P1. Convex spherical mirror (20%)  
Given: R = 20 mm, h₀ = 8 mm, and p = 30 mm.  
Find:  
a) Focal length, f. Ans. 10 mm  
b) q. Ans. 1.5 mm  
c) h₁. Ans. 2 mm  
d) Ray-diagram confirmation on right virtual  
e) Is the image real or virtual? Ans.  

P2. Concave spherical mirror (20%)  
Given: R = 20 mm, h₀ = 8 mm, and p = 40 mm.  
Find:  
a) Focal length, f. Ans. 10 mm  
b) q. Ans. 17.3 mm  
c) h₁. Ans. 2.1 mm  
d) Ray-diagram confirmation on right real  
e) Is the image real or virtual? Ans.  

P3. Convergent/divergent thin-lens (30%)  
Given: f₁ = 10 mm, h₀₁ = 8 mm, and p₁ = 20 mm.  
Find:  
a) The image location, q₁. Ans. 20 mm  
b) The image height, h₁. Ans. 8 mm  
c) Ray-diagram confirmation for the 1st lens  
d) Is the image real or virtual? Ans.  
e) If the 2nd divergent lens (dashed) with f = -30 mm is placed in the observer side, and separated with the 1st lens by 10 mm, find the final image location respect to the 2nd lens, (6%) Ans. 15 mm, and the final image height, h₂. (2%) Ans. 15 mm and indicate it on left  

P4. Wave diffraction/interference (30%)  
A single-slit diffraction/interference pattern (Fig. 1) was taken using a 5mW (mW = 10⁻³ W) HeNe laser (λ = 632.8 nm, 1 nm = 10⁻⁹ m) under the condition: the distance between the slit and screen is 2 m.  
a) (5 %) Assume circular laser beam cross-section with a diameter of 0.003 m, find the laser energy flux, Ans. 10⁻¹ W/m²  
b) (5 %) Find the electric field intensity at the slit, Ans. 1 V/m  
c) (5 %) Indicate the dark locations of m = ±1, ±2, ±3 on the figure below:  
d) (15%) Find the slit width in unit of μm (1 μm = 10⁻⁶ m), Ans. 84  

Reference Equations:  
Mirror (or thin-lens) equation: q = pf/(p−f), M = −q/p, hi = Mho, for mirror case, f = ± R/2  
Diffraction/Interference: Two-slit bright condition: dsin(θ₀) = mλ, m = 0, ±1, ±2, ±3...Single-slit dark condition: asin(θ₀) = mλ, m = ±1, ±2, ±3...Small-angle approximation: sin(θ) ~ tan(θ) ~ y/L, S_{B,M} = cε₀E², c = 3×10⁸ m/s, ε₀ = 8.85E⁻¹² F/m