PROJECT REPORT

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QUESTIONS

Q.1) Why can't we render point and directional lights with uniform hemisphere sampling or cosine weighted sampling?

Ans.1) Point and directional lights are delta distributions and cannot be rendered using "Monte Carlo Estimation". Rendering them with "Uniform Hemisphere Sampling" or "Cosine Weighted Sampling" would lead to inaccuracies and artifacts in the rendered image.

Intuitively also, directional lights are present at infinity, ∴ a sampled *omega* will never hit a directional light. On the other hand, the probability of hitting a point light is always zero, ∴ *omega* can never hit a point light either.

This is why point and directional lights are sampled using special techniques like "Importance Sampling".

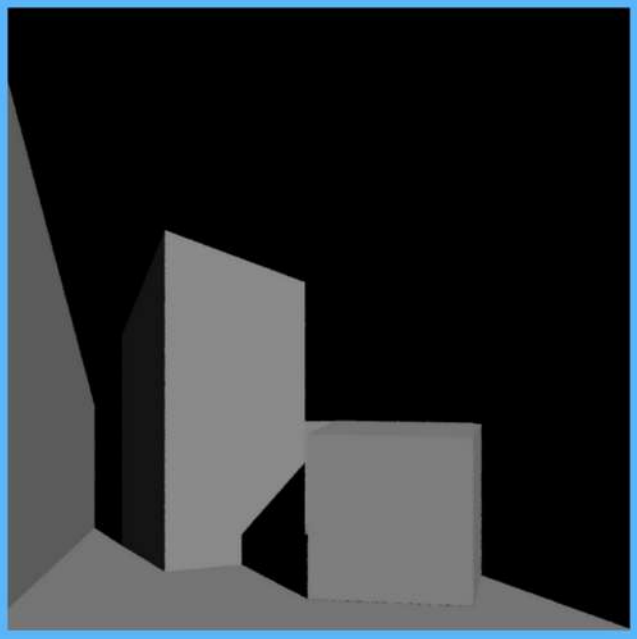
Q.2) Why does the noise increase for the same number of samples in the case of uniform hemisphere and cosine weighted sampling as the size of the area light decreases?

Ans.2) When the size of the area light decreases, the number of samples taken from that light source effectively decreases as well. This reduction in the number of samples means that fewer points contribute to the estimation of the lighting integral, leading to increased noise in the final rendered image.

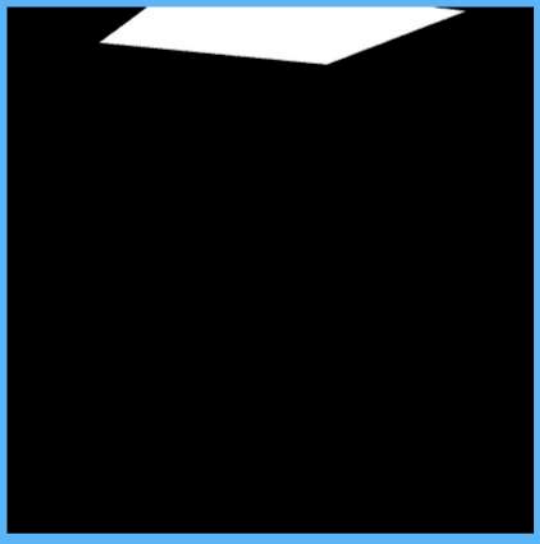
RENDERED IMAGES

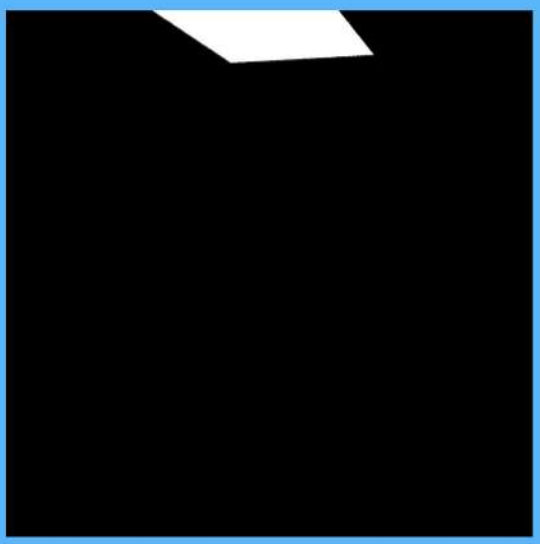
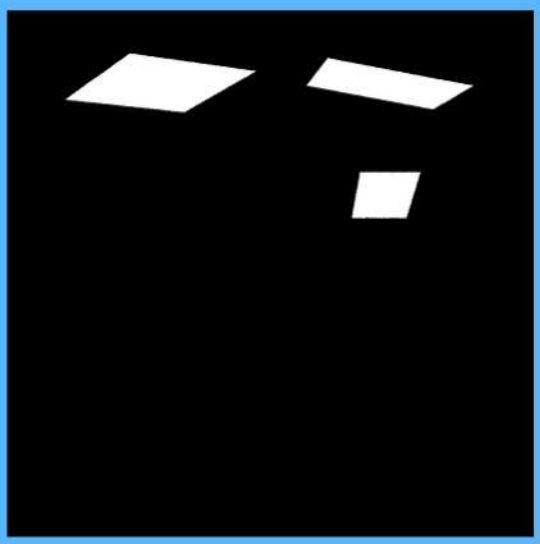
- **UHS:** Uniform Hemisphere Sampling
- **CWS:** Cosine Weighted Sampling
- **LS:** Light Sampling

Ans.1)

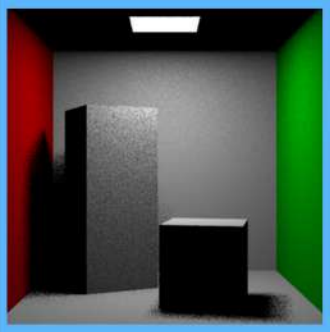
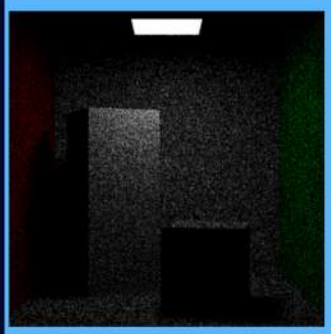
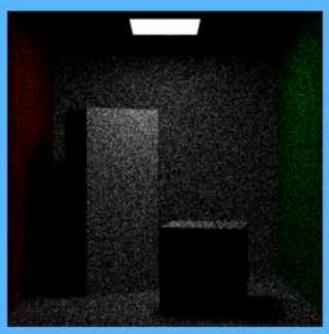
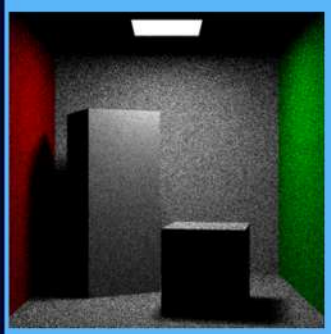
1 SPP	32 SPP
	
1854.789023 ms	68770.625000 ms

Ans.2)

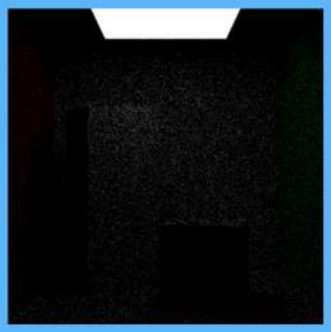
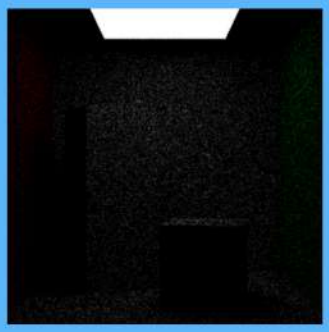
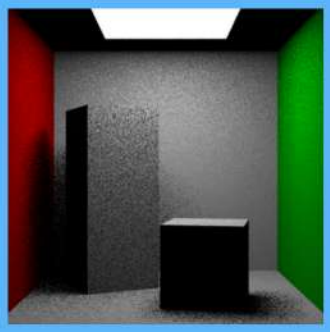
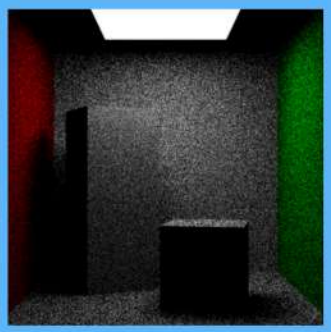
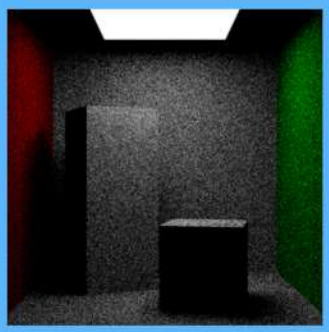
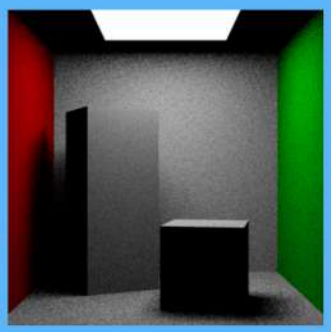
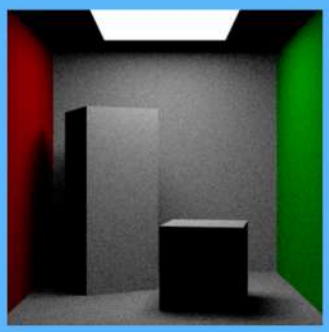
Scene 1	Scene 2
	
1619.447021 ms	1586.343018 ms

Scene 3	Scene 4
	
1611.917969 ms	3453.168945 ms

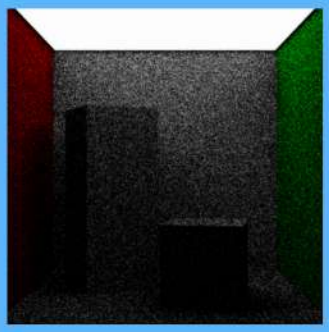
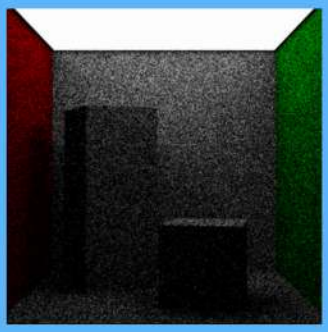
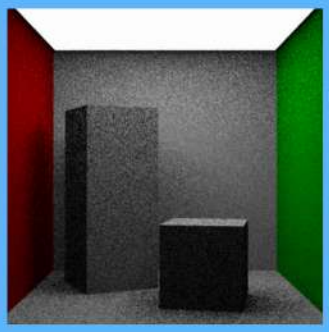
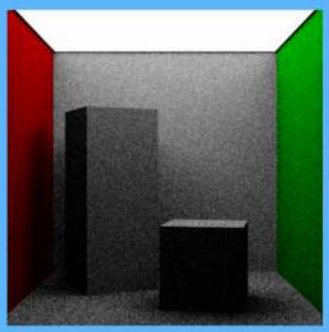
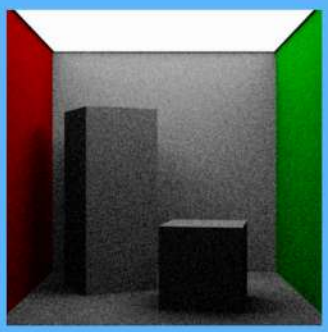
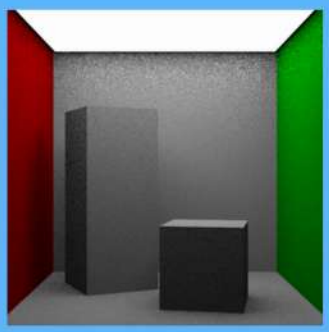
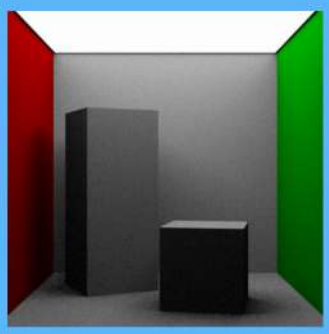
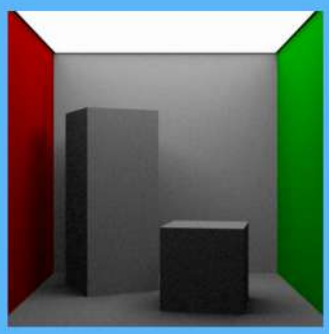
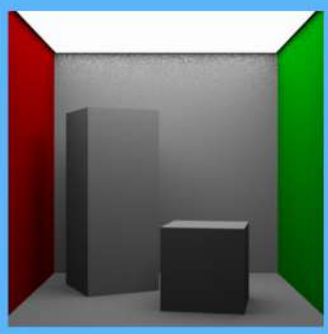
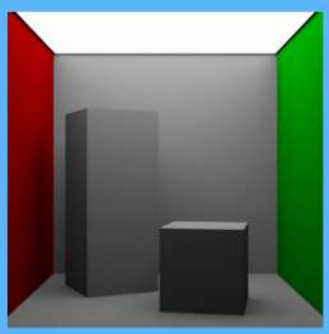
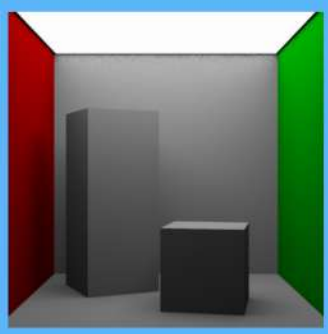
Ans.3) Small Light

SPP	UHS	CWS	LS
1			
RT	1304.573975 ms	1289.692017 ms	965.729980 ms
10			
RT	12610.800781 ms	12392.841797 ms	8726.453125 ms
100			
RT	128921.218750 ms	124854.734375 ms	92179.117188 ms
1000			
RT	2582612.750000 ms	2007794.000000 ms	1588980.500000 ms

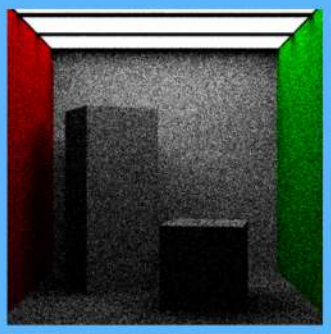
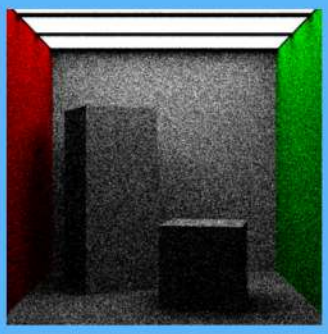
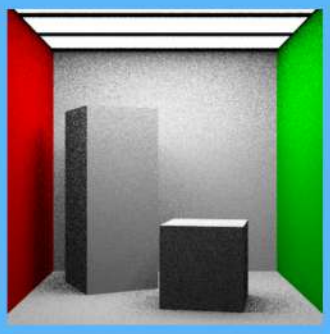
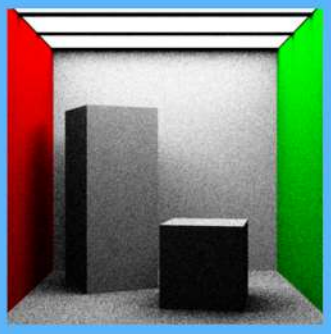
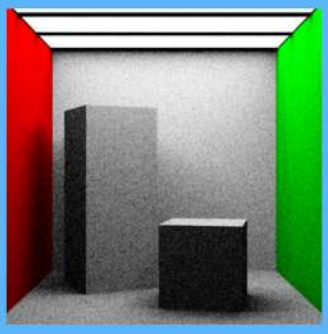
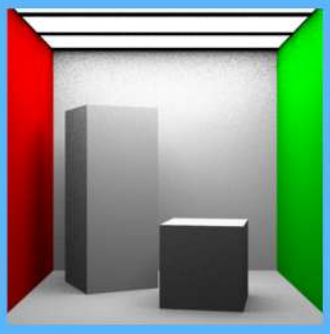
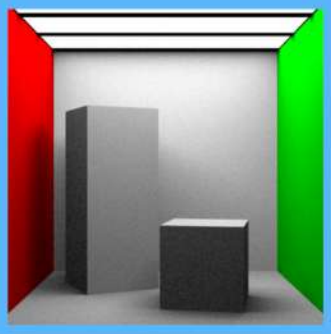
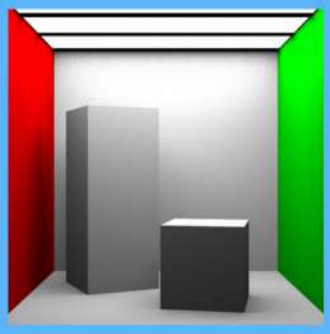
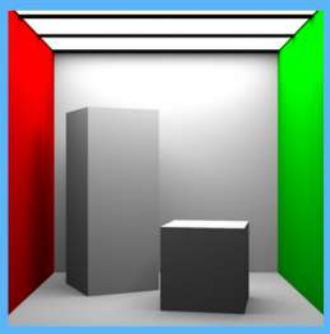
Medium Light

SPP	UHS	CWS	LS
1			
RT	1296.452026 ms	1259.848999 ms	942.450012 ms
10			
RT	12470.289062 ms	12468.554688 ms	9033.758789 ms
100			
RT	124299.968750 ms	121258.125000 ms	89924.218750 ms
1000			
RT	2544081.000000 ms	1984135.375000 ms	1558483.250000 ms

Big Light

SPP	UHS	CWS	LS
1			
RT	1291.939941 ms	1249.047974 ms	949.583984 ms
10			
RT	12445.934570 ms	12285.753906 ms	9260.351562 ms
100			
RT	123128.140625 ms	119270.289062 ms	89972.546875 ms
1000			
RT	2484186.250000 ms	1961855.250000 ms	1618413.750000 ms

Many Lights

SPP	UHS	CWS	LS
1			
RT	2990.212891 ms	2907.393066 ms	2021.406006 ms
10			
RT	51661.894531 ms	50340.664062 ms	31882.576172 ms
100			
RT	306721.400211 ms	294716.406250 ms	193115.796875 ms
1000			
RT	7322028.000000 ms	7244697.500000 ms	5748835.000000 ms