OPTI 435/535 Midterm 2009 Solutions

Problem 1

The wavefront error is given by

```
W[r_, θ_] = 0.00004 * r^4 - 0.00003 * r^3 * Cos[θ]
```

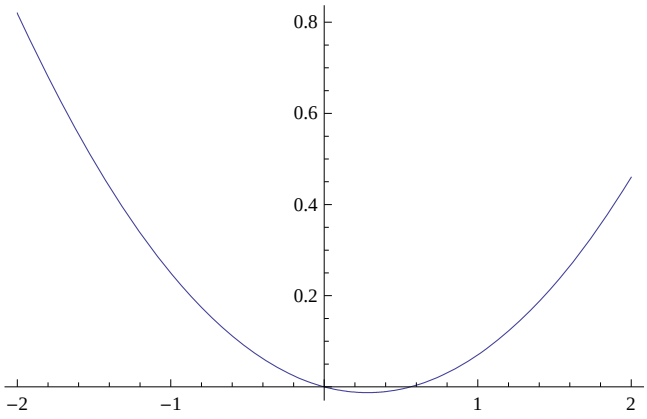
$$0.00004\, r^4 - 0.00003\, r^3 \cos[\theta]$$

Next calculate the power error in diopters

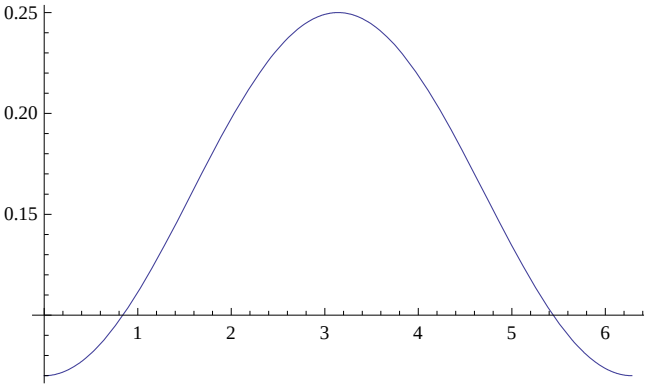
```
dϕ[r_, θ_] = FullSimplify[1000 * D[W[r, θ], r] / r]
```

$$r\,(0.16\, r - 0.09 \cos[\theta])$$

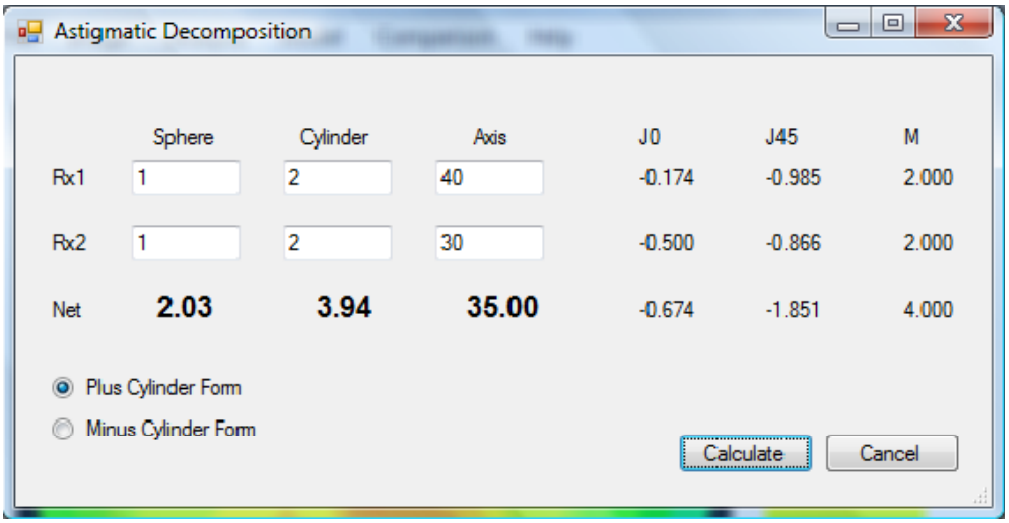
```
Plot[r (0.16 r - 0.09 ), {r, -2, 2}]
```

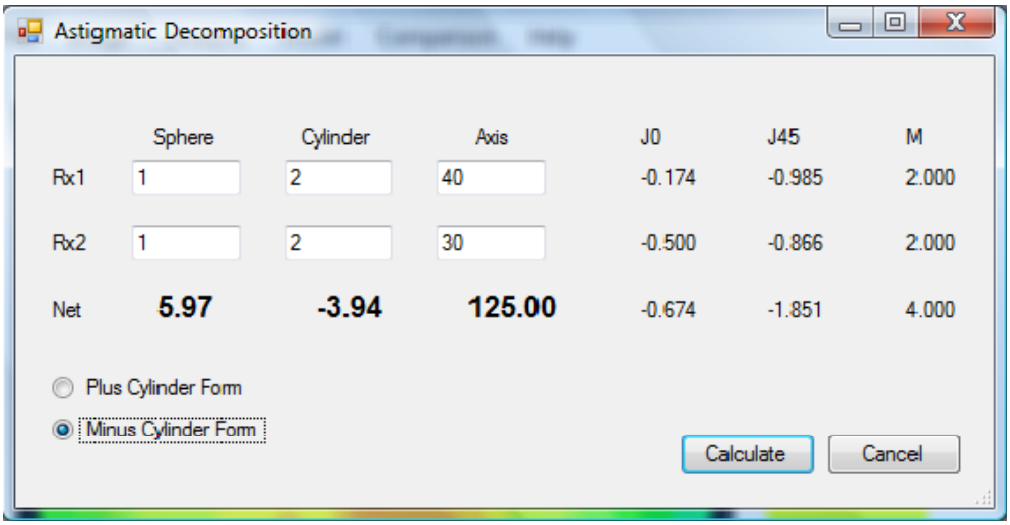



```
Plot[0.16 - 0.09 * Cos[θ], {θ, 0, 2 π}]
```



Problem 2





Problem 3

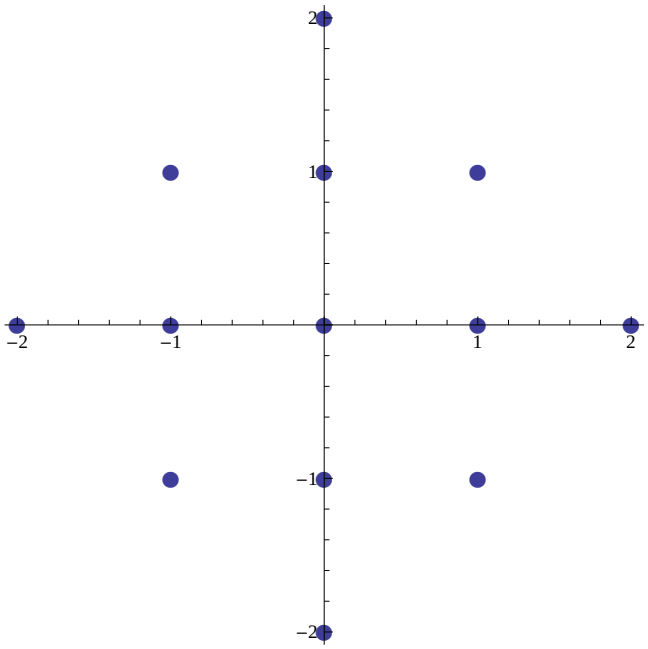
For a 1 mm spacing between the lenslets only the following coordinates pass through the pupil

```
points = {{-2, 0}, {-1, 0}, {0, 0}, {1, 0}, {2, 0},
  {-1, 1}, {0, 1}, {1, 1}, {0, 2}, {-1, -1}, {0, -1}, {1, -1}, {0, -2}}
```

```
{{-2, 0}, {-1, 0}, {0, 0}, {1, 0}, {2, 0}, {-1, 1},
 {0, 1}, {1, 1}, {0, 2}, {-1, -1}, {0, -1}, {1, -1}, {0, -2}}
```

The unaberrated spot pattern looks like

```
ListPlot[points, AspectRatio → 1, PlotMarkers → {Automatic, Medium}]
```



The spot shifts are given by $\triangle x = -f \frac{dW}{dx}$ and $\triangle y = -f \frac{dW}{dy}$. For $f = 24$ mm and $W = -0.002\, x^2$

```
Δx = -f * D[-0.002 * x^2, x]
Δy = -f * D[-0.002 * x^2, y]
```

```
0.004 f x
```

```
0
```

So Δy always equals zero and Δx is only dependent on the x position. Possible values for Δx are therefore

```
Δx /. {f → 24, x → -2}
Δx /. {f → 24, x → -1}
Δx /. {f → 24, x → 0}
Δx /. {f → 24, x → 1}
Δx /. {f → 24, x → 2}
```

```
-0.192
```

```
-0.096
```

```
0
```

```
0.096
```

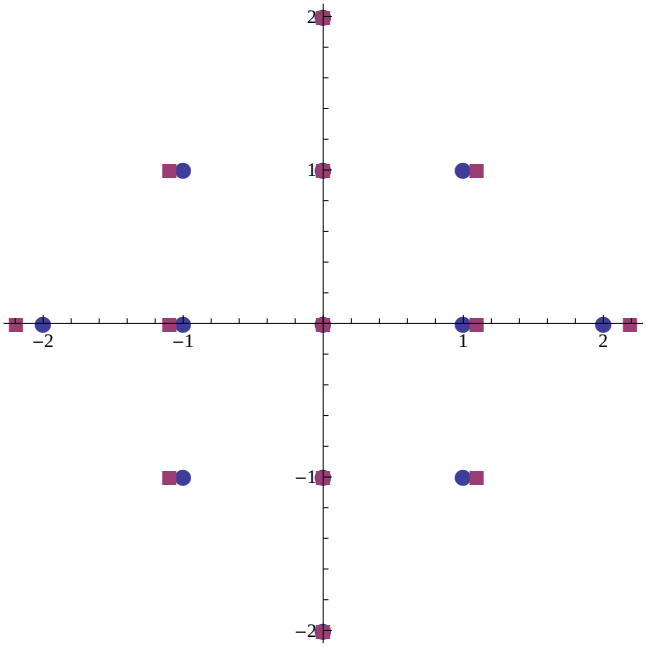
```
0.192
```

The aberrated spots are then located at

```
shiftedpoints =
 {{-2 - 0.192, 0}, {-1 - 0.096, 0}, {0, 0}, {1 + 0.096, 0}, {2 + 0.192, 0}, {-1 - 0.096, 1},
  {0, 1}, {1 + 0.096, 1}, {0, 2}, {-1 - 0.096, -1}, {0, -1}, {1 + 0.096, -1}, {0, -2}}
```

```
{{-2.192, 0}, {-1.096, 0}, {0, 0}, {1.096, 0}, {2.192, 0}, {-1.096, 1},
 {0, 1}, {1.096, 1}, {0, 2}, {-1.096, -1}, {0, -1}, {1.096, -1}, {0, -2}}
```

```
ListPlot[{points, shiftedpoints}, AspectRatio → 1, PlotMarkers → {Automatic, Medium}]
```



Problem 4

(a) Since the far point is in front of the eye, the person is near - sighted.
(b) The accommodative amplitude is 1/(Near Point in m) - 1/(Far Point in m) = 2 D - 1 D = 1 D.
(c) A -1 D lens will image infinity to their Far Point.