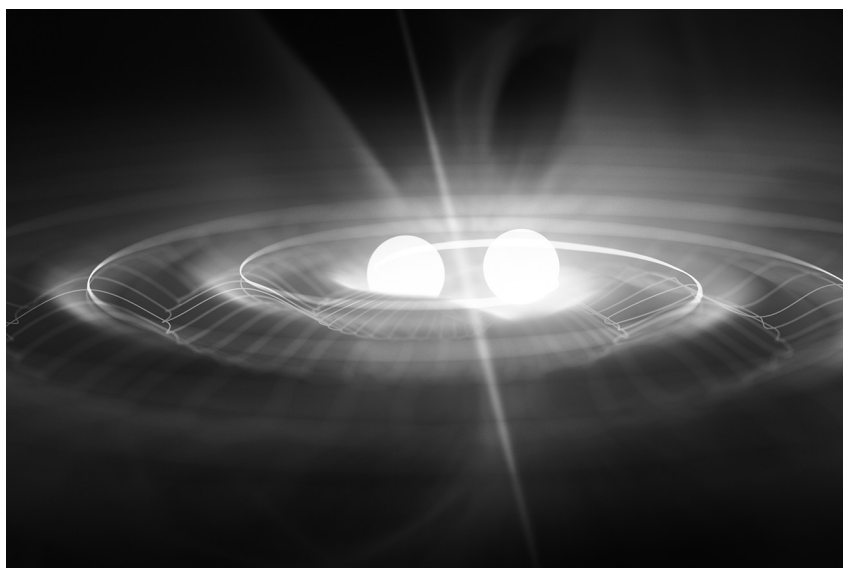


5. Astronomers have recently detected gravitational waves produced by the merging of two neutron stars.

An artist's illustration of two neutron stars merging is shown.



One of the neutron stars had a mass of 3.18×10^{30} kg.

The second neutron star had a mass of 2.27×10^{30} kg.

- (a) Calculate the separation of the neutron stars when the gravitational force of attraction between them was 1.59×10^{39} N.

3

Space for working and answer

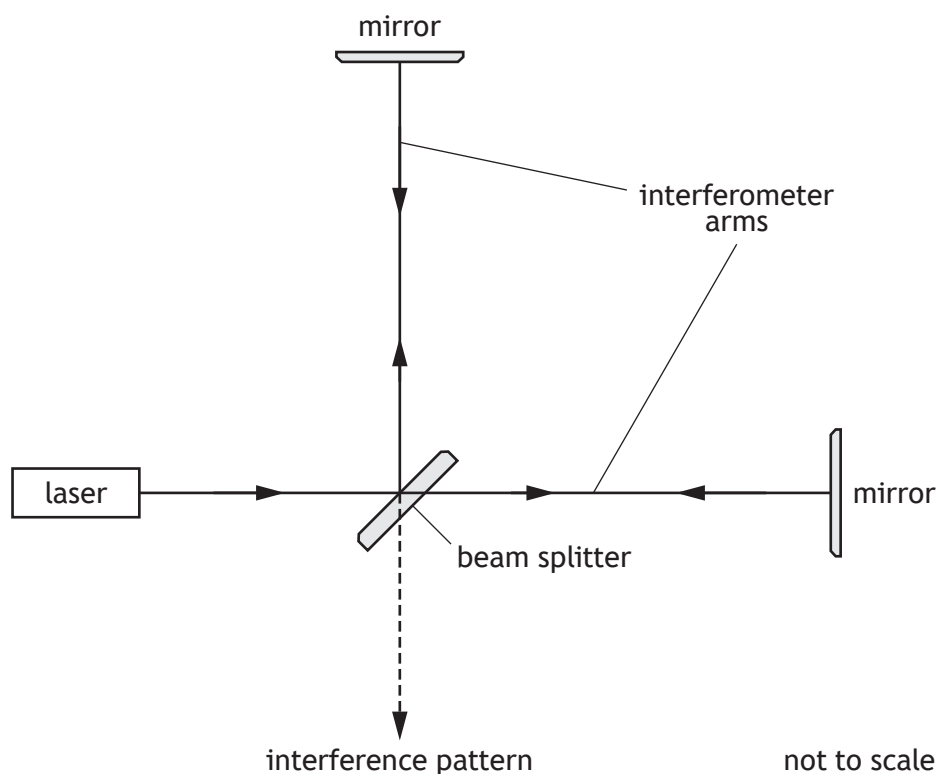


5. (continued)

- (b) An interferometer is a device that can be used to detect gravitational waves.

In the interferometer, a beam of coherent light from a laser is split into two by a beam splitter.

The two beams then travel down the interferometer arms, reflect from mirrors, and finally meet to produce an interference pattern.



- (i) Explain, in terms of waves, how a minimum is formed in the interference pattern.

1

[Turn over



5. (b) (continued)

- (ii) Each interferometer arm is 4.0 km long.

A gravitational wave changes the length of the arms, affecting the interference pattern produced.

The change in length of one of the arms is approximately 4.0×10^{-18} m.

In terms of orders of magnitude, compare the change in length of the interferometer arm with its original length.

2

Space for working and answer



* X 8 5 7 7 6 0 1 1 4 *