

APOLLO

Fusion and stars

HL

Physics

First assessment 2025

16 questions | mark schemes

Mark-scheme answers

Physics HL | Paper 1A | May 2025 TZ1 | Q40 | 1 marks

40. D

Physics HL | Paper 1A | May 2025 TZ2 | Q40 | 1 marks

40. B

Physics HL | Paper 1A | May 2025 TZ3 | Q11 | 1 marks

11. A

Physics HL | Paper 1A | May 2025 TZ3 | Q38 | 1 marks

38. A

Physics HL | Paper 1A | May 2025 TZ3 | Q39 | 1 marks

39. D

Physics HL | Paper 1A | May 2025 TZ3 | Q40 | 1 marks

40. A

7.	a	i	Mention of core temperature and density ✓ Core temperature implies high kinetic energy/high speed OR needed to overcome repulsion/e.m. force ✓ Density needed to increase frequency/number/probability of collisions ✓	Ignore reference to mass. Do not award MP1 if radius and/or surface temperature are mentioned.	[3]
	a	ii	<<Inwards>> gravitational force/pressure/ ✓ <<Outwards>> thermal/gas/radiation pressure/force ✓		[2]
	b		$\Delta m = 2M_{H1} - (M_{H2} + m_e) =$ $2 \times 1.007276 - 2.013550 - 0.000549 \checkmark$ $= 4.53 \times 10^{-4} \text{ u}$ $Q = 4.53 \times 10^{-4} \times 931.5 = 0.422 \approx 0.42 \text{ MeV} \checkmark$	Accept $6.8 \times 10^{-14} \text{ J}$ as final answer. Award [1] for final answer of 0.93 MeV, if positron ignored. Award [1] for final answer of $1.5 \times 10^{-13} \text{ J}$ if positron ignored.	[2]
	c	i	Hydrogen mass to be lost $0.1 \times 1.5 \times 10^{30} \text{ OR } 1.5 \times 10^{29} \text{ kg} \checkmark$ Number of reactions per second $\frac{3.8 \times 10^{26}}{4.3 \times 10^{-12}} \text{ OR } 8.8 \times 10^{37} \text{ s}^{-1}$ OR Time for one reaction $\frac{4.3 \times 10^{-12}}{3.8 \times 10^{26}} \text{ OR } 1.1 \times 10^{-38} \text{ s}$ OR Total mass (4H or He-4) in each reaction is $4 \times 1.67 \times 10^{-27} \text{ kg} \checkmark$ $T = \frac{0.1 \times 1.5 \times 10^{30}}{8.8 \times 10^{37} \times 4 \times 1.67 \times 10^{-27}} \text{ OR } 2.5 \times 10^{17} \text{ s OR } 8.1 \times 10^9 \text{ a} \checkmark$	Award MP1 if seen isolated or in a calculation. Award MP2 if 4 x mass of H seen isolated or in calculation. Allow ECF from MP2 if they use H instead of 4H as the mass in each reaction.	[3]

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	c	ii	The luminosity/power output has remained constant ✓	Accept rate of fusion or similar.	[1]
	c	iii	$8.1 \times 10^8 \text{ years} = 2.5 \times 10^{17} \text{ seconds}$ OR Energy produced while on the main sequence $= L \times t \checkmark$ Mass loss $= \frac{3.8 \times 10^{26} \times 2.55 \times 10^{17}}{c^2} = 1.1 \times 10^{27} \text{ kg} \checkmark$		[2]
	d		$\lambda = \frac{2.9 \times 10^{-3}}{T} \checkmark$ $\lambda = 5.0 \times 10^{-7} \text{ m} \checkmark$		[2]
	e	i	P is approaching ✓ wavelength decrease ✓ mention of Doppler/blueshift ✓		[2 max]
	e	ii	$\frac{\Delta \lambda}{\lambda_0} = \frac{v}{c} \text{ AND } v = \frac{2\pi R}{T} \checkmark$ $T = \lambda_0 \frac{2\pi R}{c \Delta \lambda} \checkmark$ $T = 656.2797 \times \frac{2\pi \times 7.0 \times 10^8}{3 \times 10^8 \times 4.4 \times 10^{-3}} = 2.19 \times 10^6 \text{ s} \approx 25 \text{ days} \checkmark$	Do not penalize the use of observed wavelength.	[3]

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Question	Answers	Notes	Total
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Mark-scheme answers

Physics HL | Paper 1A | Nov 2025 TZ1 | Q39 | 1 marks

39. D

Physics HL | Paper 1A | Nov 2025 TZ1 | Q40 | 1 marks

40. C

Physics HL | Paper 1A | Nov 2025 TZ3 | Q39 | 1 marks

39. A

Physics HL | Paper 1A | Nov 2025 TZ3 | Q40 | 1 marks

40. B

2.	a		$1.63 \times 10^9 \checkmark$ and $3.84 \checkmark$	If they use more or fewer than 3 SF, max [1].	[2]
2.	b		manipulates SB law using logs $\checkmark$ relates 4 from SB to 3.99 in the equation of line of best fit as the same $\checkmark$		[2]
2.	c		$10^{-6.15} = \sigma 4\pi \checkmark$ $\sigma = 5.63 \times 10^{-8} \checkmark$	Award [1] for use of data point to solve for σ . Do not award NCA without working.	[2]
2.	d		ALTERNATIVE 1 the linear graph suggests that SB applies to stars $\checkmark$ ALTERNATIVE 2 the « accurate » calculation of σ from the data suggests that SB applies to stars $\checkmark$ ALTERNATIVE 3 « if 2c has a value of σ that is not accurate » the calculation of the σ from the data suggests SB does not apply to stars $\checkmark$		[1]
2.	e		Use a wider range of temperatures $\checkmark$	OWTTE	[1]

Mark-scheme answers

Physics HL | Paper 1A | Specimen 2025 | Q14 | 1 marks

14. B

Physics HL | Paper 1A | Specimen 2025 | Q33 | 1 marks

33. B

Physics HL | Paper 1A | Specimen 2025 | Q37 | 1 marks

37. A

7.	a	correct substitution into $\lambda_{\text{max}} = \frac{2.9 \times 10^{-3}}{T}$ OR 9350 K ✓		1
7.	b	Attempted use of $L = 4\pi bd^2$ ✓ use of $r = \sqrt{\frac{L}{4\pi\sigma T^4}}$ ✓ $r = 1.4 \text{ Gm}$ ✓	Accept a range of values between 1.3 to 1.5 Gm	3
7.	c	Shows $r \approx 2R_{\odot}$ ✓ Correct position on diagram	[use of 9000 K gives 2.2R_⊙]	2

Question	Answers	Notes	Total
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