

Question 15

(a) Postulate I – The principle of relativity

The laws of physics can be written in the same form in all inertial frames.

Postulate II – The principle of the constancy of the speed of light.

The speed of light (in a vacuum) has the same constant value c in all inertial frames.

(b) (i) It takes light $(20 - 10) \text{ s} = 10 \text{ s}$ to perform the round trip $P \rightarrow M \rightarrow P$.

So light takes 5 s to travel from M to P , 2 s to travel from P to N and hence 7 s to travel from M to N , at speed $c = 3.00 \times 10^8 \text{ m s}^{-1}$.

The distance MN is therefore

$$7 \text{ s} \times 3.00 \times 10^8 \text{ m s}^{-1} = 2.10 \times 10^9 \text{ m.}$$

(ii) The experiment would be unaffected by the identical uniform motion of all three astronauts. This is because, from Einstein's second postulate, the velocity of light is the same in all inertial frames.

Total for Q15:

Question 16

(a) Quantum mechanical tunnelling describes the penetration of the wavefunction (and hence the possible penetration of the corresponding particle) into regions that are inaccessible from the viewpoint of classical physics.

(b)

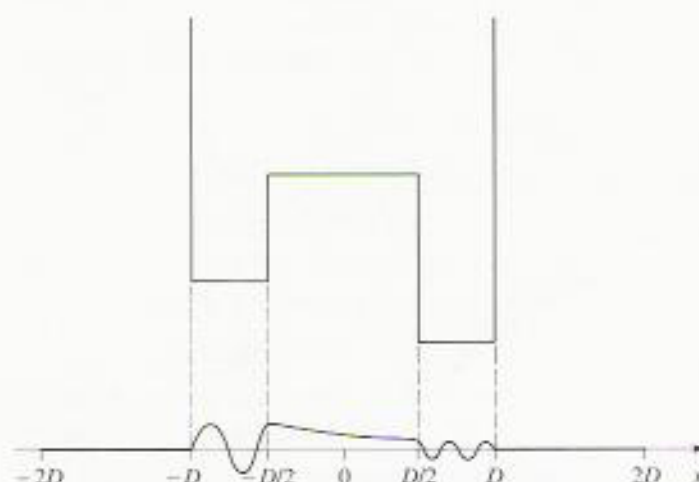


Figure 2

Marks are awarded for:

- smooth, continuous wavefunction inside infinite well, oscillating when $E > E_{\text{pot}}$ but not in the central region.
- Wavefunction zero outside well.
- Longer wavelength in left-hand well.

Tunnelling can occur into central barrier, but not into the region outside the infinite well.

Total for Q16: