**Hands-On Fields Eureka 2018 Roberta Tevlin**

All of the materials for this workshop can be found at roberta.tevlin.ca. If you have any questions or suggestions, feel free to contact me at roberta.tevlin@tdsb.on.ca

1. In what ways is the field description of gravity, Fg = m**g** = m (**GM/r2**), different from the force description, Fg = GMm/r2? Does it help you understand how the Sun can cause the Earth to orbit?
2. **Visualizing magnetic fields:**
3. Draw a simplified diagram of the pattern that iron filings make around a bar magnet.
4. **Predict** what the field in between two poles will look like. **Observe**.

Like poles Opposite poles

1. **Visualizing gravitational fields:**

Which pair of magnetic poles will provide a field that is similar to the gravitational field between two stars?

1. two north B) two south C) one north, one south

Explain:

1. **Visualizing electric fields.**
2. How can you make the electric field around a charged sphere visible?

b) What is the field like between oppositely charged plates (a capacitor)?

1. **Visualizing magnetic fields:**

Where can you find a magnetic field that is similar to the electric field above?

1. **Visualizing gravitational fields:**

What is the gravitational field in this classroom like? How can you make it visible?

1. **Simulating electric fields**: <https://phet.colorado.edu/en/simulation/charges-and-fields>
2. How do you simulate an electric field that is similar to a bar magnet?

1. How do you simulate the electric field of a parallel plate capacitor?
2. **Modelling fields with fabric**:
3. How do you model a satellite orbiting the Earth?
4. How do you model alpha particles deflected by a gold nucleus?
5. Simulating motion in electric fields:
6. Electric Field Hockey <https://phet.colorado.edu/en/simulation/legacy/electric-hockey>

How would you use this with your class?

1. Rutherford Scattering <https://phet.colorado.edu/en/simulation/rutherford-scattering>

What will you use to calculate the upper limit of the size of the gold nucleus?

1. ½ malpha v2 = KQq/r2 B) ½ mgold v2 = KQq/r

C) ½ malpha v2 = KQq/r2 D) ½ malpha v2 = KQq/r

1. **Applying electric and magnetic fields**:

**Physics in Action: Electromagnetism and Circular Motion in a Cyclotron**

<http://www.triumf.ca/home/for-media/publicationsgallery/videos/e-m-and-circular-motion>

1. What type of field is used to speed up the ions?
2. gravitational B) electrical C) magnetic

Explain:

1. What type of field is used to turn the ions?
2. gravitational B) electrical C) magnetic

Explain:

1. **Maxwell’s equations and fields**:
2. The first two equations and their diagrams tell you about a fundamental difference between electric and magnetic fields. What is it?
3. The third equation tells how an electric field can be formed by a changing magnetic field. What devices use this?
4. The fourth equation tells how a magnetic field can be formed by a changing electric field (current). What devices use this?
5. Maxwell added an extra term to the fourth equation. What does this predict? How fast does this move?
6. **Summarizing fields** **(up to 1905)**

Minute Physics: **Real World Telekinesis** <https://www.youtube.com/watch?v=NMgcX8UNIGY>

Would you show this video before or after the activities and discussions done today? Why?

1. **Fields and special relativity (1905**):
Electromagnetic radiation is made of changing electric and magnetic fields. Its velocity was calculated from two universal constants which are the same in all reference frames. This suggests that the speed of light is the same in all reference frames.
2. Suppose a space ship is travelling towards you at ½ c. The light from its headlights approaches you at \_\_\_\_\_
3. ½ c B) c C) 1 ½ c

Explain:

1. Einstein used the invariant speed of the electromagnetic fields to predict that time and space would change with one’s frame of reference. Special relativity is at work in
2. nuclear power B) GPS C) PET scans D) all three
3. **Fields and general relativity (1915):**

GR says that gravity is a fictitious force – a result of the curvature of space time. Masses curve spacetime and this curved spacetime tells masses how to move. Its predictions have been confirmed for gravitational

A) red shift B) lensing C) waves D) all three

1. **Fields and the standard model (1970”s):**
2. How is the repulsion of like charges explained?
3. How is the attraction of opposite charges explained?
4. What holds the nucleus together?
5. How is the weak nuclear force different from other forces?
6. Why were they looking for the Higgs boson for 25 years?