# Unit 16 · Solid Objects

**HARDER PRACTICE QUESTIONS · ANSWER KEY**

Full marks 35

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

## 1 Spot the errors

**ANSWER** U · 4

i. **Not regular.** Its faces are rectangles that aren't squares, and not all the same. A regular solid needs every face the same regular polygon, and the same number of faces at every vertex.

ii. **6 vertices.** The eight is its number of **faces**; it has 6 vertices and 12 edges.

iii. **Two circular faces**, the top and the bottom, and one curved surface. The cone is the one with a single circular face.

iv. **30 edges.** Each edge belongs to two faces, so counting 3 for every triangle counts every edge twice: $60 \div 2 = 30$.

**MARKING SCHEME**

✓ i. Not regular: the faces aren't all the same regular polygon.

✓ ii. 6 vertices (8 faces).

✓ iii. Two circular faces and one curved surface.

✓ iv. 30 edges: each edge counted twice.

## 2 Working backwards

**ANSWER** A · 4

i. $10 - 15 + F = 2$, so $-5 + F = 2$: $F = \mathbf{7}$.

ii. $V - 16 + 9 = 2$, so $V - 7 = 2$: $V = \mathbf{9}$.

iii. **No.** $7 - 12 + 6 = 1$, not 2, so he counted something wrong.

iv. $V = F$, so $F - 10 + F = 2$, $2F = 12$: $F = \mathbf{6}$ (and 6 vertices). Check: $6 - 10 + 6 = 2$. ✓

**MARKING SCHEME**

✓ i. 7 faces.

✓ ii. 9 vertices.

✓ iii. No: $7 - 12 + 6 = 1$, not 2.

✓ iv. 6 faces.

## 3 Counting without counting

**ANSWER** A · 4

i. $12 \times 5 = 60$ sides, each edge counted twice: $60 \div 2 = \mathbf{30\ edges}$.

ii. $12 \times 5 = 60$ corners of faces, 3 at each vertex: $60 \div 3 = \mathbf{20\ vertices}$.

iii. Sides: $12 \times 5 + 20 \times 6 = 60 + 120 = 180$. Edges $180 \div 2 = \mathbf{90}$; corners $180 \div 3 = \mathbf{60}$.

iv. $F = 12 + 20 = 32$: $60 - 90 + 32 = 2$. ✓ **Not regular**: its faces are of two kinds, pentagons and hexagons.

**MARKING SCHEME**

✓ i. 30 edges.

✓ ii. 20 vertices.

✓ iii. 90 edges and 60 corners.

✓ iv. $60 - 90 + 32 = 2$; not regular, two kinds of faces.

## 4 Angles at a corner

**ANSWER**

i. **No.** $6 \times 60° = 360°$: the triangles lie **flat**, like floor tiles, and never rise into a point. The angles must add up to less than 360°.

ii. **Only 3.** $3 \times 108° = 324°$, less than 360°. $4 \times 108° = 432°$, too many, and fewer than 3 faces make no point at all.



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iii. $90° + 90° + 60° = \mathbf{240}°$, less than 360°: **yes**, they rise into a point. **A · 4**

iv. 3 hexagons: 360°, flat, **no**. 1 square and 2 hexagons: $90° + 240° = 330°$, **yes**. 4 squares: 360°, flat, **no**.

**MARKING SCHEME**

✓ i. No: 360° lies flat.

✓ ii. Only 3: $324° < 360°$, 432° too many.

✓ iii. 240°: yes.

✓ iv. Only 1 square and 2 hexagons (330°).

## 5 Cutting off corners

**ANSWER** **A · 4**

i. A **triangle**: 3 faces meet at the corner, and the cut crosses each of them, so it has 3 sides.

ii. The 1 vertex is gone and 3 new ones are made: $V = 4 - 1 + 3 = \mathbf{6}$. The 6 edges stay (shorter) and the cut adds 3: $E = \mathbf{9}$. One new face: $F = \mathbf{5}$.

iii. $6 - 9 + 5 = 2$. ✓ **Not regular**: three of its faces now have 4 sides, while the other two are triangles.

iv. Each cut takes away 1 vertex and adds 3, adds 3 edges and 1 face: $V = 4 \times 3 = \mathbf{12}$, $E = 6 + 4 \times 3 = \mathbf{18}$, $F = 4 + 4 = \mathbf{8}$. $12 - 18 + 8 = 2$. ✓

**MARKING SCHEME**

✓ i. A triangle: the cut crosses 3 faces.

✓ ii. V = 6, E = 9, F = 5.

✓ iii. $6 - 9 + 5 = 2$; not regular.

✓ iv. V = 12, E = 18, F = 8, and $12 - 18 + 8 = 2$.

## 6 Cones from one circle

**ANSWER** **A · 4**

i. The diameter is 20 cm: $3.14 \times 20 = \mathbf{62.8\ cm}$.

ii. Three quarters stay: $62.8 \div 4 \times 3 = \mathbf{47.1\ cm}$ round. Across: $47.1 \div 3.14 = \mathbf{15\ cm}$.

iii. Half stays: $62.8 \div 2 = 31.4$ cm round, so $31.4 \div 3.14 = \mathbf{10\ cm}$ across. More was cut away, so it is narrower and **taller**.

iv. **No.** The circle's radius, 10 cm, becomes the cone's sloping side from the tip to the rim, and the cone's height is always less than that slope. So no cone from these circles can be 12 cm tall.

**MARKING SCHEME**

✓ i. 62.8 cm.

✓ ii. 47.1 cm round, 15 cm across.

✓ iii. 10 cm across; taller.

✓ iv. No: the 10 cm radius becomes the sloping side, and the height is less.

## 7 One card, two tubes

**ANSWER** **A · 4**

i. $62.8 \div 3.14 = \mathbf{20\ cm}$ across (a compass opened to 10 cm). The tube is **31.4 cm** tall.

ii. $31.4 \div 3.14 = \mathbf{10\ cm}$ across. The tube is **62.8 cm** tall.

iii. The circles are **too small**: each leaves a gap round it. Circles that close the tube must go once round its 62.8 cm, so they must be 20 cm across.

iv. **2** plane surfaces (the circles), **1** curved surface, **0** vertices, and **2** curved edges, where the circles meet the curved surface.

**MARKING SCHEME**

✓ i. 20 cm across; 31.4 cm tall.

✓ ii. 10 cm across; 62.8 cm tall.

✓ iii. Too small: a gap round each.

✓ iv. 2 plane, 1 curved, 0 vertices, 2 curved edges.



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## 8 Think: four triangles at every corner

**ANSWER** HA · 4

i. The triangles have $3F$ sides in all, and each edge is shared by 2 of them: $E = 3F \div 2$. They have $3F$ corners, and 4 meet at each vertex: $V = 3F \div 4$.

ii.

| $F$ | **4** | **8** | **12** | **16** |
|---|---|---|---|---|
| $E$ | 6 | 12 | 18 | 24 |
| $V$ | 3 | 6 | 9 | 12 |
| $V - E + F$ | 1 | **2** | 3 | 4 |

iii. Only **8** triangles give 2: the **octahedron**.

iv. $V - E + F$ is always $F \div$ **4**: it goes up by 1 each time $F$ goes up by 4. It equals 2 only when $F = 8$, so there is exactly one such solid.

**MARKING SCHEME**

- ✓ i. 3F sides shared by 2; 3F corners, 4 at each vertex.
- ✓ ii. The table: E 6, 12, 18, 24; V 3, 6, 9, 12; V − E + F 1, 2, 3, 4.
- ✓ iii. 8 triangles: the octahedron.
- ✓ iv. V − E + F = F ÷ 4, which is 2 only for F = 8.

## 9 Make your own

**ANSWER** A · 3

For example:

i. A tent shape: a square at the bottom with 4 triangles rising to a point. $V = 5$, $E = 8$, $F = 5$: $5 - 8 + 5 = 2$. ✓

ii. A card 15.7 cm long: $15.7 \div 3.14 = 5$ cm across.

iii. The rim is $3.14 \times 5 = 15.7$ cm, and the whole circle 62.8 cm: 15.7 is a quarter of 62.8. So a quarter stays, and **three quarters** are cut away.

Any correct answers are right in i and ii.

**MARKING SCHEME**

- ✓ i. A solid with its V, E and F, checked.
- ✓ ii. A length and its circles' diameter (length ÷ 3.14).
- ✓ iii. Three quarters.

| Marks by level | Knowledge | Understanding | Application | Higher ability | Total |
|---|---|---|---|---|---|
| **Marks** | 0 | 4 | 27 | 4 | **35** |



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