AQA

GCSE
BIOLOGY
8461/1H

Paper 1 Higher Tier

Mark scheme
June 2019

Version: 1.0 Final

196G84611H/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, i.e. if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	controls the (activities of the) cell	allow contains genetic information / genes / DNA / chromosomes do **not** accept brain do **not** accept controls substances entering / leaving the cell	1	4.1.1.2 AO1
01.2	red blood cell / RBC **or** bacteria / prokaryote **or** xylem (cell)	allow erythrocyte ignore blood cell unqualified ignore platelets allow named examples of bacteria do **not** accept virus	1	4.2.2.3 4.1.1.1 AO1
01.3	cell shape is similar to cell in **Figure 1 and** nucleus present any **two** features correctly identified and labelled: • nucleus • (cell) membrane • cytoplasm • mitochondria / mitochondrion • ribosome(s)	ignore shading do **not** accept a cell wall drawn allow cell wall if drawn and correctly labelled do **not** accept other plant sub-cellular structures	1 1	4.1.1.2 AO2 8.2.1 AO1
01.4	any **one** from: • (cellulose cell) wall • chloroplast • (permanent) vacuole	ignore chlorophyll allow starch grain	1	4.1.1.2 AO1

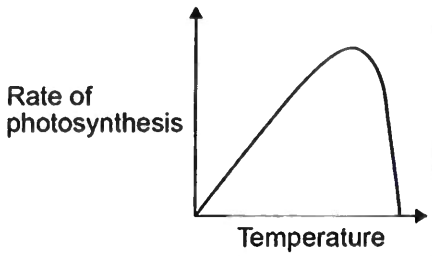
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5		an answer of (×) 400 scores **3** marks an answer of (×) 40 scores **2** marks		4.1.1.5 AO2
	24 (mm) **or** 2.4 (cm)	allow in range 23 to 25 (mm) **or** in range 2.3 to 2.5 (cm)	1	
	$\frac{24}{0.06}$ **or** $\frac{2.4}{0.06}$	allow correct calculation from their measurement of **X** to **Y** in the range 2.3 cm to 3.5 cm **or** 23 mm to 35 mm	1	
	(×) 400	allow correct magnification derived from their measurement in **mm** ignore rounding errors	1	
01.6	high(er) magnification high(er) resolution **or** high(er) resolving power	ignore bigger / zoom allow see more detail if neither mark awarded allow **1** mark for see smaller objects **or** see smaller sub-cellular structures allow 3D image	1 1	4.1.1.5 AO1
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	a protist		1	4.3.1.5 AO1
02.2	lower percentage of people with malaria when using (mosquito) nets	allow converse if clearly describing people who do not use (mosquito) nets allow fewer people with malaria when using (mosquito) nets allow **only** 1.2% of people with malaria when using (mosquito) nets ignore reference to data from table unqualified do **not** accept incorrectly calculated figures	1	4.3.1.5 AO3
02.3	any **one** from: • some people who use (mosquito) nets have malaria • data from only one area / part of Africa • size of group too small **or** sample size too small **or** only 476 people • only 50 people did not use (mosquito) nets **or** uneven group sizes (nets vs. no nets) • no other information about people considered • people may have lied about using (mosquito) nets	allow people can get malaria when they are not sleeping allow correlation does not imply causation allow examples of information not considered e.g. age, other medical issues such as sickle cell, whether taking anti-malarial medication, vaccination ignore ref to other factors unqualified	1	4.3.1.5 AO3
02.4	any value between 88 – 91	allow decimal values	1	4.3.1.5 AO2

Question	Answers	Extra information	Mark	AO / Spec.. Ref
02.5	any **one** from: • improved health care	allow examples of improved health care such as **more / cheaper / new** treatments / vaccinations / antibiotics	1	4.2.2.5 4.3.1.5 AO2
	• use of mosquito control methods	allow descriptions such as spraying of insecticides / repellent **or** draining water holes **or** preventing mosquitoes from breeding		
	• changing behaviour to avoid being bitten (by mosquitoes)	allow descriptions such as wear long clothing **or** avoid going out at dusk		

Question	Answers	Mark	AO / Spec. Ref.
02.6	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.	4–6	4.3.1.6 4.3.1.7 AO1
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.	1–3	
	No relevant content	0	
	Indicative content ***prevents pathogens from entering*** **skin** • tough / dry / dead outer layer • skin acts as a barrier • sebum / oil on (surface of) skin • sebum / oil repels pathogens • scabs form over cuts **or** scabs form a barrier • platelets are involved in forming clots / scab **stomach** • contains (hydrochloric) acid • (HCl) kills bacteria • in food **or** in swallowed mucus **eyes** • produce tears • contains enzymes to kill bacteria • tears are antiseptic **breathing system** • trachea / bronchi / nose produce mucus • mucus is sticky • (mucus) traps bacteria • (mucus) carried away by cilia ***defends itself against pathogens inside the body*** • immune system / white blood cells (WBCs) • WBCs engulf pathogens • antitoxins are produced • (antitoxins) neutralise toxins / poisons (produced by pathogen) • antibodies are produced • (antibodies) help destroy pathogens • memory cells (are formed) • (memory cells give a) more rapid response if pathogen re-enters a **level 2** response should refer to body defence **and** the immune system		
Total		**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	LHS: carbon dioxide **and** water RHS: glucose	words take precedence over symbols allow correct symbols (ignore balancing) in any order do **not** accept starch ignore carbohydrates / sugar	1 1	4.4.1.1 AO1
03.2	power output of bulb		1	4.4.1.2 AO2
03.3	any **two** from: • repeat **and** calculate a mean **or** repeat **and** to eliminate anomalies • control the (water) temperature • control the concentration of carbon dioxide • control the distance of the bulb from the pondweed • control the mass / length / species / age of the pondweed • give pondweed time to equilibrate	ignore do a control experiment unqualified allow a method of controlling (water) temperature allow a method of controlling carbon dioxide concentration allow use the same piece of pondweed allow do experiment with the bulb off / in the dark	2	4.4.1.2 AO3
03.4	3.3 (cm^3/hour)		1	4.4.1.2 AO2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	correct scale **and** axis labelled	max **3** marks for bar chart	1	4.4.1.2 AO2
	all points plotted correctly	allow points plotted to within ± ½ small square allow 3 or 4 correct plots for **1** mark allow correct plot from incorrect value calculated in question **03.4**	2	
	correct curved line of best fit	ignore line extended beyond 60 / 250 (W) ignore line joined point to point with straight lines	1	
03.6	correct answer from their line drawn on **Figure 4**	allow ± ½ small square tolerance allow 1.8 / 1.9 if no line of best fit or incorrect graph is drawn	1	4.4.1.2 AO2
03.7			1	4.4.1.2 AO2
Total			**12**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(by the guard cells) opening **and** closing the stomata	ignore ref to guard cells being plasmolysed / turgid	1	4.2.3.2 AO1
04.2	(water is) transported in xylem	ignore mechanism of water entering the roots do **not** accept translocation	1	4.2.3.2 AO1
	water evaporates (from leaves)	allow loss of water vapour	1	
	through the stomata	allow between the guard cells	1	
		if no other marks awarded allow **1** mark for reference to transpiration		
04.3	any **one** from: • plant **A** has more stomata	allow converse for plant **B** allow (the plants) have different numbers of stomata	1	4.2.3.2 AO2
	• plant **A** has more leaves	allow (the plants) have different numbers of leaves		
	• plant **A** has bigger leaves	allow (the plants) have different sized leaves		
	• plant **A** has a greater total surface area of leaves	allow (the plants) have different total surface area of leaves allow plant **A** has less (waxy) cuticle **or** (the plants) have different amounts of (waxy) cuticle allow plant **A** has fewer hairs on leaves **or** (the plants) have different number of hairs on the leaves		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4		an answer of 10 scores **3** marks		4.2.3.2 AO2
	5.2	allow in range 4.8 to 5.6	1	
	(5.2 × 2 =) 10.4 **or** $\left(\frac{5.2}{0.5} =\right) 10.4$	allow their calculated value in the range 8.8 to 12.0	1	
	10 (cm^3/hour)	allow their calculated value in the range 8.8 to 12.0 correct to 2 significant figures	1	
04.5	(rate increased because) any **two** from: • (it was) warmer • light intensity was higher • (it was) less humid • (it was) windier	answers must be comparative allow greater water vapour gradient between leaves and environment	2	4.2.3.2 AO3
Total			**10**	

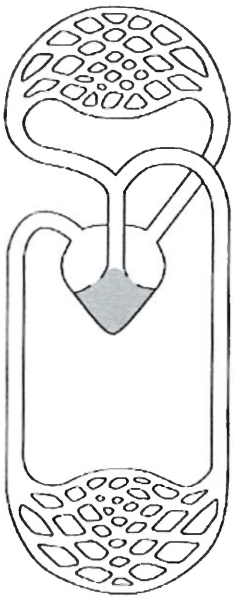
Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	**Level 2:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.		3–4	4.2.2.4 4.2.2.2 4.1.3.1 AO2
	Level 1: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.		1–2	
	No relevant content		0	
	Indicative content: • backflow can occur **or** some blood flows backwards • less blood leaves the heart **or** less blood is pumped around the body **or** some blood stays in the heart (instead of being pumped out) **or** reduced blood pressure **or** reduced flow rate • less oxygen supplied to muscles / cells • (so) less aerobic respiration • (so) less energy released • (so) less (efficient) muscle contraction • anaerobic respiration takes place • less (efficient) removal of lactic acid **or** lactic acid builds up **or** oxygen debt occurs • (lactic acid building up) causes muscle fatigue • less (efficient) removal of carbon dioxide (from blood) a **level 2** response should refer to both respiration **and** the effects on exercise			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2		ignore raw numbers from **Table 4**		4.2.2.4 AO3
	(deaths mechanical valve =) 6% / 6.31136%	allow correctly rounded value	1	
	(deaths biological valve =) 10% / 10.14823%	allow correctly rounded value	1	
	(therefore a) higher proportion / percentage of patients die with biological valve **or** patients are more likely to die with biological valve	do **not** accept more patients die with a biological valve allow **2** marks for ratio mechanical : biological = 1:1.6 **or** 1:1.7 **or** correctly calculated value allow **3** marks for deaths with biological valves = 4% / 3.83687% higher **or** correctly rounded value **or** patients are 1.6 / 1.7 times more likely to die with biological valves if **no** other marks awarded, allow for **1** mark chance of death after a valve replacement is 8% / 7.77247% **or** correctly rounded value	1	AO2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	platelets	allow thrombocytes	1	4.2.2.3 AO1
05.4	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.		5–6	4.2.2.4 AO2 AO3
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.		3–4	
	Level 1: Relevant points are made. They are not logically linked.		1–2	
	No relevant content		0	
	Indicative content: **mechanical valves** • longer lasting **or** more durable **or** don't wear out as easily **or** less likely to need replacing (within 6 years) • blood clots (on the brain) are more likely (after surgery) • patient has to take anti-clotting medication (for the rest of their lives) • if medication not taken (correctly), clots can lead to blood clots on brain / heart attack • medication can lead to excessive bleeding (after injury) • some patients say they can hear the valves opening and closing • survival rate at 5 years is slightly higher for mechanical valve • lower percentage of deaths due to heart-related problems **biological valves** • no additional medication required • ethical issues surrounding use of animal tissue • valve may harden • more likely to need further operation **or** another new valve • more likely to be rejected • more likely to need (immuno-suppressant) medication **both valves** • both are readily available • little wait time a **level 2** response should contain comparisons of both valves **and** some reference to own knowledge			
Total			**14**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	plasma		1	4.2.2.3 AO1
06.2	Benedict's (reagent / solution)	allow Fehling's (reagent / solution)	1	4.2.2.1 AO1
06.3	add chemical / Benedict's (reagent to urine) **and** boil / heat positive result – (colour changes from blue to brick) red	allow ecf from question **06.2** allow any temperature above 65 °C ignore water bath unqualified allow orange / yellow / green / brown if no other mark awarded, allow **1** mark for reference to glucose testing stick / strip	1 1	4.2.2.1 AO1
06.4	the blood is more concentrated **or** less dilute (than the solution in the cells) (so) water moves out of cells by osmosis water moves through a partially permeable membrane	allow the solution in the cells is less concentrated **or** more dilute than the blood allow correct references to water concentration **or** water potential **or** hypotonic / hypertonic ignore reference to amount of water or glucose allow (so) water moves into the blood by osmosis allow semi-permeable / selectively permeable membrane	1 1 1	4.1.3.2 AO2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.5	projections / folds / villi provide a large surface area	ignore small intestine has a large surface area do **not** allow cilia	1	4.1.3.1 4.1.3.3 4.2.2.1 4.1.1.2 AO1
	walls of projections / folds / villi / capillaries are thin / one cell thick for shorter absorption / diffusion distance		1	AO2
	(small intestine is) very long, increasing time (for absorption)		1	AO1
	good / efficient blood supply to maintain concentration gradient	allow many capillaries to maintain concentration gradient	1	AO2
	cells have many mitochondria for (aerobic) respiration for active transport **or** cells have many mitochondria for energy release for active transport	do **not** accept anaerobic do **not** accept producing energy	1	
Total			**12**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	blood is pumped to the lungs by one / right side of the heart **and** blood is pumped to the body by the other / left side of the heart	allow blood enters the heart twice for every (one) circuit around the body	1	4.2.2.2 AO1
07.2	ventricle correctly identified as any part of grey area below: 		1	4.2.2.2 AO2
07.3	oxygenated and deoxygenated blood mixes	allow some deoxygenated blood is sent to the body / tissues / cells	1	4.2.2.2 AO3
	(so) less oxygen reaches the body / tissues / cells	allow named tissues / organs	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	concentration gradient (of oxygen) is shallow(er) / less steep (therefore) less oxygen diffuses into blood / cells / gills (so) less (aerobic) respiration occurs so less energy is released / available **or** (so more) anaerobic respiration occurs so less energy is released / available (so) less metabolism **or** (so when) anaerobic respiration occurs, lactic acid is produced (and is toxic)	allow idea that concentration gradient is negative (i.e. out of axolotl) (1) so oxygen diffuses out of axolotl's blood / cells / gills (1) do **not** accept no respiration occurs do **not** accept energy production ignore reduced living processes unqualified allow reduction of building larger molecules **or** movement / muscle contraction **or** keeping warm **or** urea formation **or** chemical reactions	1 1 1 1	4.4.2.3 4.4.2.1 4.1.3.1 AO2
07.5	stem (cells)	do **not** accept embryonic stem cell	1	4.1.2.3 AO2
07.6	any **one** from: • paralysis • diabetes	allow other examples such as Parkinson's / heart disease / stroke / cystic fibrosis / cancer / burns do **not** accept infectious diseases	1	4.1.2.3 AO1
07.7	any **one** from: • easy to breed • easy / cheap to keep / rear (as are small) • don't take up much space	allow reproduce quickly allow reference to not being dangerous (to the scientist) allow they are not endangered allow removal of gill will not kill the axolotl	1	4.1.2.3 AO3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.8	any **one** from: • it's not a mammal **or** it is an amphibian • regeneration in gills may be different to that in other organs • metabolism / body processes are too different to humans	allow humans do not have gills allow it's an endangered species or species need to be protected from extinction ignore reference to genetic differences **or** ethics	1	4.1.2.3 AO3
Total			**12**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	any **one** from: • (chemical which) catalyses / speeds up reactions in living organisms • (chemical which) catalyses / speeds up biological reactions	allow biological catalyst allow reduces activation energy (of reactions) in living organisms	1	4.2.2.1 AO1
	idea of specificity **or** (is a) protein	allow made of amino acids	1	
08.2	salivary gland	ignore mouth ignore liver	1	4.2.2.1 AO1
	small intestine	allow duodenum / ileum ignore intestine unqualified do **not** accept large intestine	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	reduced / no enzyme production / release (from pancreas)	allow named example of enzymes ignore reference to hormones	1	4.2.2.1 4.4.2.3 4.4.2.1 AO2
	food is not broken down fully **or** food is not digested fully	allow no food is broken down / digested allow example	1	
	plus any **one** of the following routes for max **2** marks:	mark as pairs		
	less glucose / sugar absorbed **or** less glucose / sugar passes into the blood(stream)		1	
	(so) less glucose available for respiration so more (body / stored) fat used up in metabolism / respiration		1	
	or			
	fewer amino acids absorbed **or** fewer amino acids pass into the blood(stream) (1)			
	(so) fewer amino acids are available for making new protein for repair / replacement (1)			
	or			
	fewer fatty acids absorbed **or** fewer fatty acids pass into the blood(stream) (1)	ignore glycerol		
	(so) fewer fatty acids available so less fat is stored in the body (1)	ignore glycerol		
	or			
	chemotherapy / radiotherapy causes nausea / loss of appetite (1)			
	(so) less intake of food (1)			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.4	(cancer) cells cannot divide **or** (cancer) cells are destroyed / killed	do **not** accept reference to the drug killing (cancer) cells	1	4.2.2.7 AO3
	(so) tumour doesn't grow / get bigger **or** tumour less likely to spread **or** tumour less likely to form secondary tumours	allow cancer cells less likely to spread / metastasise	1	
	(because) enzymes **A** and **B** are not working / active / effective / present **or** (because) enzymes **A** and **B** are inhibited	allow reference to both enzymes ignore enzymes unqualified	1	
08.5	(functional) enzyme **B** would still be made / present	allow enzyme **B** is not inhibited	1	4.2.2.7 AO3
	(therefore cancer) cells would still divide uncontrollably **or** (therefore cancer) cells would not be destroyed **or** (therefore) the tumour will (continue to) grow / get bigger / spread **or** the tumour will form secondary tumours		1	
08.6	any **two** from: • to avoid the patients thinking they feel better with the drug **or** to take into account a psychological effect • as a control / comparison • to avoid bias(ed results)	ignore to make it more valid unqualified ignore to provide an independent variable	2	4.3.1.9 AO2
08.7	testing on volunteers with the disease		1	4.3.1.9 AO1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.8	monoclonal antibody is attached to radioactive substance / toxin / drug / chemical		1	4.3.2.2 AO1
	monoclonal antibody will (only) attach to / target (antigen on) cancer cells / tumour		1	AO1
	(so) radioactive substance / toxin / drug / chemical will (bind to cancer cells and) stop them growing / dividing	allow radioactive substance / toxin / drug / chemical will kill / destroy the cancer cells **OR** monoclonal antibody interrupts the cell cycle **or** monoclonal antibody aids immune response (1) monoclonal antibody will (only) target cancer cells / tumour (1) (so) action of monoclonal antibody stops cancer cells growing / dividing **or** (so) action of monoclonal antibodies helps immune system kill / destroy cancer cells (1)	1	AO1
Total			**19**	

AQA

GCSE

BIOLOGY

8461/2H

Paper 2 Higher Tier

Mark scheme

June 2019

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	primary consumer		1	AO2 4.7.2.1 4.7.4.1
01.2	correct shape: 4 tiers with largest at bottom and smallest at top correctly labelled: dragonfly / nymph + hydra + daphnia + algae	 in this order **or** allow: 3rd-order **or** tertiary consumer **or** apex / top predator **or** (trophic level) 4 2nd-order **or** secondary consumer **or** (trophic level) 3 1st-order **or** primary consumer **or** herbivore **or** (trophic level) 2 producer **or** (trophic level) 1 allow for **2** marks inverted pyramid if correctly labelled	1 1	AO2 4.7.4.2
01.3	any **one** from: (Daphnia biomass smaller because) • non-digestible parts (of algae) or lost in faeces • not all absorbed • lost in urine / urea • used in respiration **or** lost as carbon dioxide / CO_2 • algae not all eaten **or** eaten by other organisms • some algae decompose	 ignore waste allow excretion allow (to supply energy) for movement / warmth allow used to supply energy	1	AO1 4.7.4.3
01.4	 14 14 000	an answer of 14 000 scores **2** marks allow evidence of an incorrectly calculated mean × 1000 allow 1.4×10^4	 1 1	AO2 4.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5		an answer of 2.625×10^4 **or** 2.63×10^4 **or** 2.6×10^4 scores **4** marks an answer of 26250 scores **3** marks allow ecf from Question **01.4**		AO2 4.7.2.1
	(volume of pond =) 1.875 **or** 2.5 × 1.5 × 0.5	an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps	1	
	14 000 × 1.875	allow ecf from Question **01.4**	1	
	26250		1	
	2.625×10^4	allow 2.63×10^4 **or** 2.6×10^4	1	
01.6	increased (growth / reproduction of) algae		1	AO2 4.7.2.1 4.7.3.2
	(more algae so) more food for Daphnia	allow fertiliser toxic to Hydra (1) (so) fewer Daphnia eaten (1)	1	4.7.4.1
01.7	(Hydra have) less food		1	AO3 4.7.2.1
	because (graph shows) fewer Daphnia (with more fertiliser)	allow other valid suggestions, eg fertiliser toxic to Hydra (1) **or** fertiliser causes growth of algae (on surface) which block light and so die and decay **or** eutrophication (1) (decay / eutrophication) uses up oxygen (so lack of oxygen for Hydra) (1)	1	4.7.3.2
Total			**14**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	chromosome(s)	allow gene(s) / allele(s)	1	AO1 4.6.1.4 4.1.2.1
02.2	X = sugar Y = nucleotide Z = base		1 1 1	AO1 4.6.1.5
02.3	double helix		1	AO1 4.6.1.4
02.4	3		1	AO2 4.6.1.5
02.5	any **two** from: • diagnosis of inherited / genetic disorder • gene therapy **or** treatment of inherited disorders • understanding (human) evolution **or** understanding ethnic origins (of a person) **or** understanding ancestry • tracing human migration patterns	allow descriptions or named examples allow research / understand genetic disorders allow other examples – eg identification of criminals (1) paternity determination (1)	2	AO1 4.6.1.4
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec.
03.1	named example of tropism – eg geotropism / gravitropism	allow hydrotropism **or** chemotropism **or** thermotropism	1	AO1 4.5.4.1
	correct corresponding stimulus – eg gravity	allow water **or** chemical **or** 'heat'	1	
03.2	**Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	AO1 AO2 4.5.4.1
	Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.		3–4	
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	
	No relevant content		0	
	Indicative content • several seedlings in each batch **or** one pot of seedlings in each batch • measure heights of shoots • leave some in dark with light from one side / direction in box with hole • control(s) with all-round light **or** rotating on clinostat **or** in dark • control variable(s) eg same temperature / water / soil type • after suitable time (at least several hours) • record appearance of seedlings re. light direction • re-measure heights of shoots • detail of how bent shoots were measured – eg use thread or straighten them out • calculate mean height increase for each group • use ruler / protractor to estimate angle of bending for level 3 a reference to comparing the growth of plants with light from one direction with plants either in darkness or in full light along with a control variable is required			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	leaves / plant receive(s) / absorb(s) more light (so) more photosynthesis (so plant) produces more glucose	 allow starch / carbohydrate / sugar / organic material / other named organic substance if no other mark awarded allow **1** mark for any **two** of the mark points with no reference to 'more'	1 1 1	AO2 4.5.4.1 4.7.2.1 4.4 4.4.1.2 AO1
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	ciliary muscles contract		1	AO1 4.5.2.3
	(so ciliary muscles have a) smaller diameter		1	
	(so) suspensory ligaments loosen / slacken	do **not** accept 'relax'	1	
	(so) lens thickens **or** lens becomes more curved / rounded	allow lens becomes fatter ignore lens becomes bigger	1	
	(thicker) lens is more convergent	allow light rays bent (inwards) more **or** light refracted more	1	
	light rays / image focused on retina	allow light rays meet on retina	1	
04.2	eye(-ball) is (too) short **or** lens cannot be thickened enough	allow ciliary muscles (too) weak **or** lens not (sufficiently) elastic	1	AO1 4.5.2.3
	(so) light 'focuses' behind retina	allow (so) image forms behind retina	1	
04.3	convex / converging lens	allow shape described eg thicker in middle	1	AO1 4.5.2.3
	light rays bent / refracted (inwards) more	allow changes direction of light rays further inwards	1	
	light rays focused on retina	allow light rays brought to a point on retina **or** light rays converge on retina **or** focused /clear image forms on retina	1	
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	same kingdom + phylum + class + order **or** same order **or** they have the top four groups the same	allow both Poales	1	AO3 4.6.4
05.2	**Rr / rR**	do **not** accept **RR** or **rr** ignore heterozygous do not accept homozygous	1	AO3 4.6.1.6 4.6.3.3
05.3	C^WC^W		1	AO3 4.6.1.6
05.4	parental genotypes / gametes correct for both parents: $C^R C^W$ $C^R C^W$ / C^R and C^W	allow **R** and **W** throughout allow own symbols if defined	1	AO2 4.6.1.6
	genotypes of offspring correctly derived in a Punnett square: C^RC^R C^RC^W C^WC^W	allow correctly derived genotypes from incorrect gametes	1	
	correct identification of phenotypes from their cross: C^RC^R = red C^RC^W = pink C^WC^W = white	allow colours correctly identified from different offspring, only if pink and other colour(s) are given	1	
05.5	answer correctly derived from Question **05.4** to match stated phenotypes	allow 50(%) if no offspring given in Question **05.4** allow to match genotypes if no phenotypes given	1	AO2 4.6.1.6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	*(several groups)* so many / several plants can be produced	allow each (group) will give a new plant	1	AO1 4.1.2.3 4.6.1.3 4.6.2.5
	(nutrients) for making protein / amino acids **or** for making chlorophyll **or for providing** energy **or for respiration**	allow other examples do **not** accept making energy ignore for growth	1	
	(add hormones) so differentiation occurs **or** so roots / shoots develop	allow for the formation of different tissues / organs / named allow to stimulate cell division	1	
	(sterile conditions) to prevent growth / entry of microorganisms / named type **or** prevent decay / disease	ignore to kill microorganisms ignore contamination unqualified	1	
	(temperature = 20 °C) so optimum / good growth	allow reference to enzymes working well ignore enzymes not denatured ignore reference to pathogens / microorganisms	1	
05.7	(all new plants have been) produced by asexual reproduction / mitosis **or** produced without (fusion of) gametes	ignore produced from one parent	1	AO2 4.1 4.1.2.2 4.6.1.1 4.6.2.5
	(so) all are genetically identical / clones **or** all are C^RC^W / heterozygous	allow all are the same genotype / alleles / genes / DNA	1	
Total			**14**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	pituitary		1	AO1 4.5.3.3
06.2	ADH		1	AO1 4.5.3.3
06.3		allow ecf for name of hormone from Question **06.2** ignore name of gland		4.5.3.3
	high(er) concentration of blood **causes** (more) ADH / hormone release	allow low(er) water potential of blood causes (more) ADH / hormone release allow alternative descriptions in terms of – eg low(er) water concentration / level **or** high(er) osmotic pressure **or** high(er) solute concentration / level	1	AO2
	(and hormone / ADH causes) increased permeability of kidney tubules (to water)	allow increased permeability of collecting duct / distal convoluted tubule	1	AO1
	(so) increased water reabsorption	allow more water taken back into blood ignore reference to urine	1	AO1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4		allow converse if clearly describing dialysis explanation must match reason		AO3 4.5.3.3
	changes in concentrations / levels of substances / urea are minimised	allow no change in concentration / level of substances / urea allow correctly named substances	1	
	(so) less / no chance of causing damage to body cells / tissues	allow eg less / no osmotic stress **or** not poisoned by urea	1	
	not repeatedly puncturing skin **or** blood not in contact with machine	allow blood does not leave the body	1	
	(so) less / no chance of infection **or** less / no chance of blood clots **or** no need to take anti-clotting drugs	allow less / no chance of microorganisms entering body allow only one operation so less chance of infection for **2** marks allow dialysis requires anti-clotting drugs and so may lose more blood if cut for **2** marks	1	
Total			**9**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	**Level 2:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		3–4	AO1 AO2
	Level 1: The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.		1–2	
	No relevant content		0	
	Indicative content • use of quadrat • (quadrat) of given area / dimensions – eg 0.25 m^2 or 1 m × 1 m • quadrats are placed randomly • method of obtaining randomness – eg random coordinates from a calculator **or** throw over shoulder **or** throw with eyes closed • suitable number of quadrats (10 or more **or** a large number) • count number of plants (in each quadrat) • calculation of mean per quadrat or per unit area • determination of area of field (length × width) • population = mean per m^2 × area of field			4.7.2.1
07.2	more bacteria so more divisions / reproduction (per unit time)		1	AO2 4.1.1.6
07.3	any **three** from: • add (more) sugar • add (more) amino acids / protein • add (more) oxygen • increase temperature • remove toxins / waste **or** maintain pH • stir the culture	if neither point given, allow add (more) nutrients allow in range 26 °C to 40 °C allow maintain optimum temperature if no other mark awarded allow **1** mark for add more food	3	AO3 4.1.1.6 4.4.2.3 4.7.2.3 4.7.4.3 4.7.5.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4		an answer in the range of 2.9 to 3.4 scores **4** marks an answer in the range of 2.08 to 3.77 scores **3** marks		AO2 4.1.1.6 4.6.2.4
	tangent drawn to the curve at 12 hours	do **not** accept if there is an incorrect tangent at 7 hours	1	
	calculation of rate at 7 hours $\frac{\Delta y}{\Delta x}$	allow an answer that correctly rounds to a value in range 10.0 to 11.7	1	
	calculation of rate at 12 hours $\frac{\Delta y}{\Delta x}$	allow an answer that correctly rounds to a value in range 3.1 to 4.8	1	
	3.3	allow in range 2.9 to 3.4 if both rates are in the correct ranges	1	
07.5	can use the glyphosate / weed killer to kill weeds but not kill / affect crop	allow **only** kills weeds	1	AO1 4.6.2.4 4.7.1.3 4.7.5.4
	(so) less competition for light / water / minerals / ions	allow less competition for nutrients ignore food / carbon dioxide / space	1	AO2
	(so) crops have high(er) yield	allow crops grow better / well	1	AO1
Total			**15**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1		ignore incorrect organ secreting insulin / glucagon		4.5.1 4.5.3.2
	(blood glucose increases after meal causing) insulin secretion	allow (blood glucose increases after meal causing) insulin increase	1	AO2
	insulin causes glucose to enter cells / liver / muscles	allow glucose converted to glycogen in cells / liver / muscles for **2** marks	1	AO1
	(insulin causes) glucose conversion to glycogen		1	AO1
	(so) blood glucose decreases causing glucagon secretion	allow increase in glucagon when blood glucose is low	1	AO2
	glucagon causes glycogen to be converted to glucose		1	AO1
08.2	cells / liver / muscles absorb less glucose	allow cells / liver / muscles convert less glucose to glycogen do **not** accept no absorption / conversion of glucose	1	AO2 4.5.3.2
	(so) glucose concentration in blood remains high	allow (so) glucose concentration in blood does not decrease	1	
	(high blood glucose stimulates / causes) pancreas to release more insulin	allow more insulin is released from pancreas to 'try' to reduce blood glucose	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.3	any **three** from: • age • height **and** mass • proportion of males and females **or** group size • (same) severity of diabetes • (same) activity (during investigation) • (same) type of meal • dose of drug • (similar) blood glucose concentrations at start • other health conditions **or** other drugs being taken	 allow BMI allow sex of the participants allow how much / type of food / drink consumed before allow may not have followed drug-taking regime beforehand	3	AO3 4.5.3.2
08.4	Mean = 177.2 ± 15.4		1	AO2 4.5.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.5	**Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.		5–6	AO3
	Level 2: Some logically linked reasons are given. There may also be a simple judgement.		3–4	
	Level 1: Relevant points are made. They are not logically linked.		1–2	
	No relevant content		0	
	Indicative content **Pro:** • Met + A gives larger (%) reduction (in blood glucose) than Met alone • so statement is supported • Met + B gives larger (%) reduction (in blood glucose) than Met alone • so statement is supported • Met + A SD does not overlap with Met SD • so difference is significant **Con:** • Met + B SD overlaps with Met SD • so difference is not significant • difference in results could be due to chance --- • number of people used is not very large • number of people in each group is different • so may not be representative **or** may not be repeatable / reproducible • so anomalies will have a bigger impact on smaller groups • 30 minute / starting levels of blood glucose are different • all 30 minute / starting levels are higher in the 2-drug trial • so may cause different % reductions • no information about control variables **or** named eg • concentration of drugs not given / may differ • so results may not be valid for level 3 an inclusion of a discussion of significance is required			4.5.3.2
Total			**18**	

GCSE
CHEMISTRY
8462/1H

Paper 1 Higher Tier

Mark scheme

June 2019

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; e.g. allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, i.e. if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	any **one** from: • so elements / iodine / tellurium were in groups with similar properties • iodine has similar properties to Br / Cl / F / Group 7 • iodine has different properties to Se / S / O / Group 6	ignore reference to atomic structure ignore references to Cr, Mn and Mo allow corresponding argument in terms of tellurium	1	AO1 4.1.2.2
01.2	Mendeleev had predicted properties of missing elements elements were discovered (that filled the spaces / gaps) properties (of these elements) matched Mendeleev's predictions	ignore reference to atomic structure allow atomic weights (of these elements) fitted in the spaces / gaps if no other mark awarded, allow **1** mark for in previous versions of the periodic table the pattern of similar properties broke down	1 1 1	AO1 4.1.2.2
01.3	relative atomic mass		1	AO1 4.1.1.6
01.4	(increasing) atomic / proton number	ignore (increasing) electron number do **not** accept relative atomic / proton number	1	AO1 4.1.2.1
01.5	(formula) At_2 (state) solid	ignore incorrect state symbol allow (s) ignore s	1 1	AO1 4.1.2.6

01.6	any **two** from: • flame • (white) solid forms • colour of gas / chlorine disappears / fades	allow burns allow (white) smoke forms	2	AO1 4.1.2.5
Total			**10**	

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	H^+		1	AO1 4.4.2.4
02.2	hydrochloric (acid) water	allow HCl allow H_2O	1 1	AO2 4.4.2.2
02.3	burette	do **not** accept biuret	1	AO1 4.4.2.5
02.4	27.6 (cm^3)	allow 27.60 (cm^3)	1	AO2 4.4.2.5

Question 2 continued

Question	Answers	Mark	AO/ Spec. Ref
02.5	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO3 AO1
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	AO1 x 2
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	AO1 x 2
	No relevant content	0	
	Indicative content allow converse using acid added to alkali Key steps • measure the volume of acid • add indicator to the acid • add sodium hydroxide solution • until the colour changes • record volume of sodium hydroxide solution added • repeat procedure with the other acid Use of results • compare the two volumes of sodium hydroxide solution to find which sample **P** or **Q** is more concentrated Other points • pipette to measure volume of acid • use a few drops of indicator • swirl • use a white tile • rough titration to find approximate end point • add dropwise near the endpoint • read volume from bottom of meniscus • repeat and take a mean		4.4.2.5
Total		**11**	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	contain delocalised electrons (so) electrons can move through the structure / nanotube	allow contain free electrons allow (so) electrons can carry charge through the structure / nanotube ignore throughout for through ignore current / electricity for charge	1 1	AO1 4.2.3.3

Question	Answers	Mark	AO / Spec. Ref.
03.2	**Level 2:** Some logically linked reasons are given. There may also be a simple judgement.	3–4	AO3 4.2.2.7 4.2.3.3
	Level 1: Relevant points are made. They are not logically linked.	1–2	
	No relevant content	0	
	Indicative content • wood is the least dense so lightest to use • aluminium is the most dense so will make the racket too heavy • carbon nanotube is the strongest so least likely to break • wood / aluminium are too weak so the racket will break more easily • carbon nanotube is the stiffest so least likely to bend out of shape • wood / aluminium are not very stiff so could bend out of shape • justified conclusion		

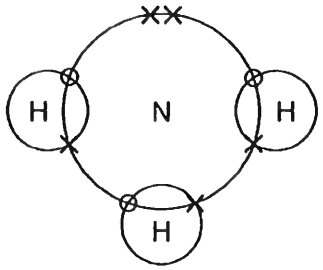
Question 3 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3		an answer of 4.0 x 10^4 (nm^2) scores **3** marks an answer of 40344 (nm^2) scores **2** marks		AO2 4.2.4.1
	(82^2 =) 6724 (nm^2)		1	
	(6 x 6724 =) 40344 (nm^2)	allow 40344 (nm^2) correctly rounded to any number of significant figures allow correct calculation using incorrectly calculated value of area of one face from step 1	1	
	= 4.0 x 10^4 (nm^2)	allow 4.0344 x 10^4 (nm^2) correctly rounded to 1 or more significant figures allow a correctly calculated and rounded conversion to standard form of an incorrect calculation of surface area	1	
03.4	any **one** from: • less can be used (for the same effect) • greater surface area (to volume ratio)	allow converse statements about fine particles ignore nanoparticles are smaller	1	AO3 4.2.4.2
Total			**10**	

Question 4

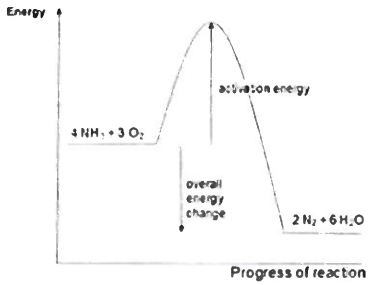
Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(neutron) 1 0	both needed allow (neutron) 1 neutral	1	AO1 4.1.1.4
	proton 1 (+1)	both needed	1	4.1.1.5
04.2	number of protons plus neutrons	allow number of protons and neutrons ignore protons and neutrons unqualified do **not** accept references to mass or relative mass of protons and / or neutrons	1	AO1 4.1.1.5
04.3	(the isotopes contain) different numbers of neutrons		1	AO2 4.1.1.5
04.4	most (alpha) particles passed (straight) through (the gold foil)		1	AO1 4.1.1.3
	(so) the mass of the atom is concentrated in the nucleus / centre **or** (so) most of the atom is empty space		1	
	some (alpha) particles were deflected / reflected		1	
	(so) the atom has a (positively) charged nucleus / centre	if not awarded for MP2, allow (so) the mass of the atom is concentrated in the nucleus / centre.	1	
Total			**8**	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1		 scores **2** marks allow dots, crosses, circles or $e^{(-)}$ for electrons		AO1 4.2.1.4
	1 bonding pair of electrons in each overlap		1	
	2 non-bonding electrons on nitrogen	do **not** accept non-bonding electrons on hydrogen ignore inner shell electrons drawn on nitrogen	1	
05.2	does not show the shape **or** only two-dimensional	allow is not three-dimensional	1	AO1 4.2.1.4
05.3	(ammonia has) small molecules	allow (ammonia has) a simple molecular (structure)	1	AO1 4.2.2.1 4.2.2.4
	(ammonia has) weak intermolecular forces	allow (ammonia has) weak intermolecular bonds do **not** accept weak covalent bonds	1	
	(so) little energy is needed to overcome the intermolecular forces	allow (so) little energy is needed to break the intermolecular bonds allow (so) little energy is needed to separate the molecules do **not** accept references to breaking covalent bonds	1	

05.4	Cr_2O_3		1	AO2 4.1.3.2
05.5	(for bonds broken) ((12 x 391) + (3 x 498) =) 6186 (for bonds made) ((2 x 945) + (12 x 464) =) 7458 (overall energy change = 6186-7458 =) (-)1272 (kJ)	an answer of (-)1272 (kJ) scores **3** marks allow correct calculation using incorrectly calculated values from step 1 and/or step 2	1 1 1	AO2 4.5.1.3

Question 5 continued

05.6	7458 (kJ) (released in making bonds) is greater than 6186 (kJ) (used in breaking bonds) **or** the products have 1272 (kJ) less energy than the reactants	allow ecf from question **05.5** allow the (overall) energy change is -1272 (kJ)	1	AO2 4.5.1.3
	(so) energy is released (to the surroundings)	dependent on MP1 being awarded allow (so) heat is released (to the surroundings) if no values given, allow **1** mark for more energy released in making bonds than used in breaking bonds	1	
05.7		 scores **2** marks allow discontinuous lines ignore arrow heads		AO1 4.5.1.2
	activation energy labelled		1	
	(overall) energy change labelled		1	
Total			**14**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	any **two** from: • temperature (of solution) • concentration of electrolyte / solution • compound / ions in electrolyte / solution	ignore room temperature allow volume of electrolyte / solution allow size of electrode allow distance between electrodes do **not** accept electrode **X** unqualified do **not** accept (measured) voltage	2	AO3 4.5.2.1
06.2	order: (most reactive) magnesium cobalt nickel tin copper (least reactive) silver justification: the higher the (positive) voltage, the more reactive (the metal) silver has a negative voltage because silver is less reactive than copper	allow **1** mark for magnesium, cobalt, nickel, tin in order at top allow **1** mark for copper and silver in order at the bottom allow the most reactive (metal) has the highest voltage	2 1 1	AO3 4.4.1.2 4.5.2.1
06.3	magnesium and tin		1	AO3 4.5.2.1

06.4	(in a fuel cell) hydrogen is oxidised (to produce water) water is produced / released as gas / vapour / steam	allow (in a fuel cell) hydrogen reacts with oxygen (to produce water) if no other mark awarded, allow **1** mark for fuel cells produce water	1 1	AO3 4.5.2.2
Total			**9**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	mixture has a lower melting point (than aluminium oxide) (so) less energy needed	allow cryolite lowers melting point (of aluminium oxide) ignore boiling point do **not** accept cryolite is a catalyst ignore cost	1 1	AO1 4.4.3.3
07.2	aluminium ions gain electrons		1	AO1 4.4.1.4 4.4.3.3
07.3	$2O^{2-} \rightarrow O_2 + 4e^-$	allow multiples allow **1** mark for an unbalanced equation containing correct species	2	AO2 4.1.1.1 4.4.3.1 4.4.3.3
07.4	the electrode reacts with oxygen the electrode is carbon / graphite (so) carbon dioxide is produced	 allow (so) the electrode / carbon / graphite is used up allow (so) the electrode / carbon / graphite is burned away ignore (so) the electrode / carbon / graphite is worn away ignore (so) the electrode / carbon / graphite is corroded	1 1 1	AO1 4.4.3.3

Question 7 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.5		an answer of 941 (kg) scores **4** marks		AO2 4.3.2.2
	(M_r of Al_2O_3 =) 102		1	
	$\left(\frac{2\,000\,000}{102} =\right)$ 19608 (mol Al_2O_3)	allow correct calculation using incorrectly calculated value of M_r of Al_2O_3	1	
	$\left(19\,608 \times \frac{3}{2} =\right)$ 29412 (mol O_2)	allow correct calculation using incorrectly calculated value of moles of Al_2O_3	1	
	$\left(\frac{29\,412 \times 32}{1000} =\right)$ 941 (kg)	allow 941.1764706 (kg) correctly rounded to at least 2 significant figures allow correct answer using incorrectly calculated value of moles of O_2	1	
	alternative approach: (2 M_r of Al_2O_3 =) 204 (1) 204 (kg of Al_2O_3) gives 96 (kg of O_2) (1) (2000 kg of Al_2O_3 gives) $\frac{2000}{204}$ × 96 (kg of O_2) **or** $\frac{2000000}{204}$ × 96 (g of O_2) (1) = 941 (kg) (1)			

07.6	hydrogen (gas) would be produced (instead of sodium) (because) sodium is more reactive than hydrogen		1 1	AO3 4.4.1.2 4.4.3.3 4.4.3.4

07.7		an answer of 50700 (dm^3) scores **2** marks an answer of 50.7 (dm^3) scores **1** mark		AO2 4.3.5
	$\left(\frac{150\,000}{71} =\right)$ 2113 (mol of Cl_2) **or** (volume of 1 g of $Cl_2 = \frac{24}{71} =$) 0.34 (dm^3)		1	
	$(\frac{150\,000}{71}$ x 24) = 50700 (dm^3)	allow 50704.22535 (dm^3) correctly rounded to at least 2 significant figures allow correct calculation using their calculated number of moles and/or calculated volume of 1 g	1	
Total			**16**	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	to make sure all of the oxide (of copper) has reacted **or** to make sure all water (produced) is removed	ignore to ensure complete reaction unqualified ignore to make sure all of the hydrogen has reacted	1	AO3 4.3.2.3
08.2	to prevent hydrogen escaping (into the air) (because) hydrogen is explosive	 ignore hydrogen is flammable	1 1	AO3 4.3.2.3
08.3	(mass of copper) 8.66 (g) (mass of water) 2.45 (g)		1 1	AO2 4.3.2.3

08.4	moles Cu = 0.04 **or** $\frac{2.54}{63.5}$ = 0.04 moles H_2O = 0.04 **or** $\frac{0.72}{18}$ = 0.04 ratio = 1:1 so equation 2 is correct **alternative approach A** (calculating mass of water from copper) moles Cu= 0.04 **or** $\frac{2.54}{63.5}$ = 0.04(1) 0.02 x 18 = 0.36 (g of water for equation 1) (1) 0.04 x 18 = 0.72 (g of water) so equation 2 is correct (1) **alternative approach B** (calculating mass of copper from water) moles H_2O=0.04 **or** $\frac{0.72}{18}$=0.04 (1) 0.08 x 63.5 = 5.08 (g of copper for equation 1) (1) 0.04 x 63.5 = 2.54 (g of copper) so equation 2 is correct (1)	**alternative approach C** (mass ratio) (copper : water for equation 1) 127 : 18 = 7.06 : 1 (1) (copper : water for equation 2) 63.5 : 18 = 3.53 : 1 (1) 2.54 : 0.72 = 3.53 : 1 = 63.5 : 18 so equation 2 is correct (1)	1 1 1	AO2 4.3.2.1 4.3.2.3
Total			**8**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	polystyrene is a better (thermal) insulator	allow polystyrene is a poorer (thermal) conductor	1	AO3 4.5.1.1
	(so) reduces energy exchange (with the surroundings)	allow (so) reduces energy / heat loss (to the surroundings)	1	
09.2	all six points plotted correctly	allow a tolerance of ± ½ a small square allow **1** mark for at least 3 points plotted correctly	2	AO2 4.5.1.1
	line of best fit through points plotted from Table 6		1	
	both lines of best fit extrapolated correctly until they cross		1	
09.3	11 (cm^3)	allow ecf from question **09.2** allow answers in the range 10.75 to 11.25 (cm^3) allow a tolerance of ± ½ a small square	1	AO2 4.5.1.1
09.4	(27.5 – 18.9) = 8.6 (°C)	allow ecf from question **09.2** allow answers in the range 8.5 to 8.7 (°C) allow a tolerance of ± ½ a small square	1	AO2 4.5.1.1

Question 9 continued

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.5		an answer of 0.62 (mol/dm^3) for concentration in mol/dm^3 scores **4** marks an answer of 0.31 (mol/dm^3) for concentration in mol/dm^3 scores **3** marks		AO2/2 4.3.1.2 4.3.2.5 4.3.4 4.4.2.5
	(moles $H_2SO_4 = 0.500 \times \frac{15.5}{1000}$) = 0.00775		1	
	(moles KOH = 2 x moles H_2SO_4 = 2 x 0.00775) = 0.0155	allow correct calculation using incorrectly calculated value of moles of H_2SO_4	1	
	(conc KOH = moles KOH x $\frac{1000}{25.0}$) = 0.0155 x $\frac{1000}{25.0}$	allow correct calculation using incorrectly calculated value of moles of KOH	1	
	= 0.62 (mol/dm^3)	allow correct answer using incorrectly calculated value of moles of KOH	1	
	(M_r KOH =) 56		1	
	(conc = M_r x conc in mol/dm^3 = 56 x 0.62) = 34.7 (g/dm^3)	allow 35 or 34.72 (g/dm^3) allow correct answer using incorrectly calculated value of concentration in mol/dm^3 and/or incorrect M_r	1	
	alternative approach for step 1 to step 4 $\frac{2}{1} = \frac{25 \times \text{conc KOH}}{15.5 \times 0.500}$ (2) (conc KOH) = $\frac{2 \times 15.5 \times 0.500}{25.0}$ (1) = 0.62 (mol/dm^3) (1)	allow **1** mark if mole ratio is incorrect		

Total			**14**

AQA

GCSE
CHEMISTRY
8462/2H

Paper 2 Higher Tier

Mark scheme

June 2019

Version: 1.0 Final

196G8462/2H/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do not accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this.

The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	a temperature between 400 (°C) and 500 (°C) inclusive	allow a temperature range entirely within 400 (°C) and 500 (°C) inclusive	1	AO3 4.7.1.2
01.2	(diesel oil has a) lower boiling point / range than heavy fuel oil (but diesel oil has a) higher boiling point / range than kerosene	ignore quoted values for boiling points ignore references to melting points ignore references to intermolecular forces or chain length allow temperature of vaporisation / condensation for boiling points throughout allow the boiling range (of diesel oil) is between those of heavy fuel oil and kerosene for **2** marks.	1 1	AO2 4.7.1.2
01.3	any **two** from: • (too) viscous • not (very) flammable • boiling point (too) high	ignore references to cost allow references to difficulty of flow allow references to difficulty of ignition / burning do **not** accept bitumen takes more energy to burn allow not (very) volatile	2	AO2 4.7.1.3
01.4	C_6H_{14}		1	AO2 4.7.1.1

01.5	high temperature any **one** from: • steam • catalyst	ignore references to pressure allow a quoted temperature above 320 °C ignore hot / heat ignore name of catalyst allow alumina allow aluminium oxide allow porous pot allow zeolite	1 1	AO1 4.7.1.4
01.6	greater demand (for smaller molecules) any **one** from: (because smaller molecules are) • more useful • better fuels • used to make alkenes • used to make polymers	allow converse argument for larger molecules allow a named polymer ignore plastics	1 1	AO1 4.7.1.4
01.7	C_3H_6		1	AO2 4.1.1.1 4.7.1.4
Total			**11**	

Question 2

Question	Answers	Mark	AO/ Spec. Ref
02.1	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 4.8.2.3 4.8.3.1 4.8.3.3
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4	
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content lithium: • crush tablets or dissolve tablet (in water or acid) • clean wire • place on wire • place in (roaring / blue / non-luminous) flame • observe flame colour • crimson flame carbonate: • add hydrochloric acid • effervescence / fizzing • bubble gas through limewater • limewater becomes cloudy		
02.2	formulation(s)	1	AO1 4.8.1.2

02.3		an answer of 58.3333333 (%) correctly rounded to at least 2 significant figures scores **3** marks		AO2 4.8.1.2
	1.20 g = 1200 mg **or** 700 mg = 0.700 g		1	
	$\frac{700}{1200} \times 100$ **or** $\frac{0.700}{1.20} \times 100$	allow correct use of incorrectly or not converted values from step 1	1	
	= 58.3 (%)	allow 58.3333333 (%) correctly rounded to at least 2 significant figures	1	
Total			**10**	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	(aq)	allow aqueous / aq	1	AO1 4.2.2.1 4.2.2.2
03.2	(gas) syringe	allow measuring cylinder (and water trough) allow balance	1	AO1 4.6.1.1
	stopclock / stopwatch	allow timer / clock / watch	1	
03.3	all points plotted correctly	allow a tolerance of ± ½ a small square allow at least 3 points plotted correctly for **1** mark.	2	AO2 4.6.1.1
	line of best fit	allow correctly drawn line of best fit for incorrectly plotted points	1	
03.4	(rate) decreases	allow slows down	1	AO3 4.6.1.1
	(rate decreases) more slowly as time increases	allow (rate decreases) at a non-linear rate	1	
	(rate) becomes zero at 60 s	allow the reaction stops at 60 s allow ecf from question **03.3**	1	
03.5	more bubbles were produced in the first 10 seconds		1	AO2 4.6.1.2
	the magnesium was used up more quickly		1	
Total			11	

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	Tube 1: (nail) rusts because air / oxygen **and** water present		1	AO1
	Tube 2: (nail) does not rust because no water	allow Tube 2: (nail) does not rust because only air / oxygen	1	AO1
	Tube 3: (nail) does not rust because no air / oxygen	allow Tube 3: (nail) does not rust because only water	1	AO1
	Tube 4: (nail) does not rust because paint is a barrier (to water / air / oxygen)	allow Tube 4: (nail) does not rust because paint is a protective layer / coating (against water / air / oxygen) **or** allow Tube 4: (nail) does not rust because paint protects it from water / air / oxygen	1	AO1 AO2 4.10.3.1 4.10.3.2
	Tube 5: (nail) does not rust because stainless steel resistant to corrosion	allow Tube 5: (nail) does not rust because stainless steel does not corrode allow Tube 5: (nail) does not rust because stainless steel contains nickel / chromium If no other mark awarded allow **1** mark for correct rusting pattern in all 5 tubes	1	

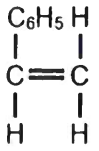
04.2	magnesium is more reactive (than iron) (so magnesium) provides sacrificial protection	allow converse allow magnesium is more reactive (than steel) allow (so magnesium) corrodes / reacts instead of iron / steel allow (so magnesium) corrodes / reacts before iron / steel ignore references to protective layers ignore references to magnesium rusting	1 1	AO2 4.10.3.1
04.3	(aluminium has a coating of) aluminium oxide (so the aluminium oxide) protects the metal (from further corrosion)	 allow (so aluminium oxide) prevents water / air / oxygen from reaching the metal	1 1	AO1 4.10.3.1
Total			**9**	

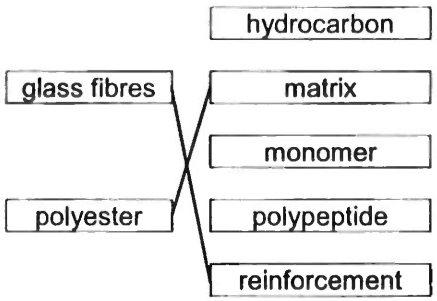
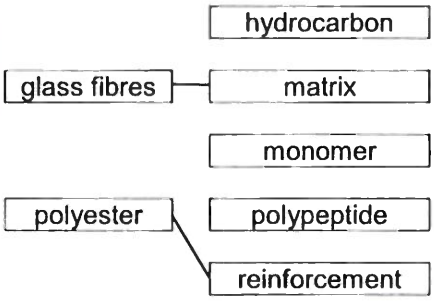
Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	wood is renewable **or** (natural) gas is finite (burning) wood produces the same amount of carbon dioxide as the trees absorbed **or** (burning natural) gas increases the amount of carbon dioxide (in the atmosphere)	 allow wood is carbon-neutral allow wood does not add to global warming allow (burning natural) gas adds to global warming allow (burning natural) gas adds greenhouse gases (to the atmosphere) ignore references to energy / cost	1 1	AO3 4.9.2.2 4.10.1.1
05.2	not enough oxygen (so) incomplete combustion	allow not enough air do **not** accept no oxygen / air	1 1	AO1 4.9.3.1
05.3	$2CH_4(g)+3O_2(g)\rightarrow 2CO(g)+4H_2O(g)$	allow correct multiples / fractions	1	AO2 4.9.3.1

05.4	ratio of $O_2 : CO_2 = 5 : 3$ (oxygen needed = $\frac{3.60 \times 5}{3}$) = 6.0 (dm^3) (oxygen unreacted = 7.25 – 6.0) = 1.25 (dm^3) (oxygen unreacted = 1.25 × 1000) = 1250 (cm^3)	an answer of 1250 (cm^3 oxygen unreacted) scores **4** marks allow correct calculation using an incorrectly determined mole ratio allow correct subtraction of an incorrectly calculated volume of oxygen allow correct conversion to cm^3 anywhere in response **alternative approach for MP1 and MP2** moles CO_2 = 0.15 **and** moles O_2 = 0.25 (1) (0.25 x 24 =) 6.0 (dm^3 oxygen needed) (1)	1 1 1 1	AO2 4.3.5 4.7.1.3
Total			**9**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	C=C bond in correct position		1	AO2 4.7.3.1
	3× C-H **and** 1× C-C bond in correct positions	do **not** accept any additional bonds or atoms ignore brackets and n before and after displayed structural formula an answer of  scores **2** marks	1	
06.2	carboxylic acid (group)	allow carboxyl (group)	1	AO1 4.7.2.4
06.3	water	allow H_2O	1	AO1 4.7.3.2
06.4	(polyester is) thermosoftening	allow (polyester is) thermoplastic ignore thermoforming	1	AO1 AO3 4.10.3.3
	(polyester has) no cross-links	allow intermolecular forces are weak do **not** accept references to breaking covalent bonds or breaking chains	1	

06.5		allow for **1** mark: 	1 1	AO3 4.10.3.3
06.6	any **two** from: (to make the board) • harder • stronger • tougher • more rigid • waterproof	must be implied comparative statements	2	AO3 4.10.3.3
Total			**10**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	add sodium hydroxide (solution to water sample)		1	AO1 4.8.3.2
	white precipitate (forms)	dependent on correct test in MP1	1	
	(precipitate which is) soluble in excess (NaOH)	dependent on correct test in MP1	1	
07.2	add barium chloride (solution) **and** (dilute) hydrochloric acid (to water sample)	allow barium nitrate (solution) allow (dilute) nitric acid	1	AO1 4.8.3.5
	white precipitate (forms)	dependent on addition of barium chloride / nitrate (solution) in MP1	1	
07.3	**Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		3–4	AO1 4.10.1.2
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	
	No relevant content		0	
	Indicative content • weigh (evaporating) basin / dish • add measured volume of water • weigh (evaporating) basin / dish and water • heat to evaporate water • reweigh • repeat heating until constant mass obtained • subtract mass of (evaporating) basin / dish from mass • repeat and calculate a mean, discarding anomalous results • calculate the mass in 100 cm^3 water if necessary			
Total			**9**	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
08.1	(Titan has) little / no oxygen	ignore references to respiration	1	AO3 4.9.1.3
	(so) photosynthesis has not occurred (on Titan)	allow (so) no plants / algae to produce oxygen (on Titan)	1	
	(therefore) little / no carbon dioxide present (on Titan) **or** (therefore) oxygen-using animals cannot have evolved (on Titan)		1	
08.2	(methane) allows short(er) wavelength radiation to pass through (from the sun)	allow (methane) allows uv / ultraviolet radiation to pass through (from the sun)	1	AO1 4.9.2.1
	(which is) re-emitted from the surface as long(er) wavelength radiation	allow (which is) re-emitted from the surface as ir / infra-red radiation	1	
	(which is) absorbed (by methane in the atmosphere)	allow (which is) trapped (by methane in the atmosphere) if no other mark is awarded, allow **1** mark for methane absorbs long(er) wavelength radiation **or** methane absorbs ir / infra-red radiation	1	
08.3	(add) bromine (water)	do **not** accept bromide	1	AO1 4.7.1.4 4.7.2.1
	(changes from) orange to colourless	dependent on correct test in MP1 allow (changes from) brown to colourless ignore clear	1	4.7.2.2
Total			**8**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
09.1	glowing splint	do **not** accept burning splint	1	AO1 4.8.2.2
	(which) relights	dependent on correct test in MP1 ignore with a pop	1	
09.2	place the conical flask in a water bath at constant temperature.		1	AO3 4.6.1.2
	use a mass of 1 g manganese dioxide each time.		1	
09.3		an answer of 0.092 (cm^3/s) scores **3** marks allow an answer of 0.091666 (cm^3/s) correctly rounded to at least 2 significant figures for **2** marks allow an answer of 0.033 (cm^3/s) for **2** marks allow an answer of 0.033333 (cm^3/s) for **1** mark		AO2 4.6.1.1
	11 (cm^3) **and** 120 (seconds)		1	
	(mean rate of reaction = $\frac{11}{120}$) = 0.09167	allow a correct calculation using incorrectly determined value(s) for difference in volume and / or time	1	
	= 0.092 (cm^3/s)	allow a correctly calculated answer given to 2 significant figures from an incorrect attempt at the rate equation	1	

09.4	line starts at origin **and** less steep than solid line		1	AO2
	line levelling off at 40 (cm^3)	allow a tolerance of ± ½ a small square	1	AO3 4.6.1.2
09.5	(because) surface area (of fine manganese dioxide powder) greater	allow converse for coarse lumps	1	AO2 4.6.1.2 4.6.1.3
	(so) more collisions (with hydrogen peroxide molecules / particles) per unit time	do **not** accept references to changes in kinetic energy or speed (of molecules / particles) ignore references to activation energy.	1	
Total			**11**	

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	$\frac{6}{34} \times 100$	an answer of 17.6470588 (%) correctly rounded to at least 2 significant figures scores **2** marks	1	AO2 4.3.3.2
	= 17.6 (%)	allow 17.6470588 (%) correctly rounded to at least 2 significant figures	1	
10.2	higher yield (of hydrogen or carbon monoxide or product)	allow converse arguments in terms of higher pressure ignore references to rate allow more hydrogen or more carbon monoxide or more product allow equilibrium moves to the right allow equilibrium moves in the forward direction	1	AO2 4.6.2.4 4.6.2.7
	(because) fewer moles / molecules / particles on left hand side **or** (because) more moles / molecules / particles on right hand side	allow (because) the reverse reaction produces fewer moles / molecules / particles **or** allow (because) the forward reaction produces more moles / molecules / particles do **not** accept fewer / more atoms	1	
10.3	no effect (on yield of hydrogen)	allow position of equilibrium unaffected by pressure ignore references to rate of reaction	1	AO2 4.6.2.7

		an answer of 2.25 scores **3** marks		AO2 4.10.4.1
10.4	350 (°C) and 285 (atmospheres) = 63 (%) **and** 450 (°C) and 200 (atmospheres) = 28 (%)	allow a value between 62 (%) and 64 (%) inclusive	1	
	$\frac{63}{28}$	allow a correct expression using incorrectly determined value(s) for percentage yield	1	
	= 2.25 (times greater)	allow a correct calculation using incorrectly determined value(s) for percentage yield correctly evaluated and rounded to at least 2 significant figures	1	
10.5	any **one** from: • the energy costs would be high(er) • the equipment would need to be strong(er) • high(er) pressures are (more) dangerous	allow converse arguments in terms of low(er) pressure ignore energy / cost unqualified allow the equipment would be (more) expensive (to build / maintain) allow (more) dangerous because (greater) risk of explosion	1	AO1 4.10.4.1
10.6	higher temperatures produce a lower (percentage) yield (of ammonia)	allow converse allow correct reference to shift in equilibrium ignore references to pressure	1	AO2 4.6.2.6 4.10.4.1
10.7	world population has increased any **one** from: • demand for fertiliser has increased • increased demand for other specified ammonia-based products e.g. nitric acid, drugs, dyes, explosives	allow more food needed	1 1	AO3 AO1 4.10.4.1 4.10.4.2
Total			**12**	

AQA

GCSE
PHYSICS
8463/1H

Paper 1 Higher Tier

Mark scheme

June 2019

Version: 1.0 Final

1 9 6 G 8 4 6 3 / 1 H / M S

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1.1	The energy transferred each second to the bulb.		1	4.1.1.4 AO1
1.2	power = potential difference × current **or** $P = VI$		1	4.2.4.1 AO1
1.3	$40 = I \times 230$ $I = \frac{40}{230}$ $I = 0.17$ (A)	an answer of 0.17 (A) scores **3** marks a correct answer that rounds to 0.17 (A) scores **3** marks	1 1 1	4.2.4.1 AO2
1.4	efficiency = $\frac{\text{useful power output}}{\text{total power input}}$		1	4.1.2.2 AO1
1.5	$0.30 = \frac{\text{useful power output}}{9.0}$ useful power output = 0.30 × 9.0 useful power output = 2.7 (W)	an answer of 2.7 (W) scores **3** marks	1 1 1	4.1.2.2 AO2
1.6	bulbs also transfer thermal energy the efficiency of the light bulb also needs to be considered	allow light bulbs emit infrared radiation as well as visible light ignore so people know how bright the bulb is allow the cost to power the light bulb depends on the efficiency allow to see how much energy is wasted	1 1	4.1.2.2 4.1.1.4 AO1 AO3
Total			**11**	

Question 2

Question	Answers		Mark	AO/ Spec. Ref.
2.1	**Level 3**: The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.		5–6	RP2 WS2.2 4.1.2.1 AO1
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.		3–4	
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.		1–2	
	No relevant content		0	
	Indicative content • Wrap N layers of newspaper around the metal can • Heated water in a kettle **or** Using a Bunsen burner • Put hot water in the metal can • Use a measuring cylinder to measure the volume of water • Measure initial and final temperature with the digital thermometer • Use a stopclock / stopwatch to measure a time of 5 minutes • Calculate temperature decrease • Repeat with different number of layers of newspaper • Repeat with no layers of newspaper • Use same initial temperature of hot water • Use same volume of water each time Level 3: Workable method which includes changing the number of layers and includes at least one control variable (same volume of water or same starting temperature)			
2.2	the digital thermometer and the datalogger have the same resolution	allow both measure to 1 d.p. ignore accuracy ignore precision they give the same result is insufficient	1	RP2 WS2.3 4.1.2.1 AO3
	only need to measure the start and end temperature **or** only need 2 readings **or** only need to calculate the temperature change		1	
Total			**8**	

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
3.1	$41 = \frac{9.8 \times h}{0.12}$ $h = \frac{41 \times 0.12}{9.8}$ h = 0.50 (m)	an answer of 0.50 scores **3** marks allow a correct answer that rounds to 0.50 for **3** marks	1 1 1	4.1.1.2 AO2
3.2	kinetic energy = 0.5 × mass × (speed)^2 ***or*** $E_k = ½ mv^2$		1	4.1.1.2 AO1
3.3	$270 = ½ \times m \times 3^2$ $m = \frac{270}{(½ \times 3^2)}$ **or** $m = \frac{270}{4.5}$ m = 60 (kg)	an answer of 60 (kg) scores **3** marks	1 1 1	4.1.1.2 AO2

3.4	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar / different is made clear.		3–4	WS3.5 4.1.1.2 AO3
	Level 1: Relevant features are identified and differences noted.		1–2	
	No relevant content		0	
	Indicative content • males have a greater muscle power than females for most of their lives • males have a greater muscle power than females above 9/10 years old • males have a lower muscle power than females below 9/10 years old • there is a similar pattern for males and females as age increases • males have a peak muscle power at 25 years old whereas females have a peak muscle power at 20/21 years old • at 9/10 years old males have the same muscle power as females • peak muscle power for males (47 W/kg) is greater than peak muscle power for females (37 W/kg) • the rate of increase of muscle power is greater for males than females (between 5 and 25 years old) • the rate of decrease of muscle power is greater for males than females. Ignore comments relating to strength			
3.5	any **1** from: • maximum height reached is a better indicator of maximum muscle power • maximum / peak muscle power was being investigated, not mean / average muscle power • volunteer may not use maximum effort on the first try • performance may improve with practise • performance may get worse with tiredness	allow maximum time in the air for maximum height reached / jumped	1	WS3.7 4.1.1.4 AO3
Total			**12**	

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4.1	electric car journey will take a (much) longer time	allow diesel car journey will take a shorter time	1	4.1.3 AO3
	(because) battery will need recharging **or** (because) the car will need to stop for 40 minutes	allow diesel car will not need to be refuelled	1	
4.2	energy stored in diesel = 45 × 51 = 2295 (MJ)		1	4.1.3 1AO1 1AO2
	energy stored in batteries = 0.95 × 280 = 266 (MJ)		1	1AO3
	(so) the diesel stores more energy than the battery (and the diesel car has a higher range)	this mark is dependent on correct calculations of energy stored	1	
4.3	any **2** from: • recharging is a continuous process	allow cars do not need to stop to recharge allow shorter journey times allow don't have to wait for battery to recharge allow longer time between recharges allow the range of the electric car is increased	2	4.1.3 AO1
	• fewer cells needed in the car	allow smaller battery needed in the car		
	• more cars can be charged at the same time	allow do not need to find a charging point allow fewer charging stations needed ignore it is quicker ignore cost of charging ignore methods of electricity generation		

4.4	when cars are plugged in the energy from car batteries could be transferred back to the National Grid	 allow mains supply for National Grid allow energy from car batteries could be used to power household appliances	1 1	4.1.3 AO1
Total			**9**	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5.1	$^{206}_{82}Pb$		1 1	4.4.2.2 AO1
5.2	alpha radiation is highly ionising causing an increased risk of cancer **or** organ failure **or** radiation sickness / poisoning **or** mutation of genes / DNA **or** damage to cells / tissues / organs until the radioactive material is removed / excreted **or** activity of radioactive material reaches / approaches background radiation levels	 allow kill cells allow all the alpha radiation is absorbed by the body ignore references to half-life	1 1 1	4.4.2.4 AO1
5.3	$\frac{414}{138} = 3$ (half-lives) $1.45 \times 10^{-4} \times 2 \times 2 \times 2$ $= 1.16 \times 10^{-3}$ (g) **or** = 0.00116 (g)	an answer of 1.16×10^{-3} (g) scores **3** marks	1 1 1	4.4.2.3 AO2
Total			**8**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6.1	50		1	4.2.3.1 AO1
	Hz / hertz	allow Hertz	1	
6.2	(both) switches need to be closed / on		1	4.2.2 AO1
	to complete the series circuit **or** to allow charge to flow **or** so there is a current in the circuit		1	
6.3		an answer of 7.5 (A) scores **3** marks an answer of 0.237(A) scores **2** marks		4.2.4.1 AO2
	$1800 = I^2 \times 32$	this mark may be awarded if P is incorrectly or not converted	1	
	$I^2 = \frac{1800}{32}$ **or** $I^2 = 56.25$	this mark may be awarded if P is incorrectly or not converted	1	
	I = 7.5 (A)	this answer only	1	
6.4		an answer of 300 (s) scores **3** marks an answer of 300 000 (s) scores **2** marks		4.1.1.4 AO2
	$1500 = \frac{450\ 000}{t}$	this mark may be awarded if P is incorrectly or not converted	1	
	$t = \frac{450\ 000}{1500}$	this mark may be awarded if P is incorrectly or not converted	1	
	t = 300 (s)	this answer only	1	
Total			**10**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7.1		an answer of 2.5 (m) scores **3** marks		4.1.1.2 AO2
	$1470 = 60 \times 9.8 \times h$	this mark may be awarded if E_p is incorrectly/not converted	1	
	$h = \frac{1470}{60 \times 9.8}$ **or** $h = \frac{1470}{588}$	this mark may be awarded if E_p is incorrectly/not converted	1	
	h = 2.5 (m)	this answer only	1	
7.2	(work done against) air resistance **or** (work done against) friction (between zip line and pulley)		1	4.1.1.1 AO1
	causes thermal energy to be transferred to surroundings	ignore sound energy	1	
7.3	different people have different surface areas	allow streamlining allow body position body size is insufficient	1	4.1.1.1 4.1.1.2 AO1
	so would be affected by air resistance differently		1	
	OR			
	initial speed may not be zero (1)			
	which would add to the total energy (of the system) (1)			
		allow people have different masses / weights (1)		
		so people have different terminal velocities (1)		
		reference to mass changing the kinetic energy or gravitational potential energy negates both these marks		
Total			**7**	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8.1	Initial temperature was a control variable		1	WS3.7 4.3.2.2 AO3
8.2	copper greater change in mass (than the other metals)	 this mark is dependent on scoring the first mark allow more ice melted (than the other metals) allow the ice melted faster (than the other metals)	1 1	4.1.2.1 AO3
8.3	variation in initial mass of ice cube **or** surface area of the ice cube touching the metal	allow variation in initial volume of ice cube allow melting of ice while handling allow variation in room temperature allow initial temperature of metal block	1	WS3.7 4.1.2.1 AO3

8.4	$E = m \times 2100 \times 15$ $E = m \times 334\,000$ $5848 = 31\,500\ m + 334\,000\ m$ **or** $5848 = 365\,500\ m$ $m = \frac{5848}{(31\,500 + 334\,000)}$ **or** $m = \frac{5848}{(365\,500)}$ $m = 0.016$ (kg)	an answer of 0.016 (kg) scores **5** marks allow **2** marks for an answer that rounds to 0.186 or 0.0175 if no other mark scored allow **1** mark for either $5848 = m \times 2100 \times 15$ **or** $5848 = m \times 334\,000$	1 1 1 1 1	4.3.2.2 4.3.2.3 AO2
Total			**9**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
9.1	metre rule has a <u>lower</u> resolution	allow metre rule has a resolution of 1mm / 1cm fewer decimal places is insufficient	1	WS2.3 RP5 4.3.1.1 AO1
	so is less accurate (than the micrometer screw gauge)		1	
9.2	record the value of the zero error when there is no object on the balance		1	RP5 4.3.1.1 AO3
	subtract / add the value of the zero error		1	
9.3		an answer of 0.0502 (kg) scores **5** marks		RP5 4.3.1.1 AO2
	$V = (18.45 \times 10^{-3})^3$ **or** $V = 0.01845^3$	this mark may be awarded if width is incorrectly / not converted	1	
	$V = 6.28 \times 10^{-6}$ (m^3)	this answer only	1	
	$8.0 \times 10^3 = \frac{m}{6.28 \times 10^{-6}}$	allow $8.0 \times 10^3 = \frac{m}{\text{their calculated V}}$	1	
	$m = 8.0 \times 10^3 \times 6.28 \times 10^{-6}$	allow $m = 8.0 \times 10^3 \times$ their calculated V	1	
	m = 0.0502 (kg)	allow an answer consistent with their calculated V	1	
Total			**9**	

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	non-contact (force)	allow electrostatic (force)	1	4.2.5.2 AO1
	attraction (between hair and balloon)	allow repulsion between the hairs on the head	1	
10.2		an answer of 2.0×10^{-6} (C) scores **3** marks an answer of 2×10^{-3} (C) scores **2** marks		4.2.4.2 AO2
	$0.0050 = Q \times 2500$	this mark may be awarded if pd is incorrectly or not converted	1	
	$Q = \frac{0.0050}{2500}$	this mark may be awarded if pd is incorrectly or not converted	1	
	$Q = 2.0 \times 10^{-6}$ (C) **or** Q = 0.0000020 (C)	these answers only	1	
10.3		an answer of 120 (Ω) scores **5** marks		4.2.1.2 4.2.1.3 AO2
	$0.16 = I \times 4.0 \times 10^{-3}$ **or** $I = \frac{0.16}{4.0 \times 10^{-3}}$	this mark may be awarded if time is incorrectly / not converted	1	
	I = 40 (A)	this value only	1	
	$4800 = 40 \times R$	allow 4800 = their calculated I × R	1	
	$R = \frac{4800}{40}$	allow R = 4800 / their calculated I	1	
	R = 120 (Ω)	allow an answer consistent with their calculated I	1	
Total			**10**	

Question 11

Question	Answers	Extra information	Mark	AO / Spec. Ref.
11.1	the (mean) kinetic energy of the particles increases	allow the (mean) speed of the particles increases 'kinetic energy increases' is insufficient by itself do not accept particles vibrating	1	4.3.2.1 AO1
	which increases the (internal) energy of the water	ignore description of evaporation	1	
11.2	Particles in a gas have more potential energy than particles in a liquid.		1	4.3.1.1 AO1
11.3	Energy given to water E = mL with quantities defined		1	4.3.3.1 AO1
	power output (of Bunsen burner) $= \frac{\text{energy transferred (to water)}}{\text{time}}$	allow $P = \frac{E}{t}$ with quantities defined	1	
	power output $= \frac{\text{change in mass} \times \text{specific latent heat}}{\text{time}}$	allow E = Pt equated with E = mL or stated in words **or** $P = \frac{mL}{t}$ with quantities defined	1	
	time should be converted to seconds **or** use a time of 300 seconds		1	
Total			**7**	

AQA

GCSE
PHYSICS
8463/2H

Higher Tier Paper 2

Mark scheme

June 2019

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the Examiner make his or her judgement
- the Assessment Objectives, level of demand and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name two planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. Full marks can, however, be given for a correct numerical answer, without any working shown.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term.

3.7 Brackets

(.....) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
1.1	focal length	this answer only	1	AO1/1 4.6.2.5
1.2	one correct line drawn from the top of the object, passing through the lens and crossing or meeting given line inverted image drawn at the correct position and length	ignore any arrow drawn on the line if two lines are drawn, both must be correct arrowhead required	1 1	AO2/2 4.6.2.5
1.3	similarity (both are) diminished difference concave is <u>virtual</u> and convex is <u>real</u> **or** concave is upright and convex is inverted	 allow smaller for diminished a comparison must be made ignore reference to positions of images	1 1	AO3/2a 4.6.2.5
1.4	$6.0 = \frac{9.0}{\text{object height}}$ $\text{object height} = \frac{9.0}{6.0}$ object height = 1.5 (mm)	an answer of 1.5 (mm) scores **3** marks provided working can be seen, an attempt to convert 9.0 mm to cm or m with all other steps correct scores **2** marks	 1 1 1	AO2/1 4.6.2.5
Total			**8**	

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
2.1	metre rule	allow metre ruler allow tape measure do not accept ruler do not accept metre stick	1	AO1/2 4.6.1.2 RPA8
2.2	(wave) speed = frequency × wavelength	allow v = f λ	1	AO1/1 4.6.1.2 RPA8
2.3	 80cm = 0.8m v = 55 × 0.8 v = 44 (m/s)	an answer of 44 (m/s) scores **3** marks this mark may be awarded if wavelength is incorrectly or not converted allow correct calculation using an incorrectly or not converted wavelength an answer of 4400 (m/s) scores **2** marks	 1 1 1	AO2/1 4.6.1.2 RPA8
2.4	move the (wooden) bridge to the right OR change the mass/weight (on the string) scores **1** mark add more masses/weights (to the string) scores both marks	 dependent on 1st mp being scored	1 1	AO2/2 4.6.1.2 RPA8

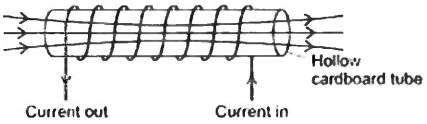
2.5	**Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO3/3a 4.6.1.2 RPA8
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content add or take away masses from the string (ignore any stated values) adjust frequency using the signal generator and/or move the wooden bridge observe a steady / stationary pattern measure the wavelength calculate wave speed from frequency and wavelength a Level 1 answer should include a way of changing tension a complete Level 2 answer would include either changing frequency and/or moving the bridge		
Total		**11**	

Question 3

Question	Answers	Mark	AO/ Spec. Ref
3.1	**Level 3**: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO1/1 AO2/1 4.5.6.3.2 4.5.6.3.3
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	
	No relevant content	0	
	Indicative content • reaction time explained in terms of longer reaction times increase thinking distance (from a given speed) • taking drugs • drinking alcohol • tiredness • age • distractions explained in terms of the effect on driver's reaction time • speed explained in terms of the faster the vehicle the greater the distance travelled in the driver's reaction time (or converse) **OR** explained in terms of increased speed increases KE so increases work done to stop the vehicle • condition of the tyres • condition of road surface • wet/icy roads explained in terms of condition of tyres and road surface (including weather considerations) affecting <u>friction</u> (between tyres and road) • condition of brakes explained in terms of effect on braking force (applied to the wheels) or reduced <u>friction</u>		

	• mass / weight of vehicle explained in terms of deceleration force or kinetic energy or change in momentum answers do not need to reference thinking / braking distance a Level 1 answer would list factors only **or** one factor with one linked explanation a Level 2 answer lists at least three factors with one linked explanation **or** two factors with two linked but different explanations a Level 3 answer lists at least three factors with at least two linked but different explanations			
3.2	work (done) = force x distance	allow W = F s	1	AO1/1 4.5.2
3.3	900 000 = 60 000 × distance distance = $\frac{900\,000}{60\,000}$ distance = 15 (m)	an answer 15 (m) scores **3** marks	1 1 1	AO2/1 4.5.2
3.4	brakes overheating **or** brakes locking (causing) loss of control **or** (causing) a skid	allow brake fade allow wheels locking allow increasing the stopping / braking distance **ONLY** if the first marking point is scored ignore any effects on passengers or possible accidents	1 1	AO1/1 4.5.6.3.4
Total			**12**	

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
4.1	field lines going in, (through) and out of the solenoid	 allow field lines only visible outside the cardboard tube allow a bar magnet shaped field with lines above and below the solenoid	1	AO1/1 4.7.2.1
	arrow(s) in correct direction		1	
4.2	the rods become (induced) magnets	allow the rods are (temporarily) magnetised ignore rods repel do not accept rods become charged	1	AO1/1 4.7.1.1
	with the same polarity (at each end)		1	
4.3	changed two (independent) variables (at the same time)	allow need to keep current or number of turns constant allow should only change one variable (at a time) allow current and number of turns both changed ignore fair test	1	AO3/1b 4.7.2.1 WS2.7
	so it is not possible to know the effect of one (independent) variable or the other		1	
4.4	(increasing the current) increases the strength until the strength reaches a maximum value	allow weight (held) for strength of electromagnet ignore a given current value for when maximum strength happens	1	AO3/2b 4.7.2.1 WS3.5
4.5	increasing the number of turns from 10 to 20 increases the strength more than increasing from 20 to 30	a general trend is required	1	AO3/2b 4.7.2.1 WS3.5
Total			**8**	

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
5.1	wavelength	this answer only	1	AO1 4.8.2 iso
5.2	(extremely) hot and dense	ignore very small	1	AO1/1 4.8.2 iso
5.3	(directly) proportional	allow a correct description of direct proportionality ignore positive correlation	1	AO3/2b 4.8.2
5.4	6×10^{24}		1	AO2/2 4.8.2 WS4.4
5.5	the furthest galaxies are moving the fastest (this suggests) the universe is expanding (from a very small region)		1 1	AO1/1 4.8.2
5.6	expanding at (an ever) greater rate	allow expanding faster	1	AO3/1a 4.8.2
5.7	any **one** from: • detects false claims • detects inaccurate data • detects bias • verifies new data • provides a consensus (of opinion)	 allow provides credibility allow detects mistakes allow removes bias allow checks validity ignore shows data is accurate ignore proves a theory	1	AO1/1 4.8.2 WS 1.6
5.8	wavelength (seems to have) decreased frequency (seems to have) increased		1 1	AO2/1 4.8.2
Total			**10**	

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
6.1	the tendency of an object to continue in its state of rest or motion	allow how difficult it is to change the velocity of an object	1	AO1/1 4.5.6.2.1 iso
6.2	(soft foam) increases the time taken to stop or increases the time taken to decrease momentum	allow increases impact/contact time allow increases the time of the collision do not accept slows down time	1	AO1/1 4.5.7.3
	decreases the rate of change in momentum	allow reduces acceleration/deceleration reduces momentum is insufficient allow increases the time to reduce the momentum to zero for **2** marks	1	
	reducing the force (on the egg)	allow impact for force	1	

6.3		an answer 4.5 (m/s) scores **4** marks an answer 4500 scores **3** marks		AO2/1 4.5.7.3
	180 ms = 0.18 s	if incorrectly or not converted, subsequent marks may still be awarded for correct method and calculations	1	
	$800 = \frac{32 \times v}{0.18}$		1	
	$v = \frac{800 \times 0.18}{32}$		1	
	v = 4.5 (m/s)		1	
	Alternative method 180 ms = 0.18 s (1) $\Delta mv = 144$ (kgm/s) (1) $\Delta v = 144 \div 32$ (1) v = 4.5 (m/s) (1)			
	Alternative method 180 ms = 0.18 s (1) $a = 25$ (m/s^2) (1) $25 = \Delta v \div 0.18$ (1) v = 4.5 (m/s) (1)			
Total			**8**	

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
7.1	The frequency increases and the wave speed in air stays the same		1	AO1/1 4.6.2.1 iso
7.2	pass through soft tissue (but) absorbed by bone	allow penetrate for pass through allow skin/muscle/etc... for soft tissue pass through tissue is insufficient allow do not pass through bone do not accept reflected by bone	1 1	AO1/1 4.6.2.4
7.3	accept a sensible practical suggestion eg • complete the investigation standing up • use (slightly) cooler water • do not touch the hot cube	do not accept use cold water pour water in carefully is insufficient ignore wear safety goggles or gloves	1	AO2/2 4.6.2.2 WS2.4
7.4	distance between each side (of the cube) and the (infrared) detector	allow distance between cube and detector	1	AO1/2 4.6.2.2 WS2.2
7.5	measurements (for each surface) have not been repeated (to show that they cluster closely)	do not accept any answer for measurement should be repeated for any reason other than to show they cluster eg to show accuracy / average / anomalies would be wrong	1	AO3/3b 4.6.2.2 WS3.7
7.6	(the student) could not conclude that black surfaces always emit more (infrared) than a white surface (as) the reading for the matt white and shiny black would both be 66 (°C)	a (matt) white surface (appears to) emit(s) the same amount (of infrared) as a (shiny) black surface the conclusion is wrong is insufficient allow (as) the reading for the matt white and shiny black would be the same	1 1	AO3/1a/2b 4.6.2.2 WS2.2
7.7	0.0	allow 0 allow zero	1	AO1/1 4.6.3.1

7.8	at night, more radiation is emitted from the Earth than absorbed from space cloud reflects radiation (towards the Earth) at A, (there is no cloud cover so) a larger proportion of radiation will be emitted into space	 allow solar radiation for radiation 	1 1 1	AO1/1 4.6.3.2
Total			**12**	

Question 8

Question	Answers	Extra information	Mark	AO / Spec. Ref.
8.1	longer arrow pointing vertically downwards	one arrow only	1	AO2/1 4.5.1.4 4.5.6.1.5
	labelled weight	allow (force of) gravity	1	AO1/1 4.5.6.1.5
8.2	initially air resistance is less than weight / gravity so the skydiver accelerates	allow drag for air resistance allow increased velocity / speed for accelerates	1	AO3/1a AO1/1 AO2/1 4.5.6.1.4
	acceleration causes the air resistance to increase	acceleration **or** increased velocity / speed is not required here if given in the first mark point	1	4.5.6.1.5 4.5.6.2.1
	resultant force decreases to zero	allow air resistance becomes equal to weight / gravity	1	
	so the skydiver falls at terminal velocity	allow constant velocity/speed for terminal velocity ignore any mention of subsequent motion and use of parachute	1	
8.3		an answer of 50 (m/s) scores **3** marks		AO2 4.5.6.1.4
	distance at 7s = 200 (m) distance at 12s = 450 (m)	**both** distances required	1	
	speed = $\frac{450-200}{12-7}$ **or** $\frac{250}{5}$	allow correct use of their two distances divided by 5	1	
	50 (m/s)	allow an answer consistent with their two distances	1	

8.4	The higher the altitude the less dense the air so the air resistance on the skydiver (falling from 39000m) was less (at the same speed) so the skydiver was able to accelerate for longer before reaching (a higher) terminal velocity **or** so the skydiver was able to accelerate for longer before air resistance = weight / gravity	allow constant velocity/speed for terminal velocity	1 1 1	AO1/1 4.5.5.2 AO1/1 AO2/1
Total			**12**	

Question 9

Question	Answers	Extra information	Mark	AO / Spec. Ref.
9.1	chicken	allow a correct answer indicated in Table 3 provided the answer space in blank	1	AO3
9.2	2×10^{-6}		1	AO1/1 4.5.6.1.2 WS4.4
9.3		an answer 0.025 (m) scores **4** marks		AO2/1 4.6.1.5 4.5.6.1.2
	time = 8μs = 8×10^{-6} (s) or 4 × their answer to 9.2	subsequent marks may be scored if the number of squares is miscounted or t = 2μs is used	1	
	distance = ½ × 6300 × 8×10^{-6}	allow 8×10^{3} or 8×10^{-3} or 8×10^{-9} for 8×10^{-6}	1	
	distance = 0.0252 (m)	allow a correctly calculated answer using 8×10^{3} or 8×10^{-3} or 8×10^{-9}	1	
	distance = 0.025 (m)	allow a calculated value correctly rounded to 2 sig figs an answer 0.050 (m) scores **3** marks an answer 0.05 or 0.0504 (m) scores **2** marks	1	
9.4	to convert (the pressure variations in) sound (waves) into variations in current / p.d	allow electrical signal for variations in current / p.d. do not accept amplifies sound	1	AO1/1 4.7.3.3

9.5	sound (waves) cause the diaphragm to vibrate	diaphragm moves is insufficient	1	AO1/1 4.7.3.3
	the diaphragm causes the coil / wire to vibrate	do not accept moves the coil / wire up and down if m.p.1 and m.p.2 do not score, allow sound (waves) cause the coil / wire to vibrate for **1** mark	1	
	the coil / wire moves through the magnetic field **or** the coil / wire cuts magnetic field lines		1	
	a potential difference is <u>induced</u> (across the ends of the coil / wire)	allow <u>induced</u> current for <u>induced</u> p.d.	1	
Total			**11**	

Question 10

Question	Answers	Extra information	Mark	AO / Spec. Ref.
10.1	the (perpendicular) distance from the pivot / hinge to (the line of action of) the force is greater	allow distance from the rope to the pivot / hinge is greater (than distance between handle and pivot / hinge)	1	AO2/1 4.5.4
	so a smaller force is required	this mark is dependent on scoring the 1st mark an answer a smaller force is required at the rope to produce the same moment scores **2** marks	1	
10.2		an answer of 770 scores **6** marks		AO2/1 4.5.4 4.5.3
	$924 = F \times 0.15$		1	
	$F = 6160$ (N)	allow use of $E = \frac{1}{2} F e$ instead of $k = F \div e$ and $E = \frac{1}{2} \times k \times e^2$	1	
	$6160 = k \times 0.25$	allow their calculated $F = k \times 0.25$	1	
	$k = \frac{6160}{0.25}$ **or** $k = 24640$ (N/m)	allow a value for k calculated using their calculated F	1	
	$E = \frac{\frac{1}{2} \times 6160 \times 0.25 \times 0.25}{0.25}$	allow $E = \frac{1}{2} \times$ their calc. $k \times 0.25^2$	1	
	$E = 770$ (J)	allow an answer consistent with their calculated k	1	
Total			**8**	