Section A: The Organism and Its Environment

A1: Matter

No.	Answers	Further Explanations
1	C	A plasma can conduct an electric current. A plasma is an ionised gas consisting of negatively charged electrons and positively charged ions which are free to move, enabling it to conduct an electric current.
2	C	
3	A	
4	B	Substance: II Melting point: –163 °C Boiling point: –4 °C Room temperature is taken as 25 °C and the boiling point of substance II is –4 °C. At room temperature, substance II would have boiled to form a gas.
5	B	They lose kinetic energy and lose freedom of movement. When a liquid freezes, it becomes a solid. The particles in a solid possess less kinetic energy than those in a liquid and they vibrate about their mean position, so they do not possess any freedom of movement.
6	D	
7	B	X Structure X is the nucleus which is essential for cell division. Without it, the cell would not be able to divide.
8	A	
9	D	

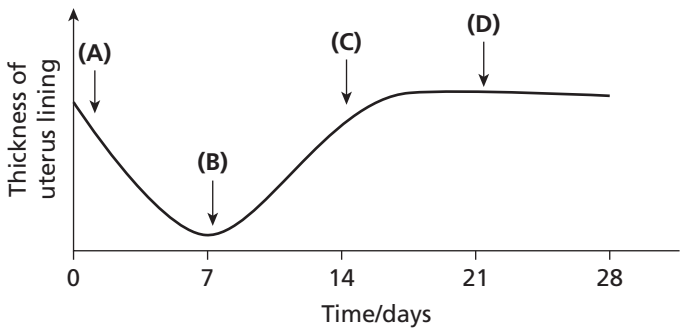
No.	Answers	Further Explanations
10	D	Typical plant cell: has no mitochondria. Typical animal cell: contains mitochondria. Mitochondria are found in both plant and animal cells.
11	C	All microbes cause disease. Most microbes are harmless and many play an important role in maintaining life on Earth. Only some microbes cause disease.
12	D	I, III and IV only **I**: Microbes decompose waste organic matter and release chemical elements back into the environment in a form that can be reused by plants, which is a positive effect. **III**: Microbes are used in sewage treatment to break down domestic and industrial organic waste forming useful fertiliser, which is a positive effect. **IV**: Microbes in the soil and in root nodules of leguminous plans convert nitrogen from the atmosphere into a form that can be used by plants in a process known as nitrogen fixation, which is a positive effect. **II**: Microbes do decompose food, but this causes food to spoil, which is not a positive effect.
13	C	Water molecules move through a partially permeable membrane from a dilute solution to a concentrated solution. During osmosis, water molecules move through a partially permeable membrane from a solution containing a lot of water molecules (which is a dilute solution) to a solution containing fewer water molecules (which is a concentrated solution).
14	A	I only **I**: The membrane of all cells is partially permeable. **II**: The cell wall found in plant cells is freely permeable, not partially permeable. **III**: The cytoplasm of cells is a solution of protein and other substances, so is not partially permeable.

No.	Answers	Further Explanations
15	A	I only **I**: Oxygen for use in aerobic respiration moves into the bodies of living organisms and into their cells by diffusion. **II**: Carbon dioxide is not produced by photosynthesis, so it cannot be got rid of by diffusion. **III**: Water for photosynthesis is obtained by the roots of plants from the soil by osmosis, not by diffusion.
16	A	

A2: Reproduction and Growth

No.	Answers	Further Explanations
1	C	
2	A	I only **I**: Asexual reproduction is a rapid process so large numbers of offspring can be produced quickly, enabling population sizes to increase rapidly. **II**: All offspring produced asexually are identical, so asexual reproduction does maintain undesirable characteristics in a population, however, this is a disadvantage, not an advantage. **III**: Since all offspring produced asexually are identical, species reproducing by this method cannot change and adapt to changing environments, so they cannot evolve.
3	A	cuttings When a cutting, consisting of a stem with a few leaves at the top, is taken from a hibiscus plant and planted in the soil, roots readily grow from the cut end of the stem and the cutting grows into a new plant.
4	D	
5	B	

No.	Answers	Further Explanations
6	B	To protect the flower before it opens. Structure T is a sepal and the function of the sepals is to protect the other flower parts when the flower is a bud.
7	D	Transfer of pollen grains from anthers to stigmas. The male anthers produce pollen grains, each of which contains a male gamete, and the stigmas are part of the female part of a flower. The pollen grains are transferred from the anthers to the stigmas of flowers during pollination so that fertilisation can then occur.
8	C	II and IV only **II**: Offspring produced as a result of cross-pollination show more variation than those produced as a result of self-pollination, and this increases their chances of survival in changing environments. **IV**: The seeds produced as a result of cross-pollination tend to be capable of surviving longer before germination and are also more likely to germinate than those produced by self-pollination. **I**: Some of the offspring produced in cross-pollination may have inferior characteristics to both parents, which is a disadvantage, not an advantage. **III**: Bees are needed for cross-pollination in many flowers.
9	B	The pollen grain travels down the style. After pollination, the pollen grain absorbs nutrients present on the stigma, swells and develops a pollen tube. The pollen tube, with the male gamete in its tip, grows down through the style by secreting digestive enzymes that digest a pathway towards the ovule. The pollen grain itself remains on the stigma and does not travel down the style.
10	D	
11	A	J Structure J is the fallopian tube or oviduct, and this is where a sperm can fertilise an ovum if one is present.

No.	Answers	Further Explanations
12	A	Contributes to the production of semen: W Stores sperm: Y Structure W is a seminal vesicle, which secretes fluid that mixes with the sperm produced by the testis to form semen. Structure Y is the epididymis, which stores the sperm that the testis produces.
13	D	
14	C	 Ovulation occurs when the uterus lining is almost at its thickest, so that if fertilisation occurs, the embryo has a thick layer of tissue with a rich blood supply to sink into.
15	D	
16	B	I and III only **I**: During menopause, the production of ova stops. Without a mature ovum in one of her fallopian tubes, fertilisation cannot occur and a female cannot become pregnant. **III**: During menopause, the secretion of oestrogen decreases so the uterus lining no longer thickens and menstruation stops. **II**: During menopause, the secretion of oestrogen decreases, it does not increase.
17	A	
18	B	

No.	Answers	Further Explanations
19	C	To produce food for the developing foetus. Food passes from the mother's blood into the foetus's blood in the placenta, the placenta does not produce food for the developing foetus.
20	B	
21	A	withdrawal Some semen is released before ejaculation, so withdrawing the penis before ejaculation would not prevent sperm from entering the female body and exposing the female to the risk of becoming pregnant.
22	D	protect against sexually transmitted infections Condoms are the only contraceptive devices that protect against sexually transmitted infections, so this gives them a distinct advantage over all other contraceptive devices.
23	D	
24	B	It increases the baby's risk of developing asthma if the mother has asthma. Breast milk lowers a baby's risk of developing many non-communicable diseases, including asthma, as it grows older, it does not increase the risk even if the mother has asthma.
25	B	Hepatitis B Hepatitis B is the only sexually transmitted infection in the options given against which a vaccine is currently available, so setting up an immunisation programme should effectively control its spread.
26	C	II and III only **II**: Gonorrhoea is caused by *Neisseria gonorrhoeae*, which is a bacterium. **III**: Syphilis is caused by *Trepanoma palladium*, which is a bacterium. **I**: Herpes is caused by the herpes simplex virus, not a bacterium.

No.	Answers	Further Explanations
27	A	
28	C	The spread of HIV/AIDS can be controlled by setting up immunisation programmes. No vaccine currently exists against HIV/AIDS, so immunisation programmes cannot be put in place to immunise people against HIV/AIDS and control its spread.
29	C	I and III only **I**: Condoms act as a barrier to prevent direct bodily contact during sexual intercourse, which prevents the bacterium causing gonorrhoea from passing from person to person, thereby helping to control its spread. **III**: Education programmes help to inform people about how gonorrhoea is transmitted and how they can protect themselves against becoming infected, thereby helping to control its spread. **II**: Gonorrhoea is not transmitted by using contaminated needles, so implementing needle and syringe exchange programmes for drug addicts would not help to control its spread.
30	D	S-shaped. The average length of the leaves increases very slowly up to day 4 and then it increases rapidly up to day 12. The increase in average length then slows down up to day 32, after which time there is no further increase in length. When average length is plotted against time, the slow increase in length, followed by a rapid increase which then slows down until the increase in length stops, would give an S-shaped curve.
31	B	
32	C	Structure C is a cotyledon, whose function is to store food, including protein, for the embryonic plant to use during germination.
33	B	

No.	Answers	Further Explanations
34	A	I only **I**: Birth control is used to prevent unintended pregnancies, therefore it should help to reduce human population growth by reducing the number of children being born. **II**: Teenage pregnancy is contributing significantly to human population growth, so it has a significant effect on it, not very little effect. **III**: If the human population continues to grow it will cause shortages of food, water, land and other natural resources, and will increase pollution, overcrowding, the spread of disease, unemployment and poverty, so living standards will decline, not improve.

A3: Food and Nutrition

No.	Answers	Further Explanations
1	B	I and II only **I** and **II**: Both water and carbon dioxide are reactants, or substrates, needed by green plants to carry out photosynthesis. **III**: Chlorophyll is needed to absorb energy from sunlight so that photosynthesis can occur, but it does not take part in the reaction, so it is not a reactant or substrate.
2	D	
3	D	iodine solution The presence of starch in a leaf is proof that the leaf has been photosynthesising, and iodine solution turns blue-black in the presence of starch. Therefore, to tell whether a leaf has been photosynthesising, it should be tested to see if it contains starch by using iodine solution.
4	C	
5	C	

No.	Answers	Further Explanations
6	A	Organic farming uses synthetic pesticides. Organic farming uses only natural inputs, it does not use any synthetic inputs, therefore synthetic pesticides are not used.
7	A	
8	C	Most primary consumers are herbivores. Primary consumers feed on producers which are green plants, and organisms which feed on plants or plant material are also known as herbivores.
9	D	
10	D	Zooplankton are secondary consumers. Zooplankton feed on plant plankton, which are producers, so zooplankton are primary consumers, not secondary consumers.
11	C	II and III only **II** and **III**: Decomposers feed on dead and waste organic matter and cause it to decompose. As the organic matter, any minerals that it contains are released back into the environment. **I**: Decomposers are bacteria and fungi which are microorganisms, they are not macroorganisms.
12	D	
13	A	I and III only **I**: Protein obtained in the diet is used by the body to make new cells. This enables the body to grow and to repair damaged tissues. **III**: Protein obtained in the diet is used by cells to make enzymes, which speed up chemical reactions in the body. **II**: Body cells can store glycogen and fat, they cannot store excess protein obtained in the diet. **IV**: Fat is stored in fat tissue under the skin where it acts as insulation, protein is not stored.

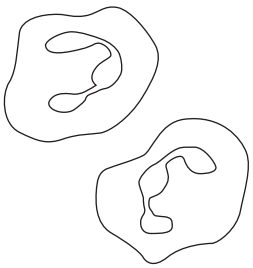
No.	Answers	Further Explanations
14	C	Person: Y Age: 25 years Energy requirement: 10 000 kJ per day To be an office worker the person should be 25 years old, not 12 years old. The manual labourer should need more energy per day than the two office workers, and a male office worker should need more energy per day than a female office worker.
15	B	Food additives are harmless chemicals added to food to enhance its flavour or colour. Food additives are chemicals added to food to prevent it from spoiling or to improve its flavour, colour or texture. Some of these chemicals may increase a person's risk of developing cancer, and some people are sensitive to certain additives and experience allergic reactions to them, therefore not all food additives are harmless.
16	C	Food R Food R contains 95 g of fat and 24 g of carbohydrate. Obesity is generally caused by excessive consumption of energy-rich foods high in fat and/or carbohydrates. Food R has the highest fat content of the four foods and the second highest carbohydrate content.
17	D	
18	D	V contained starch only. Reducing sugars cause Benedict's solution to change colour from blue to orange. Proteins cause biuret solution to change colour from blue to purple. Starch causes iodine solution to change colour from orange-brown to blue-black. Since V only caused the iodine solution to change colour, V only contained starch.

No.	Answers	Further Explanations
19	C	II and III only **II** and **III**: Certain bacteria and some fungi feed and grow in or on food, causing it to spoil by changing its appearance, texture, taste and odour. **I**: Viruses can cause food poisoning if the food containing them is eaten or contains harmful toxins released by them, but they do not feed and grow on food, so do not cause it to spoil.
20	B	I and II only **I**: The temperature inside a refrigerator is about 4 °C, which slows down enzyme activity and therefore slows down the growth of bread mould. **II**: When the bread is frozen, enzyme activity stops, which prevents the growth of bread mould. **III**: Oxygen and moisture would be present in a paper bag and being on a kitchen shelf, the temperature would be suitable for enzyme activity, so bread mould would have suitable conditions to grow.
21	B	
22	A	
23	B	III only **III**: Teeth are used to chew food, which breaks large pieces into smaller pieces. This increases the surface area of the pieces of food, which makes digestion quicker and easier because digestive enzymes have a larger area on which to act. **I**: Teeth do not change the solubility of food, so they cannot turn insoluble food into soluble food. **II**: Teeth do not have any effect on food molecules, so they cannot break down large food molecules to smaller molecules.
24	A	
25	B	

No.	Answers	Further Explanations
26	C	II and III only **II**: Dentists are responsible for examining and treating people's teeth, not doctors, so visiting a doctor regularly would not help reduce tooth decay. **III**: Bacteria in the mouth feed on sugars in food and make acid which causes tooth decay, so eating sugary food would not help reduce tooth decay. **I** and **IV**: Dentists recommend using dental floss daily and brushing teeth twice a day as two of the ways to care for teeth and therefore help to reduce tooth decay.
27	C	G Structure G is the pancreas, which produces pancreatic juice containing three enzymes: pancreatic amylase, which digests starch into maltose, trypsin, which digests proteins into peptides and pancreatic lipase, which digests lipids into fatty acids and glycerol.
28	A	
29	D	
30	D	fried bacon The gall bladder stores bile, which contains organic bile salts. These salts emulsify lipid droplets, increasing their surface area and making their digestion quicker and easier. If the gall bladder is removed, lipids would remain as larger droplets and their digestion would be more difficult. The lipid content of fried bacon is much higher than the other three foods, therefore without a gall bladder a person would find its digestion the most difficult, so should avoid eating it.
31	A	
32	B	Egestion is the process by which the body uses the products of digestion. Assimilation is the process by which the body uses the products of digestion, not egestion. Egestion is the process by which undigested dietary fibre and other materials are removed from the body as faeces.

A4: Transport Systems

No.	Answers	Further Explanations
1	B	they have a small surface area to volume ratio Multicellular organisms have developed transport systems: • to carry useful substances from specialised organs that absorb them to body cells • to carry waste products from body cells to specialised organs that excrete them. Multicellular organisms have a small surface area to volume ratio, so diffusion through their body surface is not adequate to supply all their body cells with useful substances and remove waste.
2	B	
3	C	
4	D	the loss of water vapour from leaves Water vapour, formed from water evaporating from cells inside leaves, diffuses out of the stomata of the leaves during transpiration.
5	B	I and II only **I**: The xylem vessels which transport water through a plant are extremely narrow and act like capillary tubes, so water moves through them by capillary action. **II**: The cell membranes of plant cells are partially permeable, so water moves from cell to cell in roots and leaves by osmosis. **III**: Osmosis occurring in the cells of roots and leaves, and evaporation and diffusion occurring in leaves, causes water to move through plants. None of these processes requires energy released in respiration to take place, so active transport is not involved.
6	C	they are discus-shaped Red blood cells are shaped like biconcave discs. They are thinner in the middle than at the edges. They are not discus-shaped because a discus is slightly thicker in the centre than at the edges.

No.	Answers	Further Explanations
7	C	 The cells shown in C are platelets, whose function is to help blood to form a clot at a cut or wound.
8	A	 The cells shown in A are phagocytes, whose function is to engulf and destroy pathogens, including bacteria.
9	A	
10	A	
11	D	to the body Blood vessel Q is the aorta, which transports blood from the left ventricle towards all the organs of the body except the lungs.
12	B	L, N, K, M During one complete heartbeat, the atria and ventricles relax together and fill up with blood, L. The atria then contract together, which pumps any blood remaining in them into the ventricles, N. The ventricles then contract together, which pumps the blood out of the heart, K. As they contract, the bicuspid and tricuspid valves close to prevent any blood from being pumped back into the atria, M.
13	B	twice If the red blood cell starts in the lungs, it would travel to the left side of the heart via the pulmonary vein. It would then be pumped from the left side of the heart to the body via the aorta and return to the right side of the heart via the anterior or posterior vena cava. It would then be pumped from the right side of the heart back to its starting point, the lungs, via the pulmonary artery.

No.	Answers	Further Explanations
14	C	
15	D	O– The red blood cells in group O– blood do not contain any A or B antigens on their surface, so the cells would not agglutinate or clump if given to persons with anti-A or anti-B antibodies in the plasma of their blood. As a result, group O– blood can be given to people with group A, B and AB blood, all of whom have anti-A and/or anti-B antibodies in their plasma, and it can also be given to people with group O– blood since their blood is of the same type.
16	A	I only **I**: The naming of blood groups is based on the antigens present on the surface of the red blood cells, so a man with group A blood has A antigens on his red blood cells. **II**: A man with group A blood has anti-B antibodies in his plasma, not anti-A antibodies. He could not have anti-A antibodies because these would cause agglutination of his red blood cells. **III**: A man with Rh-negative blood does not have the Rh factor on the surface of his red blood cells. If he had the Rh factor he would have Rh-positive blood.
17	A	The Rh factor poses a risk to a woman with Rh-positive blood who wishes to have children. If a woman with Rh-negative blood carries a baby with Rh-positive blood, a small amount of the baby's blood may enter her blood stream, causing her to produce anti-Rh antibodies. These antibodies can then attack the red blood cells of any subsequent Rh-positive babies that she carries. The Rh factor does not pose the same risk to a woman with Rh-positive blood.

No.	Answers	Further Explanations
18	C	
19	C	I and III only **I** and **III**: Atherosclerosis is the building up of fatty deposits containing cholesterol, known as plaque, around the inside of the walls of arteries, which makes them narrower. The plaque can sometimes rupture and form a blood clot, which gradually blocks the artery as it gets bigger. When a coronary artery supplying the heart muscle is blocked by a clot, it causes a heart attack. When an artery supplying the brain is blocked, it causes a stroke. **II**: Obesity is caused by the excessive consumption of energy-rich foods high in carbohydrates and/or fat, and a lack of physical exercise. Factors that contribute to the development of obesity can also lead to atherosclerosis; atherosclerosis does not lead to obesity.
20	B	II only **II**: Lymphocytes bring about immunity by producing antibodies in response to the presence of antigens in the walls or coats of pathogens in the body. **I**: Platelets help the blood to clot at a cut or wound but they cannot produce antibodies, so do not bring about immunity. **III**: Phagocytes engulf and destroy pathogens in the body, but they cannot produce antibodies, so do not bring about immunity.
21	D	The person develops the disease. Vaccines contain antigens of the pathogens that cause disease, they do not contain live pathogens, so they cause a person to develop immunity to a pathogenic disease without the person developing the disease.

No.	Answers	Further Explanations
22	B	II and III only **II**: The virus that causes AIDS replicates in T-helper lymphocyte cells. This destroys the cells and gradually weakens the body's immune system, to a point that it can no longer destroy invading pathogens of other types and the person becomes ill and develops AIDS. **III**: HIV belongs to the group of viruses known as retroviruses because it replicates itself inside host cells. **I**: Artificial immunity results from a person being vaccinated, not natural immunity, which results from a person having been exposed to a pathogenic disease and recovering. **IV**: The presence of foreign antigens in a person's blood sets up an immune response, not the presence of foreign antibodies.
23	D	Lengthened life spans. Abuse of drugs can lead to the death of the abuser or to the health of the abuser being damaged resulting in premature death, both of which shorten life spans, not lengthen them.
24	B	
25	C	
26	A	A person will lose weight if energy input from food exceeds energy output from daily activities. If the energy input from food eaten by a person exceeds the energy output as a result of the person's daily activities, the excess food is stored in the body and the person gains weight, the person does not lose weight.
27	A	
28	D	

No.	Answers	Further Explanations
29	C	Part of the skeleton: ribs Function: support Movement of the rib cage brought about by contraction of the intercostal muscles between the ribs causes air to be drawn into the lungs and expelled from the lungs during breathing. The ribs do not provide support to any soft parts of the body.
30	A	
31	C	T The extensor is the muscle that straightens a joint when it contracts. When T contracts it pulls on the end of the ulna, causing the radius and ulna to be lowered and the elbow joint to straighten. At the same time S, the flexor, relaxes.
32	B	
33	D	When resting, muscle tone maintains muscles in a relaxed state. Muscle tone is the unconscious low-level contraction of muscles while they are at rest, so muscle tone maintains muscles in a slightly contracted state when at rest, not in a relaxed state.

A5: Respiration and Air Pollution

No.	Answers	Further Explanations
1	C	
2	D	Y Structure Y is an alveolus and gaseous exchange takes place through the walls of the alveoli.
3	D	out of the lungs because air pressure in the thoracic cavity is increased Z is the diaphragm and when it relaxes it domes upwards. This helps to decrease the volume inside the thoracic cavity. As the volume decreases, the pressure inside the thoracic cavity increases and this causes air to be pushed out of the lungs.

No.	Answers	Further Explanations
4	C	
5	A	less carbon dioxide than exhaled air Carbon dioxide is produced by body cells during respiration and excreted by the lungs during exhalation, so the air that is inhaled contains less carbon dioxide than the air that is exhaled.
6	B	
7	A	I only **I**: The respiratory surfaces are extremely thin in both plants and animals so that gases can diffuse through them rapidly. **II**: The respiratory surfaces in organisms with blood have a rich blood supply to quickly transport gases between the surface and the body cells. Since plants do not have blood, their respiratory surfaces do not have a rich blood supply. **III**: Respiratory surfaces in both animals and plants have a large surface area so that large quantities of gases can be exchanged, they do not have a small surface area because this would mean that only small quantities of gases could be exchanged.
8	B	Respiration is the process by which body cells use energy. Respiration is the process by which energy is released from food by all living cells, it is not the process by which the cells use energy.
9	C	
10	A	
11	C	

No.	Answers	Further Explanations
12	A	I only **I**: During strenuous exercise, if oxygen cannot be delivered to the muscle cells quickly enough for the demands of aerobic respiration, the cells begin to respire anaerobically, which produces lactic acid and a small amount of energy. **II**: When yeast ferments sugars anaerobically during the wine-making process, the yeast cells produce ethanol, not ethanoic acid. **III**: When making bread, yeast ferments sugars present in the dough and this produces carbon dioxide, which makes the dough rise. It is not bacteria that ferment the sugars.
13	D	using fertilisers in agriculture Fertilisers used in agriculture can contribute to pollution of land and water, they do not contribute directly to pollution of the air.
14	A	
15	D	eutrophication Eutrophication is the nutrient enrichment of the aquatic environment, which causes the rapid growth of green plants and algae. The nutrients come from fertilisers used in agriculture, synthetic detergents and improperly treated sewage, not from polluted air.
16	B	
17	B	addiction to carbon monoxide Smoking can lead to the smoker becoming addicted to nicotine; it does not lead to the smoker becoming addicted to carbon monoxide.
18	B	Second-hand smoke is less toxic than mainstream smoke. Second-hand smoke contains the same chemicals as mainstream smoke, but it has a higher concentration of cancer-causing agents and smaller particles than mainstream smoke, making it more toxic than mainstream smoke, not less toxic.

No.	Answers	Further Explanations
19	C	II and III only **II:** Smoking is not allowed in smoke-free environments, therefore people in these environments are not exposed to second-hand smoke. **III**: Because smoking is not allowed in smoke-free environments, their aim is to help people to stop smoking. **I**: Because smoking is not allowed in smoke-free environments they help to improve air quality, they do not contribute to decreased air quality.

A6: Excretion

No.	Answers	Further Explanations
1	D	dietary fibre is not produced by the body's metabolism Excretion is the removal from the body of waste and harmful substances produced by the body's metabolism. The body's metabolism does not produce dietary fibre, so its removal cannot be considered excretion.
2	D	
3	B	
4	C	
5	A	S Structure S is the first convoluted tubule, where useful substances, including amino acids, are reabsorbed from the filtrate into the blood.
6	B	reabsorb most of the water from the filtrate Antidiuretic hormone is secreted by the pituitary gland when the blood plasma and body fluids are too concentrated. It makes the walls of the tubules and collecting ducts more permeable to water, so that most of the water is reabsorbed from the filtrate into the blood, which helps the body to conserve water.

No.	Answers	Further Explanations
7	B	become very dilute Lemonade contains a lot of water, which would cause the person's blood plasma and body fluids to become dilute. To return their concentration to normal, the excess water would be lost in the person's urine, causing his urine to be very dilute.
8	C	I and III only **I** and **III**: Kidney failure is treated using a kidney dialysis machine which performs the functions of the failed kidney, so it regulates the volume and concentration of the blood plasma and body fluids, and it removes waste products, mainly urea, from the blood. **II**: A kidney dialysis machine only removes waste products from the blood. Glucose is not a waste product, so the dialysis machine does not remove it from the blood.
9	D	Structure D is a sweat gland that absorbs water, urea and salts from the blood and excretes them as sweat.
10	A	
11	C	
12	A	active transport Active transport uses energy released in respiration to move useful substances through cell membranes, it is not a means by which living organisms, including plants, get rid of waste products.
13	C	

A7: Sense Organs and Coordination

No.	Answers	Further Explanations
1	B	
2	A	

3	C	N Structure N is the cornea, whose function is to bend the light rays entering the eye to the greatest extent. Structure L, the lens, then refracts the rays to a much lesser extent to focus them onto the retina.
4	D	
5	B	Circular muscles of the iris: relax Radial muscles of the iris: contract Pupil: dilates When the football player walks into the dimly lit changing room, his pupils dilate to allow as much light as possible to enter his eyes, enabling him to see as much as possible. To cause his pupils to dilate, the radial muscles of each iris contract, which increases the diameter of his pupils. At the same time the circular muscles relax.
6	B	Reading a book: Z Watching an aeroplane in the sky: X To be able to read the book it would have to be close to the person's eyes, so the lenses must be in a bulged shape to bend the light rays a lot to focus them on the retina. Lens Z has the most bulged shape. The aeroplane in the sky would be a long distance from the person's eyes, so the lenses must be in a flattened shape to only bend the light rays slightly to focus them on the retina. Lens X has the most flattened shape.
7	D	the ciliary muscles contracting and the suspensory ligaments slackening When the ciliary muscles contract, their circumference decreases, and this causes the suspensory ligaments to slacken and allows the lens to spring into a bulged shape.
8	C	A narrow beam of light can be separated into its component colours by passing it through a rectangular glass block. A narrow beam of light can be separated into its component colours by passing it through a triangular glass prism. Passing it though a rectangular glass block would not split it into its component colours.
9	C	

10	A	
11	D	 A person suffering from long-sightedness cannot focus on near objects because the light rays from the near objects are not refracted enough, so they focus behind the retina. It is corrected by wearing converging lenses to refract the light rays inwards before they enter the eye. If contact lenses are being used to correct the sight defect, the lenses must be curved in such a way that they can sit comfortably over the cornea.
12	D	Glaucoma can be treated by lens replacement. Glaucoma is a condition in which the pressure of the fluid within the eye increases due to the flow of aqueous humour from the eye being blocked. It is not caused by a malfunctioning lens, so cannot be treated by lens replacement.
13	B	
14	B	
15	B	
16	A	III only **III**: E and G have the same amplitude or maximum displacement, so have the same loudness. **I**: F has a lower amplitude than E, so F is quieter than E, not louder. **II**: F and G have the same frequency or number of waves per second, so they have the same pitch. F does not have a lower pitch than G.
17	D	emit up to 140 dB of sound The loudness of sound is measured in decibels or dB, and exposure to very loud sounds exceeding 120 dB can cause damage to the receptor cells in the cochlea, which can lead to hearing loss.
18	D	involuntary actions The structure labelled G is the medulla oblongata, which controls automatic, involuntary actions in the body.

19	D	
20	C	I and III only **I** and **III**: The cerebrum coordinates voluntary actions that require conscious thought such as writing. The cerebrum also controls memory. **II**: Automatic, involuntary actions such as breathing are controlled by the medulla oblongata of the brain, not the cerebrum.
21	A	
22	A	III only **III**: Children are taught that snakes are potentially dangerous. After they have been taught this, they make the conscious decision to run away when they see a snake. **I** and **II**: Sneezing and dropping a hot dish are both reflex actions that occur without conscious thought so are involuntary actions, not voluntary actions.
23	D	
24	C	II and III only **II** and **III**: Injury to the spinal cord can prevent messages passing from the central nervous system to muscles, and without these messages, muscles are unable to contract and bring about movement, which results in paralysis. **I**: Muscles bring about movement when they contract, but they do not bring about movement when they relax. Paralysis therefore occurs when muscles are unable to contract and bring about movement, not when they are unable to relax.
25	A	
26	D	M Gland M is the pancreas, which produces the hormones insulin and glucagon that regulate the level of glucose in the blood.

27	B	thyroxine Thyroxine controls the rate of metabolism and energy production in cells. If a person does not produce enough thyroxine, then the rate of his or her metabolism will be slower than normal.
28	C	

A8: Health and Sanitation

No.	Answers	Further Explanations
1	C	It helps maintain clean living areas. Maintaining good personal hygiene helps people to keep themselves clean and well groomed, it does not help people to keep their living area clean.
2	B	I and II only **I** and **II**: Keeping genitals clean and washing hair regularly are important practices to maintain good personal hygiene. **III**: To maintain good personal hygiene hands should be washed regularly, especially after visiting the toilet and before preparing food, they should not be washed once a day only.
3	C	II and III only **II**: Sewage which has not been treated in sewage treatment plants contains harmful bacteria. If this enters aquatic environments, then diseases caused by any bacteria present will spread. **III**: Garbage that is not collected on a regular basis provides a breeding site for vectors of disease, which helps to increase the spread of diseases carried by these vectors. **I**: Communities should have adequate toilet facilities to ensure that human faeces and urine do enter sewage systems and do not enter the environment.
4	B	
5	C	clean toilets Unclean toilets are likely to encourage pests and pathogens to breed. If toilets are kept clean, they are far less likely to encourage pests and pathogens to breed.

No.	Answers	Further Explanations
6	A	
7	D	
8	C	
9	B	I and II only **I**: The egg, larval and pupal stages of a mosquito all live in water, so draining all areas of standing water would kill all three stages. **II**: Since mosquitoes are insects, adult mosquitoes can be killed by spraying them with insecticides. **III**: Mosquitoes do not use garden or farmyard waste at any stage in their life cycle, so correctly disposing of this waste would not help to control mosquitoes.
10	A	Allowing mosquitoes to land on food. Female mosquitoes carry pathogens in their saliva and transmit them from person to person when they suck their blood to ripen their eggs, and both female and male mosquitoes feed on nectar and sugars from plants. Mosquitoes do not feed on human food and do not carry pathogens on the outside of their bodies, so they are very unlikely to land on food and transmit pathogens.
11	B	
12	A	
13	A	
14	D	turn it into biogas in an anaerobic digester Manure and other agricultural waste can be turned into useful products, including biogas, by bacteria in an anaerobic digester. The biogas contains mainly methane and can be used as a fuel. The leftover residue can also be used as a soil conditioner.
15	D	An increase in mosquito numbers. Solid waste collects water when it rains, so it provides a breeding ground for mosquitoes, which causes an increase in their numbers.

Section B: The Home and Workplace

B1: Temperature Control and Ventilation

No.	Answers	Further Explanations
1	B	radiation Thermal radiation takes the form of electromagnetic waves. All electromagnetic waves (radio, infrared, visible light, ultraviolet, X-rays and gamma rays) can travel through a vacuum.
2	A	
3	D	convection On heating the particles of a liquid or gas, their kinetic energy increases and they spread out more. They therefore become less densely packed and the heated region rises, carrying the heat with it.
4	A	A hot silver surface is a better emitter of thermal radiation than a hot black surface. Statement A is NOT true. A hot *black* surface is a better emitter of thermal radiation than a hot silver surface. If the surfaces were both cool, the black surface would be the better absorber of thermal radiation. Surfaces that are hotter than their surroundings are net emitters of thermal radiation, and those that are cooler than their surroundings are net absorbers of thermal radiation. A person in a freezer room is therefore an emitter because he or she is then hotter than their surroundings. A silver suit will keep him or her warmer than a black suit, because a silver surface emits poorly relative to a black surface. A rough surface has millions of very small protrusions and so has a larger surface area than is generally apparent. The rate of emission or absorption from the larger surface is therefore greater.
5	B	The black can that contains less water will warm soonest. The cans are emitters because they are warmer than their surroundings. The black cans are better emitters, so lose heat soonest. B contains less hot water than A, so there is less thermal energy in B than there is in A. It will therefore take less time for the energy in B to be radiated to the surroundings, so B cools soonest.

No.	Answers	Further Explanations
6	A	Beaker A Water, close to the base and directly above the heat source, receives heat energy by conduction as its particles collide with the heated base. The water particles then spread out more, causing the region above the heat source to become less dense and to rise. Cooler water then flows in to take the place of the rising water.
7	C	Ironing a shirt with an electric iron Heat transfer by conduction occurs as particles (atoms or molecules) collide with each other. The iron is hot and therefore its particles vibrate strongly. Since the iron is in direct contact with the shirt, particles of the iron will transfer heat to particles of the shirt as they collide.
8	B	Solar heater panels are painted dull black so that they are good conductors of heat. Statement B is NOT true since the colour of a body does not affect its ability to *conduct* heat. Solar heater panels are painted dull black so that they are good *absorbers of heat radiation*. Unlike the processes of heat transfer by conduction and convection, which require a material medium, solar energy can travel through the vacuum of space by radiation. By placing the heater panel below the storage tank, hot water will flow upwards from the panel to the storage tank by natural convection, eliminating the need for a pump. However, if the roof cannot support heavy objects, the tank must be placed on the ground, and an electric pump should be installed to circulate the water between the panel and tank. The storage tank will maintain its heat for long periods since silver is a poor emitter of thermal radiation.
9	D	

No.	Answers	Further Explanations
10	B	I and III only **I**: Since brass expands more than invar when heated, the brass strip will become longer than the invar strip. This causes the bimetallic strip to bend downwards so that brass is on the outer side (longer side) of the curve. **III**: Since brass expands more than invar when heated, it follows that it will contract more when cooled. This causes the bimetallic strip to bend so that brass is on the inner side (shorter side) of the curve. **II**: The brass does not become hotter than the invar. The brass and invar will acquire the same temperature when heated, but the particles of brass will vibrate with greater amplitude and therefore produce a greater expansion.
11	C	Hot air over the land rises and cooler air from over the sea takes its place. During the day, the surface of the land warms faster than the surface of the sea. By the process of conduction, air in contact with the land therefore becomes more heated than air in contact with the sea. Since hot air is less dense than cool air, the air over the land rises, creating a convection current that pulls cooler air from over the sea to take its place.
12	D	35 °C $\longrightarrow$ 43 °C The temperature of a living human is normally about 37 °C. Body temperatures below 35 °C will result in hypothermia, and body temperatures above 43 °C will generally result in death.
13	A	The liquid it contains can be either alcohol or mercury. Statement A is NOT true. A clinical liquid-in-glass thermometer uses mercury, *not alcohol*, as the liquid in its bore. The mercury in the bore breaks at the narrow constriction in the stem as the thermometer cools on removal from the patient. Mercury below the constriction returns to the bulb, and mercury above the constriction remains there, allowing the doctor or nurse to observe the reading. If alcohol is used in the thermometer, it will not separate at the constriction when removed from the patient.

No.	Answers	Further Explanations
14	C	As the temperature rises in a maximum and minimum thermometer, alcohol pushes on mercury and mercury pushes on a metal index. Thermoelectric digital thermometers can measure the *high* temperatures of furnaces as well as the *low* temperatures of freezers. The boiling point of mercury is much higher than the boiling point of ethanol (the alcohol commonly used in thermometers). Mercury thermometers can therefore measure *higher* temperatures than can alcohol thermometers before the liquid vaporises in its bore. Since mercury is a metal, but alcohol is not, it is a better thermal conductor, and therefore responds *faster* than alcohol to changes in temperature.
15	C	II and III only **II**: Mercury is an opaque silver metal, whereas alcohol is transparent. Alcohol must therefore be coloured so that is clearly visible in the stem of a thermometer. **III**: The freezing point of alcohol is lower than the freezing point of mercury. An alcohol thermometer can therefore measure lower temperatures than can a mercury thermometer before the liquid solidifies in its bore. **I**: Mercury is toxic (poisonous) to living organisms. This has led to a rapid decline in the use of mercury thermometers in recent times.
16	B	Lowest temperature: 10 °C Highest temperature: 30 °C The lowest and highest temperatures reached are the readings aligned with the bottom of the steel indexes in the left and right limbs respectively.
17	B	evaporation Water from the puddle can enter the air above it by changing from the liquid state to the gaseous state *over a range of temperatures*. This process is known as evaporation.

No.	Answers	Further Explanations
18	B	decreased humidity Decreased humidity results in increased evaporation, since the region above the towel will contain fewer water molecules with which the evaporated molecules can collide and then rebound to the liquid. The increased evaporation causes the towel to dry faster. Evaporation occurs only at the surface of a liquid. Folding the towel decreases the surface area exposed to the air and so *reduces* the rate of evaporation. Decreased temperature implies that the water molecules have less kinetic energy and therefore a reduced chance of escaping from the attractive forces of the other liquid molecules. Decreased temperature therefore *reduces* the rate of evaporation. Wind removes evaporated molecules from above the liquid and so prevents them from returning to the liquid. Decreased wind therefore *reduces* the rate of evaporation.
19	C	hot and humid When liquids evaporate, a cooling effect is produced as latent heat of vapourisation is absorbed from the surroundings. Evaporation of perspiration therefore reduces a person's body temperature as it results in the absorption of heat from their skin. On a *hot* day, a person's body temperature will tend to rise. By perspiring more, the chance of evaporation increases and therefore the rate of cooling increases. On a *humid* day the rate of evaporation decreases and therefore the cooling effect is reduced. In order to compensate for the reduced rate of cooling, a person then perspires more.
20	D	I, II and III **I** and **III:** The energy required by the body to sustain itself and to carry out its activities is obtained from chemical reactions occurring within the body. Metabolic rate is a measure of the amount of energy per unit time obtained from these chemical reactions. **II:** As an athlete's metabolic rate increases, his or her temperature rises due to the increased rate of heat released by the increased rate of chemical reactions occurring.

No.	Answers	Further Explanations
21	C	
22	B	II and III only **II:** Persons respiring in rooms can cause the oxygen levels to be reduced and the carbon dioxide levels to be increased. This occurs as inhaled oxygen is converted to carbon dioxide by the body and is then exhaled. Adequate ventilation will replace this stale air with fresh air having the correct balance of gases. **III:** By opening windows on opposite sides of a room, a breeze can enter through one window and push stale air through the other. **I**: Microorganisms, such as mould, multiply rapidly in *warm*, *humid* environments, not cold, dry environments. **IV:** An enclosed room packed with many people can become very *humid*, not very dry, since exhaled air contains water vapour.
23	B	Air conditioners cause the air in a room to become less humid. As air is cooled, its ability to hold water vapour decreases. The air becomes drier as the vapour it contains is removed due to condensation.

B2: Conservation of Energy

No.	Answers	Further Explanations
1	A	
2	B	Energy can be calculated from the following equation: energy = force × velocity Statement B is NOT true. Energy is calculated by the equation: energy = force × distance moved in the direction of the force (parallel to the force)

No.	Answers	Further Explanations
3	C	50 J $E = F \times d_{\|\|}$ $E = 10\ \text{N} \times 5\ \text{m}$ $E = 50\ \text{J}$ The weight of 20 N is not used in the calculation because it acts vertically downwards and therefore has no effect on the direction through which the block is moved. Recall: energy = force × distance moved *in the direction of the force* (parallel to the force)
4	B	I and III only **I:** Chemical reactions occurring in the battery convert chemical energy into electrical energy. The electrical energy flows through the connecting wires of the circuit and through the bulb. The resistance of the bulb causes the electrical energy to convert to heat and light energy. **III:** Water trapped behind a dam has gravitational potential energy due to its height above the water in front of the dam. On opening the gates of the dam, the water flows rapidly through them, and the gravitational potential energy converts to kinetic energy. The kinetic energy of the rapidly flowing water is used to turn the turbines of electrical generators where it is converted to electrical energy. **II:** During photosynthesis, light energy is converted to chemical energy, not chemical energy into light energy.
5	B	produces harmful exhaust gases The internal combustion engine does not burn nuclear fuels. It burns a mixture of gasoline and air, or diesel and air, to provide most vehicles with kinetic energy. In so doing, it pollutes the air with several harmful gases, causing engineers to be constantly researching new ways to reduce this pollution to a minimum.
6	A	A biogas generator converts energy by burning coal. Statement A is INCORRECT. A biogas generator converts energy as plant and animal matter decay in the absence of oxygen.

No.	Answers	Further Explanations
7	D	kinetic energy Some of the chemical energy converts to kinetic energy as the speed of the aircraft is increased in order to obtain the necessary lift force for take-off.
8	C	II and III only **II:** The core of the Sun has a temperature of several million degrees. At this extreme temperature, hydrogen nuclei fuse to become helium nuclei, releasing an enormous amount of energy during a nuclear fusion reaction. **III:** Nuclear energy is released in the nuclear reactors of power plants by the nuclear fission of uranium or plutonium. **I:** During nuclear fission and nuclear fusion, mass is converted to energy; energy is not converted to mass.
9	D	
10	A	solar cooker/radio wave receiver Incoming solar radiation or radio waves can be reflected by the curved surface of the dish to a focal point. A solar cooker utilises this by heating a pot of food placed at the focal point, and a radio or TV receiver utilises this by placing an antenna at the focal point. The diagram shows waves being *received* by the device. It cannot therefore be a radio transmitter or car headlamp since these devices *emit* waves. Rays incident on a rear-view mirror are generally *convergent*, not parallel, in order to produce a wide-angled view.
11	C	Light waves and seismic waves are forms of electromagnetic energy. Statement C is INCORRECT. Light waves are forms of electromagnetic energy, but seismic waves are forms of *mechanical energy* produced by the vibrations caused by earthquakes. Electromagnetic vibrations are vibrations of electric and magnetic *fields*, but mechanical vibrations are vibrations of *matter* (solids, liquids and gases).

No.	Answers	Further Explanations
12	B	
13	C	
14	D	$32\ \text{kg m s}^{-1}$ The stationary car has no momentum since it has no velocity. Total momentum before the collision = mass × velocity $= 8\ \text{kg} \times 4\ \text{m s}^{-1}$ $= 32\ \text{kg m s}^{-1}$
15	D	$2\ \text{m s}^{-1}$ The total momentum before the collision is equal to the total momentum after the collision in accordance with the principle of conservation of momentum. total momentum before the collision = total momentum after the collision $32\ \text{kg m s}^{-1} = (8\ \text{kg} \times v) + (8\ \text{kg} \times v)$ $32\ \text{kg m s}^{-1} = 16\ \text{kg} \times v$ $\frac{32\ \text{kg m s}^{-1}}{16\ \text{kg}} = v$ $2\ \text{m s}^{-1} = v$ Note that **i**n questions such as this, there are several units involved. If you find this difficult to cope with, you may do the calculation without the units as shown below. However, your final answer must include the correct unit. total momentum before the collision = total momentum after the collision $32 = (8 \times v) + (8 \times v)$ $32 = 16 \times v$ $\frac{32}{16} = v$ $2\ \text{m s}^{-1} = v$

B3: Electricity and Lighting

No.	Answers	Further Explanations
1	B	Iron, wood, polystyrene Electrical conductors: copper, aluminium, mercury, graphite, seawater, tap water Electrical insulators: plastic, wood, polystyrene, paper, rubber
2	B	I and III only **I**: Semiconductors are used in the manufacture of electronic components such as light sensors, temperature sensors, LEDs and photovoltaic cells which are found in computers, cell phones and other electronic devices. **III**: Since copper and aluminium are excellent electrical conductors, they are used extensively to make conducting electrical wires. **II**: Graphite is *suitable*, not unsuitable, for providing 'make and break' contacts in electrical circuits. It is an excellent electrical conductor and provides smooth surfaces of contact for electrical charges to travel across.
3	D	The voltmeter should be in parallel with the resistor. Ammeters are always connected in series with the component through which they are measuring current, since the current through components in series is the same. Voltmeters are always connected in parallel with the component across which they are measuring voltage, since the voltage across components in parallel is the same.
4	A	6 Ω $V = I \times R$ $\therefore R = \frac{V}{I}$ $R = \frac{12\ V}{2A}$ $R = 6\ \Omega$
5	C	24 W $P = V \times I$ $P = 12\ \text{V} \times 2A$ $P = 24\ \text{W}$
6	D	18 000 J $P = \frac{E}{t}$ $\therefore E = P \times t$ $E = 60\ \text{W} \times (5 \times 60\ \text{s})$ $E = 18\ 000\ \text{J}$ Note: time must be expressed in seconds.

No.	Answers	Further Explanations
7	B	I and III only **I and III**: If the current in a circuit reaches a point where it divides and flows through two or more branches, then the resistors in those branches are connected in parallel. **II**: There is no branch point in this circuit. The current leaving the battery has only one path to loop through the resistors of the circuit and to return to the battery. These resistors are therefore connected in series.
8	C	The current through each branch of a parallel section of a circuit must be the same. Statement C is INCORRECT. Current through the branches of a parallel section of a circuit can be *different*. The greater the resistance of the branch, the less will be the current through it.
9	A	X only Current leaves the positive terminal of the battery (indicated by the long stroke), loops around the circuit, and enters the negative terminal of the battery (indicated by the short stroke). Current will flow from the positive terminal of the battery through bulb X, so bulb X will be lit. After the branch point there are two paths, through Y or through Z. The current will take the path through Z to the next branch point, since unlike bulb Y, Z has no resistance. Bulb Y therefore does not light because current does not flow through it. Current leaves the parallel section from the second branch point and enters the negative terminal of the battery.
10	C	
11	B	Fuses must be placed in parallel with a device. Statement B is INCORRECT. Fuses are placed in *series*, not in parallel, with the device they are protecting. If the current rises above a critical value, the fuse melts ('blows') and breaks the circuit, preventing current from flowing through the device.

No.	Answers	Further Explanations
12	B	5 A $P = VI \qquad \therefore \frac{P}{V} = I \qquad \frac{48\text{ W}}{12\text{ V}} = I \qquad 4\text{A} = I$ The normal operating current for the device is 4 A. The current rating of a suitable fuse should be slightly higher than the normal operating current, so a 5 A fuse would be appropriate.
13	C	The fuse protects the device and the earth wire protects the user. If the current exceeds the recommended value, the fuse melts and breaks the circuit. The device is therefore protected from the high current. The cases of some devices are made of metal and therefore can become electrified if they are accidentally in contact with a live wire. To protect the user from this hazard, an earth wire can be connected between the case of the appliance and the ground. If a user touches an electrified case, current will instead take the easier path through the earth wire, preventing him or her from receiving an electrical shock.
14	D	thick High-powered electrical devices use high currents. Thick wires will allow more electrons to flow simultaneously through their cross-sectional area and will therefore offer less resistance. Electrons travelling through narrow wires encounter more resistance, and this results in rising temperatures, overheating and possible electrical fires.
15	C	electric kettle Heating devices generally use more energy than other devices.
16	A	$\frac{3 \times 200 \times 4 \times 7}{1000}$ kW h Each television consumes a power of $\frac{200}{1000}$ kW. The three televisions therefore consume a total power of $\frac{3 \times 200}{1000}$ kW. This power is used for a total of 4 h each day for 7 days, that is, for 4×7 h. The total energy used in kw h is therefore $\frac{3 \times 200 \times 4 \times 7}{1000}$ kW h.

No.	Answers	Further Explanations
17	A	\$ 2 Power consumed by FIVE 100 W bulbs = 500 W = $\frac{500}{1000}$kW = 0.5 kW Energy (in kW h) used by the bulbs in 8 hours = 0.5 kW × 8 h = 4 kW h ∴ Total cost = 4 kW h × 0.50 $\frac{\$}{\text{kW h}}$ = \$2
18	C	52 365 kW h The dials are read from left to right. The hands on the dials rotate alternately clockwise and anticlockwise. The digits chosen are those at which the hands point to or have just passed.
19	A	\$ 260 Energy consumed = 25 900 kW h – 25 400 kW h = 500 kW h Variable cost: 500 kW h × 0.5 $\frac{\$}{\text{kW h}}$ = \$ 250 Fixed cost: = \$ 10 Total cost: = \$ 260
20	D	I, II and III **I**: Drying using outdoor clothes lines requires zero electrical energy. **II**: Washing full loads in the washing machine reduces the amount of time the motor is running and therefore reduces the energy consumed. **III**: The water in the saucepan will be at a constant temperature as it boils. Increasing the heat supplied will only make it boil away faster, but it would not increase the temperature of the water or, for example, of the eggs which may be cooking.
21	C	
22	D	III and IV only **I**: Fluorescent tubes are more efficient than filament lamps, but *less* efficient than LED lamps. **II**: Overlapping shadows are cast by an object blocking light from a fluorescent tube, since different points along the length of the tube produce shadows in different locations. The combined shadow produced therefore *does not have sharp edges*.

No.	Answers	Further Explanations
23	C	disconnect the electrical supply if the switch is nearby The electrical supply is harming the victim and will continue to do so until disconnected.
24	B	Applying icepacks to the affected area. Statement B is NOT recommended. The low temperature of the ice will cause further damage to the skin.
25	D	
26	D	fuel, oxygen and heat Fuel and oxygen are necessary since combustion of the fuel is its reaction with oxygen. Heat is necessary to maintain the temperature above the ignition point of the fuel.
27	D	bush fires Water will remove heat and act as a barrier between the fuel and oxygen of a bush fire. Water should not be poured onto fires of flammable liquids such as oils, paints and spirits because it will instantly boil and splatter, causing the fire to spread. Water should not be poured onto electrical fires because it is an electrical conductor and can cause electrocution. Water should not be poured onto burning metals because it may react with the metals, making the fire even more dangerous.
28	A	turning off the gas supply It is difficult to smother natural gas since it is a gas of low density and will usually rise through the material placed over it. Carbon dioxide, water or a fire blanket cannot smother such a fuel, so it is best to turn off the gas supply.

No.	Answers	Further Explanations
29	A	electrical fire Electrical fires usually occur at specific points, making it easy to smother the electrical faults with carbon dioxide and so prevent oxygen from reaching them. Carbon dioxide does not effectively provide a barrier between oxygen and burning metals, flammable gas fires or bush fires for reasons given below. Metals burn at extremely high temperatures and some will react with carbon dioxide, making the fire worse. Flammable gases are usually less dense than carbon dioxide and so cannot be smothered by it. Wind will generally prevent a perfect barrier of carbon dioxide from forming over the large area of burning bush.
30	B	I and II only **I:** Flammable liquids such as gasoline can be smothered with carbon dioxide. Foam or dry powder are also suitable extinguishing agents. Since the smothering agent is denser than air, the oxygen above the flammable liquids is separated from the fuel. Water is unsuitable for extinguishing such a fire because it will instantly sink, boil and splatter, spreading the danger. **II:** Burning metals should be extinguished with an unreactive dry powder since metals burn at very high temperatures. Other extinguishing agents may react with the metals at these extreme temperatures, making the fire worse. Water will vapourise, or may even decompose to produce hydrogen, an explosive fuel. **III:** Water thrown onto burning cooking oils or fats will instantly sink, boil and splatter, spreading the danger.
31	D	Using electrically insulated boots and gloves when repairing electrical equipment. This is *not* an electrical hazard. Should the insulated boots or gloves touch a charged surface, the electrician will be protected from receiving an electrical shock.

No.	Answers	Further Explanations
32	B	
33	A	Chemist: steel-tipped leather boots, apron A chemist may be protected from harmful chemicals by using an apron but has no need to use steel-tipped leather boots.

B4: Machines and Movement

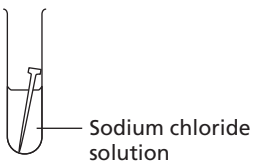
No.	Answers	Further Explanations
1	D	Foot: Class 2 Arm: Class 3 Head: Class 1 The foot is acting as a class 2 lever since the load is between the effort and the pivot. The arm is acting as a class 3 lever since the effort is between the load and the pivot. The head is acting as a class 1 lever since the pivot is between the load and the effort.
2	C	10 N The effort of 5 N creates a tension (force) of 5 N along the length of the string. The object is raised by the tensions in the two sections of string, which pull upwards on it. Since each section has a tension of 5 N within it, an object of weight 10 N can be raised.
3	B	Bottle opener The person opening the bottle exerts an upward effort on the right end of the opener, against the opposing load from the bottle cap.
4	D	
5	A	The effort is less than the load. When using a class 2 lever, the perpendicular distance of the effort from the pivot is *greater* than the perpendicular distance of the load from the pivot, and therefore the effort is *less* than the load. It should also be noted that the distance moved by the effort is *greater* than the distance moved by the load and therefore the effort is *less* than the load.

No.	Answers	Further Explanations
6	C	It has no unit. $\text{MA} = \frac{\text{load}}{\text{effort}}$ Since load and effort are both forces, their units cancel, so MA has no unit. Note also that mechanical advantage is not a measure of efficiency. Efficiency is not a ratio of forces; it is a ratio of useful work or energy output to work or energy input.
7	B	4 $\text{MA} = \frac{\text{load}}{\text{effort}} = \frac{80\ \text{N}}{20\ \text{N}} = 4$
8	C	100 J Energy converted by effort = effort × distance moved by effort = 20 N × 5 m = 100 J
9	A	the effort is less than the load A machine is a force multiplier if the effort is *less* than the load. The distance moved by the effort is then *greater* than the distance moved by the load. This type of machine is particularly useful for moving heavy loads through short distances.
10	B	$\frac{1000 \times 1.2}{500 \times 3} \times 100\%$ energy converted = force × distance moved *in direction of force* The distance moved *parallel* to the load of 1000 N is 1.2 m, so the energy converted by the load is 1000 N × 1.2 m. The distance moved *parallel* to the effort of 500 N is 3 m, so the energy converted by the effort is 500 N × 3 m.
11	B	3 times TWO revolutions of the cogged wheel connected to the pedals causes the wheel to advance by 2 × 24 = 48 teeth. The chain connecting the cogged wheels causes the smaller cogged wheel to also advance by 48 teeth. Since the smaller wheel has only 16 teeth, it must therefore rotate 3 times: 3 × 16 = 48

No.	Answers	Further Explanations
12	D	6 N Since the machine is 100% efficient, the energy output is equal to the energy input. load × distance moved by load = energy output 120 N × 0.01 m = energy output 1.2 J = energy output The energy input is therefore also 1.2 J and the effort, *E*, can be calculated as follows: effort × distance moved by effort = energy input $E \times 0.2\ \text{m} = 1.2\ \text{J}$ $E = \frac{1.2\ \text{J}}{0.2\ \text{m}}$ $E = 6\ \text{N}$
13	A	Having to raise the load through twice the distance. Raising a load through twice the distance requires that the effort will also move through twice the distance. The multiplying factor of 2 will have a cancelling effect, causing the efficiency to remain the same. Recall: $\text{efficiency} = \frac{\text{useful energy output}}{\text{energy output}} = \frac{\text{load} \times \text{distance moved by load}}{\text{effort} \times \text{distance moved by effort}}$ $\therefore \text{efficiency} = \frac{L \times d_L}{E \times d_E} = \frac{L \times 2\ d_L}{E \times 2\ d_E}$ When using a block and tackle pulley system to raise a load, the lower block must also be raised. A heavier lower block increases the effective load on the system and requires a greater effort to raise this effective load. The efficiency of the system is therefore reduced. Sand or dirt placed between the wheels and their axles will result in increased friction. The energy required to overcome this friction is wasted as heat and so reduces the efficiency of the system. Lubricating the surfaces between the wheels and their axles will result in reduced friction. Less energy will therefore be wasted as heat and so the efficiency of the system is increased.

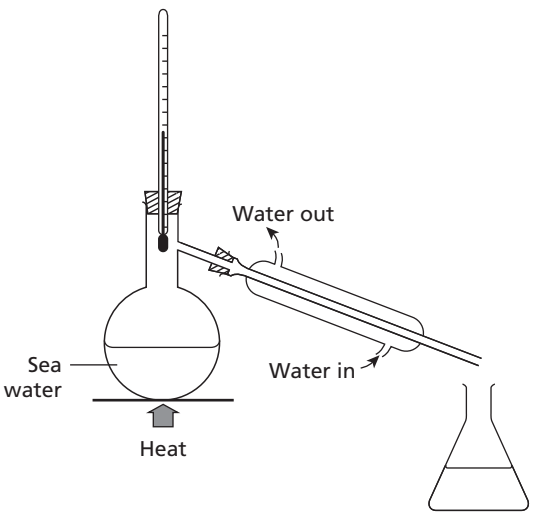
B5: Metals and Non-metals

No.	Answers	Further Explanations
1	B	I and II only **I** and **II**: Metals are good conductors of electricity and have high melting points, both of these are properties of iron, which classifies iron as a metal. **III**: Metals, including iron, have high tensile strengths, not low tensile strengths.
2	C	
3	B	
4	A	wood Wood, being a non-metallic material, is an insulator, so it would prevent heat from passing to the person's hands from the pot or pan during cooking if used to make pot and pan handles.
5	B	I and III only **I** and **III**: Plastics are resistant to damage, chemicals and decay, making them very durable. They can be made into many different shapes because they are easily moulded. Both these reasons are why plastics are used so extensively. **II**: Most plastics are non-biodegradable; they do not biodegrade easily.
6	A	They are made from a renewable resource. Plastics are made from petroleum, which is a non-renewable resource, they are not made from a renewable resource.
7	D	wood Wood is a natural raw material. Unlike the other three options, it is not a high-technology material that would enhance performance if used to make sporting equipment, so it would be the least suitable to make high-performance sporting equipment.
8	A	

No.	Answers	Further Explanations
9	D	iron + sulfuric acid ⟶ iron sulfate + hydrogen Of the metals given, only zinc, iron and tin react with hydrochloric or sulfuric acid, copper does not react. When these three metals react, a salt and hydrogen are formed. Salts formed from sulfuric acid are known as sulfates, whereas salts formed from hydrochloric acid are known as chlorides, not hydrochlorides.
10	C	They may increase a person's chances of developing Alzheimer's. When cooking with utensils made from aluminium, aluminium ions may enter the food and aluminium has been implicated in increasing a person's risk of developing Alzheimer's disease, which is a disadvantage to using these utensils, not an advantage.
11	D	
12	C	
13	C	
14	A	
15	B	 For the iron nail to rust, it must be exposed to both oxygen, which is present in the air and dissolved in water, and to water or water vapour, and rusting is speeded up by the presence of other chemicals in the air or water, in this case sodium chloride in the water.
16	D	Submerging the nail in water. Water contains dissolved oxygen, so the nail would be exposed to the two conditions needed for it to rust, water and oxygen, therefore it would be most likely to rust.

B6: Acids, Bases and Mixtures

No.	Answers	Further Explanations
1	D	
2	D	
3	A	Caustic soda Caustic soda is the household name for sodium hydroxide, which is used to remove grease, oils and fats.
4	C	
5	A	 Insecticides are used to kill insects, so they contain chemicals which are toxic. Symbol A indicates that the household chemical is toxic.
6	C	II and III only **II** and **III**: Two of the properties of aqueous solutions of acids (solutions in water) are that they change blue litmus to red and are corrosive. **I**: Aqueous acids have a sour taste, they do not have a bitter taste.
7	B	yellow Since vinegar is a weak acid it would have a pH of 5 or 6.
8	D	9 To neutralise the acid in the mouth, the toothpaste must be alkaline, so it must have a pH of 8 or above.
9	A	

No.	Answers	Further Explanations
10	A	Basic tea stains can be removed by neutralising them with borax Tea stains can be removed by neutralising them with borax, but this is because borax is alkaline and the tea stains are acidic, the stains are not basic.
11	B	I and II only **I**: The dispersed particles in a colloid are so small that they never settle, even if the colloid is left undisturbed. **II**: The dispersed particles in a colloid are too small to be seen, even when looked at with a microscope. **III**: The dispersed particles in a colloid are larger than those in a solution but smaller than those in a suspension, they are *not* larger than those in a suspension but smaller than those in a solution.
12	B	
13	C	 The bulb of the thermometer must be in line with the side arm of the distillation flask to ensure that the temperature of the steam entering the condenser remains at 100 °C. This ensures that the distillate produced is pure water. The water must also enter the condenser from the bottom and leave from the top to create a permanently cold surface on which the steam can condense.
14	C	

No.	Answers	Further Explanations
15	A	
16	D	I, III and IV only The drop of black ink separated into spots that were in equivalent positions to those produced by dyes **I**, **III** and **IV**.
17	B	turpentine Oil paint is soluble in turpentine but is not soluble in the other three solvents, making turpentine the most suitable solvent to dissolve the splashes of paint to remove them from the floor.
18	D	
19	B	I and II only **I**: Chlorine bleach is alkaline and if not used with care it can weaken the fibres in the fabrics, and this can cause holes to appear. **II**: Sodium hypochlorite in chlorine bleach is a powerful oxidising agent used to remove stains from clothes, but if it is not used carefully it can also remove colour from clothes. **III**: Chlorine bleach can burn the skin, but this is because bleach is alkaline, it is not acidic.
20	A	Using plenty of each chemical to ensure that the job is done properly. Because many household chemicals can be harmful if not used correctly, only the amount of the chemical needed to do the job should be used. More than the required amount should not be used.
21	D	Rust removers are used to remove rust on aluminium appliances. Rust removers are used to remove rust, but only iron and steel rust. Aluminium does not rust, so rust would not form on aluminium appliances.
22	C	
23	B	Adding washing powder. Washing powder is a detergent and this is added to water to remove dirt from laundry, it is not added to water to soften the water.

No.	Answers	Further Explanations
24	B	The hydrophobic tails of the detergent molecules dissolve in the grease. The tails of the detergent molecules are hydrophobic, so they are repelled by the water and attracted to the greasy dirt.
25	C	The detergents are often non-biodegradable and cause foam to form on rivers. Many soapless detergents are non-biodegradable and because of this they remain in the environment and cause foam to form on rivers, so the statement is true about soapless detergents. All soapy detergents are biodegradable and they do not cause foam to form on rivers, so the statement is untrue about soapy detergents.

Section C: Earth's Place in the Universe

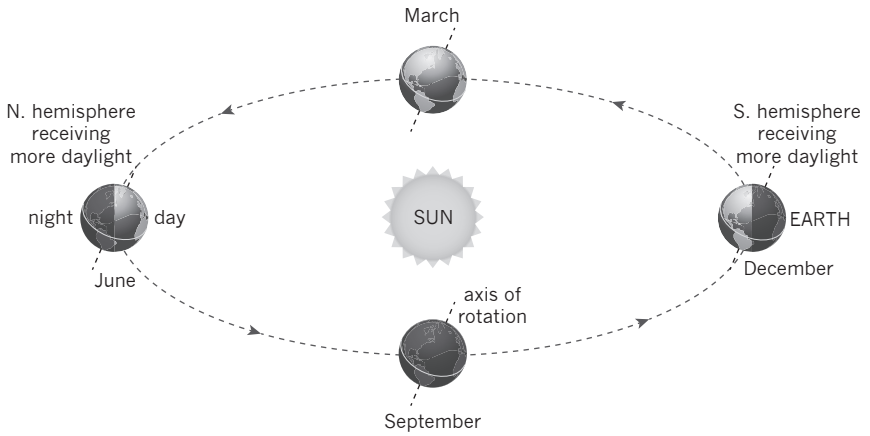
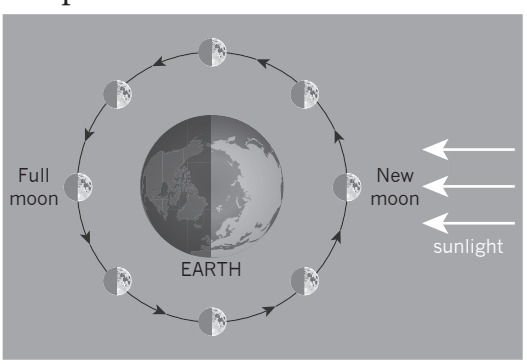
C1: The Universe and Our Solar System

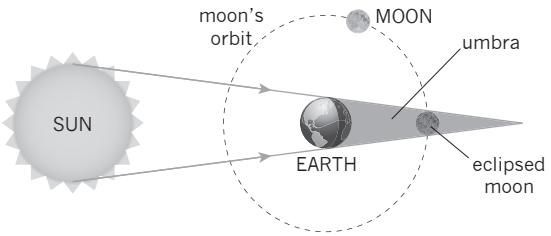
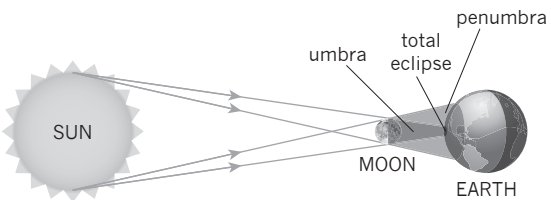
No.	Answers	Further Explanations
1	A	is so vast that it takes light more than 100 000 years to travel across it The Milky Way is a *typical* spiral galaxy having *four* arms, not two arms, where the stars are most concentrated. At its *centre*, not at its edge, is a huge black hole.
2	A	a person experiences approximately zero gravitational force Since masses are so far apart in outer space, gravitational attraction between them becomes approximately zero. Objects are *cold*, not hot, since very little radiation can reach them from the extremely distant stars. Outer space is a vacuum and so contains *no air*. It therefore has *no air pressure* and *no oxygen*. Sound waves *cannot travel through the vacuum of space* because sound waves are mechanical waves and so require a material medium for transmission.

No.	Answers	Further Explanations
3	D	I, II and IV only **I, II and IV**: A satellite is a body that orbits another body. Planets are therefore satellites that orbit the Sun and moons are satellites that orbit planets. A satellite is constantly changing direction. Since the velocity of a body depends on its speed and direction, the velocity of a satellite is constantly changing, and it is therefore accelerating. Acceleration can only be produced by a force, and this force acts towards the centre of curvature of the satellite's path. **III:** Geostationary, polar and GPS satellites, as well as the International Space Station, are *artificial* (manmade) satellites, not natural satellites. Satellites which are not manmade, for example, the planets and moons, are known as natural satellites.
4	C	I, II and IV only **I**: Geostationary satellites can be easily located because they are always above the same point on the equator. This makes them useful as communication satellites as they relay TV, radio and telephone signals. **II**: They are useful in monitoring storms because they are always located over the same hemisphere of the Earth and so can focus on a region for an extended period. **IV**: They orbit at a height of about 36 000 km above the Earth's surface, much higher than do polar or GPS satellites. **III**: Geostationary satellites make *one* revolution, not two, around the Earth in 24 hours.

No.	Answers	Further Explanations
5	D	II and IV only **II**: Polar satellites orbit the Earth in just about 90 minutes and so make several revolutions each day. **IV**: Since they orbit several times each day in a north–south direction as the planet spins in an east–west direction, they are useful in monitoring weather data from around the globe. **I**: Since polar satellites orbit in a north–south direction, they do not orbit above the equator. **III**: Since polar satellites orbit closer to the Earth than do geostationary satellites, they produce photos of *higher* resolution, not lower resolution, than do geostationary satellites.
6	B	They produce information of location and time at various points on or above the Earth. More than 10 GPS satellites are required to adequately perform their function. About *30* GPS satellites orbit the Earth in 6 orbital paths. This ensures that a minimum of 4 in each orbit can be functioning at any given time. The Hubble Space Telescope researches the formation of the planets, stars and galaxies and is *not* a GPS satellite. The orbital period of a GPS satellite is *12* hours, not 24 hours.
7	B	Venus, Earth, Mars, Jupiter The complete list of planets of our solar system in order of increasing orbit radius is as follows: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
8	D	Each of the large outer planets is orbited by a ring system of dust, or ice and dust. Planets of our solar system orbit in *elliptical* paths, not circular paths. The four planets nearest to the Sun are known as the *terrestrial planets* due to their rocky surfaces. The four planets furthest from the Sun are known as the *gas giants* because they are large and are surrounded by thick atmospheres. Terrestrial planets have *higher temperatures* than the gas giants because they are nearer to the Sun and so experience a greater intensity of radiation.

No.	Answers	Further Explanations
9	C	All planets spin about their axes in the same direction. Statement C is INCORRECT. Venus spins on its axis in a direction opposite to that of the other planets. Venus is the hottest planet although it is not the nearest planet to the Sun. Its dense atmosphere of carbon dioxide traps heat radiation by the greenhouse effect.
10	D	Saturn is known for its profound ring system. *Uranus*, not Neptune, appears to spin on its side. The asteroid belt lies between *Mars and Jupiter*, not between Earth and Mars. *Mars*, not Jupiter, is known as the red planet. Jupiter, however, has a 'great red spot' caused by a violent persistent storm.
11	A	I and II only **I**: Asteroids are rocky masses that are too small to have a gravitational force that is strong enough to maintain an atmosphere. **II**: Comets are masses of frozen material that produce a vapourised 'tail' of gas as they partially vapourise on passing close to the Sun in their elliptical orbits. **III:** *Meteors*, not meteorites, are sometimes called shooting stars. These are bright trails of light seen when meteoroids (mainly the remnants of comets or pieces of asteroids) are strongly heated as they experience friction on passing through the atmosphere. **IV:** *Meteorites*, not meteors, are the remains of rocky materials known as meteors that have fallen to the Earth.
12	A	gravitational forces For a body to remain in orbit there must be a force on it directed to the centre of the orbit. Gravitational forces are forces of attraction that exist between bodies due to their masses. For a body that orbits the Sun, it is this gravitational force that is directed towards the Sun which keeps it in its orbit.

No.	Answers	Further Explanations
13	C	I and IV only **I**: In the northern hemisphere, the days are longest, and the nights are shortest, during the months of June, July and August. This is the summer season in the northern hemisphere. At the same time in the southern hemisphere, the days are shortest, and the nights are longest, and so it is the winter season in the southern hemisphere. The opposite occurs during the months of December, January and February; it is then winter in the northern hemisphere and summer in the southern hemisphere. This seasonal effect is due to the change in the angle of incidence of the solar radiation reaching the planet as it orbits the Sun on its tilted axis.  **IV**: During a new moon, the Moon lies between the Earth and the Sun. The Moon appears obscured when viewed from Earth since light from the Sun is being blocked by it. During a full moon, the Earth lies between the Moon and the Sun. Light from the Sun, incident on the Moon, reflects to Earth from the complete disc of the Moon which faces it.  a Viewed from above the North Pole

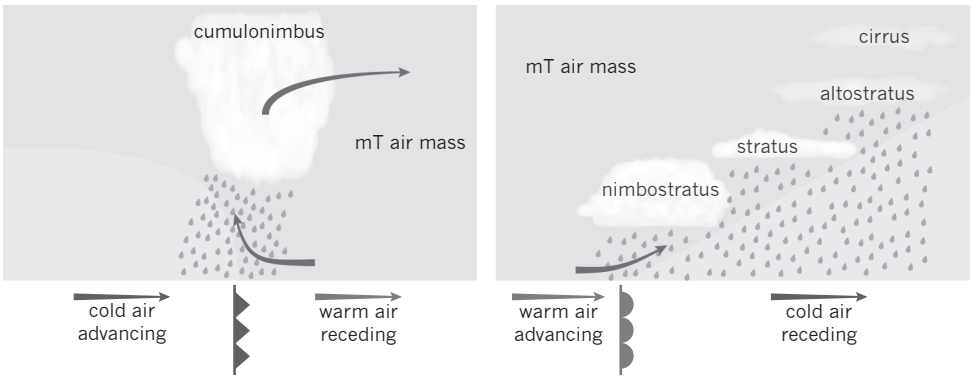
No.	Answers	Further Explanations
		II: During a lunar eclipse, the *Earth is between the Sun and the Moon*; the Moon is not between the Earth and the Sun. The Moon passes through the Earth's umbra and so light from the Sun cannot reach it to be reflected to Earth.  **III**: A total solar eclipse occurs on Earth where the Moon's *umbra*, not its penumbra, reaches the Earth. 
14	B	
15	D	15 days The moon takes approximately 30 days to orbit the Earth. Approximately 15 days after observing a 'new moon', we observe a 'full moon', and then approximately 15 days later, we once again observe a 'new moon'.
16	B	sound pollution Sound needs a material medium (solid, liquid or gas) for its transmission, so sound pollution is not possible in the vacuum of space.
17	C	is a scientific research laboratory and an intermediate port for space exploration The ISS is the *largest* artificial satellite and has an orbit radius much *smaller* than any geostationary satellite. It is owned by *five* space agencies from various countries.
18	B	Landers drive around the planet gathering information. Statement B is INCORRECT. Landers stay fixed in position on the planet. They are used to transport rovers to the planet. The rovers drive around the planet, gathering information which is received and analysed by the landers and then transmitted to Earth.

C2: The Terrestrial Environment

No.	Answers	Further Explanations
1	B	
2	D	
3	A	expansion As water freezes to form ice it expands. As any water present in cracks in rocks freezes it exerts pressure within cracks, which causes pieces of rock to break away.
4	A	
5	D	gravel, sand, silt, clay The particles sink in order of their size. Gravel particles are the largest so sink first, followed by sand, then silt and finally clay, which are the smallest particles.
6	D	a sandy soil The particles in a sandy soil are the largest, so they have the largest air spaces between. Water passes through the large air spaces quickly, so the soil is the least likely to become waterlogged during the rainy season.
7	C	Soil W: loam Soil X: clay Soil Y: sandy The lowest volume of water drained through soil X, therefore the soil retained the most water, suggesting that soil X was a clay soil which had the smallest particles with the largest total surface area. The highest volume of water drained through soil Y, therefore the soil retained the least water, suggesting that soil Y was a sandy soil which had the largest particles with the smallest total surface area. More water drained through soil W than through soil X and less than through soil Y, suggesting that soil W was a loam, containing a mixture of clay and sand.
8	C	
9	D	E contains organic matter at different stages of decomposition. E is the O horizon or litter layer, which is composed mainly of dead plant material such as leaves that are undergoing decomposition.

No.	Answers	Further Explanations
10	C	
11	C	II and III only **II**: When organic matter decomposes, mineral nutrients which are essential for healthy plant growth are returned to the soil. **III**: When organic matter decomposes, the humus formed coats rock particles and binds them together to form soil crumbs, which ensures that the soil contains adequate quantities of air and water, drains well, and is loose enough for plant roots to penetrate and soil animals to burrow. **I**: Nitrogen-fixing bacteria in the soil convert nitrogen into ammonium compounds which are then converted into nitrates by nitrifying bacteria. Organic matter does not convert the nitrogen into nitrates.
12	B	They feed on microorganisms in the soil. Earthworms feed mainly on plant debris. They can also ingest soil particles and digest the microorganisms surrounding the particles, but digesting these microorganisms is not important in agricultural soils.
13	D	
14	B	Overgrazing animals. If animals overgraze they remove all the leaves from plants and this can result in the plants dying. The plant roots are then no longer present in the soil to bind the soil together and prevent erosion.
15	B	I and II only **I**: The farmer can reduce the chances of soil loss by helping to ensure that his soil retains its crumb structure by rotating his crops. **II**: The farmer can reduce the chances of soil loss by protecting the surface of his soil from the forces of the rain and wind by covering the soil with mulch. **III**: The farmer can reduce the chances of soil loss by ploughing along the contours of his sloping land, not by ploughing down the sloping land.

No.	Answers	Further Explanations
16	C	They include bacteria, viruses and fungi. Only bacteria and fungi are capable of feeding on dead and waste organic matter, causing it to decompose. Viruses are not capable of doing this, so decomposers include only bacteria and fungi.
17	A	
18	C	
19	D	The process labelled M is decomposition. When plants die, the protein in their dead bodies is converted to ammonium compounds by decomposers in the soil, a process known as decomposition.
20	A	
21	B	Maritime polar air masses are cool and humid. Polar air masses are cool since they exist in regions near to the North Pole and South Pole. Maritime air masses are humid since they exist over water. Maritime polar air masses are therefore cool and humid.
22	C	
23	A	Cold air masses generally travel slower than warm air masses. Statement A is INCORRECT. Cold air masses generally travel *faster*, not slower, than warm air masses.
24	B	a cold front catches up with a warm front An occluded front is formed when a fast-moving cold front catches up with a warm front, lifting a warm air mass which is sandwiched between two cooler air masses.

No.	Answers	Further Explanations
25	D	warm front: rainfall for a very brief period Statement D is INCORRECT. At a warm front there is a gentle gradient between a layer of warm air over cooler air. The moist warm air therefore rises slowly as the air mass advances over a long distance at the front, usually producing stratus clouds and continuous light rainfall for an *extended* period.  **a** Cold front producing **brief**, **violent** showers or thunderstorms over a small area near to the front **b** Warm front producing **continuous**, **light** showers over a **large** area **ahead** of the front
26	B	
27	C	have low pressure at their centres When the temperature rises *above* 27 °C there is much evaporation from the oceans. The hot humid air becomes less dense and rises, creating a region of low pressure which pulls in surrounding air in an *anticlockwise* direction in the northern hemisphere. As a tropical cyclone approaches land, its wind speed *decreases* due to increased friction.
28	D	I and IV only **I**: The hurricane season is from June 1 to November 30. It is the period when the Atlantic Ocean is warmest and the rate of evaporation from the sea is highest. This results in the formation of regions of low pressure that are necessary for the creation of storms. **IV**: Since the winds rotate around the eye, they will blow in opposite directions as the eye approaches and then leaves a region. **II**: The *eye*, not the eyewall, is a region of calm. **III**: The *eyewall*, not the eye, is a region of strong wind and heavy rainfall.

No.	Answers	Further Explanations
29	A	is a deep-water wave Unlike a tidal wave, which is a shallow-water wave produced by gravitational forces among the Sun, the Moon and the Earth, a tsunami is a deep-water wave, *produced by an undersea volcano, earthquake or landslide*. A tsunami travels at very *high speed* in deep water and *grows tall* as it approaches land.
30	C	Steep slopes are produced by freely flowing, non-viscous lava. Statement C is NOT true. Lava of low viscosity is very fluid and can flow for several kilometres before solidifying. It therefore does not produce steep slopes. Strong forces exist between tectonic plates moving relative to each other. These forces can create paths for hot magma to rise to the surface through opened cracks at the interfaces between the plates. Thick lava usually causes the vent of the volcano to be blocked. Strong pressures can then develop, which may cause the vent to blow explosively. Gases and steam in the blocked vent may also produce high pressures that can result in explosive eruptions.
31	A	can spread for hundreds of kilometers These volcanoes produce magma that flows very easily for long distances before solidification. Since the magma does not solidify rapidly, the vents are usually unblocked, and the chances of explosive activity is minimal.
32	D	II, III and IV only **II**: A composite cone volcano ejects 'volcanic bombs' (large rocks and boulders) through the air due to high pressures caused by thick magma and steam in its vent. **III**: It has steep slopes, since it ejects thick, slow-moving magma which quickly solidifies. **IV**: A layer of rock, ash and cinder is formed when explosions occur due to pressure building in a blocked vent. A layer of lava is formed when the vent is unblocked and becomes less explosive. **I**: The magma ejected by a composite cone volcano is thick and viscous, and so flows relatively *slowly*, not rapidly.

No.	Answers	Further Explanations
33	C	is a submarine volcano A submarine volcano is an underwater vent or fissure in the Earth's surface from which magma can erupt. Kick `em Jenny is an active submarine volcano located 8 km north of Grenada.
34	B	Land covered in lava will always be infertile. Statement B is NOT an ecological consequence of volcanoes. Volcanic soils are among the *most fertile soils* in the world. The ash contains many important minerals and the materials break down easily by weathering to release several nutrients.
35	C	I, II and IV only **I**: Earthquakes are generally produced by forces between tectonic plates that cause bursts of energy resulting in shock waves known as seismic waves. **II**: A seismograph is a device that produces a graph known as a seismogram showing the amplitude of the Earth's vibrations over time. **IV**: Earthquakes can cause volcanoes by creating cracks for magma to rise through, or by weakening the top of a magma chamber, allowing the release of heat and pressure from its vent. **III**: The Richter scale is a scale of *1 to 10*, not 1 to 20, used to compare the strengths of earthquakes.
36	D	Each day, coastal regions experience one high tide and one low tide. Statement D is NOT true. Each day, coastal regions experience *two high tides* and *two low tides*.

No.	Answers	Further Explanations
37	A	Spring tides occur when there is a new moon or a full moon. Spring tides are formed with the occurrence of a new moon or a full moon. This is when the gravitational attraction of the Sun and Moon on the Earth is strongest. During neap tides, high tides are *not very high* and low tides are *not very low*. Both spring tides and neap tides occur *twice* each month, not once each month. *Spring* tides, not neap tides, occur when the Sun, Earth and Moon are aligned. Neap tides occur when the line joining the Earth to the Sun and the line joining the Earth to the Moon are at right-angles to each other.

C3: Water and the Aquatic Environment

No.	Answers	Further Explanations
1	A	To make a jug of lemonade. The most important use of water to humans is for drinking since they cannot live for long without water. Using water to make lemonade would provide a person with a source of water to drink during a water shortage.
2	D	
3	C	water conservation Water-saving devices and appliances reduce the quantity of water used in the home, therefore they help to conserve water.
4	D	
5	B	
6	A	Adding alum to the water. Alum removes suspended particles from the water by causing them to clump together and settle, however it does not remove microorganisms from the water, which the other three methods have the advantage of doing.

No.	Answers	Further Explanations
7	C	
8	B	the density of water is higher than the density of the ice that forms from it An object floats in water when it is less dense than the water. Since water has a maximum density at 4 °C, ice at 0 °C is less dense than water at a slightly higher temperature. As a result, ice floats on the water because the density of the water is higher than the density of the ice that forms from it.
9	A	Very few substances can dissolve in water. Water is known as the universal solvent because it can dissolve a large number of substances, not very few substances.
10	B	III only **III**: The higher salt content of sea water causes it to have a higher density than fresh water. **I**: The higher salt content of sea water causes it to have a higher boiling point than fresh water, not a lower boiling point. **II**: The lower salt content of fresh water causes it to have a higher melting point than sea water, not a lower melting point.
11	A	$2\ g\ cm^{-3}$ Mass of stone = 200 g – 140 g = 60 g Volume of stone = $50\ cm^3 - 20\ cm^3 = 30\ cm^3$ $\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{60g}{30\ cm^3} = 2\ g\ cm^{-3}$
12	D	The density of the object is less than or equal to the density of the water. If the density of the object is less than that of the water, the object will float such that it is only partially submerged. If the density of the object is equal to that of the water, it will float with its uppermost surface at the water level.

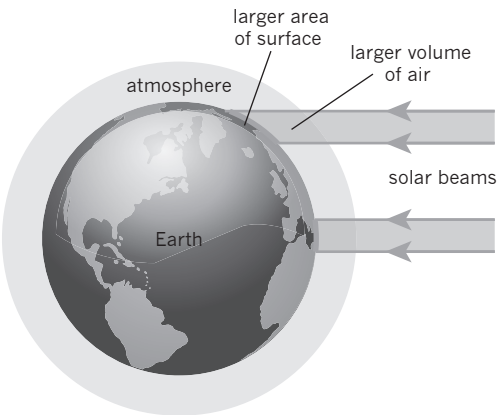
No.	Answers	Further Explanations
13	C	is the same on each ball The principle of Archimedes states that when an object is wholly or partially submerged in a fluid, it experiences an upthrust equal to the weight of the fluid displaced. Since the balls have the same diameter, they have the same volume, and therefore will displace the same amount of water to produce the same upthrust. Since the beach ball rushes upward, the resultant force on it is upward. The upthrust on it is therefore *greater*, not less, than its weight. resultant upward force = upthrust – weight
14	D	III and IV only **III**: According to the principle of Archimedes, the ship experiences an upthrust equal to the weight of water it displaces. **IV**: Since the ship floats in the water, the resultant force on it is zero. The weight of the ship is therefore equal in magnitude but oppositely directed to the weight of water it displaces (upthrust). resultant force = upthrust – weight 0 = upthrust – weight ∴ weight = upthrust **I**: The ship should be loaded so that it sinks to a maximum depth indicated by the Plimsoll line recommended for loading in *waters of the Tropics*, not in waters of the North Atlantic. **II**: As the ship enters cooler water, it will *rise* further out of the water, not sink further into it. The cooler water is denser, so less of it is displaced to provide the upthrust necessary to balance the weight and so maintain flotation.
15	C	Burning fossil fuels in motor vehicles. When fossil fuels are burnt in motor vehicles, the pollutants emitted are in the gaseous state and contribute to air pollution, the gaseous pollutants do not enter bodies of water and contribute to water pollution.
16	C	

No.	Answers	Further Explanations
17	D	
18	A	
19	A	
20	C	sonar The depth of the sea bed and the location of underwater objects can be detected using sonar, so a diver would be able to locate an underwater reef using sonar and also determine its depth.
21	A	
22	B	GPS A Global Positioning System or GPS device uses information from at least three satellites to give the latitude and longitude of a vessel at sea, thereby pinpointing the exact location of the vessel.
23	D	an inflatable ball The round shape of an inflatable ball would not be able to help to keep a person afloat in an emergency, so the ball could not be used as a water safety device.
24	B	ears As a diver descends, the pressure increases and this has the greatest effect on the parts of the diver's body that contain air. The diver's outer ears and middle ears are filled with air and are separated by his ear drums, and as he descends the increased pressure in his outer ears pushes his ear drums inwards, which causes pain and can burst the drums.
25	C	ascends from a long, deep dive too quickly During a long, deep dive, a lot of nitrogen dissolves from the air inhaled by the diver into her blood and tissue fluids. If she then ascends too quickly, the nitrogen can form bubbles in her blood stream and body tissues during or soon after the ascent. These bubbles can cause joint pain, pressure bruising of the skin and paralysis, known as 'the bends'.
26	D	

C4: Fossil Fuels and Alternative Sources of Energy

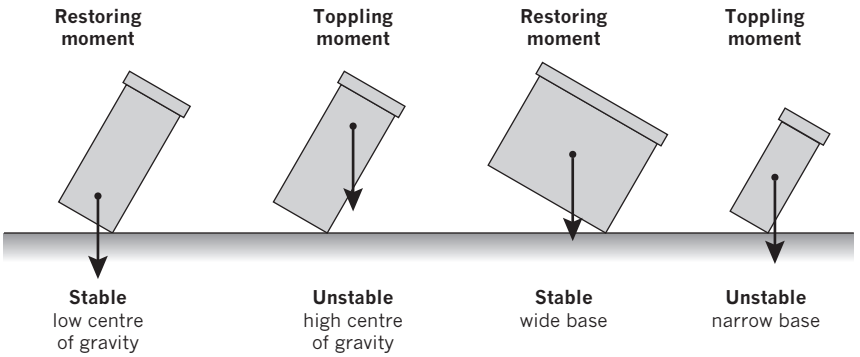
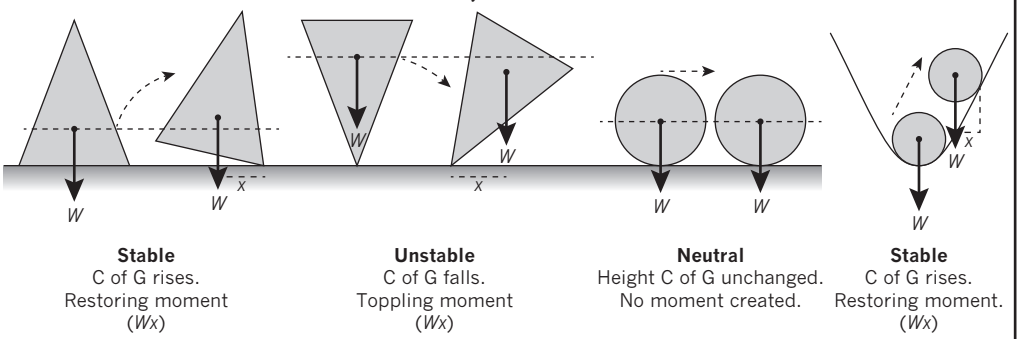
No.	Answers	Further Explanations
1	A	coal Fossil fuels are buried combustible deposits of plant and animal matter that have been subjected to intense heat and pressure in the Earth's crust for hundreds of millions of years. Wood and biomass are combustible fuels derived from plant and animal matter but have not been subjected to intense heat and pressure in the Earth's crust for hundreds of millions of years. Uranium is a metal, not plant or animal matter. It is used as a fuel as it releases energy when its atomic nucleus decays radioactively.
2	D	diesel-electric power plant Diesel is produced by the refinement of crude oil, a fossil fuel.
3	B	nuclear Unlike the energy derived from the Sun, wind and tides, nuclear energy is non-renewable because it cannot be readily replenished as it is used.
4	D	Trees can be replanted to replace the ones we use. A renewable source of energy is one which can be readily replenished.
5	A	
6	B	biogas Coal, natural gas, crude oil (petroleum) and its distillates are not alternative sources of energy because they are fossil fuels.
7	D	I, II and IV only **I, II and IV**: Greenhouse gases such as water vapour, carbon dioxide and methane (not oxygen and nitrogen), absorb long wavelength (infrared) radiation emitted by the Earth. These gases then emit radiation, much of it returning to warm the planet. **III**: As gasoline and diesel are burnt in the internal combustion engine, carbon dioxide, a greenhouse gas, is produced, and therefore global warming is *increased*.

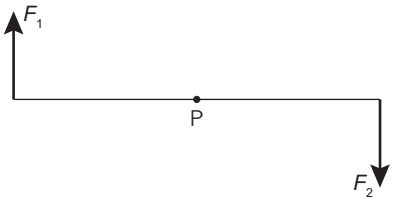
No.	Answers	Further Explanations
8	C	
9	A	carbon monoxide: increases the ability of the blood to transport oxygen A is INCORRECT. Carbon monoxide *decreases*, not increases, the ability of the blood to transport oxygen.
10	C	They are generally renewable. Most alternative sources of energy are renewable. An exception is nuclear energy. Alternative energy plants are usually very *costly to construct* but have *low operational costs*. Alternative sources of energy can have *negative effects on the environment*. For example, wind turbines cause noise pollution and make the landscape less attractive, and hydro-electric dams reduce the quality of the surrounding ecosystems.
11	C	Biofuels can only be produced from plant matter. Statement C is NOT true. Biofuels can be produced from plant and/or *animal* matter.
12	D	
13	B	heated rocks below the Earth's surface Geothermal energy plants have pipes that circulate water between the Earth's surface and the heated rocks of geothermal reservoirs below the surface. The water is heated by the geothermal reservoirs, and the hot water and steam produced rise through the pipes, where they are used to turn the turbines of electrical generators. The water is then cooled and returned to the reservoirs to be reheated.

No.	Answers	Further Explanations
14	B	at the tops of mountains than at their bases Solar energy incident at the tops of mountains has less atmosphere to penetrate and therefore less of it is absorbed before reaching the Earth. The air is also less polluted with particulate matter which would otherwise absorb a portion of the radiation. Solar energy incident on the atmosphere at high latitudes (away from the equator) does so at greater angles than does solar energy reaching the equator. The radiation therefore passes through a larger volume of the atmosphere and so more of it is absorbed by the atmosphere before it reaches the planet. At high latitudes the energy is also incident on the Earth's surface at a greater angle than it is at the equator. A given amount of radiation must warm a larger area of the surface, and therefore the intensity of the radiation reaching the surface is less.  Clouds and atmospheric pollution from factories absorb solar radiation, reducing the intensity of the solar energy reaching the surface.
15	C	

C5: Forces

No.	Answers	Further Explanations
1	C	
2	D	II and IV only **II**: The gently sloped, smooth wing results in a streamlined flow of the air passing over its surface since there are no protrusions or sharp curves to cause turbulence. **IV**: Birds have wings similar in shape to aeroplanes and so the airflow across them is also similar. **I and III**: The pressure above the wing is *less than*, not greater than, the pressure below the wing, and this causes a resultant *upward* force (lift), not downward force, on the wing.
3	C	It decreases on a body as it is submerged from air into water. Statement C is NOT true. The gravitational force on a body is unchanged as it is submerged from air into water. However, the resultant force on the body decreases, since an upthrust is created that is equal to the weight of the water displaced.
4	B	engine thrust = drag force weight = lift force Since the aircraft is moving at *constant* velocity, it is *not accelerating*. The resultant horizontal force and the resultant vertical force must therefore be zero. • The horizontal forces (engine thrust and drag force) must be equal in magnitude but opposite in direction so that they cancel each other. • The vertical forces (weight and lift force) must be equal in magnitude but opposite in direction so that they cancel each other. Note: • If the aircraft was accelerating forwards, the engine thrust would be greater than the drag force. • If the aircraft was accelerating upwards (rising), the lift force would be greater than the weight.

No.	Answers	Further Explanations
5	A	
6	B	
7	B	unstable A body is in unstable equilibrium if when slightly displaced, the position of its centre of gravity is lowered. A moment is then created that causes it to tip over from its base. This is the case for the object shown in B. A body is in stable equilibrium if when slightly displaced, the position of its centre of gravity rises. A moment is then created that returns it to its initial position. This is the case for the objects shown in A and C. A body is in neutral equilibrium if, when it is slightly displaced, its centre of gravity remains at the same level and therefore no moment is created. This is the case for the object shown in D. 
8	C	Only planets can exert gravitational forces. Statement C is NOT true. Gravitational forces are forces of attraction that can exist between all bodies.

No.	Answers	Further Explanations
9	A	A pulley wheel rotating on a rusty axle. The effort required would be greater since it must now overcome the opposing force of friction as well as the weight (load).
10	D	III and IV only **III** and **IV**: These are the conditions necessary for a system of parallel forces to be in equilibrium. **I**: A force cannot be clockwise or anticlockwise because at any given instant it acts in a fixed direction, for example, upwards, downwards, to the left or to the right. It is the *moment caused by the force* – not just the force – which may be clockwise or anticlockwise. **II**: Since moments cause rotation, we must refer to them as being *clockwise* or *anticlockwise*, not upwards or downwards. The diagram below shows two forces, each having a clockwise moment about the point, P. However, one force is directed upwards, and the other, downwards. 
11	A	250 N Taking moments about the point P: sum of anticlockwise moments = sum of clockwise moments $5\text{ N} \times 20\text{ cm} = L \times 0.4\text{ cm}$ $\frac{5\text{ N} \times 20\text{ cm}}{0.4\text{ cm}} = L$ $250\text{ N} = L$ Recall that the moment of a force about a point is the product of the force and the perpendicular distance of its line of action from the point. Since R acts through the pivot, P, it has no distance from P, and so has no moment about P. R therefore does not appear in the above equation.

No.	Answers	Further Explanations
12	D	5 N For a body in equilibrium under the action of a system of parallel forces, the sum of the forces in any direction is equal to the sum of the forces in the opposite direction. $\therefore$ sum of upward forces = sum of downward forces $R = 4\text{ N} + 1\text{ N}$ $R = 5\text{ N}$