five members per team and one teacher.

Can students who are not in Year 12 compete?

No. Students must be in Year 12 (aged 16-17) and must be studying AS-Level Physics.

Can multiple teams from one school enter?

We can permit a maximum of two teams from the same school to enter the competition. Where this occurs one teacher can supervise the designing/building phase however, due to the way the tournament day runs, we will require an extra teacher to attend the competition day.

Should more than two teams from the same school wish to participate, we suggest a preliminary design stage conducted internally at your school. Please contact us for more information.

I can't make it to the Heats. Will this affect my chances of securing a place in the final?

It will be compulsory for teams to come to the 'heats' to compete for a place in the final. Please contact Weizmann UK to discuss if you attendance is proving difficult.

International Competition

The winning team from the UK competition will be awarded a travel grant to enable them to participate in the annual International Physics Tournament which will be held at the Weizmann Institute of Science, Israel March/April 2023.

TRAVEL ARRANGEMENTS

FLIGHTS

Depart: Sunday
Return: Thursday

In order to secure the best rates, Weizmann UK will reserve seats via an independent travel agent. By entering the competition, your team agrees to travel on these reserved seats or to take responsibility for covering any lost deposits associated with cancellation. Flights will depart from a **London airport**.

Teachers from winning team will be given the relevant information and will be responsible for collecting names and passport information by the date specified.

Your Weizmann UK travel grant includes travel insurance but you may wish to supplement this with your own.

ACCOMMODATION

Accommodation is at the Weizmann Institute of Science Youth Village and is included as part of the travel grant prize.

ADDITIONAL COSTS NOT COVERED BY THE TRAVEL GRANT

Required:

1. **Safe transport –** These will need to be checked-in as oversized/excess luggage and will cost approx. £100-£150 (return)
2. The winning team will also need to budget for extra meals which are not included. We will give you more information about this after the UK competition.
3. UK passport holders do not require visas for travel to Israel. Participants who hold passports for other countries will be responsible for acquiring their own visas where necessary.

Optional:

Weizmann UK can help you organise any extra excursions. Previous groups have visited Jerusalem and Jaffa.

Please note:

- Schools requiring a second teacher chaperone to accompany teams are welcome to do so but will need to fund the costs of this themselves.
- Weizmann UK will only provide travel grants to Israel for the winning team of the UK competition. Travel grant prizes are for a team (five students) and one teacher. This is the maximum number of people that can be accommodated by the International Tournament Coordinators.

Prizes at the International Competition

Educational prizes are awarded by the Weizmann Institute to the top 3 teams after the International Tournament.

OTHER REQUIREMENTS

To enable us to continue to run the competition we need teams to help us to promote the competition and provide information and feedback for the donors who make the competition possible. Weizmann UK therefore requires the following from students who go to the International Tournament:

- A team report (approx. 500 words) about their participation in the tournament
- Send Weizmann UK your pictures from the International Tournament
- Pictures/reports in school newsletters and social media channels
- Share your experience with students who are in the school year below them, to encourage them to participate. E.g. displaying your safe at science week.

Design and construction instructions

1. PRINCIPLES

The locking mechanism should rely on secondary school physics. Details are provided via our website: **https://www.weizmann.org.uk/education/introduction**

Any design relying on material beyond this curriculum has to be approved by the coordinators and a short explanation should be attached to the safe allowing those who are not acquainted with the principle to comprehend the design and crack the safe within the allocated 10 minutes.

Safe cracking should rely on solving no more than two non-trivial (as perceived by the coordinators) physics riddles within 10 minutes.

Generally speaking all parts should be visible. Sketches of any unseen parts should be attached along with their functions (e.g. 'amplifier', 'voltage generator') and relevant characteristics (e.g. power, voltage).

2. REVERSIBILITY

Irreversible changes caused by a reasonable cracking attempt that would block any further cracking attempt should be prevented; allowing unlimited number of attempts to break in.

3. ROBUSTNESS AND RELIABILITY

The 'safe' and its locking mechanism should function for at least several hours of repeated cracking attempts, unlocked when the correct sequence of steps is applied and remaining locked otherwise.

4. SAFETY

The safe should be harmless. Any use of high voltage, gas, chemical agent or any other hazardous material should comply with the applicable safety regulations and have the prior approval of the coordinator.

5. SIMPLE MAINTENANCE

The safe should be ready for a new cracking team within 5 minutes following the conclusion of the previous attempt. Thus safe maintenance and reset time should both be simple and reliable. An alternative, quick 'safe' opening procedure should be devised for maintenance.

6. MATERIALS

Safes should measure 60cm x 30cm x 40cm, or 24"x 12" x 16" with a wooden box and transparent door. Crackers shouldn't be able to simply reach in and take the 'treasure.' Any changes to the dimensions should be discussed and agreed with the team's Physics Coordinator.

Please take some time to look at past examples from the Davidson Institute's online archive as part of your preparation: **http://davidson.weizmann.ac.il/en/archive**

For more information please contact: **scienceeducation@weizmann.org.uk**

Official scoring criteria for competition

1. PHYSICS EXPERTS – REFEREEING COMMITTEE*

A typical referee committee may include senior physicists, a physics teacher and a Ph.D. Research student. The referees review all safes, interview each team and examine the locking mechanism. They will evaluate how well the team members comprehend the theory and the practicality of their lock.

(weight = 45%)

Criteria of the refereeing committee:

- Essence of the theoretical physical concept
- Original application of the concept
- Structure, functionality and aesthetic quality
- Sophistication and elegance of the physics riddle
- Understanding the scientific and technological structure of the locking mechanism and its function.

2. NUMBER OF SUCCESSFUL CRACKING ATTEMPTS WITHIN THE ALLOCATED 10 MINUTES PER SAFE

(weight = 25%)

3. PEER RANKING

Each team marks its 5 favourite safes, thus an overall favourable ranking is generated.

(weight = 20%)

4. NUMBER OF FALSE ATTEMPTS OF OTHER TEAMS TO CRACK TEAM'S SAFE

(weight = 10%)

CREST AWARDS
Accredited scheme

Get Cracking

and earn a Gold CREST Award

CREST is a UK award scheme for 11-19 year olds recognising success, building skills and demonstrating personal achievement in STEM (science, technology, engineering and maths) project work: www.crestawards.org

CREST is an easy-to-run UK wide STEM enrichment scheme. It is endorsed by UCAS for use in personal statements and can contribute towards a 'skill' section in the Duke of Edinburgh's Award (DofE) scheme at the corresponding level.

To enter your project for a CREST Award, you will need to register online at www.crestawards.org/sign-in and select Silver and Gold to create an account.

For more information about how you can earn a CREST Award by participating in the 'Get Cracking' Tournament then please contact please contact: scienceeducation@weizmann.org.uk

Tell us about how you are getting on building your safe:

WEIZMANNUK

WEIZMANN UK VIDEOS

Case Study 1

St Paul's School

HOW IT WORKS

The safe consists of two challenges, the ultimate objective of which is to remove a ball bearing named Barry from being stuck at the top of a broken roller coaster. Burglars have access to one side of the safe, which contains two useful objects, which they should remove: a small model train carrying a cargo of ball bearings, for the first task; and a flag pole with a piece of nitinol wire, for the second.

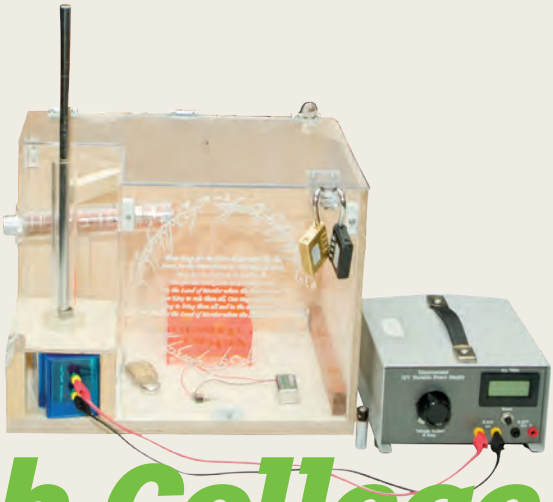
RIDDLE ONE:

To complete the first challenge they must observe that, supported in the centre of the safe, is a toroidal acrylic tank containing water dyed green, with 3 lasers shining through this tank to LDRs detecting the light level. Tilting the safe will only obscure at most 2 of 3 the lasers, so they must find a way to make the water rise up the side of the tank on all sides. This is first done by lifting the safe off its base, which contains a series of circular tracks, which can be filled with ball bearings, and then replacing the safe on the base. The safe can now be spun rapidly, causing the water to rise up the sides since the its momentum tangent to the rotation must be conserved, up until the point where the depth of the water on the outside provides sufficient centripetal acceleration to water inside it to maintain a stable situation, forming a parabolic cross section. Once all three lasers have been obscured for a short while, a lamp flashes on, notifying the burglars that they have completed the first challenge.

RIDDLE TWO:

For the second challenge, the burglars must first use the nitinol wire to push a small switch once the safe has finished rotating. This causes the lamp to turn on permanently and a small servo motor to slide the broken part of the roller coaster into place, repairing it for Barry. The lamp used is one commonly found in car side lamps, and has the property of heating up substantially during operation, due to its high resistance. When the nitinol is touched to the lamp in the correct place, as marked with white paint on the wire, it will be heated past its activation temperature of ~60C, causing its crystalline structure to transform from a flexible body-centered tetragonal structure known as Martensite to a more rigid simple cubic structure know as Austenite. This means that it will return to a predetermined shape, in this case a hook, allowing it to be used to pull a switch that was formerly inaccessible. Once the switch is pulled, the roller coaster door opens, and Barry rolls down the roller coaster and out the side of the safe.

Case Study 2



Dulwich College

HOW IT WORKS

The safe is built of wood and acrylic.
It also consists of:

- A metal pole
- A solenoid coil
- A copper coil
- Decorations including LEDs.

Potential crackers are provided with:

– A 1.5V cell
– An A.C power pack, which can provide a variable supply of current (1-15V)
– Two neodymium magnets, one of which is attached by a piece of string (or wire) to the safe
– Wires for connecting the solenoid to the power pack. Two combination locks lock the safe, each corresponding to a challenge. The challenges can be done in either order.

RIDDLE ONE:

The crackers must remove the aluminium ring from the base of the clear plastic tower. To do this one must first remove the iron ring above it using the magnet provided. After this the solenoid below the ring can be connected to the power pack provided. A.C. current must be used, and a quick change of voltage will cause the ring to be jumped up the pole out of the plastic tube. The code can then be read out from the inside of the ring.

RIDDLE TWO:

The cracker must withdraw the iron ring from the pool of rings inside the safe. To do this the aluminium tube must first be removed from inside the coil sticking into the safe. The neodymium magnets must then be connected to the 1.5V cell provided. They must be repelling each other and the one attached to string should be on the negative end. The cell can then be inserted into the coil and if it has been connected correctly it will move by itself and drop into the pool and attract the iron ring. The iron ring can then be pulled out using the string. Again the code is on the inside of the ring.

Case Study 3

Trinity School

HOW IT WORKS

RIDDLE ONE:

Hook-a-duck Challenge

There are two pulley groups. One can be hooked to the ceiling of the safe and the other to the weight which, when arranged correctly, have the ability to lift a mass of 30g with a counter weight of 20g. The burglar must successfully and efficiently thread the provided string into these pulleys in a way which can lift in this ratio of 3:2. This relates to the equation Work Done = Force x Distance Moved.

Once successfully threaded through the pulley system the string should be hooked to the bottom of the top pulley group (1kg) – that is held up by a pivoting lever. The lever, when pulled from the outside of the safe, will allow the 'duck' weight to fall. If the burglars have done this correctly the 20g 'duck' will fall and the 30g 'duck' will rise off of its base.

The base is metal and attached to a metal platform which when disconnected will send a message to a circuit. This in turn recognises when the 'duck' has been lifted up from its platform. To stop the burglars from cheating by pulling the string down with their hands, the circuit will only function when the door to the safe has been shut (this action completes the circuit).

Once the door has been shut and the pulley system has been correctly deployed, the burglar can then pull the lever on the top of the safe to release the 20g 'duck' weight and hence lift up the other 30g 'duck'.

If they have been successful, the pressure circuit will recognize that the 30g 'duck' weight has been removed and it will send a signal to a servo, which is locking a different door to the safe, to unlock and hence grant the burglars access to the next stage of the safe cracking challenge.

RIDDLE TWO:

Light up the fun fair Challenge

The next riddle is based around the physics of circuit building, electromagnetic induction and the use of specific electrical components such as LDR's and neon lamps. There are two pairs of wires coming out of two holes. One of these pairs has a potential divider set up across it. You must apply sufficient voltage to this to operate the voltage-controlled switch (with a wire at a lower potential) which will close a relay switch. The other pair is connected to a light emitting device. You must supply 90V to this to make it light up. When the relay switch is closed and the light is lit, a bolt will retract for a few seconds, and the door will open to reveal the burglar's prize.

CREST AWARDS

Accredited scheme

Registration closes:

23 September 2022

Please register your interest in participating in the **2022/23** competition by contacting:

scienceeducation@weizmann.org.uk
020 7424 6860

Registered Charity no: 232666

WEIZMANNUK

WEIZMANN UK VIDEOS

www.weizmann.org.uk

WEIZMANN UK, 9 Hampstead Gate, 1a Frognal, London NW3 6AL T. 020 7424 6860