Module At-a-Glance

Activities	Learning Objectives	Materials per class of 24	Estimated Time
1 Evading Motion Detection	• recognize that a sensor has the ability to detect changes in the environment and signal a response • predict how to evade the detector's sensor by trying to identify the stimulus to which it responds • design and conduct a test of how to evade the detector	1 or more motion detectors 4x4' sheet of polystyrene insulation and/or 4' x 4' plywood sheet large sheets of poster board box of aluminum foil box of plastic wrap cloth of light and dark colors magnets flashlights matches and candles small mirrors hot water bottles cold packs	20 to 30 minutes for activity and class discussion
2 Taking a Tour of Some Sensors	• recognize the variety and complexity of commercial sensors • describe the changes in physical and chemical properties in the sensor material • explain the stimulus/response system	Selection of commercial sensors such as: automatic night lights "Clapper" night switch motion-activated car alarm talking greeting cards touch- or sound-activated toys or tape recorder bimetallic switch thermostat pocket pH tester	20 to 30 minutes to make observations 20 to 30 minutes for class discussion and creating posters 30 minutes for poster presentations
3 Making a Microphone	• test the ability of PVDF film to respond to different types of sounds • compare the responsiveness of flexible PVDF with that of PVDF attached to a rigid backing • note the effect of using a substrate in a sound-generating system	16 pieces of PVDF film, 8 with backing and 8 without 8 Mylar™ balloons or polystyrene cups with 8 rubber gloves 8 rubber bands 8 sets connecting leads with alligator clips 8 rolls double-stick tape or 8 glue sticks 8 amplifier-speaker units	30 minutes
4 Exploring the Piezo Effect: The Inside Story	• construct a molecular model of PVDF polymer and use it to describe how PVDF acquires polarization • describe how PVDF film produces an electrical signal • explain how the degree and speed of bending affect the electrical output of PVDF	Parts A and B: 12 molecular modeling kits Part C: 8 pieces of PVDF film various substrate materials transparent tape 8 sets of connecting leads with alligator clips 8 measuring devices for recording voltage response, such as oscilloscopes, graphing calculators, or multimeters (or system for sharing those available)	10 minutes to do Part A 20 minutes to do Part B 30 minutes to do Part C
5 Measuring Piezoelectric Response	• conduct a quantitative laboratory experiment to describe the relationship between either impact force or temperature changes and voltage response using PVDF film • relate the amount and type of stress on PVDF film to the film's electrical response	Part A: 3–4 pieces of PVDF film assorted ball bearings, washers, marbles, or other small, hard objects of varying weights 3–4 rulers with a center groove 3–4 meter sticks substrate materials transparent tape 3–4 sets connecting leads with alligator clips 3–4 measuring devices for recording voltage response Part B: 3–4 pieces of PVDF film assorted heat sources 3–4 thermometers (optional) 3–4 sets connecting leads with alligator clips 3–4 measuring devices for recording voltage response hot pads, mitts, or other equipment to prevent burns and combustion	50 minutes to do either Part A or Part B

Design Projects

1 Designing a Coin Counter	• apply concepts about smart sensors from doing previous activities in the module • work with a team to set and meet goals • design, construct, test, and evaluate prototypes of a coin-counting device • keep useful, accurate records of the construction, testing, and evaluation processes • improve the best-performing device by redesigning it	PVDF film flexible substrates U.S. pennies, nickels, dimes, and quarters	electrical leads with alligator clips measuring devices for recording voltage response tape or glue	case-construction materials, such as cardboard, plywood, plastic, or polystyrene tools and hardware for construction	Four to five class periods
2 Designing a New Sensor	• apply concepts about smart sensors from doing previous activities in the module • work with a team to set and meet goals • speculate about how PVDF can be used to make a new product or improve an existing one • design and construct a smart sensor system that can be tested • test and evaluate the sensor system according to established criteria • keep useful, accurate records of the design, testing, and evaluation processes • improve the sensor system by redesigning it	PVDF film flexible substrates electrical leads with alligator clips	measuring devices for recording voltage response glue or tape component-construction materials	tools and hardware for construction	Five class periods