Ontario Association of Physics Teachers

PERIMETER INSTITUTE

Session Descriptions

Friday, May 5

Keynote Address 8:45 - 10:00	**Keynote address** 	**Dr. Katie Mack** is a theoretical astrophysicist who studies a range of questions in cosmology, the study of the universe from beginning to end. She currently holds the position of **Hawking Chair in Cosmology and Science Communication** at the **Perimeter Institute for Theoretical Physics**, where she carries out research on dark matter and the early universe and works to make physics more accessible to the general public. She is the author of the book *"The End of Everything (Astrophysically Speaking)"* and has written for a number of popular publications, such as Scientific American, Slate, BBC's Science Focus, Sky & Telescope, and Cosmos Magazine. You can find her on Twitter as @AstroKatie.

*Sessions in blue are offered by our hosts, Perimeter Institute.
**Sessions in green have a university focus.

Time		Description	Presenter(s)
Session A 10:00 – 11:00	**1**	**Climate Change.** Anthropogenic climate change is one of the most important issues facing our students. Join us as we explore the basic science behind climate change and share a series of easy experiments you can do with your students.	**Dave Fish** has been a high school Physics teacher for over 30 years. His involvement with Perimeter Institute dates right back to the beginning with the initial development of ISSYP, Einstein Plus and several other outreach activities. He has played a leading role in the production of most of the Perimeter classroom resources. He has given workshops on modern physics at local, provincial, national and international levels. Dave is currently a Teacher in Residence at Perimeter Institute.
	2	**A. Assigning and Facilitating Roles in Physics Lab Group Work.** When students work together on laboratory experiments or hands on activities, they often struggle with how to work as a team. In this workshop I will present methods and materials we have used in First Year Physics Laboratories at the University of Toronto to require that students rotate through four different roles each week: experimenter, theorist, record-keeper and manager. The roles are specifically assigned in advance so that students can prepare, specific guidance is given to the individuals in each role, and the performance of role responsibilities is assessed.	**A. Dr. Jason Harlow** is a Professor, Teaching Stream in the Physics Department at the University of Toronto. He is currently teaching the introductory physics course for Life Sciences students with 1000 students, as well as coordinating laboratories for the course of physics majors that has 300 students. **B. Dr. Miranda Schmidt** is an Assistant Professor (teaching-track) in the Department of Physics & Astronomy at McMaster University. Miranda has

	B. Comparing in-person and at-home lab experiences in first year physics. When the pandemic hit, we had to pivot the traditional labs to an at-home version quickly. The result was a set of five home-labs performed with a lab kit. We wanted to make sure students could perform the home-labs independently with simple, affordable equipment while still learning about data analysis, graphing, and physics. Now that labs are back in-person, we have taken this opportunity to compare the different modalities. We will present the data that has been compiled of this comparison, discuss pros/cons of the two modalities, and share with the group the lab kits and labs that were developed.	experience teaching different introductory level courses aimed at students interested in the life sciences, physical sciences, and engineering, as well as upper level courses. **Sara Cormier** is a course coordinator and sessional instructor and has taught introductory physics to students interested in life sciences. Both Miranda and Sara are passionate about teaching and physics education research and are excited to share what they have learned from teaching lab-based courses during COVID-19 lockdowns with a view of how we can improve student experiences and learning moving forward.
3	**Quantum Superposition and Entanglement: Not So Spooky.** Quantum superposition is one of the key features that differentiates quantum theory from classical mechanics. In this session, we will dive into how quantum superposition can be understood at a deeper level by considering the many ways we can measure a quantum state. Using the polarization of light, we'll provide a hands-on approach for students to learn these concepts. We'll then extend these tools to the study of larger systems, breaking down what makes quantum entanglement special (and certainly not spooky).	**Dr. John Donohue** is the Senior Manager of Scientific Outreach at the Institute for Quantum Computing (IQC), a research institute at the University of Waterloo. He is responsible for making quantum information science accessible, including developing curriculum-appropriate materials for educators. John earned his PhD from the University of Waterloo in 2016 for work in quantum optics with entangled photon pairs.
4	**SNOLAB: Bringing deep underground science to the classroom.** Dive into the science taking place 2km underground at SNOLAB; Canada's deep underground science laboratory located in Sudbury, Ontario. Get an update on the current science that is underway (and underground) at this world-class facility. Explore the unique journey to the lab and learn about resources you can share with your students inside the classroom.	**Blaire Flynn and Rachel Richardson** are part of The SNOLAB Education and Outreach (E&O) team. The E&O Office works to share the science of SNOLAB, Canada's deep underground science laboratory with students, educators, and members of the public through informative and engaging learning opportunities. The E&O team aims to bring the excitement and innovation of the experiments underway in the lab to students and community members, sharing the science and the people behind it with the goal of supporting science literacy and inspiring the next generation of scientists, technicians, and innovators.
5	**A. CGPS - Thor's hammer.** This is an in class assignment I use during the energy and momentum unit in grade 12 physics. It involves energy transfers and a 1D collision. Students make measurements, then predict a final speed.	**A. Mike Doig** is a high is a high school science teacher with several years teaching both grade 11 and 12 physics. He teaches his class using inquiry-based methodologies. His

		Their predictions are compared with a value measured using a Pasco smart cart. **B.** The advantages of representing physical phenomena in various ways (e.g. motion diagrams, text descriptions, interaction diagrams, energy bar charts, etc) are well established. Should representations using code be included too? Do the benefits justify the effort? This session will demonstrate how creating code to represent simple and complex physical phenomena (e.g. linear motion, Thor's Hammer) may be advantageous to the physics learner. No previous coding experience assumed.	courses involve many of the lessons developed by OAPT past president Chris Meyer, and the assignment being presented compliments those lessons. **B. Felipe Almeida** is a physics and science teacher with the Toronto District School Board who is grateful for having served K-12 and adult learners from across the city, the province and abroad for the past 15+ years.
11:00-11:30		Coffee Break and Exhibitors	
Session B 11:30 – 12:30	**1**	**Nature of Science.** Science is a powerful force in society and yet there are many misunderstandings of what science is and isn't. What makes scientific knowledge so special? Come explore the Nature of Science, Perimeter Institute's newest classroom resource. Engage in hands-on activities that will encourage students to think scientifically and reflect on the nature of science.	**Dr. Kelly Foyle** is an outreach scientist at Perimeter Institute delivering and developing science educational content. She has given workshops on science and modern physics across Canada and abroad. Kelly has a doctorate in astrophysics from the University of Heidelberg in Germany and was a postdoctoral researcher at McMaster University before joining Perimeter in 2014. She loves sharing her passion for physics and astronomy with students, teachers and the public.
	2	**A. Progress and Setbacks to Close the STEM Gender Gap in Ontario's High Schools.** The gender gap in STEM is a pressing issue for educators and parents, but much of the discourse is based solely on anecdotal data. Using 11 years of administrative data from the Ontario Ministry of Education and demographics from the Canadian Census, we present a systematic review of the STEM gender gap in Ontario's high schools. Our results indicate that while significant progress has been made in some areas, growth across disciplines has not been uniform. Most notably, the underrepresentation of women in physics remains virtually unchanged while a new gender gap favouring women in biology stream courses has emerged. **B. Calculus in First-Year Physics: Learning Your Mother Tongue as a Second language.** The mother tongue of physics, the language in which it is most naturally and reliably expressed, is calculus. It is only natural that first year university instructors want to switch students to this mother tongue as quickly as possible. But there are many challenges in doing so! In this session, Chris will share resources that he created to help first-year engineering students at the University of Toronto pick up this new language and understand its use in physics.	**A. Eamonn Corrigan** is currently a PhD student at the University of Guelph studying the gender gap seen in physics and engineering. Having previously completed an MSc in theoretical relativistic physics at Guelph, and a BEd at Queen's University, the switch to physics education research was the perfect way to merge his interests. Informed by the education literature, he enjoys working to continuously improve his teaching practice to best serve his students. He has also worked as an educational developer helping graduate students to improve their teaching and has authored a series of children's books on science. **B. Chris Meyer** is a frequent visitor to OAPT conferences. He has been teaching physics for 24 years in the Toronto District School Board where he is a Hybrid Teacher-Coach for science. He hopes to teach a little bit better next year.

	3	**Motion Concepts - A "Hands On" Approach.** Have you every wished that you could teach motion - in a more "hands-on" way? I know that I have. During this session, guests will be introduced to a collection of lessons that introduce students to - core motion concepts - such as; position, clock reading, displacement (and distance), velocity (and speed), and acceleration. But, using a "hands-on" approach - where students actually experience these abstract ideas by "walking their fingers across their desk". These lessons have been classroom tested multiple times. Guests will leave with resources that they can use in their class. NOTE: I presented this at OAPT 2022. But, OAPT 2022 was very small - so I would like the chance to present this session at a "full" OAPT conference.	**Edward Gissing** has taught - high-school physics - for over 10 years. He believes that physics is an effective way - for humans - to interpret - real-life experiences.
	4	**Using Science to Test a Hypothesis: Nuclear Fusion in the K-12 Classroom.** The McDonald Institute is developing classroom programs that bring modern physics news and discoveries into the classroom as a context for existing curriculum. How the Sun Shines is one such program, allowing high school students to engage with modern Canadian scientific discoveries, while enriching and fulfilling their existing physics curriculum. Through several hands-on activities, students investigate topics such as solar energy, nuclear fusion, and particle physics to explore and test a model of how the sun shines. We will introduce the program, take teachers through a condensed version of it, and demonstrate how to implement it in your classrooms.	**Dr. Mark Richardson** is the Education & Outreach Officer at the Arthur B. McDonald Canadian Astroparticle Physics Research Institute. Mark works with scientists to share their science with the public and with teachers, bolstering the Canadian education community with resources to incorporate contemporary and local science breakthroughs in their practice. **Maggie Oxford** is the Educational & Digital Content Developer for the McDonald Institute and has earned a Bachelor of Science in Astrophysics from Queen's University. Born and raised on the coast of New Brunswick, Maggie aspires to create educational science resources that are accessible to learners across the country.
	5	**Spiralling IB Physics**. Einstein proposed his theory of special relativity to address concerns with electromagnetism and relativity. Join us as we discuss these concerns and explore a hands-on activity that is being developed by the Perimeter outreach team to show how length contraction addresses the concerns.	**Alasdair Paterson** is a Physics and Earth & Space Science teacher, and a running coach. He often has ideas that make his fellow teachers nervous...
12:30 -1:30		Lunch and Exhibitors	
Session C 1:30 – 2:30	**1**	**Beyond Bohr: A Quantum Approach to the Atom.** Take your students Beyond Bohr in this workshop featuring a resource designed by educators in physics and chemistry in collaboration with researchers from Perimeter Institute. Most high school physics and chemistry classes culminate their discussion of the atom with the Bohr Model even	**Dr. Damian Pope** is part of Perimeter Institute's Outreach team. He holds a PhD in quantum physics from the University of Queensland in Australia where he focused on quantum information and quantum foundations.

	though Bohr himself knew the model was wrong. In this workshop we will show you how you can introduce the quantum model of the atom with classroom-ready activities.	His current work focuses on making modern physics exciting and accessible for high school teachers, students and the general public.
2	**Thinking Classrooms in Science.** With the move to destreaming in science, many teachers are looking for ways to engage a range of learners. The Thinking Classroom strategies work well to center student learning and meet students where they are at. Join Sean and Ashley to experience what a thinking classroom is and take home some strategies and activities you can run tomorrow!	**Ashley McCarl Palmer** is a teacher with the WRDSB who has been teaching science and physics for over a decade. Tired of students begging for marks when they did not understand the material, Ashley has spent the past 5 years transforming her assessment practices and classroom experiences. The focus has shifted to student learning, celebrating mistakes and bringing critical and creative thought back to science. **Sean Jackson** is also a teacher with the WRDSB. Sean was an early adopter of the flipped classroom in an effort to support student learning in his classroom. Sean has spent years working on teaching techniques and his leadership in this area led him to become a teacher with the Laurier Faculty of Ed and a recent term as the teacher in residence for the Perimeter Institute.
3	**An Art and Physics Program for your classroom.** Building on the "Drift: Art and Dark Matter" artist residency at the McDonald Institute, SNOLAB, and the Agnes Art Centre, we piloted "Drifting Together: Art & Science". Designed for high school students to embrace the commonalities of Science & Art and how they approach inquiry and knowledge, it includes clear curriculum connections and flexibility to embed the program within existing class content. Students found it rewarding and challenging, and teachers found it invaluable. I will introduce the program and take teachers through a condensed version of the workshop, and show how it can be implemented in your schools.	**Dr. Mark Richardson** is the Education & Outreach Officer at the Arthur B. McDonald Canadian Astroparticle Physics Research Institute. Mark works with scientists to share their science with the public and with teachers, bolstering the Canadian education community with resources to incorporate contemporary and local science breakthroughs in their practice.
4	**A. Projectiles without tears.** The projectile topic appears to be difficult for many Grade 12 Physics students. This is partially because the topic is traditionally taught through the lens of SUVAT formulas. A different approach to teaching this topic has been used for the last two years. It engages the revised set of formulas that students can easier relate to.	**A. Olga Smakhtina** is a Physics and Mathematics teacher with twenty years of experience at international schools in Sri Lanka and Canada, as well as lecturing experience at universities in South Africa and Ireland. For the last three years she has been teaching Physics at Ridley College, Ontario.

		B. "Epistemic Structures in Collaborative Physics: The Nature of Disagreements" We will share what we learned from our interdisciplinary project for which learning goals included: Discovering examples of popular/engaging physics communication throughout history and analyzing their efficacy with distinct audiences. **C. Why do we teach physics that is wrong? History and philosophy of Science.** Why do we still teach Newton's three laws when we know that Newtonian mechanics is not correct because we have better theories? I will draw on history and philosophy of science to supply some answers to this question. These answers can either be given to students who independently raise this question or used as the basis for a lesson. For teachers in IB programs, I will explain how this lesson supports Theory of Knowledge learning outcomes.	**B. Alexandra Holgate** is an undergraduate student at the University of Toronto's physics department with an interest in physics ethics and communication. **C. Dr. Doreen Fraser** is a professor of Philosophy at the University of Waterloo. She teaches history and philosophy of science to university students at all levels. Her research interests focus on philosophy of quantum theory, explaining why we can successfully apply mathematics in physics, and the role of analogies in both physics research and physics education.
	5	**Have You Ever Considered a Laboratory Exam for Senior Physics?** In this workshop, I will detail my journey the past 5 years using a laboratory exam for Grade 12 physics - why I changed my exam format, the benefits of a lab exam, the pitfalls, and what you can expect if you decide to try this approach. I will demonstrate several of the lab stations, how to organize a room for this event, and how to combine collaborative inquiry and individual accountability during the exam. I will make copies of my lab exam available as well!	**Dr. Glenn Wagner** is the Science, STEM and Sustainability Program Leader for the Upper Grand District School Board. His mission is to help teachers be better than yesterday so students can be better for their tomorrow.
2:30 - 3:00		Coffee Break and Exhibitors	
Session D 3:00 – 4:00	**1**	**A. Cutting-edge Radio Astronomy: Mysterious Radio Bursts from Deep Space & the CHIME Radio Telescope.** In 2007, astronomers observed a mysterious burst of radio waves coming from deep space. Since then, hundreds of similar bursts have been observed. So far, their origins are unknown. Figuring out where they're coming from is one of the hottest topics in astronomy today. The telescope that's observed the most radio bursts is the CHIME telescope in British Columbia. In this workshop, you'll analyze actual data from CHIME to explore some of the models that have been proposed to explain this puzzling phenomenon. **B. Total Eclipse of the Hammer.** On April 8th 2024, Hamilton will be in the direct path of a total solar eclipse. This incredible phenomenon is a once in a lifetime opportunity to witness for those within driving range of the steel city. At 3:20 pm on the 8th, the Sun will be completely covered by the shadow of the Moon.	**A. Dr. Damian Pope** is part of Perimeter Institute's Outreach team. He holds a PhD in quantum physics from the University of Queensland in Australia where he focused on quantum information and quantum foundations. His current work focuses on making modern physics exciting and accessible for high school teachers, students and the general public. **B. Blake Ledger** (he/him) is a PhD candidate in astronomy at McMaster University. His research work involves studying the properties of nearby galaxies using telescope observations from the prestigious Atacama Large Millimeter Array (ALMA). He has

	The result? Complete darkness in the middle of the day and a significant drop in temperature. Join this workshop to learn what you need to be prepared, how to stay safe, and how to build a pinhole camera for hands-on eclipse viewing.	completed two certificates in Teaching & Learning with the MacPherson Institute at McMaster and is passionate about education, with future ambitions to work as a professor of astronomy. Blake is currently the manager of the W. J. McCallion planetarium at McMaster. In his personal life, Blake enjoys hiking, spending time outdoors with his partner and his dog, and playing in recreational soccer leagues.
2	**Simple Harmonic Motion and Greenhouse Gases.** Are you looking for a great application of Simple Harmonic Motion? Join us as we explore a classroom activity that uses simple harmonic motion of carts and springs to model how greenhouse gases interact with infrared radiation.	**Dave Fish** has been a high school Physics teacher for over 30 years. His involvement with Perimeter Institute dates right back to the beginning with the initial development of ISSYP, Einstein Plus and several other outreach activities. He has played a leading role in the production of most of the Perimeter classroom resources. He has given workshops on modern physics at local, provincial, national and international levels. Dave is currently a Teacher in Residence at Perimeter Institute.
3	**Bringing STEM to Life with k2i Academy.** Join us in an interactive session with k2i academy! Lisa and Vanessa will share the equity-focused work of k2i academy and the teacher resources that are currently available and under development. In this session, we will explore a sample activity together connected to the Grade 9 De-streamed Science curriculum and discuss the importance of destreaming in science and physics education. Today, we continue to see challenges in creating diverse and inclusive spaces in STEM pathways. Physics and science education plays an important role. Let's collaborate!	**Lisa Cole** is the Director of Programming at k2i academy, Lassonde School of Engineering. She was a physics educator, curriculum consultant, education officer at the Ministry of Education, and a former president of OAPT. Lisa is an advocate for diversity and inclusion in STEM. **Vanessa Ironside** is the Program Officer at k2i academy, Lassonde School of Engineering. She is passionate about making STEM Education accessible, inclusive, and engaging for diverse audiences. Vanessa is a PhD candidate at Lassonde School of Engineering with a focus on Engineering Education.
4	**A. Finally flipping the classroom – the upside of teaching during a pandemic.** During the academic year 2020/2021, my courses were offered entirely online, which required a significant amount of preparation, planning, and careful execution to find ways to keep the content comprehensive and engaging. With the 3Cs of Compassion, Community, and Creativity as my guiding principles, I worked to structure our scheduled time together (online) as "Learning Together" time rather than traditional lecture time. In 2021/2022 I was teaching in	**A. Dr. Joanne O'Meara.** Joanne O'Meara is a professor in the Department of Physics at the University of Guelph and has taught for over 20 years at the post-secondary level.

		hybrid mode with some students attending in person and some logging in remotely and we continued with the philosophy of those three hours of scheduled time as our "Learning Together" time. I'll share the structure I used in flipping my second-year electricity and magnetism courses and the feedback from students on the approach taken. With the pandemic forcing my hand, I have finally flipped my classroom and I won't be going back! B. **In their own words: student voices in science classrooms.** In all my science and physics courses, I give students opportunities to hone and use transferrable skills: they conduct research, practice citing reputable sources, engage with cutting-edge scientific research, explore social issues related to science, and share findings with peers, becoming scientifically literate citizens. I will talk about giving students a choice in topic selection and providing the platform for various formats of knowledge sharing to happen. I will share some of the learning happening by students in my grade 9 astronomy, grade 10 biology, and senior physics classrooms.	B. **Vjera Miovic** has been teaching physics, math and science in the TDSB for almost 5 years now, always striving to improve as a culturally relevant educator and continually learning from her students.
	5	**Hack your curriculum - workshop to redesign a course into engaging spiralling storylines.** Bring a curriculum of your choice and work though ways to rearrange concepts, topics, themes and skills to develop an engaging, spiring, thematic/storyline approach for students to learn. During this workshop you will get guidance and ideas for how to step back from your whole curriculum to identify priorities, skill development, conceptual links across units and more! The hope is for everyone to walk away with a first draft plan for their course, fingers crossed.	**Dr. Libby Boulianne** is the Head of Science at Ashbury College. They currently teach Ontario and IB Physics for grade 11 and 12 students and have previously taught grade 9 science, grade 6-12 Physics in England (including iGCSE and IB), and undergraduate astronomy at MIT and University of Toronto. Libby has always enjoyed pushing the boundaries of how students are learning in their classroom and exploring how to empower students to more deeply think as they are learning and build connections between concepts and to the real world.
	6	**An Approach to Problem Based Learning.** How do drones work? How can you wire your house? How does a cell phone network work? Exploring interesting problems in your classroom can create relevance to learners, develop critical thinking skills, provides a background for future careers and fun for everyone. In this session, you will learn how to structure student learning around real-world problems. Problem-based learning can be used for lessons, units, entire courses, or even cross-curricular experiences. Resources will be provided, and you will develop an activity to take with you to use in your classroom.	**Dale Simnett** has been teaching science and physics in the Peel District School Board for 14 years. His focus throughout his career has been literacy and problem-based learning. He incorporates problem solving in his pedagogical practice to create relevance and make curriculum more meaningful.

Saturday, May 6

Time		Description	Presenter(s)
Session E 9:00 – 10:10	**1**	**James Webb Space Telescope (JWST) Classroom Connections.** Are you looking for ways to connect your students with the latest results from the JWST? Join us as we describe what the JWST is revealing and explore ways to bring the latest results into your classroom. Topics will include cosmological redshift, lensing, exoplanet atmospheres and how JWST works.	**Dr. Kelly Foyle** is an outreach scientist at Perimeter Institute delivering and developing science educational content. She has given workshops on science and modern physics across Canada and abroad. Kelly has a doctorate in astrophysics from the University of Heidelberg in Germany and was a postdoctoral researcher at McMaster University before joining Perimeter in 2014. She loves sharing her passion for physics and astronomy with students, teachers and the public.
	2	**Embodying Physics.** Wellness and mindfulness act as buzz words these days, often seen as separate from physics. Yet we know they are important, and everything is related to physics! Join us to explore how we can integrate physics, teaching, and wellness in a new light. Wear comfortable clothes and be prepared to practice simple motions. We will experience together ways to integrate the clarity and rationality of basic physics with wellness practices such as mindfulness and tai chi, and discuss how we can apply these insights in our classrooms. Tai chi instructor Mackenzie Hawkins may be able to join us virtually.	**Dr. Carolyn Sealfon** has taught, or more, facilitated learning in the University of Toronto Department of Physics, at Minerva University, at Princeton University as Associate Director of Science Education, at a Pennsylvania public university, at an inner-city high school in New Jersey, and in interactive workshops across the continent. She earned her PhD in theoretical cosmology at the University of Pennsylvania and her BA in physics from Cornell University. She aims to foster scientific reasoning, curiosity, and compassion to empower diverse demographics to realize their full potential.
	3	**Static electricity: the most important science in high school.** The concepts of static electricity are the foundation for much science learning in high school: current electricity, models of the atom, electric fields, and pretty much all of chemistry. This means we should explore it carefully in grade 9 so students can benefit from this understanding throughout high school. In this session, Chris will share experiments from his grade 9 science course that provide a deep understanding of static electric phenomenon.	**Chris Meyer** is a frequent visitor to OAPT conferences. He has been teaching physics for 24 years in the Toronto District School Board where he is a Hybrid Teacher-Coach for science. He hopes to teach a little bit better next year.
10:10-10:30		Coffee Break	

Session F 10:30 – 11:40	**1**	**A search for the extraordinary: Leading a scavenger hunt in Stellarium.** Do you want to add some flare to teaching about space in your classroom? How about finding interesting astronomical events observed in the past, present, and future? Join us in this workshop to learn how to use a free open-source astronomy computer software called Stellarium to observe eclipses, zoom in on planets, find locations of past historical astronomical events, and more! We'll provide basic download, installation, and orientation instructions ahead of the workshop itself. During the workshop, we'll run through a demonstration of the software and then encourage participants to work in pairs or trios on an astronomy scavenger hunt.	**Blake Ledger** (he/him) is a PhD candidate in astronomy at McMaster University. His research work involves studying the properties of nearby galaxies using telescope observations from the prestigious Atacama Large Millimeter Array (ALMA). He has completed two certificates in Teaching & Learning with the MacPherson Institute at McMaster and is passionate about education, with future ambitions to work as a professor of astronomy. Blake is currently the manager of the W. J. McCallion planetarium at McMaster.
	2	**A. Studying resonance using the PHYPHOX phone app.** Delegates will use their phones and the PHYPHOX app to study resonance using both dropped coins and graduated cylinders being filled with water. This activity can be adapted to work for both high school and university students. The students can do either quantitative or qualitative analysis. Both activities and fun, easy to do and connect to the real world. **B. Cheap Tricks: Hot Wheels, 3D Printing, & Multi-Purpose Sensors.** Modern smartphones, inexpensive multi-function sensors, and 3D printed components can replace thousands of dollars of specialty equipment. This hands-on workshop will showcase some of the many possibilities, emphasizing physics but with applications in astronomy and climate change as well. For maximum benefit participants should install the free PocketLab and Phyphox apps on their phones.	**A. James Ball** has been teaching physics at both the high school and university level for the last 34 years. Whether his class has 250 students or 25 students, his teaching approach is based on Physics Education Research. This has lead to greater student engagement and improved conceptual understanding. **B. Robert Prior** has three decades of experience teaching at high school and college level. He started playing with simulations in the 1970s and hasn't stopped since. He has written for the Canadian Space Agency, and published the OAPT newsletter since 2012. In 2021 he received the Outstanding Canadian Award.
	3	**To deeply learn physics, they need to retrieve it!** We all want our students to remember what we teach them, especially those important science concepts they may likely need again. In this hands-on, minds-on workshop, we will learn and play with a variety of short, cooperative learning activities that can be used daily to engage science and physics students to deepen learning and strengthen recall. Warning! Using these activities will produce socially engaging classrooms where the students do the cognitive heavy-lifting (yes!). The result will be more formative assessment for the students (yes!), less grading for the teacher (yes!) and improved learning for your students (yes!).	**Dr. Glenn Wagner** is the Science, STEM and Sustainability Program Leader for the Upper Grand District School Board. His mission is to help teachers be better than yesterday so students can be better for their tomorrow.