

LEVEL 1 — SURDS

Note: Only turn back to page number if you have difficulty

Page

Q1. Simplify the following:

65

$$\begin{array}{lll} \text{(a)} \sqrt{6} \times \sqrt{3} & \text{(b)} \sqrt{15} \div \sqrt{3} & \text{(c)} 2\sqrt{8} \times \sqrt{7} \\ \text{(d)} 3\sqrt{8} + \sqrt{2} & \text{(e)} 4\sqrt{2} \times 3\sqrt{3} & \text{(f)} 6\sqrt{12} \div 3\sqrt{3} \end{array}$$

Q2. Simplify these surds:

66

$$\begin{array}{llll} \text{(a)} \sqrt{50} & \text{(b)} \sqrt{18} & \text{(c)} \sqrt{45} & \text{(d)} \sqrt{72} \\ \text{(e)} \sqrt{12} & \text{(f)} \sqrt{20} & \text{(g)} 4\sqrt{24} & \text{(h)} 3\sqrt{27} \end{array}$$

Q3. Simplify these expressions:

67

$$\begin{array}{lll} \text{(a)} 5\sqrt{2} - 3\sqrt{2} & \text{(b)} 2\sqrt{5} + 3\sqrt{3} - \sqrt{5} & \text{(c)} 6\sqrt{10} - 4\sqrt{5} - 3\sqrt{10} \\ \text{(d)} 4\sqrt{3} + 2\sqrt{12} & \text{(e)} 9\sqrt{12} - 2\sqrt{75} & \text{(f)} 5\sqrt{80} + 5\sqrt{125} \end{array}$$

Q4. Expand and simplify:

68

$$\begin{array}{lll} \text{(a)} 5(\sqrt{6} + 3) & \text{(b)} \sqrt{2}(\sqrt{3} - 1) & \text{(c)} \sqrt{10}(4 - 2\sqrt{5}) \\ \text{(d)} 2\sqrt{2}(\sqrt{5} + 5) & \text{(e)} \sqrt{7}(2\sqrt{7} + 3) & \text{(f)} 2\sqrt{6}(7 - 3\sqrt{6}) \end{array}$$

Q5. Expand and simplify:

68, 69

$$\begin{array}{lll} \text{(a)} (2 + \sqrt{7})(3 - \sqrt{5}) & \text{(b)} (1 - \sqrt{2})(1 + \sqrt{2}) & \text{(c)} (2\sqrt{2} + 3)(\sqrt{3} - 1) \\ \text{(d)} (\sqrt{6} - 4)^2 & \text{(e)} (2 - \sqrt{5})(4 + 2\sqrt{3}) & \text{(f)} (3\sqrt{2} + 2)(3\sqrt{2} - 2) \end{array}$$

Q6. Express the following with rational denominators:

70

$$\begin{array}{llll} \text{(a)} \frac{1}{\sqrt{2}} & \text{(b)} \frac{5}{\sqrt{5}} & \text{(c)} \frac{10}{2\sqrt{3}} & \text{(d)} \frac{\sqrt{2}}{\sqrt{6}} \\ \text{(e)} \frac{7}{2\sqrt{7}} & \text{(f)} \frac{2\sqrt{3}}{3\sqrt{10}} & \text{(g)} \frac{3 - \sqrt{2}}{\sqrt{2}} & \text{(h)} \frac{\sqrt{5} + 4}{2\sqrt{3}} \end{array}$$

Q7. Rationalise the denominator in each expression:

71

$$\begin{array}{llll} \text{(a)} \frac{1}{1 + \sqrt{2}} & \text{(b)} \frac{5}{6 - \sqrt{3}} & \text{(c)} \frac{\sqrt{5}}{\sqrt{3} + 3} & \text{(d)} \frac{7}{3\sqrt{6} + 2} \\ \text{(e)} \frac{\sqrt{3}}{5 - 3\sqrt{3}} & \text{(f)} \frac{2}{\sqrt{5} - \sqrt{3}} & \text{(g)} \frac{10}{2\sqrt{3} - 2\sqrt{2}} & \text{(h)} \frac{5 + \sqrt{3}}{5 - \sqrt{3}} \end{array}$$

LEVEL 2 — SURDS

Q1. Simplify:

(a) $3\sqrt{48}$ (b) $2\sqrt{54}$ (c) $4\sqrt{96}$ (d) $2\sqrt{108}$
 (e) $3\sqrt{162}$ (f) $\sqrt{\frac{3}{4}}$ (g) $\sqrt{\frac{24}{25}}$ (h) $\sqrt{x^3}$

Q2. Simplify:

(a) $5\sqrt{20} - 2\sqrt{18} - \sqrt{45}$ (b) $\sqrt{98} + \sqrt{32} - \sqrt{63}$ (c) $\sqrt{108} - \sqrt{24} + \sqrt{27}$
 (d) $\sqrt{500} + 2\sqrt{45} - \sqrt{80}$ (e) $2\sqrt{4x} + 5\sqrt{9x} - \sqrt{x}$ (f) $x\sqrt{16y} - \sqrt{x^2y} + 3x\sqrt{9y}$

Q3. Expand and simplify:

(a) $(2\sqrt{5} + 3\sqrt{3})^2$ (b) $(2\sqrt{3} + \sqrt{6})(3\sqrt{2} - \sqrt{3})$
 (c) $(4\sqrt{2} - 2\sqrt{3})(4\sqrt{2} + 2\sqrt{3})$ (d) $(3\sqrt{6} - 2\sqrt{7})(2\sqrt{6} - 3\sqrt{3})$
 (e) $x\sqrt{y}(6\sqrt{x} - 2\sqrt{y})$ (f) $(x\sqrt{x} - y\sqrt{y})(x\sqrt{x} + y\sqrt{y})$

Q4. Express the following with rational denominators:

(a) $\frac{\sqrt{3} - \sqrt{5}}{3\sqrt{5} + 2\sqrt{3}}$ (b) $\frac{\sqrt{6} - \sqrt{2}}{2\sqrt{6} - 4\sqrt{2}}$ (c) $\frac{2\sqrt{5} - 3\sqrt{3}}{2\sqrt{5} + 3\sqrt{3}}$
 (d) $\frac{3}{2\sqrt{x} - 3\sqrt{y}}$ (e) $\frac{2 - \sqrt{5}}{3\sqrt{x} + 4\sqrt{y}}$ (f) $\frac{\sqrt{x} + \sqrt{y}}{4\sqrt{x} - 2\sqrt{y}}$

Q5. Express the following as single fractions with rational denominators:

(a) $\frac{1}{2\sqrt{5}} + \frac{1}{5\sqrt{2}}$ (b) $\frac{\sqrt{3}}{\sqrt{2}} - \frac{\sqrt{2}}{\sqrt{3}}$ (c) $\frac{\sqrt{5}}{2\sqrt{6}} + \frac{\sqrt{5}}{\sqrt{7}}$
 (d) $\frac{1}{\sqrt{3} + 2} - \frac{1}{\sqrt{3} - 2}$ (e) $\frac{3}{\sqrt{6} - 2} + \frac{3}{\sqrt{6} + 3}$ (f) $\frac{2}{2\sqrt{2} + 3} - \frac{1}{5\sqrt{2} + 3}$

Q6. If $x = \frac{1}{\sqrt{2} + \sqrt{5}}$ evaluate $x^2 + \frac{1}{x^2}$

Q7. Simplify: $\frac{x\sqrt{x} \times \sqrt{x^3}}{2\sqrt{x} \times \sqrt{2x}}$ (Express answer with a rational denominator)

Q8. Expand and simplify: $(3\sqrt{2} + \sqrt{3})^2 - (3\sqrt{2} - \sqrt{3})^2$

Q9. Show that $\frac{2\sqrt{3} - 2\sqrt{2}}{3\sqrt{3} - 3\sqrt{2}}$ is a rational number.

Level 1 — Surds

- Q1. (a) $3\sqrt{2}$ (b) $\sqrt{5}$ (c) $4\sqrt{14}$ (d) 6 (e) $12\sqrt{6}$ (f) 4
- Q2. (a) $5\sqrt{2}$ (b) $3\sqrt{2}$ (c) $3\sqrt{5}$ (d) $6\sqrt{2}$ (e) $2\sqrt{3}$ (f) $2\sqrt{5}$ (g) $8\sqrt{6}$ (h) $9\sqrt{3}$
- Q3. (a) $2\sqrt{2}$ (b) $\sqrt{5}+3\sqrt{3}$ (c) $3\sqrt{10}-4\sqrt{5}$ (d) $8\sqrt{3}$ (e) $8\sqrt{3}$ (f) $45\sqrt{5}$
- Q4. (a) $5\sqrt{6}+15$ (b) $\sqrt{6}-\sqrt{2}$ (c) $4\sqrt{10}-10\sqrt{2}$ (d) $2\sqrt{10}+10\sqrt{2}$ (e) $14+3\sqrt{7}$ (f) $14\sqrt{6}-36$
- Q5. (a) $6-2\sqrt{5}+3\sqrt{7}-\sqrt{35}$ (b) -1 (c) $2\sqrt{6}-2\sqrt{2}+3\sqrt{3}-3$
 (d) $22-8\sqrt{6}$ (e) $8+4\sqrt{3}-4\sqrt{5}-2\sqrt{15}$ (f) 14
- Q6. (a) $\frac{\sqrt{2}}{2}$ (b) $\sqrt{5}$ (c) $\frac{5\sqrt{3}}{3}$ (d) $\frac{\sqrt{3}}{3}$ (e) $\frac{\sqrt{7}}{2}$ (f) $\frac{\sqrt{30}}{15}$ (g) $\frac{3\sqrt{2}-2}{2}$ (h) $\frac{\sqrt{15}+4\sqrt{3}}{6}$
- Q7. (a) $\sqrt{2}-1$ (b) $\frac{30+5\sqrt{3}}{33}$ (c) $\frac{3\sqrt{5}-\sqrt{15}}{6}$ (d) $\frac{21\sqrt{6}-14}{52}$
 (e) $\frac{-9-5\sqrt{3}}{2}$ (f) $\sqrt{5}+\sqrt{3}$ (g) $5\sqrt{3}+5\sqrt{2}$ (h) $\frac{14+5\sqrt{3}}{11}$

Level 2 — Surds

- Q1. (a) $12\sqrt{3}$ (b) $6\sqrt{6}$ (c) $16\sqrt{6}$ (d) $12\sqrt{3}$ (e) $27\sqrt{2}$ (f) $\frac{\sqrt{3}}{2}$ (g) $\frac{2\sqrt{6}}{5}$ (h) $x\sqrt{x}$
- Q2. (a) $7\sqrt{5}-6\sqrt{2}$ (b) $11\sqrt{2}-3\sqrt{7}$ (c) $9\sqrt{3}-2\sqrt{6}$ (d) $12\sqrt{5}$ (e) $18\sqrt{x}$ (f) $12x\sqrt{y}$
- Q3. (a) $47+12\sqrt{15}$ (b) $6\sqrt{6}+6\sqrt{3}-3\sqrt{2}-6$ (c) 20
 (d) $36-27\sqrt{2}-4\sqrt{42}+6\sqrt{21}$ (e) $6x\sqrt{xy}-2xy$ (f) x^3-y^3
- Q4. (a) $\frac{5\sqrt{15}-21}{33}$ (b) $\frac{-1-\sqrt{3}}{2}$ (c) $\frac{12\sqrt{15}-47}{7}$
 (d) $\frac{6\sqrt{x}+9\sqrt{y}}{4x-9y}$ (e) $\frac{6\sqrt{x}-8\sqrt{y}-3\sqrt{5x}+4\sqrt{5y}}{9x-16y}$ (f) $\frac{2x+3\sqrt{xy}+y}{8x-2y}$
- Q5. (a) $\frac{\sqrt{2}+\sqrt{5}}{10}$ (b) $\frac{\sqrt{6}}{6}$ (c) $\frac{\sqrt{1470}+5\sqrt{315}}{84}$ (d) 4
 (e) $\frac{12+\sqrt{6}}{2}$ (f) $\frac{249-169\sqrt{2}}{41}$
- Q6. $\frac{70+16\sqrt{10}}{9}$ Q7. $\frac{x^2\sqrt{2}}{4}$
- Q8. $12\sqrt{6}$ Q9. $\frac{2}{3}$