M17/4/NATSC/SP2/ENG/TZ0/XX/M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

May 2017

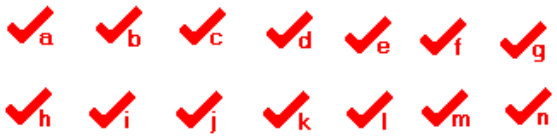
Nature of Science

Standard level

Paper 2

12 pages

The following are the annotations available to use when marking responses.

Annotation	Explanation	Shortcut
	Correct point (automatically awards 1 mark when stamped)	ALT 1
	These are annotations which can be used to show which marking point was used to award a mark. It is easier to use these than to pick up the tick stamp and then the text box (they each automatically award 1 mark when stamped)	
	Quality marks awarded for clarity and structure (these each automatically award 1 mark when stamped)	
	Pointer (use when you want to delete an annotation or change colour)	
	Benefit of the doubt	ALT 5
	Error carried forward	
	Irrelevant, a significant amount of material that does not answer the question	ALT 4
	Contradiction	
	Omission/incomplete	ALT 3
	Too vague	
	No working shown	
	Unclear	ALT 2

Annotation	Explanation	Shortcut
	This is a dynamic annotation; it can be used to surround work	
	This is a dynamic, vertical wavy line that can be expanded (for instance, to highlight a section of irrelevant work)	
	This is a dynamic, vertical wavy line that can be expanded (for instance, to highlight a section of irrelevant work)	
	Valid part (to be used when more than one element is required to gain the mark e.g. drawings)	
	Same as	
	Or words to that effect	ALT 6
	Advantage / pro (to identify elements in an unclear discussion when pairs are required).	
	Disadvantage / con (to identify elements in an unclear discussion when pairs are required)	
	Difference (to identify elements in an unclear comparison)	ALT 7
	Similarity (to identify elements in an unclear comparison	ALT 8
	Highlight, stamp and drag out to highlight an area of the script	
	Text box used for additional marking comments. It can be linked to a specific tick if that is appropriate (please see pages 7–8 for more information)	
	Seen; to be stamped on parts of a question or option which have been left blank.	ALT 9
0	Zero; to be used when a question part is not worthy of credit. Awards zero for the question part.	ALT 0

You **must** make sure you have looked at all pages. Please put the  annotation on any blank page, to indicate that you have seen it.

General Marking Instructions

Assistant Examiners (AEs) will be contacted by their team leader (TL) through RM™ Assessor, by e-mail or telephone – if through RM™ Assessor or by e-mail, please reply to confirm that you have downloaded the markscheme from IBIS. The purpose of this initial contact is to allow AEs to raise any queries they have regarding the markscheme and its interpretation. AEs should contact their team leader through RM™ Assessor or by e-mail at any time if they have any problems/queries regarding marking. For any queries regarding the use of RM™ Assessor, please contact emarking@ibo.org.

1. Follow the markscheme provided, award only whole marks and mark only in **RED**.

2. Make sure that the question you are about to mark is highlighted in the mark panel on the right-hand side of the screen.

3. Where a mark is awarded, a tick/check (✓) **must** be placed in the text at the **precise point** where it becomes clear that the candidate deserves the mark. **One tick to be shown for each mark awarded.**

4. Sometimes, careful consideration is required to decide whether or not to award a mark. In these cases use RM™ Assessor annotations to support your decision. You are encouraged to write comments where it helps clarity, especially for re-marking purposes. Use a text box for these additional comments. It should be remembered that the script may be returned to the candidate.

5. Personal codes/notations are unacceptable.

6. Where an answer to a part question is worth no marks but the candidate has attempted the part question, use the “ZERO” annotation to award zero marks. Where a candidate has not attempted the part question, use the “SEEN” annotation to show you have looked at the question. RM™ Assessor will apply “NR” once you click complete.

7. If a candidate has attempted more than the required number of questions within a paper or section of a paper, mark all the answers. RM™ Assessor will only award the highest mark or marks in line with the rubric.

8. Ensure that you have viewed **every** page including any additional sheets. Please ensure that you stamp “SEEN” on any additional pages that are blank or where the candidate has crossed out his/her work.

9. Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have got wrong. However, a mark should not be awarded where there is contradiction within an answer. Make a comment to this effect using a text box or the “CON” stamp.

Subject details: Nature of science standard level paper 2 markscheme

Candidates are required to answer **all** questions in Section A and Section B. Maximum total = **45 marks**.

1. Each row in the "Question" column relates to the smallest subpart of the question.

2. The maximum mark for each question subpart is indicated in the "Total" column.

3. Each marking point in the "Answers" column is shown by means of a tick (✓) at the end of the marking point.

4. A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

5. An alternative word is indicated in the "Answers" column by a slash (*/*). Either word can be accepted.

6. An alternative answer is indicated in the "Answers" column by "***OR***". Either answer can be accepted.

7. An alternative markscheme is indicated in the "Answers" column under heading **ALTERNATIVE 1** *etc*. Either alternative can be accepted.

8. Words inside chevrons **« »** in the "Answers" column are not necessary to gain the mark.

9. Words that are <u>underlined</u> are essential for the mark.

10. The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

11. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the "Answers" column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect) in the "Notes" column.

12. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

13. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script.

14. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

Question			Answers	Notes	Total
1.	a		a. mean ΔT = 20 «°C» ***OR*** «heat produced =» 100 «g» × 20.0 × 4.18 «J g^{-1}» ✓ b. 8360 J ✓	*For mp b: units required.*	**2 max**
	b		a. ethanol ✓ b. energy generated per gram of fuel is higher for ethanol ***OR*** 1.5 g of ethanol produced 8275 J of energy whereas 2 g of methanol produced 8360 J of energy ✓	*Remember to allow ECF.* *OWTTE*	**2**
	c		a. not all the energy produced is transferred to the water ✓ b. some heat is lost to the air/surroundings ✓ c. some heat is used to heat up the metal container ✓ d. there is an error in measuring the masses/temperatures ***OR*** margin of error ✓ e. instrumental/systemic/calibration error ***OR*** better equipment/ideal conditions/better experimental design ✓		**3 max**
	d		a. ethanol contains more bonds than methanol ✓ b. ethanol contains more C and H «atoms» ✓ c. energy is released when bonds are broken ✓	*Accept vice versa*	**2 max**
	e		a. from sound wave energy to kinetic energy ✓ b. kinetic to sound wave ✓ c. kinetic to electrical ✓ d. electrical to kinetic ✓	*Allow sound wave to electrical **OR** electrical to sound wave.*	**1 max**

Question			Answers	Notes	Total
	f		a. mobile phones consist of plastics/«precious» metals/rare earth elements ✓ b. need extraction/transportation of «rare earth» metals ***OR*** damage to environment ✓ c. some of these resources «*eg* rare earth elements» are in short supply/have limited known reserves/are expensive ✓ d. stimulates/forces scientific research into replacing these limited resources ✓ e. stimulates recycling of mobile phones ✓		**2 max**

Question			Answers	Notes	Total
2.	**a**		Hertzsprung–Russell ***OR*** HR diagram ✓		**1**
	b	**i**	between $10^3/10^4$ and 10^6 **«**L_{Sun}**»** ✓		**1**
	b	**ii**	a. red supergiants begin their life on the main sequence ✓ b. red supergiant evolves from an **«**expanding**»** red giant **«**that has run out of helium/He as fuel**»** ✓ c. as they age they use up their nuclear fuel/helium/He ✓ d. they expand/cool down ***OR*** move away from the main sequence ✓		**2 max**
	c		with increasing surface temperature, decreased life span ***OR*** inverse relationship ✓	*Accept vice versa*	**1**
	d		a. increased surface temperature is an indication of increased internal temperature ✓ b. increased internal temperature promotes/allows for increased rate of fusion ✓ c. increased fuel consumption/rate of fusion reduces lifetime ✓		**2 max**
	e		a. fusion **«**reaction**»** ✓ b. fusion of hydrogen into helium ✓ c. **«**some**»** fusion of helium into heavier elements ✓		**2 max**
	f		a. each element in **«**its gaseous/excited state**»**, produces a unique spectrum ✓ b. **«**this spectrum**»** allows individual elements to be identified ✓ c. chemical composition of a star can be determined by comparing the spectrum of the star with spectra of known elements ✓		**2 max**

Question			Answers	Notes	Total
3.	**a**		highest: 5800 × 0.9 = 5220 **«**fatalities**»** ✓		**1**
	b		a. may help to contain the virus in certain areas protecting people outside the area ***OR*** may prevent outbreaks in other parts of the country ✓ b. **«**implies**»** needs of the many outweigh the needs of the few/utilitarian/public interest ✓ c. increases the risk of those in the containment area ***OR*** does not stop the spread of the virus in the containment area ✓ d. facilitates the work of health workers, so more people are protected in the area ✓ e. **«**may**»** need to use force to maintain quarantine ***OR*** may cause mass panic ✓ f. preventing people from moving away from infected patients is unethical ***OR*** against human rights ✓	*OWTTE*	**4 max**
	c		a. education/media/advertising ***OR*** scientific understanding of disease transmission ✓ b. avoid all skin to skin/body fluids contact ***OR*** unprotected sex ***OR*** less physical contact with infected people **«**ebola**»**✓ c. wear protective clothing/preventative equipment ✓ d. burn bedding and other material that has been in contact with infected patients ✓ e. leave the area before becoming infected ***OR*** restrict entry into infected areas ✓ f. ban trade in bush meat ***OR*** proper disposal of infected animals ***OR*** avoid contact with animals ✓ g. use of vaccines ✓		**3 max**

Question			Answers	Notes	Total
	d	**i**	post hoc ergo propter hoc ***OR*** false cause ✓		**1**
	d	**ii**	if an occurrence A is seemingly directly followed by an event B, B must be caused by A ✓	*OWTTE*	**1**
	d	**iii**	a. research paper sent to scientific journal for evaluation by experts/peers **«**in the same field**»** ✓ b. experts check scientific methodology/prior publications/validity of conclusions/conflict of interest ✓ c. experts recommend publication or sent back with recommendations ***OR*** peer reviewed publication is credible ✓	*Peer review refers only to the appraisal of the paper; it is not about replication of results/experiments.*	**2 max**

Question			Answers	Notes	Total
4.	a		catalytic converter ***OR*** development of the electric car ***OR*** hybrid technology ✓		**1**
	b		a. evidence should be obtained/evaluated by independent research/non-motor industry sources ***OR*** no conflict of interest/unbiased ***OR*** international collaboration ✓ b. «independent» quantitative data ***OR*** collect more data ✓ c. «independent» results on CO_2 emissions **«**from diesel and petrol driven cars**»** ✓ d. comparison of NO_x emissions ✓ e. comparison of particulate matter/$PM_{2.5}$ emissions ✓ f. «independent» research on health effects ✓		**4 max**
	c		a. devising accurate tests ***OR*** testing well controlled ***OR*** testing should be independent ***OR*** testing in labs not on roads ✓ b. companies cheat with special software ***OR*** companies may not comply ✓ c. some drivers remove filters/catalytic converters to improve driving performance ✓ d. sampling size/method ***OR*** **«**logistics**»** of testing all cars ✓ e. selecting penalties for non-compliance/breaking the law ✓ f. removal/replacement of old cars ✓ g. cost of program/enforcing legislation ✓	*OWTTE*	**3 max**
	d		a. it is a global issue ***OR*** CO_2 does not respect national boundaries ***OR*** total CO_2 emissions is sum of all national emissions ✓ b. individual national targets may be too low ✓ c. no individual nation or region has the capacity to achieve the **«**IPCC**»** global targets ✓		**2 max**