

# Unit 18 Sources of Energy

**Vocabulary**  
 carbohydrates  
 coal  
 to crush  
 energy  
 engine

oil  
 petrol  
 petroleum  
 power  
 ray

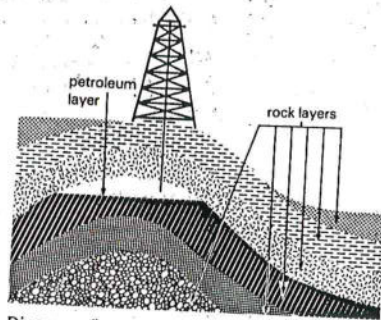


Diagram of petroleum and rock layers

**A**  
 Nearly all energy *comes from* the sun, either *in a roundabout way* or *straight from it*, in the form of heat rays and light rays. The *light from the moon, too*, comes from the sun. The moon can be *said to be like* a large mirror which *throws back* the sun's light to the earth.

5 Electrical energy comes from the sun in a roundabout way; e.g. it can come from the power of water falling down a mountainside. The water fell there as rain, *and we know that rain is made* by the sun's heat evaporating the water on the earth's surface. This water vapour rises, condenses on cooling, and falls as rain.

10 The light and heat energy from coal also comes from the sun in a roundabout way. Coal was *made* by the *rocks pressing* on *trees and plants* which died millions of years ago. Those trees and plants grew with the aid of sunlight, from which they made carbohydrates, *in this way changing the sun's energy* into chemical energy. When we burn coal, some of this

15 energy is *set free*.  
 Energy *which we use* to drive car engines comes from petrol, which also was made with the aid of the sun in a roundabout way. Plants, and animals which *ate the plants*, died millions of years ago, and *the parts of them that were left* were pressed under the rocks in the earth. These

20 *parts left from dead animals and plants* made petroleum, from which petrol and oil are now obtained.  
 Thus we can say that the sun is the *place where nearly all energy comes from*, and that *without* the sun's heat and light, *there could be no life* on earth.

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**B**  
 Nearly all energy (1) is derived from the sun, either (2) indirectly or directly, in the form of heat rays and light rays. (3) Also moonlight (1) is derived from the sun. The moon can be (4) compared to a large mirror which (5) reflects the sun's light to the earth.

5 Electrical energy (1) is derived from the sun (2) indirectly; e.g. it can be (1) derived from the power of water falling down a mountainside. The water fell there as rain, (6) which is known to be formed by the evaporation of the water on the earth's surface, by means of the sun's heat. This water vapour rises, condenses on cooling, and falls as rain.

10 The light and heat energy from coal (1) is also derived (2) indirectly from the sun. Coal was (7) formed by the (8) pressure of the rocks on (9) vegetation which died millions of years ago. That (9) vegetation grew with the aid of sunlight, from which carbohydrates were (7) formed, (10) thus converting solar energy into chemical energy. When coal is burnt some

15 of this energy is (11) released.  
 Energy (12) used to drive car engines (1) is derived from petrol, which was also (7) formed with the (2) indirect aid of the sun. Plants, and animals which (13) fed on them, died millions of years ago, and (14) their remains were pressed under the rocks in the earth. These (15) dead animal and

20 vegetable remains (7) formed petroleum, from which petrol and oil are now obtained.  
 Thus the sun can be said to be the (16) source of nearly all energy, and that (17) in the absence of the sun's heat and light, (18) no life could exist on earth.

**Exercise 1** Find the way in which the words and phrases italicised in Text A are expressed in Text B:

- |   |   |
|---|---|
| 1 comes from                              | 11 set free                                 |
| 2 in a roundabout way or straight from it | 12 which we use                             |
| 3 light from the moon, too                | 13 ate the plants                           |
| 4 said to be like                         | 14 the parts of them that were left         |
| 5 throws back                             | 15 parts left from dead animals and plants  |
| 6 and we know that rain is made           | 16 place where nearly all energy comes from |
| 7 made                                    | 17 without                                  |
| 8 rocks pressing                          | 18 there could be no life                   |
| 9 trees and plants                        |   |
| 10 in this way changing the sun's         |   |

**Exercise 2** Notice how a WHICH clause in the passive form has been used to avoid the repetition in this sentence:

- (a) In engines we burn petrol, *and we know that petrol is derived from petroleum.*
- (b) In engines we burn petrol, *which is known to be derived from petroleum.*

Rewrite these sentences to avoid repeating the parts italicised, as in example (b):

- 1 We obtain petrol from petroleum, *and we know that petroleum is derived indirectly from the sun's energy.*
- 2 The sun's rays are reflected by the moon, *and we can compare the moon to a large mirror.*
- 3 Sunlight helps plants in the formation of carbohydrates, *and we can say that this formation of carbohydrates converts the sun's energy into chemical energy.*
- 4 The formation of carbohydrates converts the sun's energy into chemical energy, *and this chemical energy is released when coal is burnt.*
- 5 Some energy is in the form of heat and light rays, *and we know that these heat and light rays come directly from the sun.*

**Exercise 3** Notice how a WHICH clause in the passive form has been used to avoid the repetition in this sentence:

- (a) Water fell as rain, *and we know that the rain was formed by means of the sun's heat.*
- (b) Water fell as rain, *which is known to have been formed by means of the sun's heat.*

Rewrite these sentences as in example (b) to avoid repeating the parts italicised.

- 1 Energy is derived from coal, *and we know that coal was formed by the pressure of rocks on dead vegetation.*
- 2 We also derive energy by consuming petrol, *and we know that petrol was derived from petroleum, and we know that petroleum was formed from dead animal and vegetable remains.*
- 3 The vegetation grew with the aid of sunlight, *and we know that sunlight assisted the plants to form carbohydrates.*
- 4 Coal was formed by the pressure of rocks on dead vegetation, *and we know that the vegetation died hundreds of millions of years ago.*
- 5 The sun's heat evaporated water, *and we know that the water fell onto the mountain-as-rain.*

**Exercise 4** Answer each question with a full sentence in the passive. (The short answer, subject of the passive sentence, is given in brackets.) Decide whether the agent is necessary.

- (a) What does the moon reflect? (Light from the sun)
- (b) *Light from the sun* is reflected by the moon.
- 1 What can we derive from the power of water falling down a mountain-side? (Electrical energy)
- 2 What does heat from the sun evaporate? (Water from the earth's surface)
- 3 What does this evaporation form, on condensing? (Rain)
- 4 What did vegetation form with the aid of sunlight? (Carbohydrates)
- 5 By forming carbohydrates, what did the vegetation convert into chemical energy? (Solar energy)
- 6 When coal burns, what does it release? (Chemical energy)
- 7 What did the sun also form indirectly? (Petroleum)
- 8 What did the rocks crush for millions of years? (Animal and vegetable remains)
- 9 What did these dead animal and vegetable remains form? (Petroleum)
- 10 What can we now obtain from petroleum? (Oil and petrol)
- 11 What can we say is derived from the sun? (Nearly all energy)

**Exercise 5** Use each of these phrases in a sentence:

- |                              |                             |
|------------------------------|-----------------------------|
| 1 energy is derived          | 5 heat and light rays       |
| 2 in the absence of sunlight | 6 the remains of plants     |
| 3 the pressure of rocks      | 7 energy is released        |
| 4 reflected light            | 8 the main source of energy |

**Exercise 6** Questions for further discussion:

- 1 What other forms of energy are there? Are they too derived from the sun, directly or indirectly?
- 2 From where do we obtain our physical energy?
- 3 Which are the energy-giving foods?
- (a) From where do they obtain their energy?
- (b) How do they give energy?

**Exercise 7** Suggestions for further activities:

Draw a diagram to show how solar energy indirectly gives us life. e.g. Show how energy from sunlight reaches grass, which is eaten by a cow or sheep, which is eaten by us.

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Revision Exercises IV (Units 16-18)

I Give the meaning of these words in your own language:

- |          |            |                  |
|----------|------------|------------------|
| 1 jar    | 7 ray      | 13 breathing     |
| 2 lime   | 8 lung     | 14 pure          |
| 3 cloudy | 9 coal     | 15 oil           |
| 4 petrol | 10 upright | 16 to crush      |
| 5 height | 11 unusual | 17 to get rid of |
| 6 engine | 12 power   | 18 energy        |

II Explain the meaning of:

- 1 derived from the sun indirectly
- 2 air was believed to consist of a single gas
- 3 air also contains traces of other gases
- 4 exhaled air is richer in carbon dioxide
- 5 it does not accumulate in the atmosphere
- 6 with the exception of a few
- 7 oxygen supports combustion
- 8 a bell-jar
- 9 placed upright
- 10 at high altitudes
- 11 require oxygen for respiration
- 12 no life could exist
- 13 can be compared to
- 14 the atmosphere is rarefied

III Give ONE word for:

- |                               |                                     |
|-------------------------------|-------------------------------------|
| 1 the light of the moon       | 11 to make pure                     |
| 2 to give fresh air           | 12 to use up                        |
| 3 very small amounts          | 13 to become more and more          |
| 4 to breathe in               | 14 to take up                       |
| 5 because of this             | 15 trees and plants                 |
| 6 found out                   | 16 went higher                      |
| 7 parts which are left behind | 17 get rid of                       |
| 8 thrown back                 | 18 place where something comes from |
| 9 only one                    | 19 in time, after a time            |
| 10 set free                   | 20 air round the earth              |

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IV Answer these questions without referring to the Texts:

- 1 What is our greatest source of energy?
- 2 From where does the moon derive its light?
- 3 How was (a) coal (b) petroleum formed?
- 4 What does air consist of?
- 5 Which gas supports combustion?
- 6 Why doesn't carbon dioxide accumulate in the atmosphere?
- 7 Which is richer in carbon dioxide, exhaled or inhaled air?
- 8 What is meant by 'purify the blood'? Where is this done?
- 9 What is formed when sugar is consumed?
- 10 How are our bodies heated?
- 11 Which gas is required by green plants for their development?
- 12 Name two things which are now obtained from petroleum.

V Find the correct word to complete each of these sentences:

- 1 Nearly all energy is — from the sun.  
(a) condensed (b) crushed (c) exhaled (d) derived
- 2 The gas which supports combustion is known as —.  
(a) oxygen (b) nitrogen (c) carbon dioxide (d) chlorine dioxide
- 3 Carbon dioxide is — from the body by exhaling.  
(a) dissolved (b) eliminated (c) ventilated (d) purified
- 4 It cannot be said that nitrogen — combustion.  
(a) consists of (b) requires (c) supports (d) contains
- 5 The blood is — when oxygen replaces carbon dioxide.  
(a) absorbed (b) exhaled (c) eliminated (d) purified
- 6 Coal was formed by the — of rocks on vegetation which died millions of years ago.  
(a) remains (b) energy (c) source (d) pressure
- 7 Carbon dioxide does not — in the atmosphere because it dissolves in water.  
(a) reflect (b) accumulate (c) replace (d) eliminate
- 8 Rain is formed by the — of water on the earth's surface by means of the sun's heat.  
(a) condensation (b) reflection (c) survival (d) evaporation
- 9 Vegetation grows with the aid of sunlight, from which — are formed.  
(a) carbohydrates (b) water vapour (c) electrical energy (d) petroleum energy
- 10 When coal is burnt, some of the chemical energy is —.  
(a) condensed (b) derived (c) compared (d) released

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# 19 Heat Transfer: (1) Radiation

Vocabulary  
dull

shiny

wave

A

Heat is derived from the sun. *We do not exactly know how it comes, but we think that it is with electro-magnetic waves which cannot be seen*, which are able to pass through a *completely empty space*. When the rays of the sun touch *a thing*, they make it warm, although the rays themselves are not hot. We know this because *the space between the sun and the earth* remains quite cold, although the rays are travelling through it.

But when the rays reach the earth, they warm the air, the ground, and everything else they touch. *Some rays are thrown back and some are taken in* by the things on which they fall. A *shiny* surface throws back more heat than a dull surface, which takes in more heat than a shiny surface.

We say that the sun radiates heat, and we call this way of heating *the passing of heat* by radiation. Radiation is only one of the three ways in which heat is passed from one place to another.

B

Heat is derived from the sun (1) in a way which is not fully understood, but (2) it is thought to be with (3) invisible electro-magnetic waves, which are able to pass through a (4) vacuum. Although they themselves are not hot, when the rays of the sun touch (5) an object, they make it warm. This is known because (6) space remains quite cold, although the rays are travelling through it.

(7) However, on reaching the earth, the rays warm the air, the ground, and (8) all other objects they touch. (9) The rays are partly reflected and (10) partly absorbed by the (5) objects on which they fall. A (11) polished surface (9) reflects more heat than a dull surface, which (10) absorbs more heat than a (11) polished surface.

(12) The sun is said to radiate heat, and (13) this method of heating is known as (14) heat transfer by radiation. Radiation is only one of the three (15) methods by which heat is (16) transferred.

Exercise 1 Find the way in which the words and phrases italicised in Text A are expressed in Text B:

- |   |                                     |
|---|-------------------------------------|
| 1 We do not exactly know how              | 8 everything else                   |
| 2 we think that it is                     | 9 Some rays are thrown back         |
| 3 which cannot be seen                    | 10 some are taken in                |
| 4 completely empty space,                 | 11 shiny                            |
| 5 a thing                                 | 12 We say that the sun radiates     |
| 6 the space between the sun and the earth | 13 we call this way of heating      |
| 7 But when the rays reach the earth       | 14 the passing of heat              |
|   | 15 ways in which                    |
|   | 16 passed from one place to another |

no

**Exercise 2** Compare these two ways of saying the same thing:

In everyday speech or writing: In science:  
 (a) *We say that the sun radiates heat.* (b) *The sun is said to radiate heat.*  
 In scientific writing, the passive form (b) is usually preferred to the active form (a).

Rewrite these sentences as in example (b):

- 1 People think that heat from the sun is radiated by electro-magnetic waves.
- 2 People do not yet fully understand how this heat comes.
- 3 People believe that the sun's heat travels as invisible electro-magnetic waves.
- 4 We know that the rays themselves are not hot.
- 5 We have proved that space itself is quite cold.
- 6 We can observe that the rays warm everything they touch.
- 7 We have observed that dull surfaces absorb heat.
- 8 We have observed that polished surfaces reflect heat.
- 9 We know that the moon reflects sunlight.
- 10 When heat travels in this way we say that it is radiated.
- 11 We say that this is heat transfer by radiation.
- 12 We know that three methods of heat transfer exist.

**Exercise 3** Rewrite this passage, using passive forms. (The subjects of the passive sentences are italicised):

We derive *heat* from the sun, but we do not fully understand *the way in which it comes*. We think that *it* is transferred by electro-magnetic waves, but we cannot see *them*. The heat rays from the sun do not heat *space*, although they travel through it. We know *this* because space remains cold, although the rays warm *the air and all other objects they touch*. All objects reflect *some of the rays* and absorb *some of the rays*. A polished surface reflects *more radiated heat* than a dull surface. A dull surface absorbs *more radiated heat* than a polished surface. We say that *the sun radiates heat*, and we call *this method of heating* heat transfer by radiation.

**Exercise 4** Give ONE word for each of these phrases. Then use these words to complete the sentences below:

- completely empty space
- cannot be seen
- the space between the sun and the earth
- passed from one place to another
- throws back
- takes in

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- 1 Electro-magnetic waves are —.
- 2 Electro-magnetic waves can travel through a —.
- 3 Electro-magnetic waves travel from the sun to the earth through —.
- 4 A polished surface — more rays than a dull one.
- 5 Heat from the sun is — by radiation.
- 6 A dull surface — more heat rays than a polished one.

**Exercise 5** Answer these questions without referring to the Texts:

- 1 What is not fully understood?
- 2 Are electro-magnetic waves able to be seen? No
- 3 Can they pass through a vacuum? yep
- 4 How do we know that the sun's rays are themselves cold? space is empty
- 5 What is the difference in meaning between 'a space' and 'space'?
- 6 What is the sun said to do? radiates heat
- 7 What is this method of heating known as?
- 8 How many more methods of heat transfer are there?

**Exercise 6** Questions for further discussion:

- 1 Why is it cooler in the shade?
- 2 Why is it cooler at night than during the day?
- 3 Find out about new forms of heating systems which use the heat radiated by the sun.
- 4 Why would a white house be cooler in summer than a house with dark-coloured walls?
- 5 Why do silver pots keep things hot for a long time?

**Vocabulary**  
the shade

**Exercise 7** Suggestions for further activities:

Take two mercury thermometers, marked A and B, and leave them in the room for a while so that they both register the same temperature. Cover the bulb of thermometer A with black paper, and the bulb of thermometer B with silver paper. Place them side by side in the sun and observe the rise of the mercury in each. Which rises faster? Why?

# 20 Heat Transfer: (2) Conduction

M2

M3

### Vocabulary

- asbestos
- cork
- to dip
- fibre-glass handle
- material molecule
- silver wool

### A

If you dip a *silver spoon* and a *wooden spoon* into boiling water at *exactly the same time*, the handle of the silver spoon *quickly gets hot*, while the handle of the wooden one *stays cool*. Why is this?

The reason is that the heat at one end of the silver spoon is *passed on quickly* from one molecule of silver to the next. However, this is not *true for wood*.

The *passing on* of heat from one molecule to the next is known as conduction. When heat is passed on *like this*, we say that it is conducted.

Materials in which this *happens easily and quickly* are said to be good conductors of heat, and all metals are good heat conductors. In materials such as wood, rubber and air, heat does not pass easily and quickly from one molecule to the next. *When we say that we mean* that these materials are *bad* conductors of heat.

Bad conductors of heat are *often* known as insulators. They *stop heat from getting away* because their molecules do not pass on heat easily and quickly from one to the next. *Air which is not moving* is one of the *worst* conductors, and so it is one of the best insulators. Any material which *holds inside itself* plenty of air is a good insulator: e.g. wool, cork, asbestos and fibre-glass.

### B

If (1) a silver and a wooden spoon are dipped (2) simultaneously into boiling water, the handle of the silver spoon (3) rapidly becomes hot, while (4) that of the wooden one (5) remains cool. Why is this?

The reason is that the heat at one end of the silver spoon is (6) transferred rapidly from one molecule of silver to the next. However, this is not (7) the case with wood.

The (8) transfer of heat from one molecule to the next (9) is known as conduction. When heat is (6) transferred (9) in this way, it is said to be conducted.

Materials in which this (10) occurs readily are said to be good conductors of heat, and all metals are good heat conductors. In materials such as wood, rubber and air, heat is not (6) transferred (10) readily from one molecule to the next. (11) By this is meant that these materials are (12) poor conductors of heat.

(12) Poor conductors of heat are (13) frequently known as insulators. They (14) prevent heat from escaping because their molecules do not (6) transfer heat (10) readily from one to the next. (15) Still air is one of the (16) poorest conductors; (16) consequently it is one of the best insulators. Any material which (17) encloses plenty of air is a good insulator: e.g. wool, cork, asbestos or fibre-glass.

Exercise 1 Find the way in which the words and phrases italicised in Text A are expressed in Text B:

- |                                     |                                |
|-------------------------------------|--------------------------------|
| 1 a silver spoon and a wooden spoon | 10 happens easily and quickly  |
| 2 at exactly the same time          | 11 When we say that we mean    |
| 3 quickly gets                      | 12 bad                         |
| 4 the handle                        | 13 often                       |
| 5 stays                             | 14 stop heat from getting away |
| 6 passed on quickly                 | 15 Air which is not moving     |
| 7 true for                          | 16 worst                       |
| 8 The passing on                    | 17 and so                      |
| 9 like this                         | 18 holds inside itself         |

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Exercise 2 THE CASE is often used to mean 'true':

- (a) This is not *true* for wood.
- (b) This is not *the case* with wood.

Read or rewrite these sentences, using THE CASE, as in example (b):

- 1 Heat is transferred readily in silver, and this is true for all metals.
- X2 Heat is transferred readily in metals, but this is not true for wood.
- 3 The handle of a metal spoon quickly becomes hot, but this is not true for a plastic spoon.
- X4 Wool and cork enclose plenty of air, and this is also true for fibre-glass.
- 5 Fibre-glass encloses plenty of air, but this is not true for metals.
- 6 It was thought that heat could not travel through a vacuum, but this is not true.
- X7 Air was once thought to consist of a single gas, but this is not true.
- 8 It was once believed that the moon radiated its own light, but we now know that this is not true.
- X9 It might be thought that carbon dioxide would accumulate in the atmosphere, but this is not true.
- 10 It was once thought that the atmosphere did not exert a pressure, but this is not true.

Exercise 3 Rewrite this passage, using passive forms without agent. (The subjects of the passive sentences are italicised):

If we dip *a silver spoon* into boiling water, the handle soon becomes hot, but if we dip *a wooden spoon* into boiling water, the handle remains cool. We call *this kind of heat transfer* conduction, and when heat travels in this way, we say that *it* is conducted. We say that *all metals* are good conductors of heat, and we say that *any materials enclosing air* are poor conductors. We call *poor conductors of heat* insulators. They prevent *the heat* from escaping. We know that still *air* is one of the best insulators.

Exercise 4 Give ONE word in place of each phrase below. Then use this word to complete the sentences:

passed from one place to another *transferred*  
 at exactly the same time *simultaneously*  
 easily and quickly *readily*  
 getting away *escaping*  
 holds inside itself *encloses*  
 the passing on *transfers*

- 1 The two spoons are dipped in boiling water *simultaneously*
- 2 Heat is quickly *transferred* from one silver molecule to the next.

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- 3 Any material which *encloses* air is a good insulator.
- 4 *Travel* of heat occurs readily in all metals.
- 5 Good heat insulators prevent the heat from *escaping*.
- 6 Heat is conducted *readily* in silver and all other metals.

Exercise 5 Answer these questions without referring to the Texts:

- 1 When two spoons are dipped into boiling water, which handle remains cool, a silver or a wooden one?
- 2 Why doesn't the wooden handle become hot quickly?
- 3 When is heat said to be conducted?
- 4 Which materials are said to be good conductors of heat?
- 5 Give examples of poor heat conductors.
- 6 What is another name for a poor heat conductor?
- 7 Give the name of one of the best insulators.
- 8 Why are wool, cork, asbestos and fibre-glass good insulators?
- 9 Is a good conductor also a good insulator?

Exercise 6 Questions for further discussion:

- 1 If you held a nail in a flame, what would happen and why?
- 2 If you held a thin piece of wood in a flame, what would happen and why?
- 3 Why do the pans and kettles used in cooking usually have wooden or plastic handles?
- 4 Give more examples of everyday uses of poor conductors of heat.
- 5 How does clothing keep us warm? Which materials would keep us warmest?
- 6 Why do birds ruffle their feathers in cold weather?
- 7 Why are wooden houses cool in summer and warm in winter?
- 8a Why do some houses have double windows?
- 8b Wouldn't it be just as effective to have simply thicker glass instead of two thin layers?
- 9 People often say that warm clothing 'keeps out the cold'. Why is this expression unsuitable for scientific purposes? What do they really mean?

Vocabulary

effective a flame a nail

Exercise 7 Suggestions for further activities:

Get a pan of very hot water and simultaneously dip into it a long wooden spoon and a metal spoon of the same length. Which handle becomes hot first?