



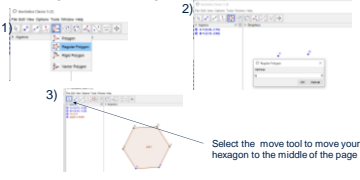

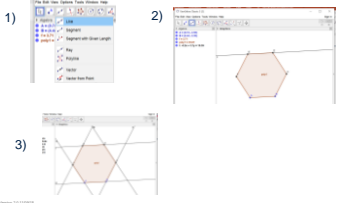

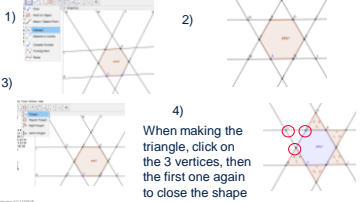
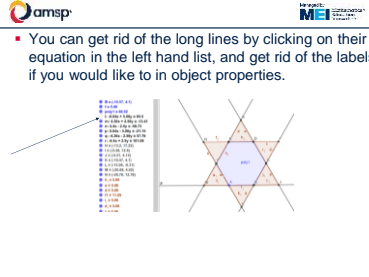
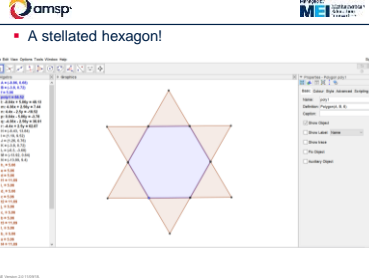
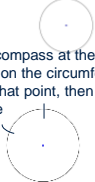


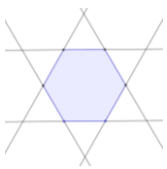
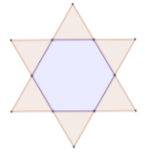
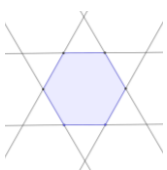
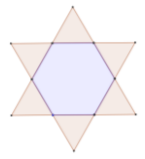


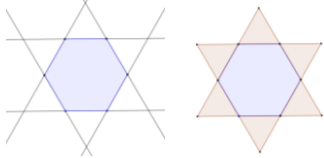


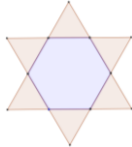












Slide 1	 <p>Advanced Mathematics Support Programme®</p>	
Slide 2	 <h3>Stellating shapes</h3> <ul style="list-style-type: none"> Stellating shapes can create exciting and different polygons. We can investigate which shapes can be stellated, how they can be constructed and how we can describe them. Construction can be done in software for example geogebra, or with a ruler and compass, or using pre-printed shapes. 	<p>Geogebra is beneficial as although it might take students a while to get used to it, the programme has so many uses both in geometry and graphing.</p> <p>For ruler and compass constructions, students will be using skills that they can apply to the GCSE curriculum.</p> <p>However, for speed, using pre-printed shapes is the most time efficient way!</p>
Slide 3	 <h3>Instructions</h3> <ul style="list-style-type: none"> There are instructions to stellate a hexagon using 3 different approaches <ul style="list-style-type: none"> Geogebra Compass and ruler A printed hexagon 	
Slide 4	 <h3>To start</h3> <ul style="list-style-type: none"> Draw a hexagon. Geogebra = use regular polygon tool  <p>Select the move tool to move your hexagon to the middle of the page</p>	<p>We have used the GeoGebra 5 download, however you can also do this using the web app. If students are using the web app and want to save their work they will need to create a login. The web app looks slightly different but the tools are the same. If you are using the web app, click on the 3 lines in the left corner to select the menu, then choose the geometry option.</p> <p>To clear the grid and axis, right click in the main screen.</p>
Slide 5	 <ul style="list-style-type: none"> Select the line through two points Click on pairs of vertices to extend all the edges 	<p>To move the polygon, select the arrow then you can click and drag.</p> <p>If you make a mistake, you can undo in the edit menu.</p>
Slide 6	 <ul style="list-style-type: none"> Create a vertex where each pair of lines meet Create a triangle that extends from each edge  <p>When making the triangle, click on the 3 vertices, then the first one again to close the shape</p>	

<p>Slide 7</p>	 <ul style="list-style-type: none"> You can get rid of the long lines by clicking on their equation in the left hand list, and get rid of the labels if you would like to in object properties. 	
<p>Slide 8</p>	 <ul style="list-style-type: none"> A stellated hexagon! 	
<p>Slide 9</p>	<p>Ruler and compass instructions</p> <ul style="list-style-type: none"> Choose a point and draw a circle  <ul style="list-style-type: none"> Keeping the compass at the same distance, make a mark on the circumference, place the compass on that point, then make an arc on the circumference 	
<p>Slide 10</p>	<ul style="list-style-type: none"> Continue to make arcs, placing the compass point at the previous arc. <p>You should end up with 6 marks at equal distance around the circumference.</p>  <p>Join the marks up to make a hexagon</p> 	<p>You can ask students why this construction works and why you get a hexagon rather than regular polygon with a different number of sides.</p> <p>Could they construct an equilateral triangle using a similar approach? What is the link between equilateral triangles and hexagons?</p>
<p>Slide 11</p>	<ul style="list-style-type: none"> Extend each side out with a ruler, rub out the extra lines  	
<p>Slide 12</p>	<ul style="list-style-type: none"> Extend each side out with a ruler, rub out the extra lines  	

<p>Slide 13</p>	  <p>Stellating a pre drawn hexagon</p> <ul style="list-style-type: none"> Extend each side out with a ruler, rub out the extra lines 																																													
<p>Slide 14</p>	  <ul style="list-style-type: none"> We can describe this shape with it's Schläfi symbol. This is given to all regular stellated polygons. This has Schläfi symbol {6/2} 	<p>To generate the Schläfi symbol, we need to count the number of sides in the basic shape and the number of sides that are missed out when we travel around the stellated shape instead of the basic shape. The Schläfi symbol is {number of sides of basic shape/number of sides missed out plus 1}.</p> <p>In the hexagon, there are 6 sides and we miss out one side so the Schläfi symbol is {6/(1+1)} or {6/2}</p>																																												
<p>Slide 15</p>	  <ul style="list-style-type: none"> From a heptagon we can create this shape  <p>This shape has Schläfi symbol {7/2}</p> <p>What would the Schläfi symbol of this star?</p> 	<p>The Schläfi symbol {m/n}, m describes the number of edges the original polygon has, n-1 is the number of sides 'missed out', so the Schläfi symbol of the second star is {7/3}.</p>																																												
<p>Slide 16</p>	  <ul style="list-style-type: none"> Explore what different stellations are possible with different polygons? Can you stellate a square? Can you create a formula for the number of stellations a shape can make? You may find two different formulae fits your results best. What can you work out about Schläfi symbols where the numbers can be simplified (i.e. {6/2} can be simplified to {3/1})? 	<p>For a regular n-agon, where n is even there are (n-4)/2 stellations, where n is odd there are (n-3)/2 stellations.</p>																																												
<p>Slide 17</p>	  <table border="1" data-bbox="236 1317 571 1507"> <thead> <tr> <th>Polygon Name</th> <th>Number of sides</th> <th>Number of different star polygons</th> <th>Schläfi symbol(s)</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>	Polygon Name	Number of sides	Number of different star polygons	Schläfi symbol(s)																																									
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<p>Slide 18</p>	  <p>ANSWERS AFTER THIS SLIDE</p>																																													

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Polygon shape	Number of sides (n)	Number of different star polygons	Schläfi symbols
Pentagon	5	1	{5/2}
Hexagon	6	1	{6/2}
Heptagon	7	2	{7/2}, {7/3}
Octagon	8	2	{8/2}, {8/3}
Nonagon	9	3	{9/2}, {9/3}, {9/4}
Decagon	10	3	{10/2}, {10/3}, {10/4}
hendecagon	11	4	{11/2}, {11/3}, {11/4}, {11/5}
Dodecagon	12	4	{12/2}, {12/3}, {12/4}, {12/5}

The formula for number of star polygons:
 Where n is even = $(n-4)/2$
 Where n is odd = $(n-3)/2$

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