INTERMEDIATE SCIENCE
Grade 9

Scientific Literacy Assessment
June 2010

Answer Key

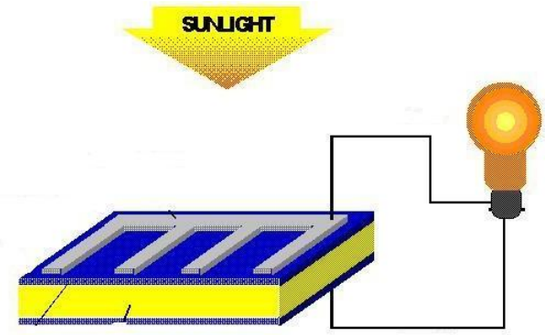
Student Name:_____

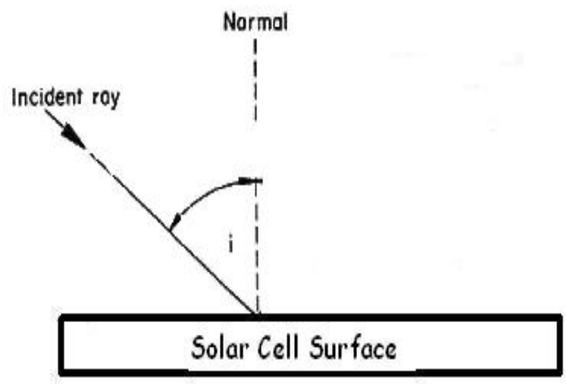
Homeroom: _____

Data Analysis

Read the following situation and answer all questions in the space provided. (10 points)

Solar cells are used to convert energy from the sun into electrical energy which can be immediately used or stored in a battery for later use. They are made from silicon, a substance found in abundance on Earth. The rotation of our planet causes the sun to rise in the east and set in the west. From sunrise to sunset, the sun travels 180^{o} across the horizon. This is why the **angle of incidence** on a solar cell surface would change throughout the day.





A student wishes to determine if changing the **angle of incidence** of sunlight throughout the day affects the voltage produced by a solar cell.

One 4 cm^2 solar cell, protractor and light ray box were used inside of a cardboard box to keep out other sources of light.

A **voltmeter** was connected to the solar cell using wires and was located outside of the box so it could be easily read.

The experiment was conducted and the following data was collected.

Angle of Incidence (°)	Voltage (mV)
0	140
10	140
20	135
30	130
40	100
50	90
60	80
70	50
80	30

Normal: The line perpendicular to the reflecting surface.

Incident ray: A light ray that strikes a reflecting or refracting surface.

Angle of incidence (i°): The distance between the incident ray and the normal. It is measured in degrees.

Voltmeter: A device used to measure voltage.

1. State a suitable hypothesis to be tested in this experiment. (1)

   As the angle of incidence increases (decreases), voltage will decrease (will increase/will not change.)

2. In this experiment, identify the independent (manipulated) and dependent (responding) variables. (1)

   Independent (manipulated): ***Angle of incidence.***

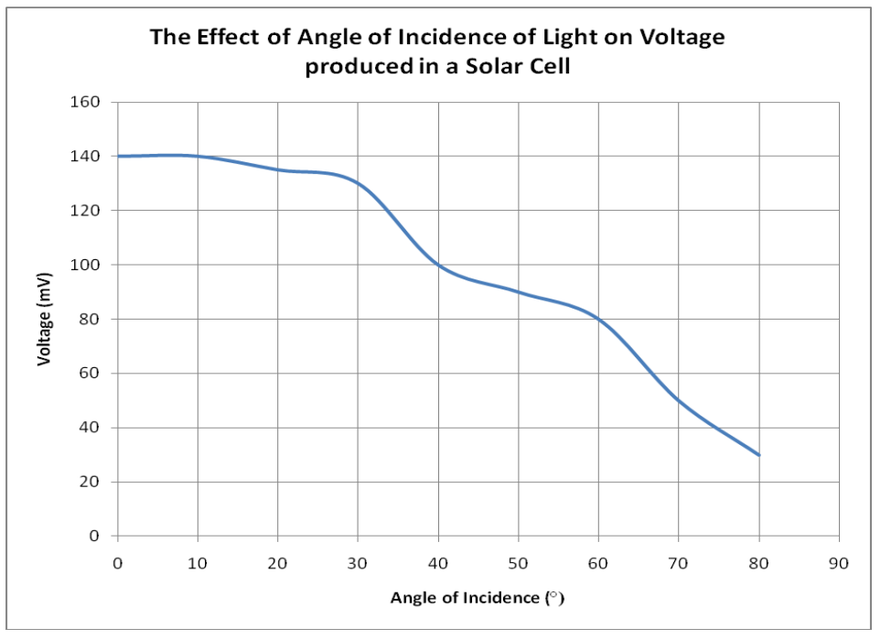
   Dependent (responding): ***Voltage.***

3. State **two (2)** variables which have to be kept constant (controlled) in order for the results of this experiment to be valid. (1)

   Voltmeter, solar cell, ray box or any other suitable controls.

4. Plot a fully-labelled line graph of the data obtained in this experiment on the grid below. (4)

0.5 - title
1.0 - labels (x and y axis)
0.5 - scales (x and y axis)
2.0 - points and graph



5. Predict the voltage if the angle of incidence is 85°. (1) ***15-25 °***

6. What is the voltage at a 65° angle of incidence? (1) ***60-70 mV***

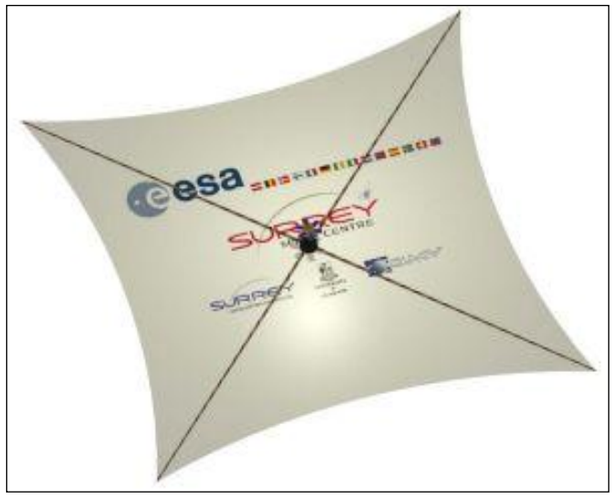
7. State a suitable conclusion for this experiment. (1)

   As the angle of incidence increases, the voltage decreases.

Case Study I: <u>Cleaning the Skies</u>

Read the article and answer the questions that follow. (10 points)

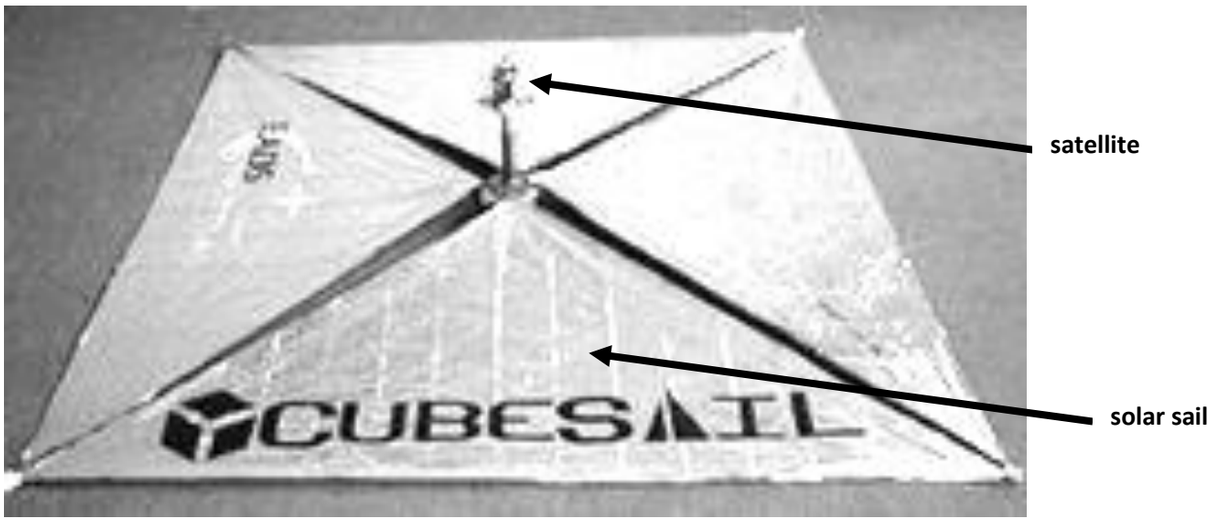
The skies above the Earth are littered with junk. By some estimates there are more than 5 500 tons of rocket boosters, satellites, tools dropped by astronauts, pieces of plastic, and flecks of paint traveling through space at 25 000 km/h. In February 2009, Russian and American satellites crashed, spewing space junk for thousands of cubic kilometers. At high speeds, even small junk can rip holes in a spacecraft or disable a communications satellite. A fleck of paint could easily break through an astronaut's spacesuit.



The amount of man-made space debris has grown so large that scientists say it poses a bigger safety threat to space shuttles than either accidents on liftoffs or on landings. There is also the potential threat of large debris falling back to Earth and killing people. "We need to treat space like a national park – carry out what you carry in," says Heiner Klinkrad, chairman of the global Inter-Agency Space Debris Coordination Committee.

For 20 years the international space community has brainstormed and experimented with methods for cleaning up space without coming up with an economically feasible method. Suggestions included launching big nets and large magnets to catch debris, burn the debris with high-energy lasers, and launching a giant NERF ball that would slow any debris that hit it, causing it to lose energy and fall back to Earth.

Now Vaios Lappas of the University of Surrey, England, has designed a system that will safely and cheaply remove **decrepit** satellites from orbit and keep the sky clean as it does so. Dr. Lappas' system uses a solar sail attached to the satellite. When a satellite is first launched, the plastic sail is angled towards the sun to help to keep the satellite in orbit. When the satellite's job is done, the angle of the sail is changed so that it will slowly drag the satellite into the atmosphere where it will burn up. As the sail falls towards the Earth it will also act like a handkerchief, mopping up microscopic orbital **detritus** such as flecks of paint from previous launches.



A **prototype** of Dr. Lappas' design, called CubeSail, will be launched late next year. It weighs just 3 kilograms and, when folded up, measures 30 cm by 10 cm. Once **unfurled**, however, the sail will have an area of 25 m^2.

According to Dr. Vaios Lappas, "Protecting our planet and environment is key…the CubeSail can dramatically reduce the problem of space debris."

Glossary

Decrepit: Worn out from age or wear.

Detritus: Junk, debris.

Prototype: The first working model of an invention.

Unfurled: Opened up; unfolded.

****Adapted from Science News, May 2010**

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1. The skies above the Earth are littered with approximately how many tons of junk? (1) 1. ***C***

   A. 1 500
   B. 2 000
   C. 5 500
   D. 7 000

2. What poses the biggest safety threat to the Space Shuttle? (1) 2. ***C***

   A. Accidents on liftoff or landings
   B. Enemy satellites
   C. Man-made space debris
   D. Meteors

3. Dr. Lappas has a solar sail system to remove decrepit satellites. Which statement describes how this system works? (1) 3. ***D***

   A. The solar sail is folded up on launch and is folded out when the satellite is ready to be removed from orbit.
   B. The solar sail is angled towards the sun upon launch and then folded up when the satellite is ready to be removed from orbit.
   C. The solar sail is angled towards the Earth upon launch and then angled towards the sun when the satellite is ready to be removed from orbit.
   D. The solar sail is angled towards the sun upon launch and then angled towards the Earth when the satellite is ready to be removed from orbit.

4. Name two (2) problems that space junk can cause for astronauts. (2)

   - ***It can create holes in space suits.***
   - ***It can create holes in spacecrafts.***

5. The article suggests some interesting methods to get rid of space junk. Suggest one (1) other way. (1)

Answers will vary.

- ***Launching big nets and magnets to catch the debris.***
- ***Incinerating debris with high-energy lasers.***
- ***Launching a giant nerf ball that would slow the debris that hit it, causing it to lose energy and fall back to earth.***

6. The CubeSail is only a prototype – it hasn't been tested in space yet. Suggest two (2) problems that it might encounter when it is in space. (2)

Answers will vary.

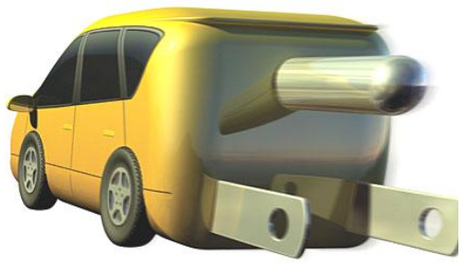
- ***The sail may not open properly after launch.***
- ***The sail may open it at the wrong angle.***

7. Based on what you read in the article, make drawings or diagrams to show how the CubeSail works to clean up space junk. (2)

Answers will vary.

Case Study II: <u>Ready, Unplug, Drive</u>

Read the article and answer the questions that follow (10 points)



When a handheld video game runs out of juice, all you have to do is plug it in and charge it up. Within a few years, some of you might do the same thing with mom's car.

Automobile companies are developing vehicles that will plug in to electric sockets, just like many laptops, digital cameras, cell phones and small video-game players do. Called "plug-in hybrids," these cars will get most of their power from electricity. Their drivers will rarely have to stop at gas stations.

The technology is more than just gee-whiz cool. In our automobile-filled world, plug-in vehicles could reduce the amount of gasoline we use. That gas is made from crude oil, which has been skyrocketing in cost. Much of our oil also comes from countries overseas where wars and other unrest make supplies uncertain. So plug-in hybrids could both save money and lessen the nation's dependence on overseas energy supplies. Plus, motoring around in these hybrids may even help the environment.

Plug-in hybrids aren't a cure-all for energy problems, however. Some experts say that replacing gasoline with electricity, much of it generated by burning fossil fuels, might simply swap one type of environmental strain for another. Engineers still have a lot of work to do to make plug-in hybrids practical and inexpensive. Researchers need to figure out what kind of technologies will work best and how much people will be willing to pay for the cars.

Out of Gas

Many people depend on their cars and trucks to get everywhere, and most automobiles today get their *vroom* from gasoline.

Burning this gasoline produces more than just energy, though. Gas-burning cars also produce a lot of carbon dioxide, a type of greenhouse gas. These gases accumulate in the atmosphere, where they trap heat and fuel global warming.

Gasoline is also getting more expensive. Reasons for the rise in price are complicated, but the trend is leading many people to look for alternatives to gasoline.

Hybrid vehicles are one solution. Introduced in the late 1990s, hybrid cars get power from a combination of electricity and gasoline. At times, such as when driving on the highway, they run like regular gas-powered cars. But hybrids also have a special type of rechargeable battery and an electric motor, which allow them to sometimes drive with the engine off. With the engine off, the car uses no gasoline.

As a result, hybrids can go more kilometers on less gas. For example, the newest model of the Toyota Prius, the most widely purchased kind of hybrid in North America, gets an average of 5.0 litres per 100 km. By comparison, the gas-powered Toyota Camry, a similar-sized car, gets about 8.4 litres per 100 km on average.

Plug-in hybrids will go a step further. On a full charge, they'll be able to drive up to 64 km without using any gasoline at all, says Ted Bohn, an engineer with the company Argonne. Surveys show that nearly 80 percent of North Americans drive fewer than 32 km a day. So people who only drive short distances could, in theory, recharge their cars every night and not refill the gas tank—for years! During longer trips, plug-in hybrids will work like regular hybrids, with a gas-powered engine that recharges the battery.

On average, a typical plug-in hybrid driver would get an estimated 1.6 litres per 100 km. Sounds like the perfect way to save money on gas, right? And you might even help to save the planet from pollution.

Perhaps, but scientists still have some kinks to work out.

The Weak Link

Batteries pose the biggest challenge. A standard gas-powered car uses a lead-acid battery, which is fairly cheap but is also extremely heavy. You also have to run the engine regularly to keep it charged. These batteries are only strong enough to power the car's lights and other electronic equipment.

In a hybrid vehicle, batteries must store much more energy — enough to actually run the car with the engine off. It would take many, many lead-acid car batteries to do the job, Bohn says. In fact, so many that batteries would take up half of the car.

Instead, most hybrid cars use nickel-metal-hydride batteries. They're lighter, more efficient and quicker to charge than lead-acid batteries. They are also more expensive, which helps explain why hybrids cost thousands of dollars more than gas-powered cars the same size.

Batteries for plug-in hybrids need to be able to store even more energy than do those in typical hybrid cars. That's where scientists keep getting stuck — designing smaller, more powerful, long-lived and lighter-weight batteries

In the plug-in-hybrid world, lithium-ion (Li-ion) batteries are getting the most attention. These batteries can store a large amount of energy in a small package, and they last a relatively long time between charges. Li-ion batteries are standard in laptops, cell phones, heart devices, power tools and similar portable devices.

Scientists have found ways to make Li-ion batteries — and the gadgets that contain them — smaller and sleeker in recent years. But because cars are so big and heavy, it would still require a suitcase-sized Li-ion battery to power about 13 km of driving, Bohn says. It would take five of these mega-batteries to propel a car for 64 km. What's more, the batteries are extremely expensive. "A car filled with batteries could go a long distance," Bohn says. "But it couldn't haul any people, and it would cost $100,000."

Drive for the Environment

Several companies plan to release fleets of plug-in hybrids in the next few years. Still, it'll probably be a while — if ever — before most people make the switch.

There are environmental complications, too. A recent study found that if 60 percent or more of North American drivers switched to plug-in hybrids, then we would produce a third fewer greenhouse gases. However, most of the electricity that comes out of our wall sockets is produced by power plants that burn fossil fuels, which also results in pollution.

To get around that environmental dilemma, Bohn says, plug-in owners could someday choose to charge their cars in the middle of the night instead of in the middle of the day. Thanks to the way the country's energy system works, the timing would allow the car to get electricity created by wind power and other more Earth-friendly technologies.

In this way, drivers of the future might start to realize that, "My car is not just going to get me from point A to point B," Bohn says. "It will help me make energy decisions."

Adapted from *Science News for Kids* Oct. 29, 2008. Original article by Emily Sohn:
http://www.sciencenewsforkids.org/articles/20081029/Feature1.asp

1. Which statement describes why plug-in hybrids are not a cure-all for energy problems? (1) 1. ***C***

A. They could reduce the amount of gasoline our nation uses.
B. They may help the environment.
C. They may swap one type of environmental strain for another.
D. They could save money.

2. Which type of battery is getting the most attention for potential use in plug-in hybrid vehicles? (1) 2. ***C***

A. Carbon-zinc
B. Lead-acid
C. Lithium-ion
D. Nickel-metal-hydride

3. How many fewer litres per 100 km would a typical plug-in hybrid driver get when compared with a typical gas-powered Toyota Camry driver? (1) 3. ***B***

A. 1.6 litres/100 km
B. 6.8 litres/100 km
C. 8.4 litres/100 km
D. 10.0 litres/100 km

4. What are two advantages and two disadvantages of gasoline-powered and plug-in hybrid vehicles? (4)

Accept any reasonable answers.

	Gasoline-powered vehicles	**Plug-in hybrid vehicles**
Advantages	***1. Gas-powered vehicles can go more kilometres between fill-ups.*** ***2.Gas-powered vehicles are less expensive than hybrids.***	***1.Hybrids can go more kilometers on less gas.*** ***2.Hybrids produce fewer greenhouse gases.***
Disadvantages	***1.Gas-powered vehicles produce lots of carbon dioxide, which contributes to the greenhouse effect.*** ***2. Gasoline supplies are becoming more unstable.***	***1.Hybrids are more expensive.*** ***2.Hybrids go a shorter distance before needing to be recharged.***

5. According to the article, charging an electrical vehicle in the middle of the night is more environmentally-friendly. Suggest one (1) reason why this would be the case. (1)

Accept any reasonable answer.

There is less demand for electricity during the night, so less strain on the grid.

6. In your opinion, are hybrid vehicles worth the extra cost? Give at least two (2) reasons for your answer. (2)

Accept any reasonable answer stating two reasons.