

ENERGY FORMS & CONVERSION

- 1.1 Energy sources and forms
- 1.2 Energy conversion
- 1.3 Energy storage and conservation

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

- (a) state what is meant by energy
- (b) describe different forms of energy (e.g. kinetic, potential, light and sound) and how energy changes from one form to another

Skills and Processes

- (a) infer that energy is conserved and can be transformed from one form to another

Ethics and Attitudes

- (a) show an appreciation of the need for Singapore, which has no natural resources of her own, to conserve energy



Energy sources and forms

MCQs

09ZA01-01-01

01-01-M-01

B

Option (I) is incorrect because solar energy is a renewable source of energy.

Option (II) is incorrect because fossil fuels are non-renewable sources of energy. They originate from remains of dead plant and animal matter formed over a long period of time. It is impossible to replenish the amount of remains of dead plant and animal matter in a short amount of time.

Option (III) is correct because nuclear fission releases a large amount of energy which can be used to convert into electrical energy.

Option (IV) is correct because wind is always available when there is a temperature difference between regions and it does not cause any pollution.

09ZA01-01-02

01-01-M-02

D

Solar cells convert light energy to electrical energy by absorbing the light that falls on them. Some of these solar cells can be found in a calculator.

Solar panels are usually used for heating water in houses and are painted black as black surfaces are good absorbers of radiation from the Sun. They are built on top of houses to capture as much sunlight as possible.

Solar collectors are expensive equipments used for powering electrical systems in space crafts and satellites. They can absorb huge amount of sunlight for heavy power consumption. They are expensive to build.

09ZA01-01-03

01-01-M-03

B

Option (I) is incorrect because the conversion of wind energy to electrical energy is efficient. However, due to land space limitation and also practical reasons, wind energy is not utilised extensively by all countries.

09ZA01-01-04

01-01-M-04

D

Wave surge devices channel and concentrate waves and lead them to a reservoir to generate electrical energy when water flows out of the reservoir.

Floats or pitching devices make use of bobbing of a floating object to generate electrical energy.

Oscillating water columns make use of rise and fall of the sea to power the turbine, generating electrical energy.

09ZA01-01-05

01-01-M-05

B

Tapping on hydroelectric energy requires the construction of large dams to store large amount of water. The gravitational potential energy of the water must be high in order to be converted into large amount of kinetic energy to turn the turbines to generate large amount of electrical energy. Hence these dams need to be large-scale and often, in building such structures, many natural habitats are inevitably destroyed as they are flooded with water.

09ZA01-01-06

01-01-M-06

B

Option (I) is incorrect because the waves need to be strong all the time. Wave energy is also very difficult to harness and convert to electrical energy.



Hence the devices must be located at a location where strong waves are formed all the time.

Option (II) is incorrect because using wave energy as a source of energy produces no pollution at all.

Option (III) is correct because although it is difficult to harness wave energy, large amount of electricity can be produced from wave energy.

Option (IV) is correct because wave energy is a natural source of energy and is renewable.



09ZA01-01-07

01-01-M-07

D

Tidal energy is not cost effective because building a tidal barrage is very expensive. Very high tides are required to harness the tidal energy. The tidal changes caused by tidal barrages may also have a negative impact on various marine lives as they disrupt their habitat.

The advantage of using tidal energy is that tides are always available so they are reliable and renewable.



09ZA01-01-08

01-01-M-08

D

Volcanoes, hot springs and geysers are all sources of geothermal energy, which is heat energy from hot rocks at the centre of the earth.



09ZA01-01-09

01-01-M-09

D

Using geothermal energy is relatively expensive because the locations are limited and must be near the surface of the Earth. When tapping geothermal energy, harmful gases from underground escape together with the steam, causing air pollution.



09ZA01-01-10

01-01-M-10

D

Fossil fuels are non-renewable sources of energy and they consist of three groups – coal, crude oil and natural gas. They are formed from remains of dead plants and animals over a long period of time ago. Sulphur is the main impurity in fossil fuels. Hence, when burnt, sulphur dioxide is inevitably formed and this acidic gas can cause acid rain.



09ZA01-01-11

01-01-M-11

D

Kerosene is used as a jet fuel. Bitumen is used in making tar for the roads. Diesel is used in lorries, trains and trucks.



09ZA01-01-12

01-01-M-12

B

Biomass is present all around us and thus is renewable. Wood, waste and alcohol are biomass and when burnt, it can cause air pollution and global warming, just like fossil fuels due to the emission of carbon dioxide and other harmful gases.



09ZA01-01-13

01-01-M-13

D

All 3 options contain members that are either wood, waste or alcohol. Hence, they all contain examples of biomass.



09ZA01-01-14

01-01-M-14

B

The materials used in nuclear plants to generate electricity are uranium and plutonium as they are radioactive in nature.

The nuclear reactions in nuclear plants are nuclear fission and they do not depend on sunlight at all and they do not cause global warming because the reactions do not release greenhouse gases into the atmosphere.

However, they can cause serious contamination and health hazards when radioactive wastes are not disposed of properly.



09ZA01-01-15

01-01-M-15

C

Nuclear reactions can produce by-products which are known as radioactive wastes. They need to be stored and disposed of properly to prevent any leakage. If improperly handled, contamination can occur and since such wastes are radioactive, the radiation emitted can lead to long term health defects as they can alter the genetic material in our body cells, causing cancer or genetic mutation which can be passed down to future generations.

Nuclear fuels are also non-renewable but nuclear reactions do not cause air pollution as no harmful gases are released into the atmosphere.



Questions – 1.1

09ZA01-01-16

01-01-Q-01

Fossil fuels contain sulphur as the main impurity. When fossil fuels are burnt, sulphur in the fossil fuels combines with oxygen in the air to form sulphur dioxide, which is acidic in nature. Sulphur dioxide can dissolve in water to form sulphurous acid, which causes the acid rain.

When burning fossil fuels, the high temperature also causes the reaction between nitrogen and oxygen in the air to form nitrogen dioxide which is acidic in nature, also causing acid rain.



09ZA01-01-17

01-01-Q-02

When fossil fuels are burnt, carbon dioxide is released into the atmosphere. Carbon dioxide is known as a greenhouse gas because it traps heat energy. When excess carbon dioxide is released into the atmosphere, it causes temperature to increase around the globe as they retain the heat energy from the sun.



09ZA01-01-18

01-01-Q-03

Burning of fossil fuels to generate electrical energy is much easier and economically practical as compared to other renewable sources of energy such as wind energy, geothermal energy and tidal energy.

Such renewable sources of energy are often limited due to land space, site locations as well as cost-effectiveness. Burning of fossil fuels is much more convenient and reliable as compared to renewable sources, which depend on tapping nature for its energy.

Compared to fossil fuels, renewable sources of energy are not as reliable even though they are cleaner and can last forever. Due to increased industrialisation, we need a large supply of electricity for our daily needs and depending primarily on renewable sources for our energy needs is not practical at the moment.





09ZA01-01-19

01-01-Q-04

Petroleum is a form of fossil fuels and can be used as a source of energy when burnt. It is used to generate electricity. When petroleum undergoes fractional distillation, useful products such as petrol, diesel, kerosene, naphtha and bitumen can be obtained.

Petrol can be used as a fuel in motor vehicles. Diesel can be used in engines of lorries, trucks and trains. Kerosene can be used as a fuel in jets. Naphtha can be used as a material to make other chemicals. Bitumen can be used as a material to make tar for roads surfacing.



09ZA01-01-20

01-01-Q-05

Nuclear fuels and wastes are radioactive in nature and if not carefully stored and disposed of, the radiation emitted can contaminate a large area and this radiation can cause genetic mutation in body cells, causing long term undesirable health hazards to people. These defects can also be passed down to future generations. Radiation can also cause cancer in our body cells.

Nuclear contamination stays in the environment for a long time, typically tens to thousands of years.



1 • 2 Energy conversion

MCOs

07ZZ01-02-01

01-02-M-01

A

The energy stored inside batteries is known as chemical energy. When the torchlight is switched on, the chemical energy is converted to electrical energy followed by light and heat energy when light is shone at a location.

07ZZ01-02-02

01-02-M-02

B

When the object is falling from a height, the gravitational potential energy decreases. This potential energy is being converted to kinetic energy as it moves down the slope to the ground. Hence, the potential energy decreases while kinetic energy increases.

07ZZ01-02-03

01-02-M-03

D

The energy stored inside the reservoir of water is potential energy. When the pump is activated to move the water from the reservoir to the storage tank, the potential energy is converted to kinetic energy. When the water reaches the storage tank, the kinetic energy is then converted back to potential energy.

09ZA01-02-04

01-02-M-04

A

Hydroelectric energy is obtained from dams. They store large amount of water and makes use of the high gravitational potential energy the water to release it from a great height, converting it to

kinetic energy. This energy turns the turbines, converting the kinetic energy to electrical energy.

09ZA01-02-05

01-02-M-05

C

As the pendulum swings, the gravitational potential energy is converted to kinetic energy and back. Since C is the lowest point as compared to other positions, it contains the highest amount of kinetic energy because it contains the lowest amount of gravitational potential energy.

09ZA01-02-06

01-02-M-06

A

Wind energy and hydroelectric energy make use of kinetic energy and convert it directly to electrical energy. In nuclear reactions, nuclear fission releases a large amount of heat energy. Geothermal energy is also heat energy from the hot rocks at the centre of the Earth.

09ZA01-02-07

01-02-M-07

D

A mobile phone has a battery in it. When it is switched on, the chemical energy in the battery is being converted to electrical energy. This electrical energy is converted to heat and light energy to produce the image on the phone and also sound energy to produce sound.

09ZA01-02-08

01-02-M-08

C

Energy cannot be created or destroyed because the total amount of energy in a system would always be the same. Energy can be converted from one form to another and can be absorbed and transmitted.



09ZA01-02-09

01-02-M-09

B

Machines often do not have 100% energy conversion because some of the electrical energy is converted to heat energy as there is always friction between machine parts. Energy cannot be destroyed but can be converted from one form to another.

Questions – 1.2

07ZZ01-02-10

01-02-Q-01

He should eat the doughnut since it provides the highest amount of energy among the food listed.



07ZZ01-02-11

01-02-Q-02

Chemical potential energy → Kinetic energy + Heat energy → Potential energy



1 • 3

Energy storage and conservation

MCQs

09ZA01-03-01

01-03-M-01

D

All the storage options are correct for the different types of energy forms. Energy storage is important because we do not need energy all the time and we would need to be able to store the energy and to use it in future when necessary.



09ZA01-03-02

01-03-M-02

D

Energy needs to be conserved because fossil fuels, our main sources of energy, are non-renewable. They do not last forever and are fast depleting due to increasing energy consumption as a result of industrialisation. Conserving energy also reduces air pollution as lesser amount of harmful gases are released into the atmosphere.



09ZA01-03-03

01-03-M-03

C

Building more power plants requires more energy in terms of building up the infrastructure using energy consuming machines. Moreover, more power plants would mean more fossil fuels will be burnt to supply electricity.

Energy efficient machines use less amount of energy for them to function. They can convert electrical energy more efficiently so less amount of energy is gone to waste.

Turning off electrical appliances when not in use is also another method to conserve electricity because less fossil fuel would need to be burnt if there is a lower demand for electricity.

Recycling ensures the long term sustainable use of our natural resources by extracting less mineral

ores, and that in turn uses less energy since many ore extraction processes are energy hungry.



09ZA01-03-04

01-03-M-04

D

Hydrogen fuel cells are environmentally-friendly because water is the only product in the fuel cells, which is harmless. The reaction burns cleanly and no harmful gases are released into the atmosphere.

Using gaseous materials as fuel may not be environmentally-friendly. An example is natural gas, which releases harmful gases and carbon dioxide into the atmosphere.

Hydrogen is not a readily available gas because it is present in very minute amount in our atmosphere.

Hydrogen fuel cells are not considered very safe because the reaction between hydrogen and oxygen is explosive in nature as it releases a lot of heat energy.



09ZA01-03-05

01-03-M-05

D

All the examples in the options are about energy conservation and recycling, which reduces the burning of fossil fuels. This in turn reduces the amount of harmful gases released into the atmosphere.





Questions – 1.3

09ZA01-03-06

01-03-Q-01

Energy storage is important and necessary because we do not need energy all the time. We need to be able to store the energy for future use, otherwise the energy produced would be wasted.

Energy conservation is important because we have finite sources of energy such as fossil fuels. We need to conserve energy so that they can last longer before they are completely depleted.

Conserving energy also reduces air pollution and global warming since less harmful and greenhouse gases are released into the atmosphere. Less air pollution would lead to reduced acid rain, which can corrode buildings and destroy marine and plant lives, by increasing the acidity of water and soil.



09ZA01-03-07

01-03-Q-02

We can use more energy-efficient electrical appliances such as light bulbs, refrigerators and air-conditioners. Energy consumption is reduced when energy-efficient electrical appliances are used, reducing the amount of energy required. Hence, less fossil fuels are burnt and as a result, less carbon dioxide is released into the atmosphere, a greenhouse gas that causes global warming.

Electrical appliances should also be switched off when not in use so that energy is not wasted. Recycling also saves energy as there is less manufacturing of materials and processing of metal ores.



Notes: