

Question 15

(7 marks)

(a) State the two postulates on which Einstein's theory of special relativity is based.

(b) Consider three astronauts who are located at fixed points M, P and N along a straight line in the given order as shown in Figure 6 (which is *not* drawn to scale).



Figure 6

Suppose that they have synchronized their clocks, and that at time $t_0 = 10$ s, P sends out two light signals, one towards M and the other towards N. One of the signals is reflected by M and returns to P at $t_1 = 20$ s; the other is received by N at $t_2 = 12$ s.

(i) What is the distance between M and N?

(ii) Would the arrival times t_1 and t_2 be affected if all three astronauts were travelling in the same direction at a speed of $0.5c$? Explain your answer.

Question 16

(8 marks)

(a) Explain briefly what is meant by the term *quantum mechanical tunnelling*.

(b) Consider the one-dimensional potential energy well shown in Figure 7 and suppose that a bound state exists at the energy E_1 shown. Sketch a possible form of the wavefunction for this bound state in the region $-2D < x < 2D$, calibrating the x -axis, and comment on any features that correspond to tunnelling, or to a lack of tunnelling, in regions that are classically inaccessible.

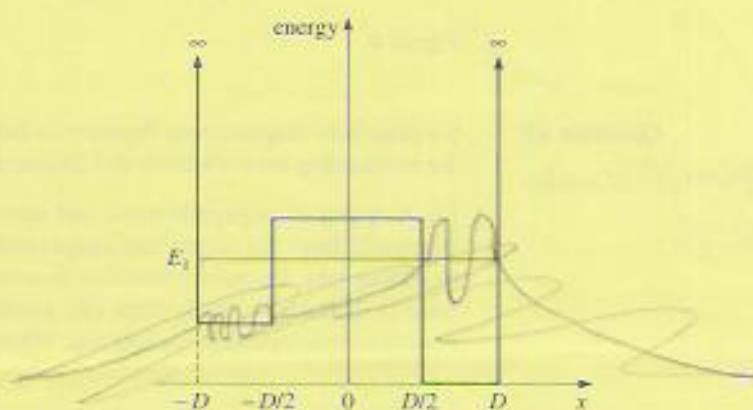


Figure 7



E_1 —

