Name: _____ Class: _____ Date: _____

Exploring Photonics

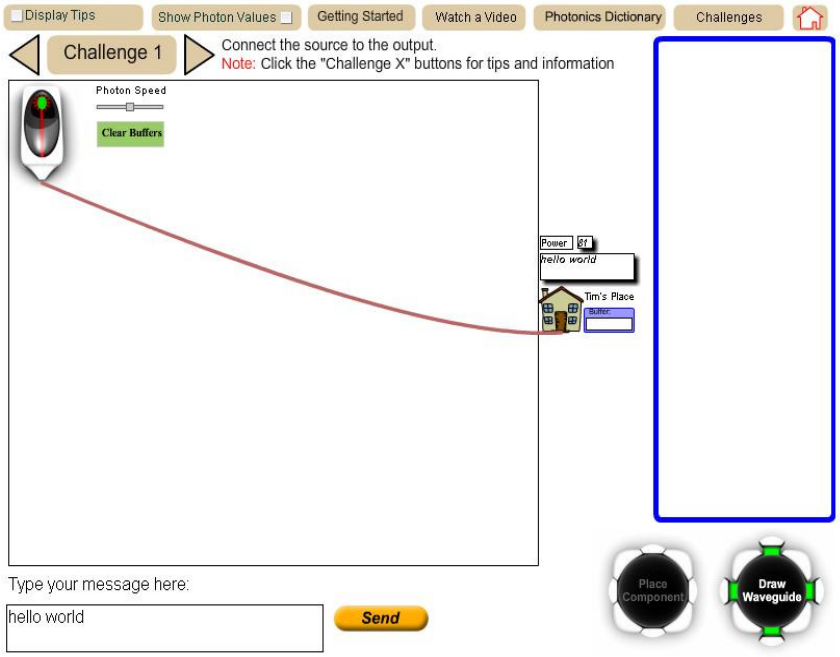
What is Photonics? Imagine a computer chip made purely of glass, using optical properties to perform functions previously done using electronic components. This is **PHOTONICS**.

Load up the Photonic Simulator:

- **Website address:**
  `http://web.science.mq.edu.au/groups/cudos/education/Simulator.html`
- Select **"Build a Photonic Network"**

Activity 1a. Build a simple optical network

1. **Select CHALLENGE 1 on the simulator**
2. Read the challenge, then **click on the CHALLENGE 1 button**
3. **Build your first network, send a message!**



Activity 1b. What is happening?

4. Click "Show Photon Values" ON
5. Slow down the photon speed using the slider
6. Write **your name** in the message box, press **Send**.
7. Observe how your name is transformed into a digital signal.

Activity 1 Questions:

1a) What is the digital version of your name? _____

1b) What do you think the photon source is? _____

1c) How do you think the photon source is making the '0's and '1'? _____

_____

1d) **Why** is your name converted to 0s and 1s? _____

_____

Finding out more:

Visit the Photonics Dictionary and read the sections **"How do I encode text for transmission?**" and "**What is an optical signal?**"

=> Continue to the next page for Activity#2

Activity 2. Exploring Optical Networks and Signal Strength

1. **Select CHALLENGE 2 on the simulator**
2. Read the **Tips** and **Things to note –** pay special attention to the information about **Power.**
   Questions:

What is the Power of the pulse? _____

What happens to the power when the signal is split? _____

What does the amplifier do to the power? _____

3. Set up a waveguide to Tim's place.
4. Send a message to Tim's place

   Question: What is the power of the signal arriving at Tim's place? _____

5. Double click on the waveguide to remove it, then set up a waveguide to Louise's place.
6. Send a message to Louise's place

Question: What is the power of the signal arriving at Louise's place? _____

Question: Why is this different to the power at Tim's place? _____

_____

7. Remove the waveguide.
8. Select **Place Component**, then drag a **Splitter** across to the network.
9. Select Draw Waveguide
10. Build the network using **only the splitter** so your message goes to both Tim and Louise at the same time.
11. Send a message.

Question: What happened ? _____

_____ _____

Question: Why? _____

Hint: Look at the power of the signals arriving at the houses

12. Use one or more amplifiers in your design to fix up the signals.

Question: How is the amplifier helping? _____

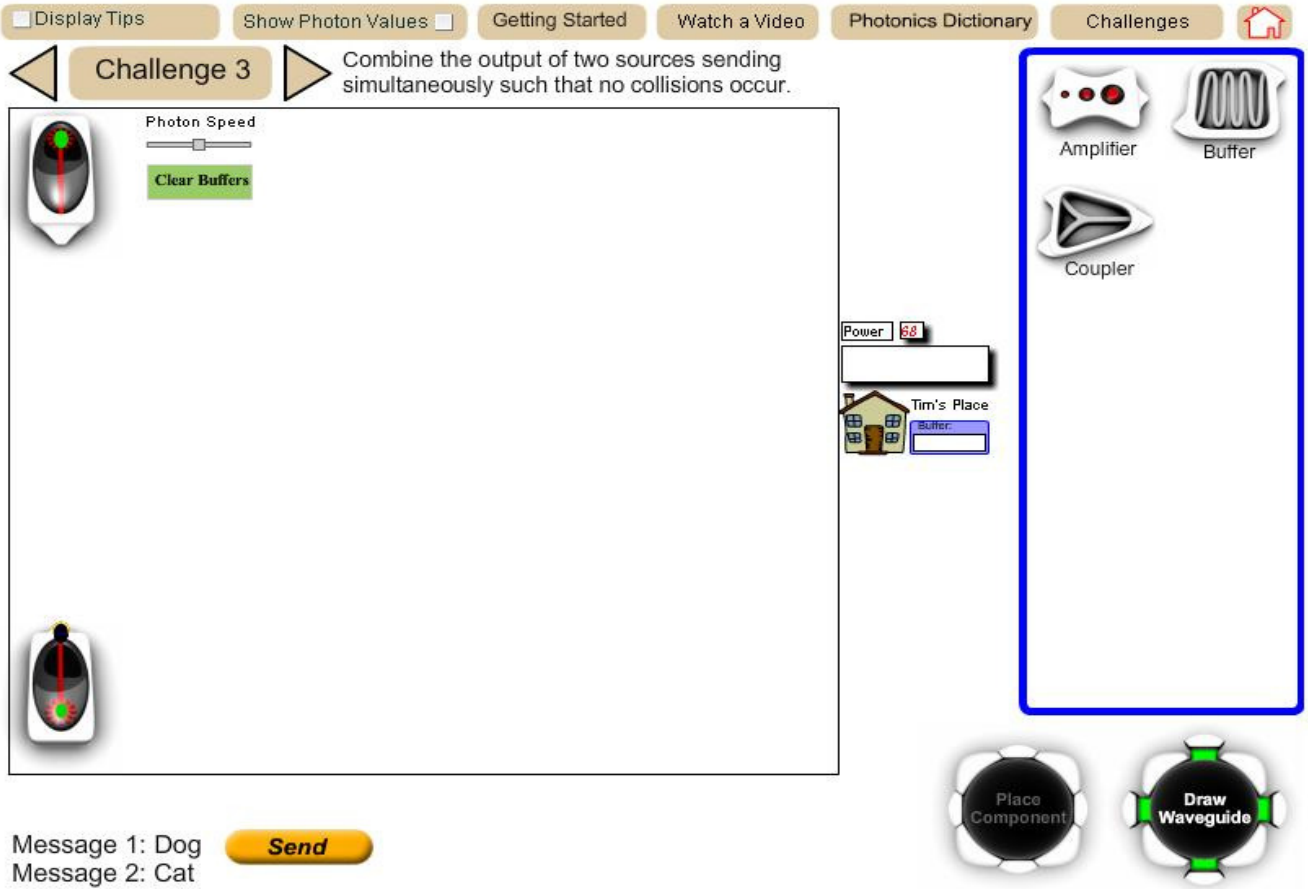
_____ _____

Activity 3. Combining Signals

1. **Select CHALLENGE 3 on the simulator**
2. Read the **Tips** and **Things to note**
1. Build a network using only the Coupler. Send the messages.
   Describe what happens and why : _____
   _____ _____
2. Rebuild your network by adding in a Buffer between the second photon source and Coupler.

Describe what happens and why? _____
_____ _____

3. Add in one or more amplifiers to solve the challenge.



4. **Draw your solution** of Challenge#3 here:

5. Question: Why did you need to use an amplifier? _____
_____ _____

Finding out more:

- Select the "**Watch a Video"** button and watch a description of how a photonic chip is able to work with light signals without converting the data to an electrical signal.
- Visit the '**Catalyst' website** at http://www.abc.net.au/catalyst/stories/2675781.htm

Teacher Notes

- This activity sheet scaffolds the **first three challenges** on the Photonics Simulator to help students go beyond intuitively or experimentally solving the Challenges.
- Once they have thought more deeply about the first three challenges, they should find the remaining challenges much easier to solve based on their understanding of what is happening.
- Some students may prefer to immediately tackle the challenges before doing the worksheet – in which case they can just revisit the activity after they have solved the challenge.
- A pedagogical challenge presented by the simulator is it gives the impression the components are discrete elements of a large optical network, whereas in reality it is modelling elements used to build a photonic chip. While there is applicable metaphor to larger systems, more advanced students will see through the metaphors and ask deeper questions. *(Or have we misunderstood?)*
- The remaining challenges will make more contextual sense once students have understood what a Photonics chips is, and the challenges the designers face.

Question: The collision modelled in Challenge#2 shows the CAT and DOG signals interleaved as `CDATOG` (or something similar). We question however if the resulting collision would more likely be a garbled signal resulting from a logical Oring of the signals, rather than the preservation of discrete time shifted bytes – generating a similar effect to that displayed for power loss.