# hw1_ChangYang

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## Question 1 solution

One representation point of the origin in physical space can be (0, 0, 1). According to the fact that radial line is the same class except the origin in representational space. The points are on the Z-axis except the origin.

## Question 2 solution

No, they are not the same. Each point at infinity has a direction. The representational form of a physical point at infinity is $(a, b, 0)$. The direction of this point is controlled by the pair $(a, b)$.

## Question 3 solution

HC representation of degenerate conic is given by $C = lm^T + ml^T$. The rank of $lm^T$ is one. And since $ml^T$ is the transpose of $lm^T$. The rank of $ml^T$ is one and the rank of the sum of two will not exceed 2.

## Question 4 solution

First, $l_1$ pass through (0, 0), (2, 6), which are (0, 0, 1) and (2, 6, 1) respectively in representational space. Thus, $l_1 = (0, 0, 1)^T \times (2, 6, 1)^T$, which is $(-6, 2, 0)^T$.

Second, similarly, $l_2 = (-6, 8, 1)^T \times (-3, 2, 1)^T$, which is $(6, 3, 12)^T$.

Finally, the intersection of $l_1$ and $l_2$ is $(-6, 2, 0)^T \times (6, 3, 12)^T$, which is $(24, 72, -30)^T$. This is $(-0.8, -2.4, 1)^T$. Thus, the intersection of this two lines is (-0.8, -2.4)

If second line pass through (-10, 3) and (10, 3), then obviously this line pass through (0, 0). Plus two lines have different slopes. Then obviously the intersection is (0,0). One step is enough.

## Question 5 solution

$l_1 = (0, 0, 1)^T \times (2, -2, 1)^T$, which is $(2, 2, 0)^T$.

$l_2 = (-3, 0, 1)^T \times (0, -3, 1)^T$, which is $(3, 3, 9)^T$.

The intersection is $l_1 \times l_2 = (18, -18, 0)^T$.

Above results show $l_1$ and $l_2$ are parallel lines. Thus, the intersect is on infinity. The intersect is ideal point.

## Question 6 solution

First find the HC representation of the circle. Physical representation is $(x - 5)^2 + (y - 5)^2 = 1$, which is $x^2 - 10x + y^2 - 10y + 49 = 0$. Thus, $C = \begin{bmatrix} 1 & 0 & -5 \\ 0 & 1 & -5 \\ -5 & -5 & 49 \end{bmatrix}$.

Nest find the polar line. For x $= (0, 0, 1)^T$, the polar line is $l = Cx = (-5, -5, 49)^T$.

Finally find the intersection. For x axis $l_x = (0, 1, 0)^T$, the intersection is $l^T \cdot l_x = (49, 0, 5)^T$. Thus, the intersect is $(\frac{49}{5}, 0)$. Similarly, y axis $l_y = (1, 0, 0)^T$. The intersect is $(0, \frac{49}{5})$.

## Question 7 solution

Obviously, the intersection is (1,1).

However, we can also use the HC representation. For $x = 1$, $l_1 = (1, 0, -1)^T$. For $y = 1$, $l_2 = (0, 1, -1)^T$. Thus, the intersection is $l_1 \times l_2 = (1, 1, 1)^T$. Thus, the intersection is (1,1).