

Biology

Variety of life, adaptation and competition

Variety of life

- Large eyes (also accept large, sensitive ears). (1 mark)
 - Large, sensitive ears. ('Listening for the insects' would not get a mark, as that is a behaviour not a feature.) (1 mark)
 - Long, pointed middle finger. (1 mark)
 - Sharp claws. (1 mark)
 - Bushy tail. (1 mark)
- Statements B and C are correct. (2 marks)

Environment, energy flow and nutrient transfer

Humans and the environment

- They might object to the conditions that battery chickens were kept in and so not want to buy the product. (1 mark)
 - Costs can be reduced because less land is needed (1 mark).
Less food is required because the chickens don't move around/use much energy (1 mark). (2 marks)
- The pesticide won't drift on the wind to other areas (1 mark).
Only organisms that eat the crop will get the pesticide/it won't kill harmless insects (1 mark). (2 marks)
 - It could remain in the plant and get into humans when they eat the crop. (1 mark)

Pollution indicators

- 3 km (or between 2–3 km) (1 mark). The number of rat-tailed maggots increases significantly at that point (1 mark). (2 marks)
 - Between 3–5 km from the original sample point. (1 mark)
 - The pollution will get dispersed in the water and so will be reduced (1 mark) and the lower level of pollution will mean that rat-tailed maggots will decline/have more competition (1 mark). (2 marks)
- Sulfur dioxide. (1 mark)
 - The sulfur builds up inside them. (1 mark)
 - Flat lichen. (1 mark)
 - Medium. (1 mark)

Types of pollution

- 7 a) i)** The water plants (a total of 11 dots). (1 mark)
- ii)** The carnivorous birds (they have 6 dots in a small total mass). (1 mark)
- b)** 500 kg (the amount of carnivorous fish is half that of the herbivorous fish). (1 mark)
- c)** Any two from: build up/bioaccumulation; the pests may build up a resistance to the insecticide; the biodiversity in the environment will decrease. (2 marks)

8 Indicative content:

- The fertiliser will stimulate the growth of algae/microscopic plants.
- These organisms are short-lived and so will soon die.
- Bacteria will feed on the dead algae in large numbers and their respiration will reduce the oxygen level in the water.
- The lack of oxygen will kill the fish.

(Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)

Food chains and food webs

- 9 a)** Energy flow. ('Feeding' or 'eating' would also get a mark.) (1 mark)
- b) i)** The producer is the green plant (1 mark). Its source of energy is the Sun (1 mark). (2 marks)
- ii)** Either the shrew or the fox (1 mark), because each of these eats another animal (or 'meat') (1 mark) (2 marks)
- c) i)** Any one from: heat/waste materials/parts not eaten/repair and maintenance of cells. (1 mark)
- ii)** C. (1 mark)
- 10 a)** Decrease (1 mark), because there are fewer frogs to eat (1 mark). (2 marks)
- b)** Increase (1 mark), because there will be less competition for food from frogs (1 mark). (2 marks)
- c)** Increase (1 mark), because of an increase in the population of grasshoppers, which they eat (1 mark). (2 marks)

Ecological pyramids

- 11 a)** Lettuce. (1 mark)
- b)** Greenfly: 30. Ladybird: 14. Blue tit: 8. (Must get all correct for mark.) (1 mark)
- c)** Any one from: waste/excretion/egestion/repair of cells/maintenance of cells/heat/respiration/movement. (Not: growth/death/decay.) (1 mark)
- 12 a)** 1 – C, 2 – A, 3 – B. (3 marks)
- b)** Sketch should show widths of blocks getting smaller as they go up (1 mark). Explanation: a small number of large producers will still have a greater mass than the larger number of smaller first consumers (or words to that effect) (1 mark). (2 marks)

Decay and the carbon cycle

- 13 a) i)** Any two from: leaves, grass, twigs. (2 marks)
ii) Compost. (1 mark)
iii) To improve the soil (fertiliser is not accepted). (1 mark)
- b) i)** Bacteria/fungi. (Not 'mould'). (1 mark)
ii) Oxygen. (1 mark)
- 14 a)** A – respiration; B – photosynthesis; C – feeding/eating; D – (death and) decay (death alone is not accepted). (4 marks)
- b)** Burning fossil fuels/burning **named** fossil fuel. (1 mark)

The nitrogen cycle

- 15 a)** M – excretion; N – feeding/eating; K – decay/decomposition. (3 marks)
- b)** L – urea; X – urease. (2 marks)

16 Indicative content:

- The nodules in the roots of the clover make nitrates.
- The nitrates are absorbed by the roots of the grass.
- The nitrates provide nitrogen which is used for growth.
- The grass therefore grows longer.

(Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)

- 17 a)** There was not a high enough concentration of urea to allow the rate to increase/they did not control the urea concentration. (1 mark)
- b)** The enzyme (and therefore the experiment) works faster at 40°C than at room temperature. (1 mark)

Inheritance

Chromosomes, genes and DNA

- 18** The characteristics of living organisms are controlled by structures called genes, which are found in long chains called chromosomes inside the cell's nucleus. These structures are made of a chemical called DNA, which contains a code which controls the manufacture of proteins by the cell.
 (1 mark for each correct word) (5 marks)
- 19 a) i)** The missing amino acid is a circle. (1 mark)
ii) The missing piece of code is AAT. (1 mark)
- b)** The protein would have a different sequence of amino acids. ('It would be different' or 'a different protein would be formed' are not acceptable – mention must be made of amino acids.) (1 mark)
- 20 a) i)** A gene is a section of DNA which controls a particular feature of an organism. An allele is a particular type/form of a gene. (1 mark)

- ii) A chromosome is a string of genes/length of DNA. A nucleus is the organelle in which chromosomes are found. (1 mark)
- b) A. All the others are correct statements, but do not describe a **function**. (1 mark)

DNA analysis

- 21 a) Reference to ownership of DNA/worries about insurance companies/employers having access/invasion of privacy/infringement of human rights. (Not: reference to fear of being convicted of an offence/arrested later/stealing records.) (1 mark)
- b) Allows police to identify people/suspects (on the database) who have committed a crime/identify a dead body. (Not: solve crimes/catch or track down criminals.) (1 mark)
- 22 a) Craig (1 mark). His DNA profile is identical to the one found at the scene of the crime (1 mark). (2 marks)
- b) Craig and Ashley are related (1 mark). Their DNA profiles are similar (1 mark). This would occur because relatives share a proportion of their genes (1 mark). (3 marks)
- c) Only very small samples of DNA are required (1 mark). It is harder for criminals to avoid leaving DNA at the scene than avoid leaving fingerprints/DNA is more likely to be found than fingerprints (1 mark). (2 marks)

Gamete formation

- 23 a) i) 46. (1 mark)
- ii) 23. (1 mark)
- b) Egg cell/ovum ('female' not accepted). (1 mark)
- c) Reference to gametes producing correct number of chromosomes in fertilised egg/need 23 in egg and 23 in sperm to get 46 in embryo. (Would also accept reference to meiosis allowing variation to occur.) (1 mark)
- 24 a) **Indicative content:**
- Males have X and Y chromosomes/different types of sex chromosome.
 - Females have two X chromosomes/all the same type of sex chromosome.
 - Half of sperm will carry X chromosome, half Y.
 - All the egg cells/ova will carry an X chromosome.
 - The gender of the baby will depend on which type of sperm fertilises the egg.
- (Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)
- b) i) Half of sperm cells contain X chromosomes and half have Y chromosomes (1 mark). These types of sperm have an equal chance of fertilising an egg (1 mark). There is a 50:50 chance of getting a boy or a girl (1 mark). (3 marks)

- ii) The difference is just due to chance/is not significant (1 mark).

The examiner would also accept any *reasonable* suggestion, e.g. female babies are more prone to miscarriage; male sperm are 'healthier' and better able to survive the journey through the female reproductive system. (It is irrelevant whether the suggestion is true, as long as the idea is reasonable)

(1 mark).

(1 mark)

Mendel and inheritance

- 25 a) Purple parent = RR (1 mark); white parent = rr (1 mark). Note that the purple parent cannot be Rr, because all the offspring are purple. If it was Rr, half would be white. (This exam question does not use the usual convention for choosing genotype letters. As purple is dominant, you might expect P and p to be chosen.) (2 marks)

b)

Gametes	R	R
r	Rr	Rr
r	Rr	Rr

All four gametes correct (1 mark); correct combinations in boxes (1 mark).

(2 marks)

26

Gametes	R	r
r	Rr	rr
r	Rr	rr

All four gametes correct (1 mark); correct combinations in boxes (1 mark).

(2 marks)

- 27 B – DNA and genes hadn't been discovered.

(1 mark)

Genetic engineering

- 28 a) Transfer of genes/DNA from one species/type of organism to another. (1 mark)

- b) **Example:** herbicide/weed killer/pesticide resistant (gene) in soya; disease resistance in potatoes; tomatoes remaining fresher longer; or any other correct example (1 mark).

Advantage: when the crop is sprayed with herbicide, the soya is unaffected/reference to increased yield/financial advantage/advantage to the environment/oil seed rape modified to produce fish oils (1 mark).

(2 marks)

- c) Any one from: concerns about health/creating a pest species/genes escaping to create weeds/superweeds (that cannot be controlled)/the long-term effects are not known/genes escaping into the wild or organic crop population (by cross-pollination) or words to that effect (not just genes 'escaping'). Answers relating to religion/God or answers like, 'it is against nature' are not accepted. (1 mark)

(1 mark)

- 29 a) Spray/treat (the plant) with herbicide and it survives (the genes have been successfully introduced)/plant will not be affected by herbicide.

(1 mark)

- b) Be able to provide sufficient fish oil to supply global demand and conserve fish stocks, or words to that effect. (1 mark)
- c) Ethical reasons/might create organisms that we have no control over/morally wrong/genes could spread to other species/long-term effects unknown/could create herbicide resistant weeds/concern over eating GM produce. (Not: playing God/cross contamination/spread to other organisms.) (1 mark)

Variation and evolution

Variation

- 30 a) $174 - 152 = 22$ cm. For the mark, the height of the tallest and shortest person must be correctly identified, and the answer must be correct, with units. (1 mark)
- b) i) The people were all female/same age. (1 mark)
- ii) They could test more people/have a larger sample size. (1 mark)
- c) Height. (1 mark)
- d) Variation results from sexual reproduction when two parents produce offspring which have different genes. The environment can also cause variation. (1 mark for each correct word) (3 marks)

Genetic disorders and gene therapy

- 31 a) Llinos – Nn (1 mark); Rhydian – Nn (1 mark). (2 marks)
- b) nn. (1 mark)
- c) NN or Nn. (2 marks)
- 32 Only rich countries/people may benefit from the research (1 mark). It might allow people to alter their babies to a specific design (or words to that effect) (1 mark). Any other reasonable alternative can be awarded a mark, but no credit will be awarded for answers referring to 'playing God' or similar. (2 marks)

Evolution and natural selection

- 33 a) Any five from: variation in colour/pattern results from mutation/change in genes/DNA; natural selection by predation/survival of the fittest; and sexual selection/females select most colourful males to breed with; most colourful males survive/are at an advantage; to pass on genes. (5 marks)
- b) i) Evolution (not 'survival of the fittest'). (1 mark)
- ii) (Charles) Darwin. (1 mark)

34 Indicative content:

- The length of the neck will vary in a giraffe population.
- The longer neck will be an advantage as it means they can access more food.
- Not all the babies that giraffes have will survive.
- There is competition for survival.

- If food is in short supply, the giraffes with the longer necks will have a greater chance of survival.
- They will then breed and pass on their 'long-neck' gene.
- The next generation will have a higher proportion of giraffes with longer necks.

(Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)

Response and regulation

Sensitivity in plants and animals

35 a)

Body organ	Stimulus	Sense
eye	light	(sight)
tongue	(chemical)	taste
(ear)	sound	hearing

(1 mark for each completely correct **row**) (3 marks)

- b) Sense organs are groups of receptor cells. They respond to stimuli and relay information as electrical signals called nerve impulses to the brain.

(1 mark for each correct word) (5 marks)

- 36 a) A is correct. Although the message is probably relayed by a chemical, this is not conclusively proved by the experiment, so B is not justified. Conclusion C is incorrect because plant C was damaged but still showed a response. D is incorrect because the tip was present in plant D but no bending occurred. (1 mark)

- b) The evidence comes from plant C. Even though the stem has been cut through (which would have cut any structure connecting the tip to the stem) (1 mark), bending still occurred (1 mark). (2 marks)

- c) Gravitropism (accept negative gravitropism, though the question is general and not about stems). (1 mark)

Homeostasis and hormones

- 37 The human body has processes which keep key factors inside it relatively constant. One of these factors is blood sugar level. Control is carried out by hormones. These are chemical messengers which are carried in the blood to many organs.

(1 mark for each correct word) (5 marks)

- 38 a) The pattern for the insulin is the same as for the blood glucose (1 mark) but with a slight delay (1 mark). The marks are awarded for the ideas of the similar patterns and the delay, although these ideas may be expressed in different ways. (2 marks)

- b) Negative feedback involves a rise in a factor causing events which result in the factor being lowered again (or reverse). (1 mark)

- c) The rise in blood sugar causes the production of insulin, as shown by the slightly later raised level of insulin (1 mark). The insulin lowers the blood sugar levels, as is shown by the fall in the blood sugar level as insulin levels rise (1 mark). (2 marks)

Glucose control and diabetes

- 39 a) Pancreas. (1 mark)
- b) Converts (excess) glucose into glycogen/turns it into glycogen/makes it into glycogen. (Spelling of glycogen must be correct.) (1 mark)
- c) Liver. (1 mark)
- 40 a) i) Owen injected too little insulin before the evening meal/forgot to inject/hasn't taken enough insulin/eaten more sugar than usual/meal he has eaten is high in sugar, carbohydrates, starch, or fruit/(the evening meal) contained too much sugar or carbohydrate. (Not: high energy meal.) (1 mark)
- ii) He (injected) too much insulin (before the midday meal)/didn't eat at midday, lunch time or dinner/ate too little carbohydrate at midday, lunch time or dinner/exercised (in the afternoon) (without a snack). (Not: didn't eat/missed a meal.) (1 mark)
- b) If his blood sugar is too low at bedtime it could fall below 4.0 mmol/l during the night/he could 'hypo' at night. To prevent blood sugar level going too low/high. To make sure the level is safe/high enough. (Not: reference to level increasing/to see if insulin needs to be taken.) (1 mark)

The skin and temperature control

- 41 a) A – hair; B – muscle; C – sweat gland; D – blood capillary. (4 marks)

b)

Structure	How heat loss is reduced
Hair	Stands up
Blood capillary	Becomes narrower (constricts)
Sweat gland	Does not produce sweat

(3 marks)

- c) It generates heat. (1 mark)

42 Indicative content:

- When the feathers are raised, air is trapped between them.
- Air is an insulator so this insulates the skin.
- This reduces heat transfer and so stops the birds losing heat, which avoids the body temperature dropping in winter.
- Reducing the air layer by keeping feathers flat in the summer has the reverse effect of allowing more heat loss from the body and so cools them down.

(Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)

Health

Food, energy and health

- 43 a)** Starting temperature of the water (1 mark) and end temperature after the food has burnt away (1 mark). (2 marks)
- b)** The mass of the foods. (1 mark)
- 44 a) i)** $1315 - 1045 = 270$ kJ. (1 mark)
- ii)** $1315 \times 2 = 2630$ kJ. (1 mark)
- b) i)** Fat. (1 mark)
- ii)** Skimmed. (1 mark)
- c)** High level of calcium (which strengthens teeth) (1 mark).
Less sugar (sugar causes tooth decay) (1 mark). (2 marks)

Lifestyle and health

- 45 a)** Fat (not 'high fat diet'). (1 mark)
- b)** Eat less high energy food/do not eat excess food (1 mark)
(not: eat more low energy foods/don't eat too much/eat less fat or calories). Eat less salt/do not add (excess) salt to food (1 mark) (not: eat no salt). (2 marks)
- c)** Any two from kidney/liver/stomach (organ only, not 'cirrhosis of liver'). (1 mark)
- 46 a)** 100 mg/cm^3 (must have units). (1 mark)
- b)** 3 hours. (1 mark)
- c)** C. (1 mark)

Treatment of disease

- 47 a) i)** Testing new drugs. (1 mark)
- ii)** Any two from: AIDS, kidney failure, strokes. (1 mark)
- iii)** The tests cause monkeys distress/the tests could be done using tissue cultures or computers. (1 mark)
- iv)** Tissue cultures and using computers. (1 mark)
- b)** Monkeys are closely related to humans. (1 mark)
- c)** There should be fewer tests on monkeys. (1 mark)

Chemistry

Elements, the Periodic Table and compounds

Atoms, elements and the Periodic Table

- 1 a) A – electron; B – nucleus. (2 marks)
 b) Ne. (1 mark)
- 2 a) He did not know the identity of the elements/the elements had not yet been discovered. (1 mark)
 b) Any **two** of copper/silver/hydrogen. (1 mark)
 c) By increasing atomic number. (1 mark)

Distinguishing metals and non-metals

- 3 a) Ductile. (No mark for silvery-white – this is not necessarily 'shiny', or high boiling point – 688°C is not really a high boiling point.) (1 mark)
 b) Low melting point; and very soft. (2 marks)
 c) Any one from: good conductor of heat; good conductor of electricity; dense; shiny; malleable. (1 mark)
- 4 a) Between –110 and –125°C. (1 mark)
 b) Fluorine (1 mark) and chlorine (1 mark), because their boiling points are below room temperature (1 mark). (3 marks)

Compounds

- 5 a) A. (1 mark)
 b) i)  (1 mark)
 ii)  (1 mark)
- 6 a) 1. (1 mark)
 b) 6. (1 mark)
- 7 a) i) C. (1 mark)
 ii) B. (1 mark)
 iii) F. (1 mark)
 b) H₂O. (1 mark)
- 8 A and D. (2 marks)

Ionic bonding

- 9 a) i) Na⁺ and Cl⁻. (Must have charges, both needed for mark.) (1 mark)
 ii) NaCl. (1 mark)
 b) i) Sodium (Na). (1 mark)
 ii) Sodium chloride (NaCl). (1 mark)

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Compound	Formula	Metal ion present	Non-metal ion present
sodium chloride	NaCl	Na ⁺	Cl ⁻
potassium oxide	K ₂ O (1 mark)	K ⁺	O ²⁻
magnesium bromide	MgBr ₂	Mg ²⁺	Br ⁻
		(both needed for 1 mark)	
calcium iodide (1 mark)	CaI ₂ (1 mark)	Ca ²⁺	I ⁻

(4 marks)

11 D.

(1 mark)

12 $2\text{Na} + 1\text{F}_2 \rightarrow 2\text{NaF}$

(1 mark)

Metals and non-metals

Metals and ores

13 a) i) Aluminium before iron (1 mark); iron before copper (1 mark). (2 marks)

ii) A substance loses oxygen (or gains electrons). (1 mark)

b) i) A is zinc sulfate. (1 mark)

ii) B is copper. (1 mark)

14 Show that magnesium ribbon displaces metal X from solution of its nitrate (1 mark). Show that metal X displaces iron from solution of iron nitrate (1 mark). Metal X displaces less reactive metal from solution of its nitrate/salts (1 mark). (The final mark will only be awarded if you have coherently linked the conclusion to the point above.) Therefore X must be less reactive than magnesium but more reactive than iron (1 mark). (4 marks)

Properties and uses of metals and nano-scale particles

15 a) Chromium. (1 mark)

b) Contains more carbon. (1 mark)

c) Mild (steel). (1 mark)

d) Doesn't corrode/rust. (1 mark)

16 a) 1–100 nm (units required). (1 mark)

b) Nano-particles have very different properties from the same substance in a bigger form. (1 mark)

c) Could be absorbed (into blood) through the skin (1 mark), long-term effect **unknown** (must imply uncertainty for second mark). (2 marks)

Hydrogen and oxygen

- 17 a) A – nitrogen; B – oxygen; C – argon/neon. (1 mark)
b) Fractional distillation. (1 mark)
- 18 a) Each water molecule is made of two hydrogen atoms and one oxygen atom. (1 mark)
b) Use a lighted splint or flame **and** hear a 'squeaky pop' or small explosion (both points needed). (1 mark)
c) **Indicative content:**
- A description/explanation of advantages and disadvantages of hydrogen gas as fuel for cars, based on the table which appears in the question, e.g. forms water vapour on burning so does not contribute to global warming, electricity required to produce hydrogen must be generated somehow.
 - A complete response will include explanation of at least **two** advantages and **two** disadvantages.
(Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)

The halogens and the noble gases

- 19 a) Implication that similar results are observed for large numbers/significant majority of people **or** results could be purely chance if only small numbers of people complete the survey. (1 mark)
b) There would be no bias, e.g. the consumer group would not gain or lose anything depending on the result of the survey. (1 mark)
c) A high concentration/large amount of fluoride is toxic/can cause fluorosis/bone cancer **or** it is unethical to force all to take fluoride when it can be obtained from toothpaste. (1 mark)
- 20 a) i) Gas. (1 mark)
ii) Liquid. (1 mark)
b) i) Poor conductors (of electricity). (1 mark)
ii) Increases. (1 mark)
c) It destroys bacteria/kills germs. (1 mark)

Reactions of acids

Acids and alkalis

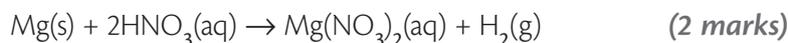
- 21 a) i) 30 (seconds) (must be exact). (1 mark)
ii) 45 (°C) (must be exact). (1 mark)
b) Any one of: measurements taken at exactly the correct time; measurements will be precise; there will be no **random** errors/measurements will be more accurate than those made with a standard thermometer; results can be plotted as the reaction occurs. (1 mark)

- c) i) Bubbles form/gas is produced (1 mark), magnesium disappears (1 mark). (2 marks)
 ii) Green. (1 mark)

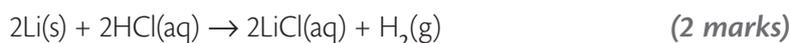
22 1 mark for each correct word equation.

2 marks for the balanced symbol equation (1 mark for correct formulae of compounds and 1 for correct balancing).

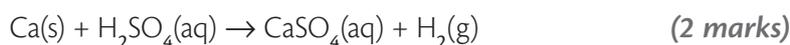
- a) magnesium + nitric acid → magnesium nitrate + hydrogen (1 mark)



- b) lithium + hydrochloric acid → lithium chloride + hydrogen (1 mark)



- c) calcium + sulfuric acid → calcium sulfate + hydrogen (1 mark)



Neutralisation

- 23 a) To ensure that all the acid reacts/is neutralised/pH **changes/ rises to 7** (not 'to make alkaline' or reference to a pH **higher than 7**). (1 mark)
- b) i) Filtering. (1 mark)
 ii) Evaporating. (1 mark)
- c) i) Salt. (1 mark)
 ii) Elements are made of only **one type** of atom. Compounds are made of **more than one type** of atom. (1 mark)
- d) Sodium sulfate. (1 mark)

The production and uses of fuels and plastics

Crude oil and its uses

- 24 a) A – evaporation/boiling/vaporisation. B – condensation. (2 marks)
 b) It shows the temperature of the vapour/gas. (1 mark)
 c) Cools the vapour so that it condenses. (1 mark)
 d) Fractional distillation. (1 mark)
- 25 A (1 mark), because it lights easily and burns with a clean flame (1 mark).

Plastics and polymers

26 Indicative content:

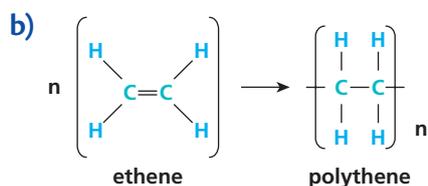
- Reference to useful properties of plastics, e.g. resistance to corrosion, insulating properties, and to those properties which are not desirable in this case, e.g. flexibility, low density.
- Reference to the fact that most waste plastic is currently disposed of in landfill sites or burnt/incinerated and the associated drawbacks.

- Reference to benefits of using waste plastic, e.g. reduced amounts disposed of in landfill sites, reserves of other resources, e.g. timber and sand, are depleted less quickly/available for other uses.

(Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)

27 a) i) C_8H_{18} . (1 mark)

ii) Heat/high pressure/catalyst. (1 mark)



(1 mark for correct formula; 1 mark for presence of 'n') (2 marks)

c) There is a C=C double bond. (1 mark)

The ever-changing Earth

Plate tectonics

28 a) Similar fossils/rocks on different continents **or** continents/coastlines fitted together like a jigsaw. (1 mark)

b) He could not explain how the continents moved. (1 mark)

29 a) It shows that new rock must have been formed at the volcanic ridge (1 mark) and that the older rock had been moved away from the ridge (1 mark). (Or words to that effect.) (2 marks)

b) The theory of plate tectonics/the plate tectonic theory. (1 mark)

Earthquakes and volcanoes

30 a) Any two from: a gap is formed; magma rises or pushes through the mantle; magma cools/solidifies to form new rock/crust; an ocean ridge/volcano is formed. (2 marks)

b) The oceanic plate sinks below the continental plate (1 mark) because the oceanic plate is denser (1 mark). (2 marks)

31 a) The volcanoes are aligned/in a line (1 mark) because they are on the boundary of a tectonic plate (1 mark). (2 marks)

b) The citizens of Mexico City should be more worried (1 mark) because earthquakes happen at plate boundaries (1 mark) and the distribution of volcanoes (1 mark) suggests that there is a plate boundary near Mexico City (but not Monterrey) (1 mark). (4 marks)

Earth's atmosphere

32 a) Carbon dioxide and water vapour. (2 marks)

b) The atmosphere cooled (1 mark) and the water froze (1 mark). (2 marks)

c) Any two from: more carbon dioxide on Mars; less nitrogen on Mars; more argon on Mars; no oxygen on Mars. (2 marks)

- 33 a) i)** 14.26°C. (1 mark)
ii) The average global temperature has increased. (1 mark)
iii) About the same/not changed much/fairly constant. (1 mark)
b) Carbon dioxide. (1 mark)

Global warming and acid rain

- 34 a)** Before 1900 there was a gradual rise (1 mark), which got much steeper after 1900 (1 mark). (2 marks)
b) Increased amounts of fossil fuels burnt (1 mark); and deforestation (1 mark). (2 marks)
c) Raising it. (1 mark)
d) Global warming. (1 mark)
e) Melting of polar ice caps/disruption of weather patterns. (1 mark)

Physics

Generation and transmission of electricity

Generating electricity from fossil fuels and nuclear power

- 1 coal + oil + gas + nuclear = 31 + 1 + 46 + 13 = 91%. (1 mark)
- 2 Any three sensible points relating to:
- commissioning/decommissioning costs
 - energy source availability/cost/lifetime/sustainability
 - transport
 - environmental impact.
- (Maximum of 1 mark per bullet point) (3 marks)
- 3 a) Transport of fuel or waste. (1 mark)
- b) Access to water for cooling. (Not 'water needed for steam'.) (1 mark)
- 4 a) Any three reasoned points from:
- day to day safety
 - risk of terrorist attack
 - cost of decommissioning
 - problems with decommissioning the site
 - danger of explosion
 - danger from radioactive waste. (3 marks)
- b) Any three reasoned points from:
- dirty
 - effect of carbon dioxide
 - effect of sulfur dioxide
 - respiratory problems in the public nearby
 - transport of coal. (3 marks)

Micro-generation of electricity

- 5 a) Wind costs 5.4 p/kWh and nuclear costs 2.8 p/kWh. (At least one number used or the statement 'wind costs more per kWh/unit'.) (1 mark)
- b) Any reference to carbon footprints (1 mark); onshore wind lower footprint than nuclear/offshore wind higher than nuclear (1 mark). (Not reference to waste.) (2 marks)
- c) A nuclear power station produces much more power (1 mark); nuclear power stations have a longer lifetime (1 mark) (there must be a comparison for mark); nuclear will last longer (1 mark). (Not reference to price/cost.) (2 marks)

- 6 a) $\text{density} = \frac{\text{mass}}{\text{volume}}$
 re-arranged to give $\text{mass} = \text{density} \times \text{volume}$ (1 mark);
 insert numbers and calculate answer:
 $\text{mass} = 1000 \times 0.15 = 150 \text{ kg}$ (1 mark) (2 marks)
- b) $\text{Efficiency} = \frac{\text{output}}{\text{input}} \times 100$
 $\text{Efficiency} = \frac{48}{120} \times 100 = 40\%$ (1 mark)

The National Grid and transformers

- 7 a) i) Transformer. (1 mark)
 ii) Current. (1 mark)
 iii) Transformer. (1 mark)
- b) Any three from: B increases/steps up the voltage; so decreasing the current; cutting down heat/energy loss; D decreases/steps down the voltage to a safe level. (3 marks)
- c) Conversions:
 $100\,000\,000 \text{ W}$ and $400\,000 \text{ V}$ (1 mark)
 $= 100\,000 \text{ kW}$ and 400 kV
 re-arrange formula and substitute values:
 $\text{current} = \frac{\text{power}}{\text{voltage}}$
 $\text{current} = \frac{100\,000\,000}{400\,000}$ (1 mark)
 $\text{current} = 250 \text{ A}$. (1 mark)
 (If you do the sum $100/400 = 0.25 \text{ A}$ – only 1 mark.) (3 marks)
- 8 a) A. (1 mark)
 b) $132\,000 \text{ V}$. (1 mark)
 c) E. (1 mark)
 d) B. (1 mark)

Energy supply and energy transfer

Domestic energy

- 9 a) Cost of 1 unit = $100/5 = 20\text{p}$ (£0.2 accepted). (1 mark)
 b) Time = $5/2$ (1 mark) = 2.5 h (1 mark) (2 h 30 m accepted). (2 marks)
- 10 a) Cost per unit = cost/units used (1 mark); cost of 1 unit = $949.65/37\,986$ (1 mark) = £0.025 (2.5p) per kWh (1 mark). (3 marks)
- b) i) No. of units from panel = $36\,958 - 33\,446 = 3512$ (1 mark)
 ii) Money saved = $3512 \times 2.5\text{p} = £87.80$ (1 mark)
 iii) Payback time for solar panel = $2000/87.80$ (1 mark) = 22.78 years (1 mark) (2 marks)

- iv) Sunnier summers (increase output)/fuel prices could increase or higher use of heating = greater savings so shorter payback time! (1 mark)

Energy transfer and efficiency

- 11 a) Equation: % efficiency = (useful energy transfer/total energy input) \times 100 (1 mark).
Calculation: % efficiency = $400/1000 \times 100$ (1 mark) = 40% (1 mark). (3 marks)
- b) Wasted energy = 100 J (1 mark); useful energy = 900 J (1 mark). (2 marks)
- 12 Equation: % efficiency = (useful energy transfer/total energy input) \times 100 (1 mark).
Calculation: % efficiency = $2100/6000 \times 100$ (1 mark) = 35 % (1 mark). (3 marks)

Home heating

- 13 a) i) £100. (1 mark)
ii) £1600. (1 mark)
- b) £1000. (1 mark)
- c) Air cannot move/is trapped within the insulation (so no convection possible). (1 mark)
- 14 a) Heat is lost through the window by conduction (1 mark). The double glazed window has (trapped) air, which is a poor conductor (or good insulator) (1 mark). (2 marks)
- b) i) Line (reasonable curve) extrapolated to y-axis (1 mark) giving a reading of 106 W/m^2 (answer in range 106–108) (1 mark). (2 marks)
- ii) Above 20 mm, the rate of heat loss is about the same (1 mark); a larger air gap will increase the cost or size of window (1 mark). (2 marks)

The characteristics of waves

Describing waves

- 15 a) Frequency of 0.2 Hz used (i.e. reading from graph) (1 mark); wave speed = $40 \times 0.2 = 8 \text{ m/s}$ (1 mark). (2 marks)
- b) i) Time = distance/speed = $5600/8 = 700 \text{ s}$ (1 mark)
- ii) No mark is given for just 'before' or 'after'. The first mark is given for identifying a reasonable strategy. The second mark is given for correctly using the strategy to form a conclusion. For example, strategy of calculating speed using the graph (1 mark) leading to a lower speed (of 4 m/s) and hence it would take longer (1 mark). (2 marks)
- 16 a) 2.5. (1 mark)
- b) i) A and B. (1 mark)
ii) B and C. (1 mark)
- c) Average wavelength = $240/8 = 30 \text{ cm}$. (1 mark)

17 Wave speed = frequency \times wavelength, $c = f\lambda$ (1 mark)

re-arranged: wavelength = wave speed/frequency

$$\lambda = c/f = 3 \times 10^8 / 5 \times 10^{14} \text{ (1 mark)}$$

$$= 0.6 \times 10^{-6} \text{ m (1 mark).}$$

(3 marks)

The electromagnetic spectrum

18 a) i) Radio waves. (1 mark)

ii) Ultraviolet waves. (1 mark)

b) i) Infrared (accept radio or microwave). (1 mark)

ii) Microwave. (1 mark)

c) i) Any one from: ultraviolet (or UV)/X-rays/gamma rays. (1 mark)

ii) Burns. (1 mark)

19 a) $3727 - 2727 = 1000^\circ\text{C}$. (1 mark)

b) As the temperature increases, the wavelength of the maximum decreases (1 mark), and the intensity of the maximum increases (1 mark). (2 marks)

c) The surface of the Sun emits a range of different parts of the EM spectrum from UV through visible light to infrared (1 mark). The peak intensity of radiation is emitted in the visible part of the spectrum (1 mark). The intensity of the radiation drops into the UV region **and** into the IR region (1 mark). (3 marks)

The greenhouse effect

20 Radiation absorbed by the ground is visible light (1 mark); radiation emitted by the ground is infrared (1 mark). **Or** the emitted radiation has a longer wavelength (2 marks). (2 marks)

21 The under-surface of the plastic covering acts as a mirror reflecting the radiation back into the biome. (1 mark)

22 a) The transparent plastic. (1 mark)

b) The reflection in the atmosphere is carried out by greenhouse gases (such as carbon dioxide, methane and water vapour). (1 mark)

23 Water vapour is a greenhouse gas (1 mark) so it will reflect some of the radiation from the ground back into the biome (1 mark). (2 marks)

24 Indicative content:

- Increasing global warming leading to higher surface temperatures will cause polar ice-caps to melt. This will result in an increase in sea-level causing widespread population displacement (refugees).
- Crop failures, resulting in widespread food shortages and famine.
- Deforestation, resulting in increased levels of carbon dioxide in the atmosphere, leading to further global warming.

(Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)

Communications

- 25 a)** 24 hours (or 1 day). (1 mark)
- b)** Signal goes from A to satellite and back to B – line from A–satellite–B. (1 mark)
- c)** Microwaves. (1 mark)
- 26 a)** Microwaves. (1 mark)
- b)** Radio. (1 mark)
- c)** Infrared. (1 mark)
- 27 a)** Time = distance/speed (1 mark)
 convert km to m: $3.6 \times 10^4 \times 1000 = 3.6 \times 10^7$ (1 mark)
 time = $3.6 \times 10^7 / 3 \times 10^8 = 0.12$ s (1 mark)
 but there and back = $0.12 \times 2 = 0.24$ s (1 mark) (4 marks)
- b) i)** Distance is very much shorter. (1 mark)
- ii)** Any two from: less interference; less energy loss; less costly than satellite in orbit. (Will also accept: multiple signal channels/more information; comparisons with copper conductors e.g. security/interference/boosting distance/easier to maintain.) (2 marks)

Ionising radiation

Ionising radiation

- 28 a) i)** $(1000 - 200 =) 800$ counts per minute. (1 mark)
- ii)** Gamma. (1 mark)
- b) i)** 900. (1 mark)
- ii)** One mark is given for a correct relevant statement, e.g. (3 mm of) aluminium blocks alpha and beta radiation but has no (or very little) effect on gamma radiation (1 mark). The second mark will only be awarded if you correctly and coherently link a second point to the first, e.g. so the radiation which penetrates the aluminium is the gamma radiation (1 mark). (2 marks)
- c) Indicative content:**
- Background radiation is (radiation) from the environment in the absence of the source under investigation.
 - Its sources include cosmic rays, which originate in space, radon, rocks and other materials in our environment.
 - To investigate the quantity of radiation received from a given source the contribution from background radiation needs to be subtracted – this is ‘corrected for background’ (leaving only the radiation from the source).

(Refer to the QWC mark scheme on page 110 of the Revision Guide to see how this question would be marked.)

The Solar System and the evolving Universe

The scale of the Universe

- 29 a) i)** Jupiter. (1 mark)
- ii)** Uranus. (1 mark)
- b)** Any two from: Mars is rocky but Neptune is made of gas/ice; Mars is hotter; Mars is faster (in orbit)/has a smaller orbit. (Planets must be named for any marks.) (2 marks)
- 30 a) i)** Time given must be in range 3 to 9 (years) **and** temperature given must be in range -40°C to -100°C . (1 mark)
- ii)** The first mark is given for correct identification of the position of Ceres in relation to Mars and Jupiter, e.g. the distance to the Sun is between that of Mars and Jupiter (or equivalent)/between 228 and 778 million km (1 mark). The second mark is only given if the candidate correctly and coherently links the figures for orbit time and/or temperature to this, e.g. so the figures for orbit time and/or temperature are between those for Mars and Jupiter (or equivalent in figures) (1 mark). (2 marks)
- b) i)** Points plotted correctly to scales $\pm\frac{1}{2}$ square (2 marks); smooth curve between the points (1 mark). (3 marks)
- ii)** It is not straight/it's a curve. (1 mark)
- iii)** No – there is no pattern. (1 mark)

Measuring the Universe and the Big Bang

- 31 a)** One mark is given for a correct and relevant statement, e.g. light from Sun/star passes through atmosphere of Sun/star (1 mark). The second mark is only given if you correctly and coherently link a second point to the first, e.g. atoms of the gas in the atmosphere absorb light at specific wavelengths (1 mark). (2 marks)
- b)** Galaxy 2 is further away than galaxy 1 (1 mark). The second mark is given for a correct relevant statement, e.g. the Universe has expanded since the light was sent out (so the waves are 'stretched') or equivalent statement in terms of Doppler shift (1 mark). The final mark is only given if you correctly and coherently link a third point to the second, e.g. light from galaxy 2 is red-shifted more than that from galaxy 1 (1 mark). (3 marks)

32 a)

Element	Wavelengths (nm)	Present in the star?
Helium	447, 502	Y
Iron	431, 467, 496, 527	N
Hydrogen	410, 434, 486, 656	Y
Sodium	590	Y

(1 mark)

- b) The wavelengths of the lines would be greater/the position of the lines would be shifted towards the long-wavelength end of the spectrum (or red shifted/shifted to right/shifted to red) (1 mark); because distant galaxies are moving away (from us)/because of the expansion of the Universe/space (1 mark). (2 marks)