Oxford Cambridge and RSA

GCSE Physics B (Twenty First Century Science)

J259/03 Depth in physics (Higher Tier)

Question Set 21

1 A solar flare is an explosion on the surface of the Sun.

Solar flares release huge amounts of radiation, including visible light and X-rays.

(a) Describe **two** differences between visible light and X-rays.

[2]

(b) Sometimes when there is a solar flare, a huge cloud of gas is also forced out from the Sun.

Jack finds out the following information:

- Speed of X-rays in a vacuum 3.0×10^8 m/s
- Typical wavelength of X-rays: 0.10 nm
- Time taken for visible light to travel from the Sun to the Earth: 8.3 minutes
- Speed of cloud of gas: 500 000 m/s

(i) Use the data to calculate the typical frequency of X-rays.

Frequency = ... Hz **[3]**

(ii) Calculate the time taken, in minutes, for the cloud of gas to reach the Earth.

Time taken = ... minutes **[4]**

Total Marks for Question Set 21: 9

Mark scheme

The breakdown of Assessment Objectives for GCSE (9-1) Physics B:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Question			Answer	Marks	AO element	Guidance
1	(a)		**Any two from:** X-rays shorter wavelength / visible light longer wavelength ✓ X-rays higher frequency / visible light lower frequency ✓ X-rays higher energy (photons) / visible light lower energy (photons) ✓ X-rays ionising / visible light non-ionising ✓ X-rays not detectable by human eye / visible light detectable by human eye **OR** X-rays can penetrate the body / visible light cannot penetrate the body ✓	**2**	**1.1 × 2**	Mark point 1, 2 and 3 must be comparative **DO NOT ALLOW** X-rays are more ionising than visible light
	(b)	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 3.0×10^{18} (Hz) award 3 marks** recall and rearrange the wave equation to give frequency = speed ÷ wavelength ✓ conversion 0.10 (nm) = 1.0×10^{-10} (m) ✓ $3.0 \times 10^{8} \div 1.0 \times 10^{-10} = 3.0 \times 10^{18}$ (Hz) ✓	**3**	**1.2** **1.2** **2.1**	Maximum of one mark if incorrect conversion **ALLOW** $3 \times 10^{8} \div 0.1$ as evidence of a rearranged formula **ALLOW** 3×10^{18} / 3 000 000 000 000 000 000

Question			Answer	Marks	AO element	Guidance
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4980 (minutes) award 4 marks** recall and rearrange the speed equation to give e.g. distance = speed × time or time = distance ÷ speed ✓ recognise that speed of visible light = speed of X-rays ✓ distance travelled = $3 \times 10^8 \times (8.3 \times 60)$ **or** 1.494×10^{11} **or** $3 \times 10^8 \times 498$ ✓ time taken = $3 \times 10^8 \times 8.3 \div 500\,000 = 4980$ (minutes) **or** $1.494 \times 10^{11} \div (500\,000 \times 60) = 4980$ (minutes) ✓	**4**	**1.2** **1.1** **2.1 x2**	**ALLOW** max three marks if conversion from seconds to minutes omitted = 298800 seconds **ALLOW** max three marks if incorrect speed of light but all else is correct **ALTERNATIVE APPROACH:** t is proportional to 1/speed OR $t_{cloud}/t_{light} = v_{light}/v_{cloud}$ ✓ recognise that speed of visible light = speed of X-rays ✓ $t_{cloud} = (3 \times 10^8 \div 500\,000) \times 8.3$ ✓ = 4980 (minutes) ✓