Question 6

		Answer	Marks
(a)		Mass of a gold atom = 197 g mol^{-1} / 6.02 ×10^{23} mol^{-1} = 3.27 × 10^{-22} g	1 mark
(b)		Number of atoms in unit cell = (8 × 1/8) + (6 × 1/2) = 4	1 mark
(c)	**i)**	If a is the length of the unit cell edge and r is the radius of an atom: $a\sqrt{2} = 4r$ length AB = $4r / \sqrt{2} = 2\sqrt{2} \times r$	1 mark
	ii)	volume of unit cell = $32r^3 / \sqrt{2} = 16\sqrt{2} \times r^3$	1 mark
	iii)	length of body diagonal $a\sqrt{3} = 2\sqrt{6} \times r$	1 mark
(d)		Molar volume of gold = 197 g mol^{-1} / 19.3 g cm^{-3} = 10.2 cm^3 mol^{-1}	1 mark
(e)		Fraction = 4 × volume of gold atom / unit cell volume = $(4 \times 4/3\ \pi r^3) / (16\sqrt{2} \times r^3) = \pi\sqrt{2} / 6 = 0.74$ Can accept $\pi\sqrt{2} / 6$	1 mark

(f)		Radius of gold atom = [(volume of gold atom) / (4/3)π]$^{1/3}$
		    = [(10.2 cm^3 mol^{-1} / 6.02 × 10^{23} mol^{-1}) × 0.74 / (4/3)π]$^{1/3}$
		    = 1.44 × 10^{-8} cm
			1 mark

(g)	**i)**	Surface area of dome = ½ × 4π(21 m / 2)^2 = 693 m^2 Volume of gold = 80 000 g / 19.3 g cm^{-3} = 4 145 cm^3 = 0.004 145 m^3 Average thickness of gold = 0.004 145 m^3 / 693 m^2 = 6.0 × 10^{-6} m = 6.0 × 10^{-4} cm	1 mark
	ii)	Thickness of a layer of gold atoms = $(2\sqrt{6} \times r) / 3$ = 2.35 × 10^{-8} cm Number of layers of gold atoms = 6.0 × 10^{-4} cm / 2.35 × 10^{-8} cm = 2.5 × 10^4	1 mark
		Only penalise once for error carried forward	