3. A student sets up an experiment to investigate the interaction between two trolleys on a smooth, horizontal track.
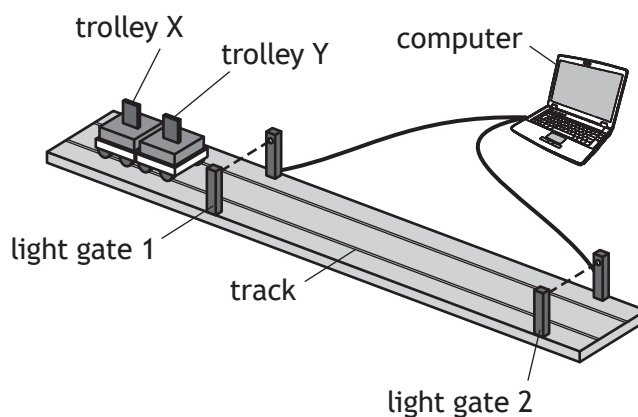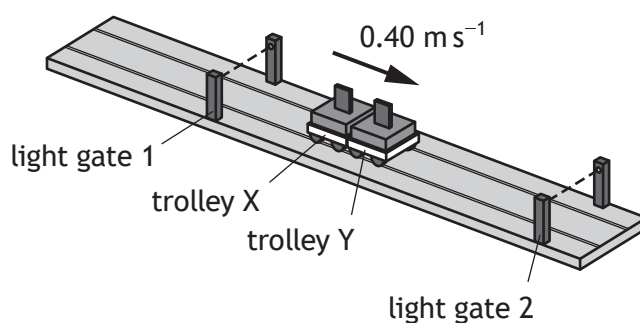
The mass of trolley X is 0.50 kg and the mass of trolley Y is 0.25 kg.

The trolleys X and Y are moving together to the right at 0.40 m s^{-1}.
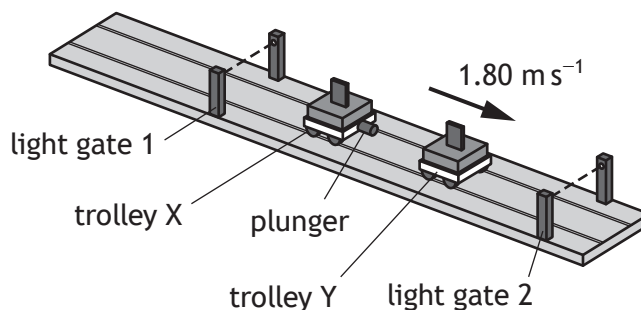

When the trolleys are between the light gates, a plunger in trolley X is activated.

The plunger extends and pushes trolley Y with an average force of 6.25 N for a short time, so that the trolleys separate.

Trolley Y now moves to the right at 1.80 m s^{-1}.

The effects of friction are negligible.

3. (continued)

(a) (i) Calculate the magnitude of the change in momentum of trolley Y when the plunger is activated. **3**

Space for working and answer

(ii) Calculate the time during which the plunger exerts a force on trolley Y. **3**

Space for working and answer

(b) Calculate the velocity of trolley X immediately after the trolleys separate. **3**

Space for working and answer

3. (continued)

(c) Explain how the student would determine whether this interaction was elastic.

2

(d) The light gates used during the experiment each contain a lamp and a photodiode.

A photodiode is a p-n junction.

(i) A photodiode produces a potential difference when photons of light are incident on it.

State the name of this effect.

1

(ii) Light from the lamp is incident on the photodiode.

Using **band theory**, explain how a potential difference is produced when photons of light are incident on the photodiode.

3