Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Mark Schemes

Q1

Question Number	Acceptable Answers	Additional Guidance	Mark
(i)	An explanation that makes reference to: **EITHER** • holding the lens steady in your hand would be difficult and would make the distance measurement inaccurate **(1)** • so the lens should be in a holder on a stable surface to make the measurement accurate **(1)** **OR** • holding the ruler steady parallel to the principal axis would be difficult and make the distance measurement inaccurate **(1)** • so the ruler should be on a stable surface to make the measurement accurate **(1)** **OR** • focal length is image distance when object distance is infinite **(1)** • this is not at infinity so lens formula should be used **(1)**	These marks can be awarded only for answers in the context of the method described in the question. Reference to use of an optical bench is acceptable. Reference to use of a clamp is acceptable.	**2**
(ii)	• use of power = 1/focal length **(1)** • calculates at least two powers correctly **(1)** • analyses data to compare powers or focal lengths **(1)** • draws a conclusion that is consistent with calculated values about how well the relationship is supported **(1)**	This is a comparison, so use of cm not penalised if used for all and unit D is not required. MP3 calculates combined power and uses it to calculate focal length for the combination and compares this with the measured value of focal length. Example of calculation: $P = 1/f$ power $_{lid} = 1/0.12 = 8.3$ D power $_{optional} = 1/0.175 = 5.7$ D power $_{combined} = 1/0.07 = 14$ D $8.3 + 5.7 = 14$ D	**4**

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Q2

Question Number	Acceptable answers	Additional guidance	Mark
	• Use of $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$ (1) • … with consistent units for u and f (1) • Use of displacement = $v-f$ (1) • Displacement of lens = 0.07 mm away from sensor (1)	Example of calculation $\frac{1}{25\times10^{-2}\text{ m}}+\frac{1}{v}=\frac{1}{4.25\times10^{-3}\text{ m}}$ $\therefore\frac{1}{v}=(235.3-4)\text{ m}^{-1}$ $\therefore v=\frac{1}{231.3\text{ m}^{-1}}=4.32\times10^{-3}\text{ m}$ Displacement of lens = (4.32 – 4.25) mm = 0.0735 mm	4

Q3

Question Number	Acceptable answers		Additional guidance	Mark
(i)	• Use of $P = 1/f$ • f = 8.47 (mm)	(1) (1)	Example of calculation f = 1 / 118 D = 8.47 mm	2
(ii)	• Use of $1/v + 1/u = 1/f$ (allow u and v reversed, but not f) • u = 14.8 mm (ecf for f from 19(a)(i))	(1) (1)	Example of calculation 1/20 mm + 1/u = 1/8.5 mm u = 14.8 mm	2
(iii)	• (Freshwater has a lower refractive index than seawater, so) there will be greater refraction of light on entering the lens • This means that the power of the lens is greater in freshwater **Or** this means that the focal length is less in freshwater • This means that the shortest distance will be decreased	(1) (1) (1)		3
(iv)	• Use of $n = c/v$ • $v = 2.2\times10^8\text{ m s}^{-1}$	(1) (1)	Example of calculation $1.37 = 3.00\times10^8\text{ m s}^{-1} / v$ $v = 2.2\times10^8\text{ m s}^{-1}$	2

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Q4

Question number	Acceptable answers	Additional guidance	Mark
(i)	• use of $F = Q_1Q_2/4\pi\varepsilon_0 r^2$ **(1)** • use of $F = Gm_1m_2/r^2$ **(1)** • Expresses forces as a ratio **(1)** **OR** calculates the individual forces $F_e = 8.1 \times 10^{-8}$ N $F_g =$ • 3.6×10^{-47} N **(1)** • Ratio = 2×10^{39} or 5×10^{-40} and identifies gravitational force as insignificant **(1)**		**4**
(ii)	• use of $F = mv^2/r$ and $F = Q_1Q_2/4\pi\varepsilon_0 r^2$ **(1)** • to derive $v = \sqrt{\frac{Q_1Q_2}{4\pi\epsilon_0 rm}}$ **(1)** • velocity = 2.2×10^6 m s^{-1} **(1)**	Example of calculation: $v = \sqrt{\frac{Q_1Q_2}{4\pi\epsilon_0 rm}}$ $v = \sqrt{\frac{1.6\times10^{-19}\text{ C}\times1.6\times10^{-19}\text{ C}}{4\pi\times8.85^{-12}\text{ Fm}^{-1}\times5.3\times10^{-11}\text{m}\times9.1\times10^{-31}\text{ kg}}}$ $v = 2.185 \times 10^6$ m s^{-1}	**3**

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