Question Number	Answer	Acceptable answers	Mark
1(a)	Any two suitable such as: • Measurements can be taken (1) • Permanent record/evidence (1) • Can be magnified (1) • Can detect waves outside visible part of spectrum (1) • Long exposure (to see faint objects/track objects) (1)	Analysis/compare 'can record data' Taking photo is insufficient zoom in/show more detail can detect gamma rays, X-rays, ultraviolet, infrared Allow collect more light IGNORE better, brighter, clearer	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(b)	An explanation linking: • (Idea of) geocentric model believed initially (1) • Observation of moons orbiting Jupiter (rather than Earth) (1) • (Idea of) heliocentric model then preferred (1)	Initially everything {orbits/goes around} Earth Accept 'going around' for 'orbiting' Then everything {orbits/goes around} Sun Accept stopped believing geocentric Accept then not everything orbits the Earth	**(3)**

Question Number	Answer	Acceptable answers	Mark
1(c)	**B** 20 cm		**(1)**

Question Number	Answer	Acceptable answers	Mark
1(d)(i)	Substitution 12/(14-12) (1) Evaluation 6.0 (1)	Award full marks for correct with no working Ignore any units	**(2)**

Question Number	Answer	Acceptable answers	Mark
1(d)(ii)	-12	Negative sign essential	**(1)**

Question Number	Answer	Acceptable answers	Mark
1(d)(iii)	Suggestion to include one of: • Shows whether it is real or virtual (1) • A positive sign for magnification indicates a {real image/inverted image/opposite side of lens to object} (1)	 Allow shows whether it is inverted or upright Allow shows which side of lens image is formed A negative sign for magnification indicates a {virtual image/upright image/same side of lens as object} IGNORE simple reference to magnification	**(1)**

Total for Question 4 = 10 marks

Question Number	Answer	Acceptable answers	Mark
2 (a)	normal (1)	normal line	**(1)**

Question Number	Answer	Acceptable answers	Mark
2 (b)(i)	plot the points: • 0,0 (1) • 6,9 (1)	allow within one square tolerance. Bod if 0,0 not clearly visible but must be able to see a plotted point for 6,9 If they plot more than 2 points, take a mark off for each incorrect one plotted.	**(2)**

Question Number	Answer	Acceptable answers	Mark
2 (b)(ii)	straight line through both points joining existing curve (1)	Reject multiple lines and unreasonably wavering lines. allow ecf from wrongly plotted points, including curves if plausible	**(1)**

Question Number	Answer	Acceptable answers	Mark
2 (b)(iii)	42^{o} (1) +/- 0.5^{o}		**(1)**

Question Number	Answer	Acceptable answers	Mark
2 (c)(i)	diagram showing: • reflection (1) • angle of incidence = angle of reflection (1)	reject (for this marking point) with an additional partial refraction / ray along boundary judge by eye allow angles marked as equal	**(2)**

Question Number	Answer	Acceptable answers	Mark
2 (c)(ii)	The idea that it enters along the normal	At 90^{o} to the surface / at right angles to the surface / along a radius / perpendicular to the tangent / hits straight on reject 'goes through centre of glass'	**(1)**

(Total for Question 1 = 8 marks)

Question Number	Answer	Acceptable answers	Mark
3 (a)	**B**		**(1)**

Question Number	Answer	Acceptable answers	Mark
3b(i)	A description including **three** of the following points • reflection (of light) at (either) mirror (1) • (the curved mirror) focuses the light (1) • (mirror) inverts (1) • (lens / eyepiece) magnifies image (1) • image is formed where the light rays cross (1)	Bounces for reflects flips it over/turns over lens/eyepiece refracts light Image is real(1) Accept for 1 mark if no other mark awarded: (Telescope) reflects <u>and</u> refracts light (1)	**(3)**

Question Number	Answer	Acceptable answers	Mark
3(b)(ii)	An explanation including two from • collects more light (1) • produces a magnified/bigger image (1) • shows more detail (1) • shows stars the naked eye is unable to see (1) • can observe stars day and night (1)	brighter looks closer/zooms in makes it clearer/better see further/more (stars)	**(2)**

Question Number	Answer	Acceptable answers	Mark
3(c)(i)	transverse (wave)	mechanical	**(1)**

Question Number	Answer	Acceptable answers	Mark
3(c)(ii)	move up and down a bigger distance		**(1)**

Question Number	Answer	Acceptable answers	Mark
3(c)(iii)	substitution (1) 4 x 0.5 evaluation (1) 2 (m/s)	 give full marks for correct answer, no working Accept power of ten error for 1 mark eg. 0.2, 20, 200, 2000	 **(2)**

Question Number	Answer	Acceptable answers	Mark
4(a)(i)	refraction	refracting	**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(ii)	B		**(1)**

Question Number	Answer	Acceptable answers	Mark
4(a)(iii)	An explanation linking **two** of the following • change in direction (1) • towards the normal (1) • (resulting from) decrease in speed (1) • (because) the left hand part of the wavefront {hits the boundary first / slows down first} (1)	 bends Ignore away from normal change in speed (ignore increase in speed)	**(2)**

Question Number	Answer	Acceptable answers	Mark
4(b)	substitution (1) 25 = 120 x f transposition (1) f = 25/120 evaluation (1) 0.21 (Hz)	 substitution and transposition can be in any order 0.2 0.20 0.208(3...) give (3) marks for correct answer, no working Allow (2) marks for 20.8 stated with no working	**(3)**

Question Number	Answer	Acceptable answers	Mark
4(c)	an explanation linking the following • light waves are transverse waves / sound waves are longitudinal (1) • in transverse waves oscillations are at right angle to the direction of travel (1) • in longitudinal waves oscillations are parallel to the direction of travel (1)	Allow up and down (or side to side) movement of lamp as evidence that water waves are transverse up and down. Side to side. 90^{o} labelled diagram correctly identifying both axes backwards and forwards, push and pull compressions and rarefractions	**(3)**

Question number	Answer	Additional guidance	Mark
5(a)	An answer that combines the following points of understanding to provide a logical description: • shine the light along a radius (1) • by marking it on the paper before putting the block down (1)	allow shine the ray at the centre of the straight edge before putting the block down	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(i)	all points correctly plotted to +/− half a square (2)	4 points plotted correctly (i.e. one error) (1)	**(2)**

Question number	Answer	Mark
5(b)(ii)	smooth curve through at least 3 of the points (1)	**(1)**

Question number	Answer	Additional guidance	Mark
5(b)(iii)	• continues line as far as 90° (1) • estimate between 43° and 47° (1)	award full marks for correct numerical answer without working	**(2)**

Question number	Answer	Mark
5(c)	An answer that provides a description by making reference to: • (all) light reflected (1) • back inside block (1)	**(2)**