## Task A: Construction of a Pyramid

To construct the 3D representation of a pyramid according to a question in Paper 1 of Compulsory Part, HKDSE 2014.

17. Figure 6(a) shows a solid pyramid $VABCD$ with a rectangular base, where $AB = 18$ cm, $BC = 10$ cm, $VB = VC = 30$ cm and $\angle VAB = \angle VDC = 110°$.

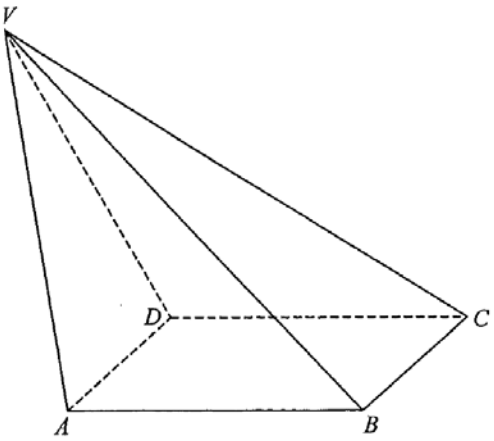



Figure 6(a)

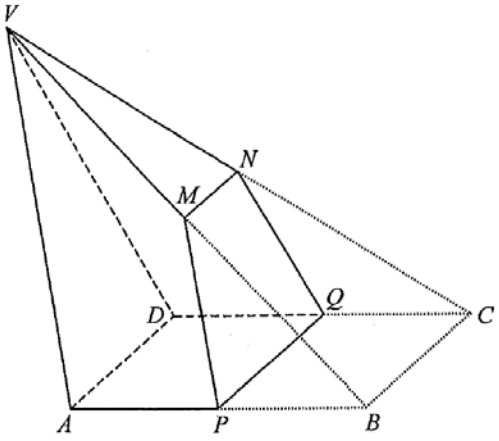
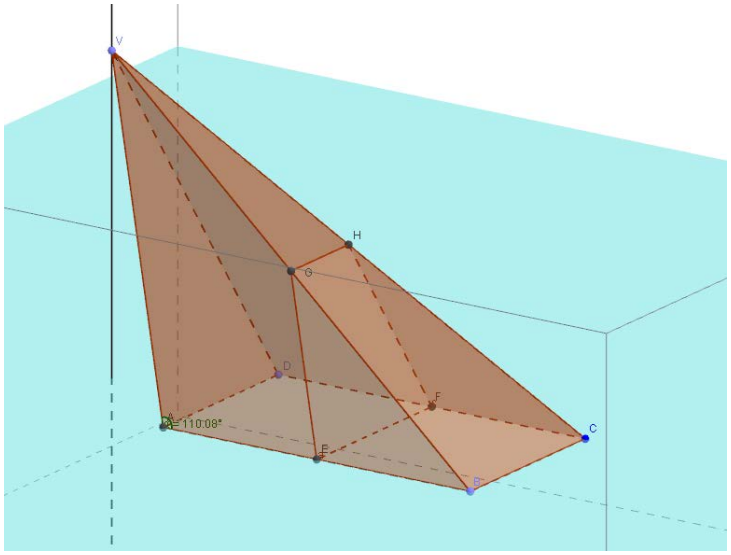
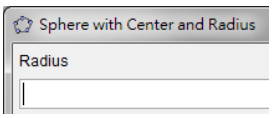
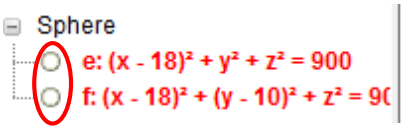


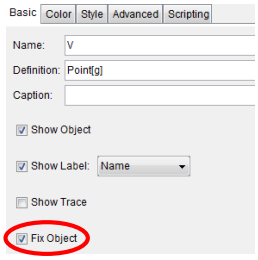

Figure 6(b)

(Q. 17, Paper 1, Compulsory Part, Mathematics, HKDSEE 2014)



Create objects on the Graphics window as follows:

| Steps | Objects to be created | Actions |
|---|---|---|
| 1. | (Change View Setting) | ◆ In "View" menu, choose "3D Graphics"<br>◆ In the drop-down menu next to the header of "3D Graphics", choose the "Toggle Clipping Box"  and drag the slider to the right. |
| 2. | The base of the pyramid | ◆ In the "Graphics" window, add 4 points *A*, *B*, *C* and *D* at coordinates (0, 0), (18, 0), (18, 10) and (0, 10) respectively, then use the "Polygon" tool  to join *A*, *B*, *C*, *D* and *A* to form the base of the pyramid.<br>◆ Check the "3D Graphics" window, the same rectangle should also be seen. Close the "Graphics" window. |
| 3. | The vertex *V* according to the description of the question | ◆ Click the bottom-right corner of the "Sphere" tool  and choose "Sphere with centre and radius".<br>Click the point *B* in "3D Graphics" window.<br>Type "30" in the "Radius" window.  <br>◆ Similarly, construct another sphere with centre at point *C* and radius of 30 units.<br>◆ Click the "Intersect Two Surfaces" button  , then choose the two spheres in the "Algebra" window.<br>Hide the spheres by clicking the button next to the equations of the spheres in the "Algebra" window.  <br>◆ The intersection of the spheres is a circle.<br>On the circle, add a point and rename it as *V*.<br>Hide the circle. |

| Steps | Objects to be created | Actions |
|---|---|---|
| 4. | Construct the pyramid *VABCD* according to the description of the question. | ◆ Click the "Pyramid" button  , then click the point *V* and the rectangle *ABCD* in order.<br>◆ Use "Angle" function  to measure ∠*VAB*.<br>Drag *V* until ∠*VAB* = 110°.<br>Right-click the point *V* in "Graphics" window, and check the box "Fix Object" in "Object Properties".<br>  |
| 5. | (Optional) Construct trapezium *MNQP* and the height of *VABCD*. | ◆ In "Point" tools, choose "Midpoint or Centre"  to locate the midpoint of *VB* by clicking *V* and *B* in "Graphics" window.<br>Rename the point as *M*.<br>◆ Similarly, construct *N*, *P* and *Q* accordingly.<br>Use "Polygon" tool to construct trapezium *MNQP*.<br>◆ Click "Plane through 3 Points" button  and then click *A*, *B* and *C* to create the base plane.<br>◆ Click "Perpendicular Line" button  and then click *V* and the base plane to construct the perpendicular from *V* to the base of *VABCD*. |

**Task B:** **<u>Construction of a Model of Paper-folding</u>**

To construct the 3D representation of a model of paper-folding according to a question in Paper 1 of Compulsory Part, HKDSEE 2015.

19. In Figure 3(a), $ABCDB'$ is a pentagonal paper card. It is given that $AB = AB' = 40$ cm, $BC = B'D = 24$ cm and $\angle ABC = \angle AB'D = 80°$.

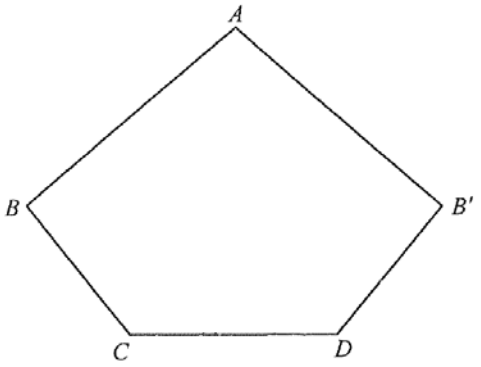



Figure 3(a)

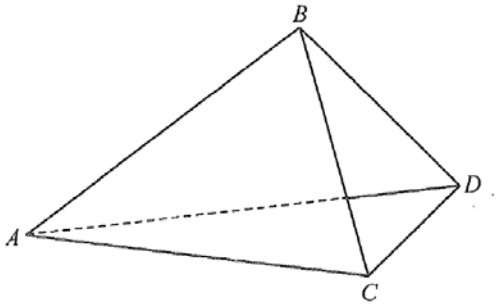
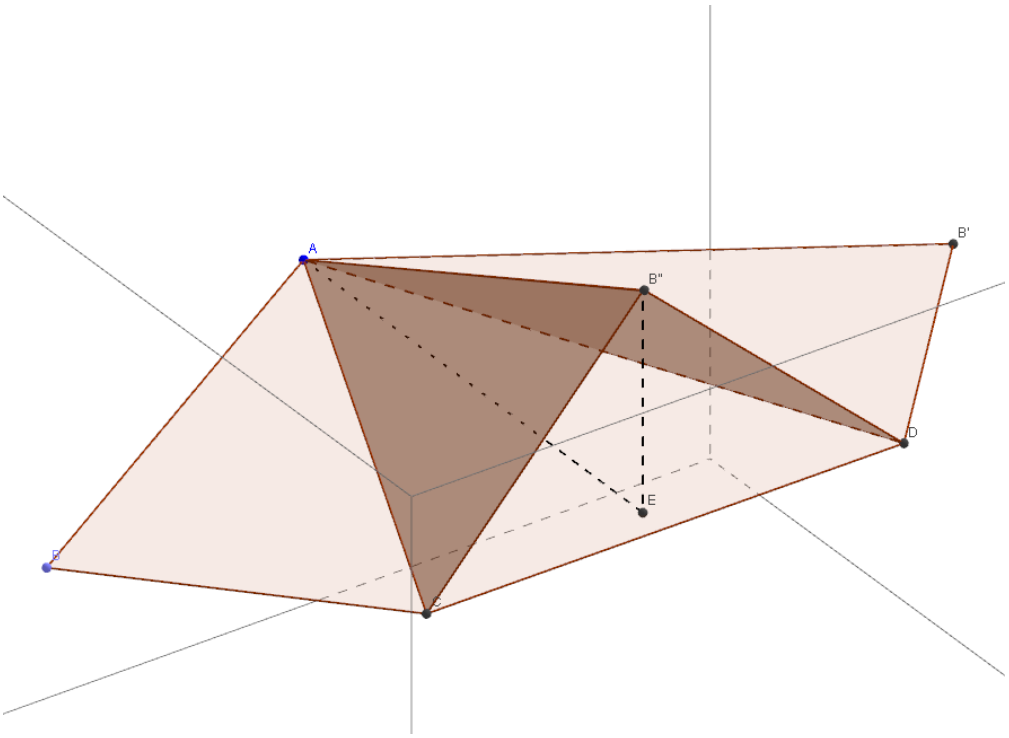



Figure 3(b)

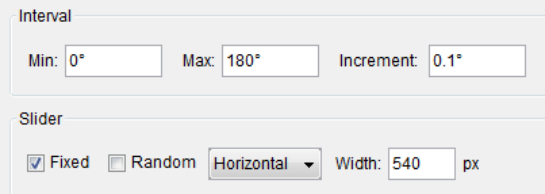
(b) Suppose that $\angle BCD = 132°$. The paper card in Figure 3(a) is folded along $AC$ and $AD$ such that $AB$ and $AB'$ join together to form a pyramid $ABCD$ as shown in Figure 3(b). Find the

(Q. 19, Paper 1, Compulsory Part, Mathematics, HKDSEE 2015)



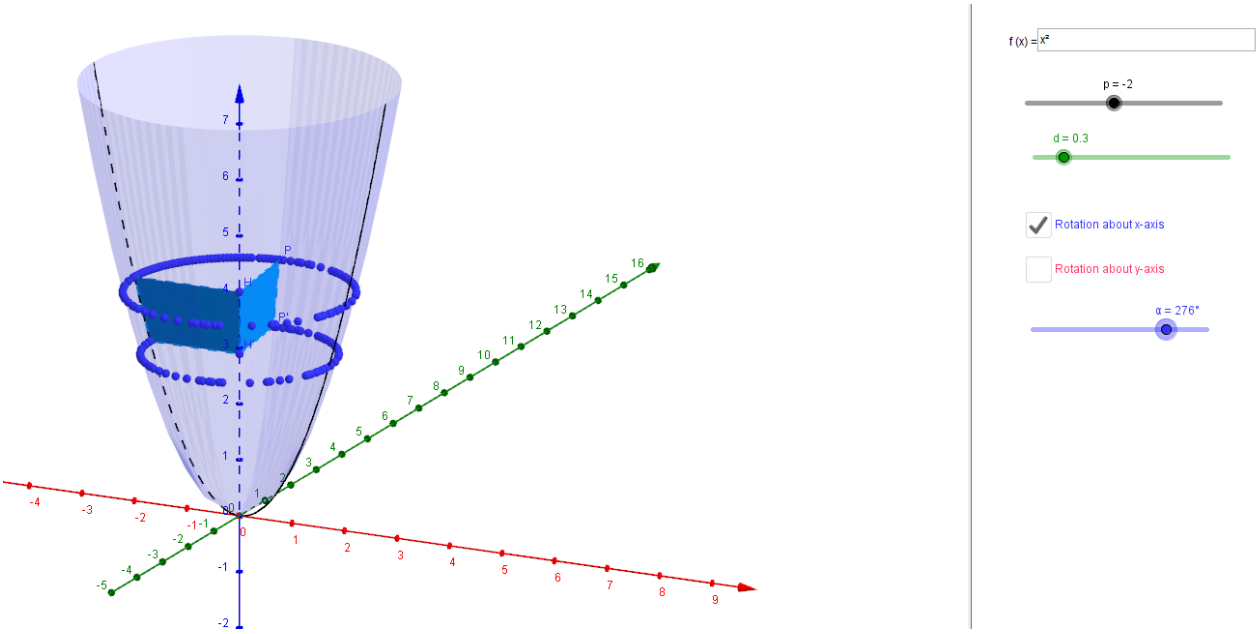
Create objects on the Graphics window as follows:

| Steps | Objects to be created | Actions |
|---|---|---|
| 1. | (Change View Setting) | ◆ In "View" menu, choose "3D Graphics"<br>◆ In the drop-down menu next to the header of "3D Graphics", choose the "Toggle Clipping Box"  and drag the slider to the right. |
| 2. | The pentagonal paper card *ABCDB'* | ◆ In the "Graphics" window, add a free point *A*.<br>◆ Click the button "Circle with Centre and Radius" to construct a circle centred at *A* with radius 40 units.<br>◆ Add a point *B* on the circle.<br>Then click "Circle with Centre and Radius" to construct a circle centred at *B* with radius 24 units.<br>◆ Click the button "Angle with Given Size", then click the points *A* and *B*, and fix the angle at 80° clockwise.<br>Draw a ray from *B* along the angle created.<br>Label the point of intersection of the ray and the smaller circle as *C*.<br>◆ Similarly, draw a ray from *C* such that the ray and *BC* form an angle of 132°.<br>◆ Click the button "Circle with Centre through Point" to construct a circle centred at *A* and passes through *C*.<br>Label the point of intersection of the ray from *C* and this circle as *D*.<br>◆ From *D*, construct a circle with radius 24.<br>Label the point of intersection of this circle and the larger circle centred at *A* as *B'*.<br>◆ Draw the pentagon *ABCDB'* by using the "Polygon" button .<br>◆ Check the "3D Graphics" window, the same pentagon should also be seen. |

| Steps | Objects to be created | Actions |
|---|---|---|
| 3. | The animation of the paper-folding process | ◆ Using the "Polygon" button, create two triangles *ABC* and *AB'D*.<br>◆ Create a slider α with the following settings:<br>  <br>◆ In the "3D Graphics" window, click "Rotate around Line" button  , then click Δ*ABC* and the line *AC* respectively.<br>Set the angle of rotation as α clockwise.<br>◆ Similarly, rotate Δ*AB'D* at α counter-clockwise.<br>◆ Drag the slider in "Graphics" window to see the animation in "3D Graphics".<br>◆ Set the opacity of the figures in their "Object Properties" → "Colour" for clearer presentation. |

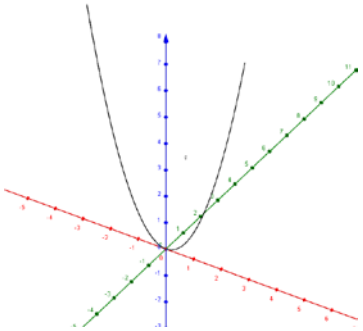
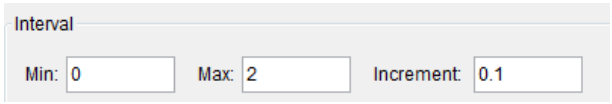
**Task C: <u>Solid of revolution</u>**

To create a dynamic worksheet to explore how a solid of revolution is generated and hence the method of calculation the volume of the solid.




Create objects on the Graphics window as follows:

| Step | Objects to be created | Actions |
|---|---|---|
| 1. | (Change View Setting) | ◆ Choose "3D Graphics" module.<br>Choose to hide *xOy* plane and maximise the "Toggle Clipping Box" at the following drop-down tool bar:<br>  <br>◆ In the "View" menu, choose to open "Graphics" view.<br>Move the "Graphics" window to the right and appropriately adjust the window size so that "3D Graphics" window is still clearly shown. |
| 2. | A function of *x* to be discussed | ◆ In "Graphics" window, enter an arbitrary function such as "f(x)=x²" in the input field.<br>Then create an input box with caption "f(x)=", and link the box to *f* (*x*).<br>Hide the graph of *y* = *f* (*x*). |

| Step | Objects to be created | Actions |
|---|---|---|
| 2. | A function of $x$ to be discussed | ◆ In "3D Graphics" window, define a parametric function $c$ ($t$) by inputting "`c(t)=curve[t,0,f(t),t,-20,20]`".<br>  <br>◆ Teachers and students can key in other functions in $x$ for other curves. |
| 3. | Strips under the curve to demonstrate | ◆ In "Graphics" window, create two sliders (named $p$ and $d$), with the interval settings as follows respectively:<br>slider $p$:  <br>slider $d$:  <br>◆ In "3D Graphics" window, define two points $P$ and $P'$ by inputting "`P=c(p)`" and "`P'=c(p+d)`" respectively.<br>◆ Define another four points $H$, $H'$, $V$ and $V'$ by inputting "`H=P-p*(1,0,0)`", "`H'=P'-(p+d)*(1,0,0)`", "`V=P-f(p)*(0,0,1)`" and "`V'=P'-f(p+d)*(0,0,1)`" respectively.<br>◆ Create two polygons $PHH'P'$ and $PVV'P'$ and label them with two colours with the value of opacity being 100.<br>◆ In "Graphics" window, create two check boxes, labelled with "Rotation about x-axis" and "Rotation about y-axis". Link the polygon $PVV'P'$, the points $V$ and $V'$ to "Rotation about x-axis", and the polygon $PHH'P'$, the points $H$ and $H'$ to "Rotation about y-axis". |

| Step | Objects to be created | Actions |
|---|---|---|
| 4. | The surface of revolution of the curve about *y*-axis | ◆ In "Graphics" window, create a slider α, as an angle with the interval settings as follow:<br>  <br><br>◆ By using the "Rotate around Line"  button, rotate the points *P*, *P* ' and the polygon *PHH* '*P* ' around *y*-axis, with angle of rotation being α.<br>Trace the image of *P* and *P* '.<br>◆ Create the surface of revolution by inputting "`Surface[t*cos(θ), t*sin(θ), f(t), t, -20, 10, θ, 0, α]`".<br>Colour it with a similar colour to *PHH* '*P* ' with the value of opacity being 25.<br>◆ Link all the objects created in this procedure to the checkbox "Rotation about *y*-axis". |