

Exam Introduction to seismology and seismics, Part 1

December 10, 2018, 8:30-10:30 (with extra time until 10:45)

1. The deformation of a volume element is given by

$$u_1 = 0,$$

$$u_3 = 0,$$

$$\frac{\partial u_2}{\partial x_1} = a > 0,$$

$$\frac{\partial u_2}{\partial x_2} = b > 0,$$

$$\frac{\partial u_2}{\partial x_3} = 0,$$

where $\mathbf{u} = (u_1, u_2, u_3)^T$ represents the displacement vector.

- Sketch the deformation of this volume element in the (x_1, x_2) -plane.
- Give the strain tensor.

2. For the stress tensor

$$\sigma = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 2 \\ 0 & 2 & 3 \end{pmatrix}$$

find the principal stresses and the directions of the associated stress axes.

3. A seismic displacement field is given by

$$\mathbf{u}(\mathbf{x}, t) = \mathbf{A} \sin(\omega t - \mathbf{k} \cdot \mathbf{x})$$

with $\mathbf{A} = (0, 0, 1)^T$ and $\mathbf{k} = (0, k, 0)^T$ where k is a scalar.

- Calculate the divergence and curl of the displacement field \mathbf{u} .

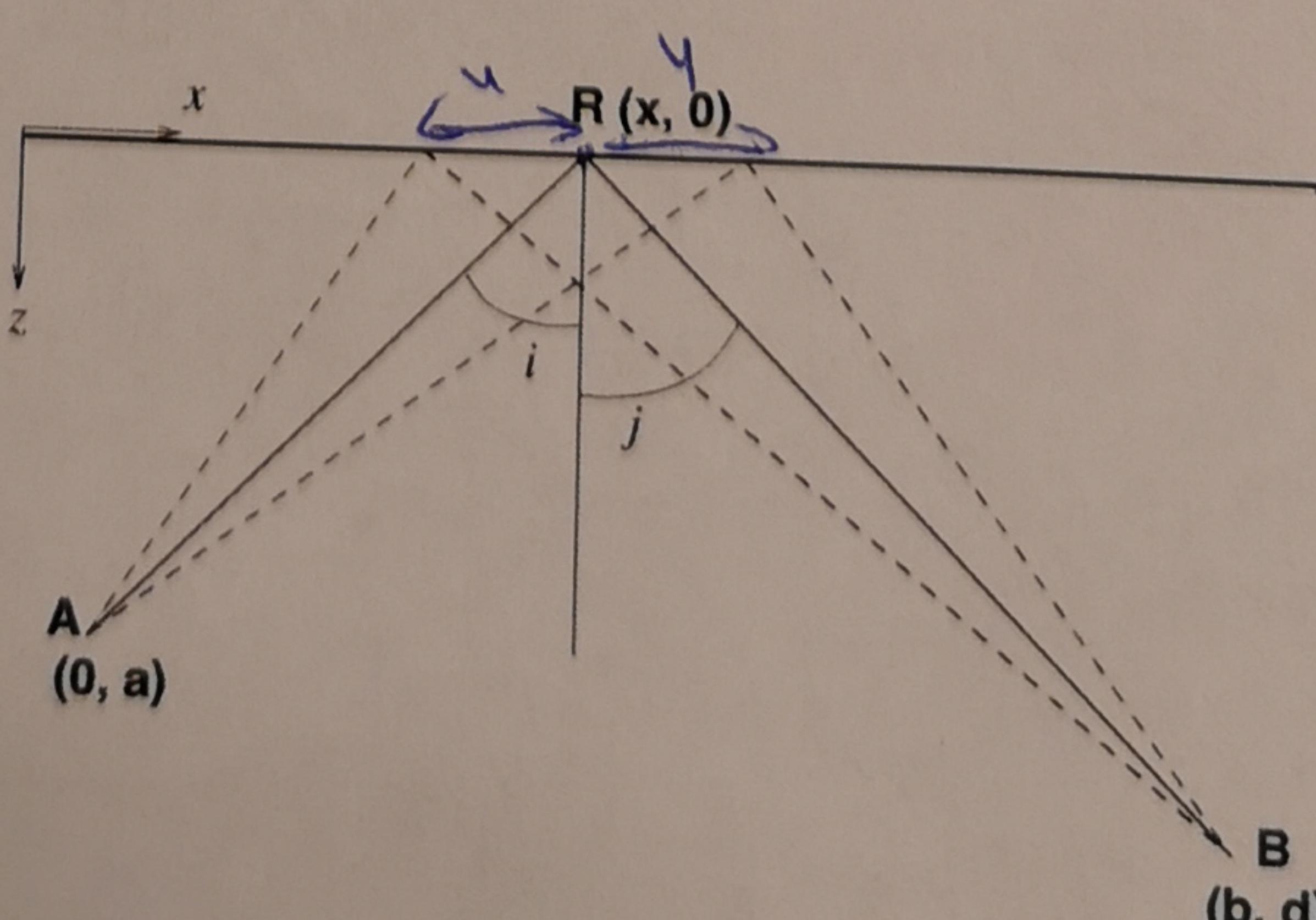
Use these results to explain whether it represents a P wave or an S wave.

- What is the direction of wave propagation? \rightarrow *richtung* ✓ *golfcarplanting*

4. (a) State Fermat's principle.

- Find the travel time for paths from points A to B for various reflection points R (i.e. as a function of x) for a medium with velocity v .

Use Fermat's principle to find the relation between the angle i and the angle j for the ray path indicated by the solid line.



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