Question 3

(a)

Diagram of an ideal gravitational lensing system

(b)

Image of the source *as seen from earth*

(c)

Image of the source *as seen from earth*

Diagram to explain source-lens system

(d)

(e)

(f) Consider the case where we have a lensing object of the order of a few solar masses ($M \sim$ a few $\times 10^{30}$ kg) in the nearby regions of the galaxy (distance $D_L \sim$ a few $\times 10^{18}$ m away) and a source object somewhat further out ($D_S \sim$ a few $\times D_L$). Which of the following apply in this case?

Choose the following conditions that apply to the case as described in the question:

- ☐ α is large and $\tan\alpha$, $\sin\alpha$, $\cos\alpha$ must be calculated exactly
- ☐ α is small and the small angle approximations to $\tan\alpha$, $\sin\alpha$, $\cos\alpha$ are permissible
- ☐ α is irrelevant and need not be calculated
- ☐ θ_E is large and $\tan\theta_E$, $\sin\theta_E$, $\cos\theta_E$ must be calculated exactly
- ☐ θ_E is small and the small angle approximations to $\tan\theta_E$, $\sin\theta_E$, $\cos\theta_E$ are permissible
- ☐ θ_E is irrelevant and need not be calculated

(g)

(h)