Question	Answer	Marks
1	D	1
2	Volume of 1 mole of Silver = $\frac{0.108\,\text{kg}}{10\,490\,\text{kg m}^{-3}}$ = 1.029×10^{-5} m^3 Volume of 1 atom of Silver = $\frac{1.029 \times 10^{-5}\,\text{m}^3}{6.0 \times 10^{23}}$ = 1.7×10^{-29} m^3	1 1 1
3	Any points from : • Dislocation is a defect in the regular crystalline structure of a material. • Dislocations in metals are mobile and make the metal softer. • Alloying atoms pin the dislocations. • Alloying metals make them harder if the plastic flow is reduced.	1 mark per correct point (2 max)
4 a	12 cm	1
4 b	The long chain molecule uncoils; Under tension, increasing the length as it changes from a random orientation of its repeating lengths to a linear orientation.	1 1
4 c	Strain = $\frac{LN - L\sqrt{N}}{L\sqrt{N}}$ = $\frac{8L - L\sqrt{8}}{L\sqrt{8}} = \sqrt{8} - 1$ $= 1.8$ (2 s.f.)	1 1 1
5	Any points from: • Strong, directional bonds make the material hard because the planes of atoms cannot slip over each other. • This is a consequence of the lack of mobile dislocations in directionally-bonded materials. • Lack of mobile dislocations reduces plastic behaviour. • Stress concentrations lead to brittle fracture.	1 mark per correct point (3 max)
6	Any points from: • Polythene and rubber are long-chain molecules. • Long-chain molecules can 'uncoil' under stress. • 'uncoiling' allows large strains before breaking. • Rubber molecules relax back into a random orientation once the deforming load is removed.	1 mark per correct point (3 max)
7	$E = \frac{400 \times 10^{-12}\,\text{N}/2 \times 10^{-17}\,\text{m}^2}{0.2}$ = 1.0×10^{8} N m^{-2}	1 1
8 a	Volume = $\frac{0.063\,\text{kg}}{8960\,\text{kg m}^{-3} \times 6 \times 10^{23}}$ = 1.17×10^{-29} m^3 (3 s.f.)	1 1
8 b	2.3×10^{-10} m	1
8 c	0.5 mm^2 = 5×10^{-7} m^2 Number of atoms = $\frac{5 \times 10^{-7}\,\text{m}^2}{5.6 \times 10^{-20}\,\text{m}^2} = 8.9 \times 10^{12}$	1 1
8 d	$8.9 \times 10^{12} \times 5 \times 10^{-11}$ N = 450 N	1 1

8 e	Breaking stress = $\frac{450\text{ N}}{0.5\times10^{-6}\text{ m}^2}$ $=9 \times 10^8$ Pa	1 1
8 f	This is much higher than the actual estimate. This model does not take into account dislocations in the crystalline structure; which lower the yield and breaking stress of the material.	1 1 1
9 a	Strong/3-d bonding; No slip/dislocation (to allow plastic flow) because of directional bonding.	1 1 1
9 b	Any three from: • Scratches on surface weaken material. • Scratches have stress concentrations at their tips. • Cracks propagate through material. • The crack will open under the correct direction of bending. • Brittle fracture along the length of the scratch. • Local stress is not relieved by plastic flow.	1 mark per correct point (3 max)
9 c	In the solid the ions are locked in position; near melting temperature the ions gain mobility as glass softens; solid ions cannot flow/move to carry current OR near melting temperature charge flows as ions can move.	1 1 1
10 a	To fill the space completely, each atom of radius *r* would occupy a cube of radius 2 *r*. Volume of the cube = $8r^3$ Ratio of volumes = $\frac{\frac{4}{3}\pi r^3}{8r^3} = \frac{\pi}{6}$	1 1 1
10 b	Distance between centres of atoms = *d* Length $L^2 = d^2 + d^2$ so $L = \sqrt{2}\,d$ Length of gap between atoms = $\sqrt{2}\,d - 2(\frac{d}{2}) = \sqrt{2}d - d \approx 0.4d$	1 1 1