## Grade 9 Mathematics Worksheet

## Transformation geometry and geometric shapes

## Questions:

1. Create the following grid pattern by translating the triangle shown below along a ruler for the three different sides of the triangle. Answer the following questions. Mark the relationship between the parts of the triangle as you progress.
i) Label a hexagon in the figure and describe its properties.
ii) Label a rectangle in the figure and describe its properties.
iii) Label a parallelogram in the figure and describe its properties.
iv) Label a trapezium in the figure and describe its properties.

2. Angles in three dimensions for a cube and a square based pyramid. Fill out the table.
i) Name all the dihedral angles for a cube and a square based pyramid.
ii) Name the linear angle of the dihedral angle for a cube and a square based pyramid.
iii) Name the two vertical dihedral angles that are supplementary to each other for a cube and a square based pyramid.
iv) Name the rigth dihedral angles for a cube and a square based pyramid.


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|  | dihedral angles | linear angle of <br> the dihedral <br> angle | $\frac{\text { vertical dihedral }}{\text { angles that are }}$ <br> supplementary | $\frac{\text { right dihedral }}{\text { angles }}$ <br> Cube |
| :--- | :--- | :--- | :--- | :--- |
| Square based <br> Pyramid |  |  |  |  |

3. Take a careful look at each of these diagrams I, II and III of cubes with pyramids inside and answer the following questions for each diagram.
i) How many faces does the pyramid have?
ii) Name the equal faces of the pyramid.
iii) Name the equal dihedral angles of the pyramid.
iv) Name the equal sides and equal angles in each of the pyramids.


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| Pyramid | faces | equal faces | equal dihedral angles <br> TAKE CARE: IT <br> IS TWO LABELS <br> ONLY WHICH <br> CONTRADICT <br> WITH LINE <br> LABELS IN <br> PLANE FIGURES | equal sides and equal angles | right plane and right dighedral angles. <br> TAKE CARE: IT <br> IS TWO LABELS <br> ONLY WHICH <br> CONTRADICT <br> WITH LINE <br> LABELS IN <br> PLANE <br> FIGURES |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ACDH |  |  |  |  |  |
| ABCDM |  |  |  |  |  |
| ABCDH |  |  |  |  |  |

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## Solution

1. 



This is an example of the line segment that could be labelled. The angles should also be marked as shown in the diagram below. That will help the learners to see the relationship clearer. There are many different versions of the shapes in question that can be found. See teacher notes for more guidance.

2. Definitions for:
i) Diheral angle is a figure in space that is formed by two half-planes, which have the same edge. The dihedral angles are labelled based on the shared edge and the names of the two planes, where it is labelled as plane S and plane T .
If there are several dihedral angles with the same edge that are named by four letters of which the middle two marks the edge and the other two marks the plane and the names of the two planes, where it is labelled as plane $S$ and plane T and plane M.
So the dihedral angle is ABMS and ABMT and ABST. If there were only planes S and $T$ the dihedral angle would be labelled as $A B$ only.

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## TAKE CARE: IT IS TWO LABELS ONLY WHICH CONTRADICT WITH LINE LABEL SIN PLANE FIGURES



Diheral angles are also seen as internal and external as shown below.

External
dihedral angle


Internal dihedral angle

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ii) Linear angle is formed when any ray e.g. GH and its corresponding ray HK is drawn perpendicular to the edge $A B$ in the two faces.
iii) Vertical dihedral angle is the same as vertical opposite angles in a plane except the angles are formed by two planes.
iv) Right dihedral angle if the size of the dihedral angle is $90^{\circ}$.

|  | dihedral angles | linear angle of <br> the dihedral <br> angle | vertical dihedral <br> angles that are <br> supplementary | right dihedral <br> angles |
| :--- | :--- | :--- | :--- | :--- |
| Cube | 12 | 0 | 0 | 12 |
| Square based <br> Pyramid | 8 | 0 | 0 | 0 |

3. 

| Pyramid | faces | equal faces | equal dihedral angles <br> TAKE CARE: IT <br> IS TWO LABELS <br> ONLY WHICH <br> CONTRADICT <br> WITH LINE <br> LABELS IN <br> PLANE FIGURES | equal sides and equal angles <br> (TAKE CARE: IT <br> IS TWO LABELS <br> ONLY WHICH <br> CONTRADICT <br> WITH LINE <br> LABELS IN <br> PLANE <br> FIGURES) |
| :---: | :---: | :---: | :---: | :---: |
| ACDH | 4 | 3 | HD, AD and DC | AH,HC,AC <br> HAD, HDC, ADC <br> All base angles of the right angles are equal to one another HAD, AHD, DHC etc All angles around d are 90 degrees $A D, B C, D C$ and AB |
| ABCDM | 5 | 2 | AD and BC MA and MB MD and MC | MD and MC, MA and MB $A D, D C, C B$ and |

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|  |  |  | $A D, B C, D C$ and <br> $A B$ | $B C$. <br> $A D, B C, D C$ and <br> $A B$ |
| :--- | :--- | :--- | :--- | :--- |
| $A B C D H$ | 5 | 2 different sets <br> of 2 | $A D, B C, D C$ and <br> $A B$ <br> $H A$ | All angles $H C$ <br> around $D$ are <br> 90 degrees <br> $A H D$ and $D H C$ <br> $A H B$ and $B H C$ <br> $H A$ and $H C$ <br> $A D, B C, D C$ and <br> $A B$ |

The pre-knowledge that is required is knowledge of properties of shapes as well as the effect of translating a given figure (Shape properties/size stay the same while orientation and position can change). In the case of the rigid transformations e.g. translation, reflection and rotation.

Shape properties/proportion changes while orientation and position can change). In the case of the non- rigid transformations e.g. dilations, shrinks, stretches.

The combined pre- knowledge should be used to identify the different shapes in the figure.

An extension activity could be to look at dilations and inflations of the various shapes on the grid.

The representation and introduction of terms related to solid objects should be carefully negotiated. Many of the concepts related to solid objects poses a conflict when represented on paper (e.g. skew lines looks as if they actually intersect on paper).

