

Question		Answers / Explanatory notes	Marks available
3	(a)	Air gives drag (1) [or no drag in a vacuum] Air also gives lift (1) [or no lift in a vacuum] Lift has a greater effect (on range) (1) [can be impl.]	3
	(b)	The <u>wing</u> (or golf ball) exerts a <u>downward</u> force on the <u>air</u> . (1) The <u>air</u> exerts an <u>upward</u> [accept: opposite] force on the <u>wing</u> (or golf ball)(1)	2
	(c)	More lift (1); less drag (1)	2
	(d)	Dimples produce a (thin) layer of turbulent air / boundary layer (1), (which) follows the curvature of the ball better (1). The size of the wake decreases (1). The pressure difference (between the front and back of the ball) decreases (1) [Accept equivalent, alternatively expressed statements]	4
	(e)	Dimples have a greater effect at <u>high speed</u> . Or at low speeds, lift is similar / same with and without.	1
	(f)	(i) Lift force on smooth ball = 0.05 N (<i>sic</i>) (1) [accept 0.03–0.05] ×2 (or ×3) and ÷g [$\rightarrow m = 0.006 - 0.015$ kg (<i>sic</i>)] (1)	2
		(ii) $50 \div 0.305 = 164 \text{ m s}^{-1}$ (1) $F \sim 0.25 \text{ N}$ (1) [accept 0.23 – 0.28]	2
	(g)	One pair of readings from correct line (1) [e.g. (110, 0.12)] Another pair sufficiently removed (1) [e.g. (220, 0.43)] Sensible approach, e.g. $\frac{F}{v^2} = k$ or $V \times 2 \rightarrow F \times 4$ (1) Sensible comment [e.g. 110 \rightarrow 220 doubled; 0.12 \rightarrow 0.43, not quite quadrupled, hence not quite correct / reasonable or calculating values of k from the two points and making comparison] (1)	4
			[20]