Name of the Student:_____
Max. Marks : 23 Marks **Time : 23 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable answers		Additional guidance	Mark
(a)(i)	• σ = 54-56 (MPa) • Use of $\sigma = \frac{F}{A}$ with their value of σ • F = 64.5 N – 67.5 N	(1) (1) (1)	do not penalise powers of 10 Example of calculation $F = 56\times10^{6}\,\text{Nm}^{-2} \times 1.2\times10^{-6}\,\text{m}^{2}$ F = 67 N	3

Question Number	Acceptable answers		Additional guidance	Mark
(a)(ii)	• Use of $\varepsilon = \frac{\Delta x}{x}$ • Extension = 1.0 cm	(1) (1)	Example of calculation 0.04 = Δx / 25 cm Δx = 0.04 × 25 cm = 1.0 cm Allow 1 cm, 0.01 m, 10 mm	2

Question Number	Acceptable answers		Additional guidance	Mark
(b)	An answer that makes reference to the following: • Shrilk has less strain for same stress **Or** Shrilk is stiffer • Shrilk breaks at a higher stress (compared to polythene) **Or** Shrilk can withstand a greater stress/force/load/weight **Or** Shrilk is stronger • Shrilk doesn't stretch as much (for a given force)	(1) (1) (1)	It should be clear from the student's answer that shrilk is the better material Ignore references to Young modulus, renewable, biodegradable, cost Accept converse arguments for polythene	3

Q2.

Question Number	Acceptable Answers	Additional guidance	Mark
(i)	• Recognises resultant force on raindrop = 0 **Or** Uses $W=F(+U)$ (1) • Use of $F = 6\pi\eta r v$ • Use of U = weight of air displaced (1) **Or** $U = \frac{4}{3}\rho_a \pi r^3 g$ **Or** $U = \rho_a V g$ **and** $V = \frac{4}{3}\pi r^3$ **Or** $U = mg$ **and** $\rho = \frac{m}{V}$ **and** $V = \frac{4}{3}\pi r^3$ **Or** states upthrust is negligible (1) • 1.7 m s^{-1} (1)	Example of Calculation $W=F+U$ $F = 6\pi \times 1.3 \times 10^{-5}\text{Nm}^{-2} \times 1.0 \times 10^{-4} \times v = (2.45 \times 10^{-8}\, v)$ (N) $U = 1.225\ \text{kg m}^{-3} \times \frac{4}{3}\pi(0.0001\ \text{m})^3 \times 9.81\ \text{m s}^{-2}$ $= 4.9 \times 10^{-11}$ (N) $v = \frac{4.1\times10^{-8}\ \text{N} - 4.9\times10^{-11}\ \text{N}}{2.45\times10^{-8}} = 1.7\ \text{m s}^{-1}$	4
(ii)	turbulent flow (1) (so) Stokes law does not apply (1)		2

Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	• As graphene is only 1 atom thick so the CSA/thickness is far smaller than for a sample of steel **Or** most applications need a thickness greater than one atom **Or** if more than one layer of graphene is used it will be weaker or the bonds between the layers will not be strong **Or** Graphene is difficult to manufacture because it has only one atomic layer (1) • Although graphene has a greater breaking stress it will break at a lower force (1)	MP1: accept graphene can only be 1 atom thick but steel can be any thickness (MP1, treat references to cost/energy as neutral)	2

Question Number	Acceptable Answer		Additional Guidance	Mark
(b)	• Use of depth of graphite = 100 × diameter of 1 carbon atom	(1)	<u>Example of calculation</u> Depth of graphite = $100 \times 1.4 \times 10^{-10}$ m = 1.4×10^{-8} m	
	• Use of cross-sectional area = depth × (0.5×10^{-3} m)	(1)	CSA = 1.4×10^{-8} m × 0.50×10^{-3} m = 7.0×10^{-12} m^2	
	• Use of $\rho = \frac{RA}{l}$	(1)	$\rho = \frac{1.029 \times 10^{6}\Omega \times 7.0 \times 10^{-12}\text{m}^2}{0.200\text{ m}} =$	
	• $\rho = 3.6 \times 10^{-5}\ \Omega$ m **Or** 36 μΩ m		$3.6 \times 10^{-5}\ \Omega$ m	**4**

Question Number	Acceptable Answer		Additional Guidance	Mark
(c)	**Max 3**			
	• Silicon will only release a (photo) electron for a limited range of frequencies/wavelengths	(1)	MP1: accept single frequency for limited range	
	• <u>electron</u> per incident photon	(1)		
	• Greater current (for the same illumination) in graphene	(1)		
	• Graphene (cells are) more efficient **Or** graphene cells could be smaller / cheaper / thinner			**3**