Diploma Programme
Programme du diplôme
Programa del Diploma

Nature of science
Standard level
Paper 2

Tuesday 15 May 2018 (morning)

Candidate session number

1 hour

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[45 marks]**.

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Answer **all** questions. Answers must be written within the answer boxes provided.

1. Ecosystems found near deep ocean hydrothermal vents survive under extreme conditions. Deep ocean chemosynthetic bacteria use inorganic chemicals as a source of energy and are consumed by other organisms, including giant tubeworms (*Riftia pachyptila*) shown below.

[Source: https://en.wikipedia.org]

(a) Fossils provide evidence that deep ocean bacteria may be the oldest living organisms on Earth. Outline the basis for this conclusion. [2]

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(b) Outline **two** reasons that oxygen was unavailable to early chemosynthetic bacteria. [2]

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(Question 1 continued)

(c) Evaluate the hypothesis that deep ocean hydrothermal vents played a role in the origin of the first living organisms. [3]

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(d) Laboratory experiments, confirm that organic molecules can be synthesized through interactions between inorganic molecules. This suggests another possibility of how life on Earth may have originated. Comment on this alternative hypothesis. [3]

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(e) Active hydrothermal vents may exist on the moons of Jupiter and Saturn. Outline the value of investigating the existence of these hydrothermal vents. [2]

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2. The Arab scientist Ibn al-Haytham (965–1040 CE) made significant contributions to the understanding of vision and optics. He investigated reflection and refraction, overturning an earlier theory that light rays coming from the eye explained sight.

(a) It has been suggested that his work resulted in a paradigm shift. Outline what is meant by a paradigm shift. [1]

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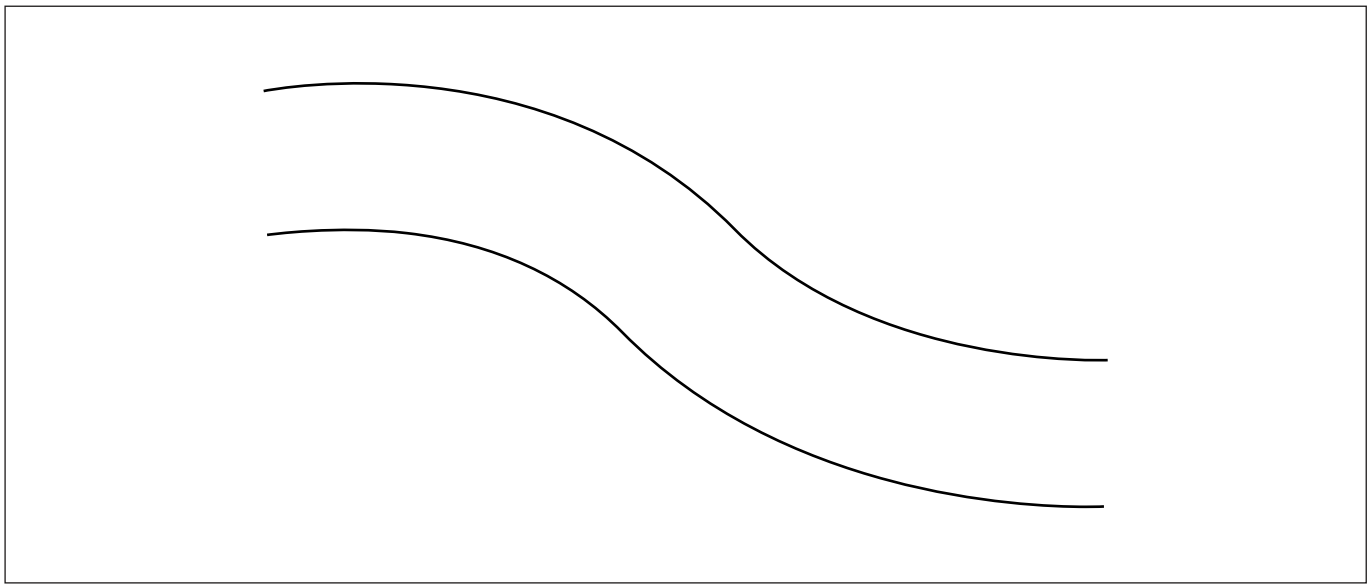
(b) (i) Sketch the path of a ray of light in the optical fibre section in the following diagram. [2]



[Source: International Baccalaureate Organization, 2017]

(ii) State the process that allows all the light to pass through the optical fibre. [1]

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(Question 2 continued)

(c) In communication technology, distinguish between the use of optical fibres and copper wires. [3]

Optical fibres	Copper wires

(d) Ibn al-Haytham was also a pioneer in the development of experimentation to collect evidence. Describe the methods used in the modern scientific approach. [4]

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3. The Atacama Large Millimeter/submillimeter Array (ALMA) is composed of 66 high precision antennae, located on the remote, high altitude Chajnantor Plateau in Chile's Atacama desert.

[Source: www.almaobservatory.org]

(a) (i) State the type of electromagnetic waves detected by ALMA. [1]

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(ii) Suggest possible information that scientists could obtain using the data collected from ALMA. [2]

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(b) Outline why the high altitude and dry conditions in the Andes mountains are necessary for the best performance of ALMA. [2]

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(Question 3 continued)

(c) ALMA is a partnership between Europe, North America, East Asia and Chile. Discuss the benefits of international cooperation in scientific research. [3]

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4. Throughout history, various models have been used to explain the structure of matter. J J Thomson's 1904 model of the atom is shown in the following diagram.

[Source: adapted from http://culturesciences.chimie.ens.fr]

(a) (i) Explain how this model was falsified. [3]

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(ii) These findings were published in a scientific journal. Outline the importance of this process in communicating scientific knowledge. [2]

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(Question 4 continued)

(b) The European Organization for Nuclear Research (CERN) operates the Large Hadron Collider in Geneva, Switzerland. Discuss the evidence from this particle physics laboratory that has changed current understanding of subatomic structure. [3]

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5. The table shows the percentage of vitamins in milk when heated for different lengths of time at a constant temperature.

Heating time / min	Vitamin A / %	Vitamin C / %	Vitamin B6 / %	Vitamin B12 / %	Folate / %	Riboflavin / %	Thiamin / %
0	100	100	100	100	100	100	100
10	100	85	90	80	85	100	90
30	100	65	75	55	80	100	75
60	100	45	55	40	70	100	60

[Source: www.ars.usda.gov]

(a) Calculate the difference in vitamin B12 retained when milk is heated from 10 to 60 minutes. [1]

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(b) Data on retention of vitamins in milk after heating were collected by scientists. List **two** variables that would need to be controlled for the results to be reliable. [2]

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(c) Using the table and scientific knowledge, evaluate heat treatment as a means of preserving milk. [3]

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