2. **A)** a) A beam of positively charged pions is incident on a one-dimensional potential step of height eV_0, i.e.

$$V(x) = 0 \quad \text{for } x < 0,$$
$$V(x) = V_0 \quad \text{for } x > 0.$$

(i) State the relativistic wave equation obeyed by the pions, and the general form of the solutions to this equation. **{2}**

(ii) Show that the reflection coefficient, R, for the pions is

$$R = \left|\frac{p-p'}{p+p'}\right|, \quad \text{where}$$

$$pc = \pm(E^2 - m_0{}^2c^4)^{\frac{1}{2}} \quad \text{and}$$
$$p'c = \pm[(E - eV_o)^2 - m_0{}^2c^4]^{\frac{1}{2}}.$$ **{8}**

(iii) Discuss the physical interpretation of the case when

$eV_0 > E + m_0c^2$ and $p' < 0$. **{4}**

(iv) What experimental situation does the choice

$eV_0 > E + m_0c^2$ and $p' > 0$ represent? **{2}**

b) (i) The relativistic wave equation for pions has two solutions. Why does the corresponding equation for electrons have four solutions ? **{2}**

(ii) Describe the process $e^+e^- \rightarrow e^+e^-$ in terms of hole theory and Feynman diagrams. **{6}**