Sheet (3)

Question (1) :-

1) The area covered by the camera = area of circular sector = $\frac{1}{2} r^2 \theta_{(radian)}$

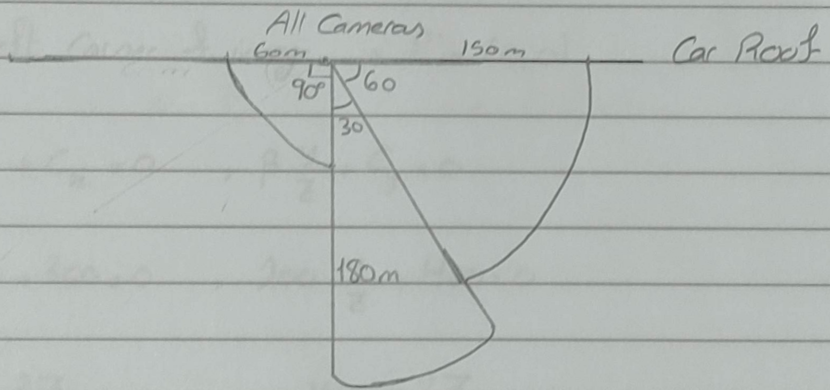
→ Camera (1) :- Area = $\frac{1}{2} (180)^2 \left(\frac{\pi}{180} \times 30\right) = 8482.3 \ m^2$

→ Camera (2) :- Area = $\frac{1}{2} (150)^2 \left(\frac{\pi}{180} \times 60\right) = 11781 \ m^2$

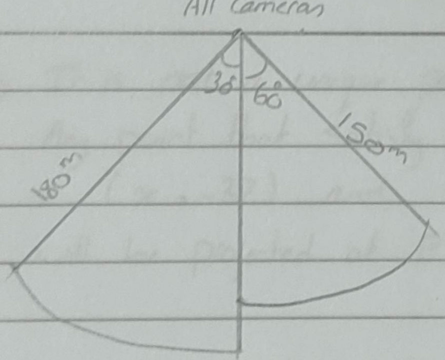
→ Camera (3) :- Area = $\frac{1}{2} (60)^2 \left(\frac{\pi}{180} \times 90\right) = 2827.5 \ m^2$

Camera (2) covers the largest area.

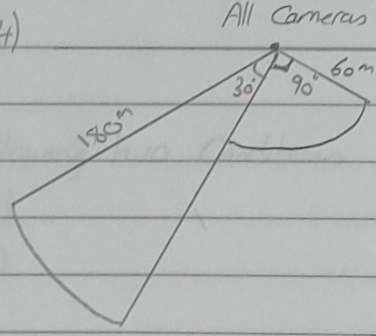
2)



3)



4)



Question (2) :-

1] a. $P = (30, 20, 50) \longrightarrow P' = \left(\alpha \frac{x}{z} + c_x , \beta \frac{y}{z} + c_y\right)$
$= (360, 480)$

b. $P = (10, 10, 10) \longrightarrow P' = (400, 600)$

c. $P = (-30, -20, 50) \longrightarrow P' = (240, 320)$

2] Any point that will have P' outside the image size (600X800)

Example : $P = (300, 200, 50) \longrightarrow P' = (900, 1200) >$ image size

3] At top left corner of image $\longrightarrow P' = (0,0)$

$\alpha \frac{x}{z} + c_x = 0 \quad , \quad \beta \frac{y}{z} + c_y = 0$

$100 \frac{x}{z} + 300 = 0 \quad , \quad 200 \frac{y}{z} + 400 = 0$

$x = -3z \qquad\qquad y = -2z$

$\Longrightarrow$ It is not a unique point.
Any point that satisfy the following two conditions
$(x = -3z)$ and $(y = -2z)$
will be projected at $P' = (0,0)$

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4] Yes.

Example :- in the previous answer we said that, if a point satisfy ($x = -3z$) and ($y = -2z$) then they will be projected at $P' = (0,0)$

Put $z = 1 \longrightarrow P_1 = (-3, -2, 1)$
$z = 2 \longrightarrow P_2 = (-6, -4, 2)$
$z = 3 \longrightarrow P_3 = (-9, -6, 3)$

P_1, P_2, P_3 will be projected at $P' = (0,0)$

$\longrightarrow$ check if they are Collinear by using triangle inequality :-

$a = \sqrt{14}$ $b = 2\sqrt{14}$ $c = \sqrt{14}$

$\because a + c = b$

$\therefore P_1, P_2, P_3$ are Collinear

2. Calculating the triangle sides a, b and c by the equations:

$$a = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

$$b = \sqrt{(x_3 - x_1)^2 + (y_3 - y_1)^2 + (z_3 - z_1)^2}$$

$$c = \sqrt{(x_3 - x_2)^2 + (y_3 - y_2)^2 + (z_3 - z_2)^2}$$

Now apply one of the following methods:

triangle inequality: $a + b > c$ $a + c > b$ $b + c > a$

if all the inequalities are true then the points are not collinear.

Second method is by calculating the area by Heron's formula:

$$A = \sqrt{s(s-a)(s-b)(s-c)}$$

If the area equal 0 then the points are collinear (s - half the perimeter).

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Question (3) :-

a- using the Constant Velocity model :-

$$d(t+\Delta t) = d(t) - v_0 \Delta t$$

$$0 = 25 - \left(30 \times \frac{5}{18}\right) \Delta t$$

$$\Delta t = 3 \text{ second}$$

b. using the Constant Velocity model :-

$$d(t+\Delta t) = d(t) - V(t)\,\Delta t - \frac{1}{2} a_0 \Delta t^2$$

$$0 = 25 - \left(30 \times \frac{5}{18}\right) \Delta t - \frac{5}{2} \Delta t^2$$

$$\Delta t = 1.91 \text{ sec}$$

c- using a hybrid model :-

At Constant deceleration :-

$$V(t+\Delta t) = V(t) - a_0 \Delta t$$

$$V' = \left(30 \times \frac{5}{18}\right) - 5 \times 1$$

$$V' = \frac{10}{3} \text{ m/s}$$

$$d(t+\Delta t) = d(t) - V(t)\,\Delta t - \frac{1}{2} a_0 \Delta t^2$$

$$d' = 25 - \left(30 \times \frac{5}{18}\right) \times 1 - \frac{1}{2} \times 5 \times (1)^2$$

$$= \frac{85}{6} \text{ m}$$

At Constant Velocity :-

$$d(t+\Delta t) = d(t) - v_0 \Delta t$$

$$0 = \frac{85}{6} - \frac{10}{3} \Delta t$$

$$\Delta t = 4.25 \text{ sec}$$

$\therefore$ Total TTC = 1 + 4.25 = 5.25 seconds

d. At hybrid Model :-

→ At Constant deceleration :- $\Delta t = 1\ sec$ $\quad a = ??$

$$v' = (30 \times \frac{5}{18}) - a \times 1$$

$$v' = \frac{25}{3} - a$$

$$d' = 25 - (30 \times \frac{5}{18}) \times 1 - \frac{1}{2} a (1)^2$$

$$= \frac{50}{3} - \frac{1}{2} a$$

→ At Constant Velocity :- $d(t+\Delta t) = d(t) - V_0 \Delta t$

$$0 = d' - v' \Delta t$$

$$0 = \frac{50}{3} - \frac{a}{2} - \frac{25}{3} \Delta t + a \Delta t$$

Equ. (1)

At Constant deceleration :- $d(t+\Delta t) = d(t) - v(t)\Delta t - \frac{a_0}{2} \Delta t^2$

$$0 = 25 - \frac{25}{3} \Delta t - \frac{1}{2} a \Delta t^2 \rightarrow \text{Equ. (2)}$$

By using Equ. (1) and Equ. (2) :-

We got $75 t^3 - 525 t + 225 = 0$

:- $\Delta t = 2.398\ sec. \rightarrow a = 1.75\ m/s^2$

$\Delta t = 0.44\ sec. \rightarrow a = 217\ m/s^2$

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Question (4) :-

1) We have 15 iterations

Points	d_0	d_1	$h_1/h_0 = d_0/d_1$
1,2	28.3	14.1	2
1,3	72.8	51	1.4
1,4	100	70	1.4
1,5	72.8	51	1.4
1,6	28.3	14.1	2
2,3	50	40	1.25
2,4	82.5	60.8	1.36
2,5	64	44.7	1.43
2,6	40	20	2
3,4	36	22.4	1.6
3,5	40	20	2
3,6	64	44.7	1.43
4,5	36	22.4	1.6
4,6	82.5	60.8	1.36
5,6	50	40	1.25

2) → by using the average (mean) h_1/h_0 :-

mean $(h_1/h_0) = 1.57$ $\quad TTC = \frac{-\Delta t}{1 - h_1/h_0} = \frac{-1/20}{1-1.57} = 0.088$ sec

→ by using the median h_1/h_0 :-

median $(h_1/h_0) = 1.43$ $\quad TTc = \frac{-\Delta t}{1 - h_1/h_0} = \frac{-1/20}{1-1.43} = 0.1163$ sec