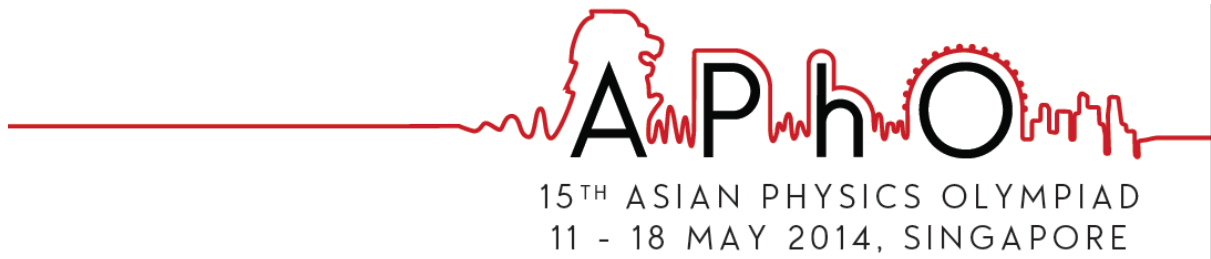


Country Code: Student Code:



Question 3

(a)

Diagram of an ideal gravitational lensing system



Source



Lens



Observer

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(b)

Image of the source *as seen from earth*

(c)

Image of the source *as seen from earth*

Diagram to explain source-lens system



Source



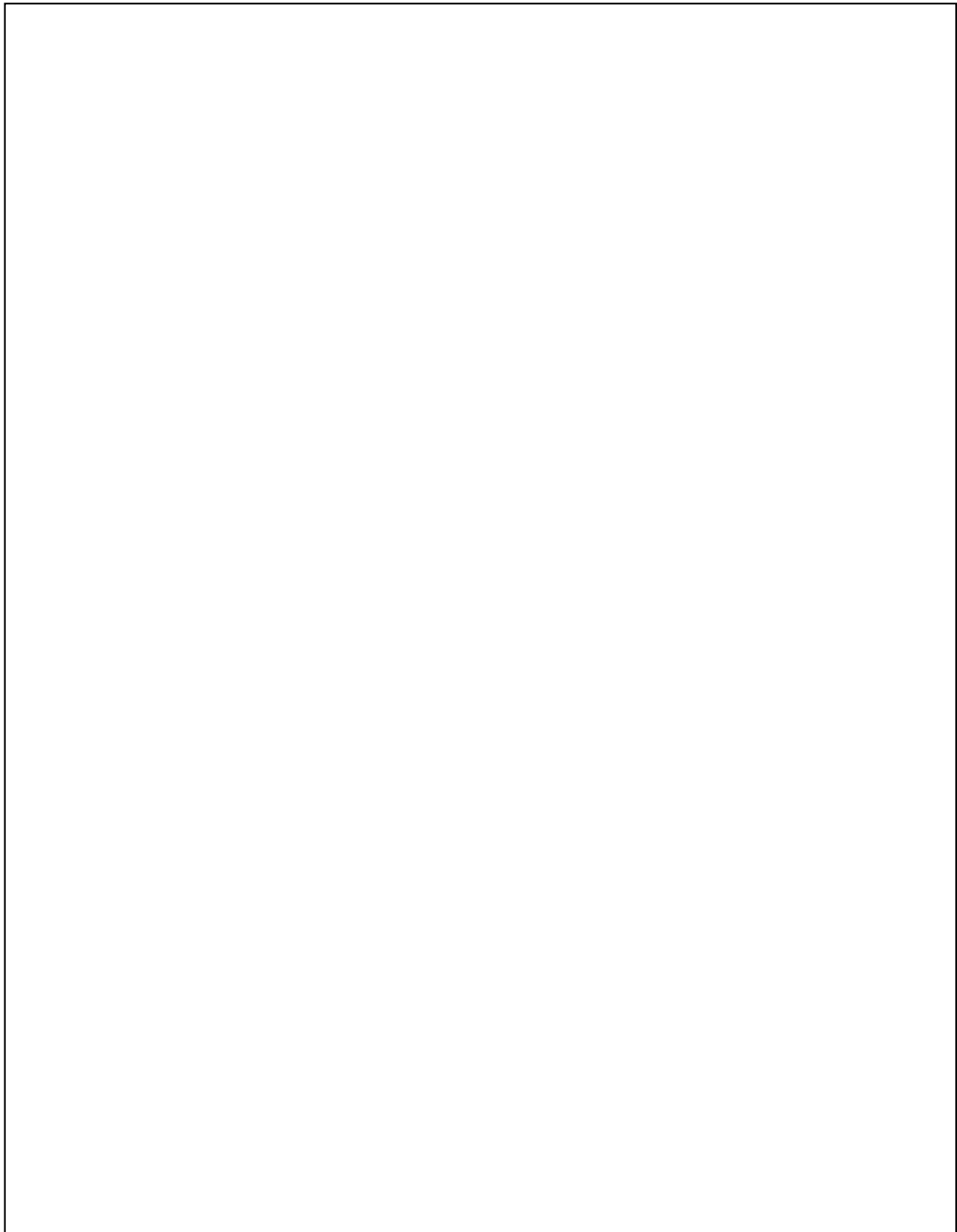
Lens



Observer

Country Code: Student Code:

(d)



(e)

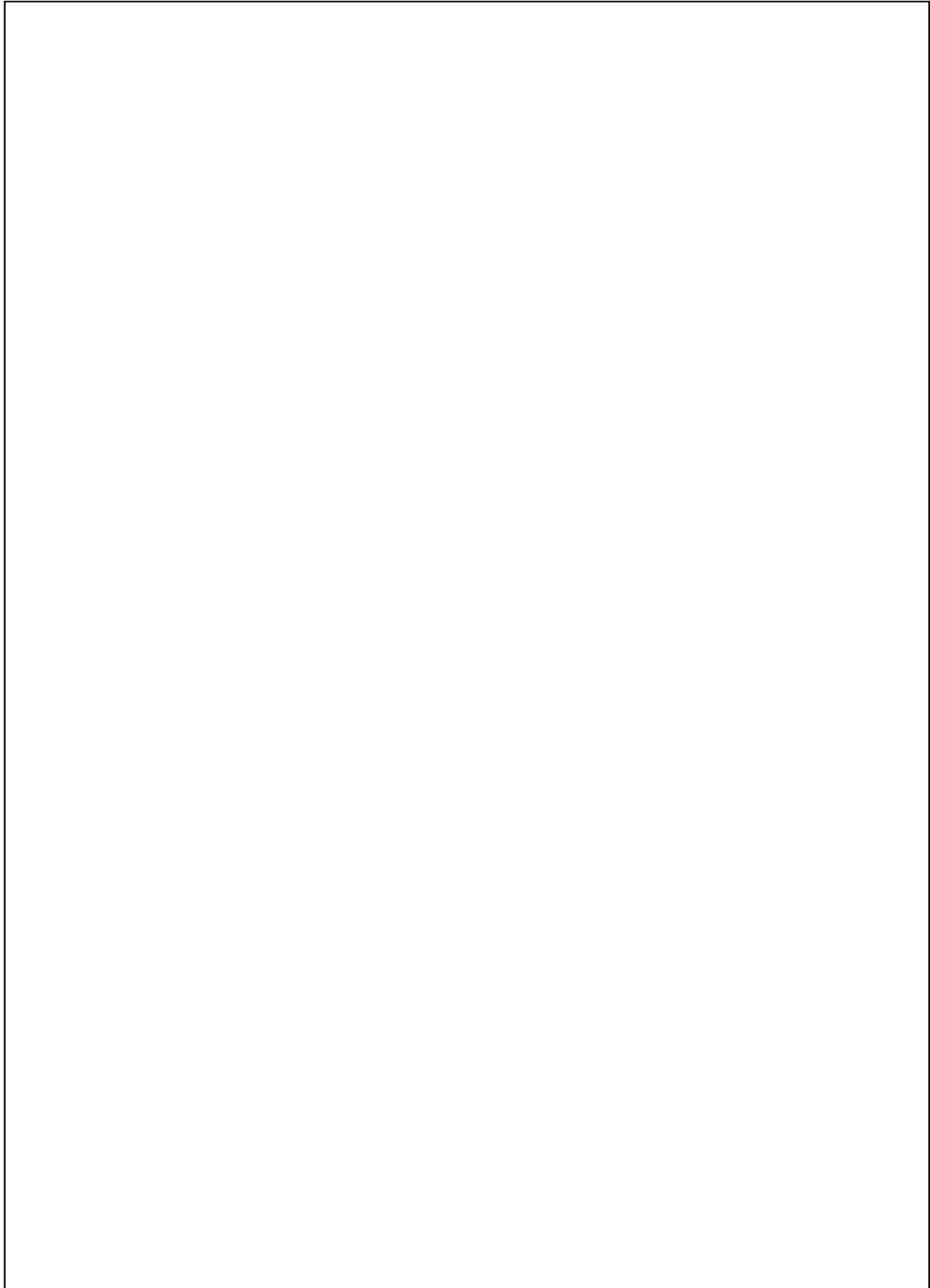
- (f) Consider the case where we have a lensing object of the order of a few solar masses ($M \sim \text{a few} \times 10^{30} \text{ kg}$) in the nearby regions of the galaxy (distance $D_L \sim \text{a few} \times 10^{18} \text{ m}$ away) and a source object somewhat further out ($D_S \sim \text{a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

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

- | | |
|--|--|
| <input type="checkbox"/> α is large and $\tan \alpha$, $\sin \alpha$, $\cos \alpha$ must be calculated exactly | <input type="checkbox"/> θ_E is large and $\tan \theta_E$, $\sin \theta_E$, $\cos \theta_E$ must be calculated exactly |
| <input type="checkbox"/> α is small and the small angle approximations to $\tan \alpha$, $\sin \alpha$, $\cos \alpha$ are permissible | <input type="checkbox"/> θ_E is small and the small angle approximations to $\tan \theta_E$, $\sin \theta_E$, $\cos \theta_E$ are permissible |
| <input type="checkbox"/> α is irrelevant and need not be calculated | <input type="checkbox"/> θ_E is irrelevant and need not be calculated |

Country Code: Student Code:

(g)



Country Code: Student Code:

(h)

