2 A small frictionless trolley is attached to a fixed point A by means of a spring. A second spring is used to attach the trolley to a variable frequency oscillator, as shown in Fig. 2.1.

For Examiner's Use

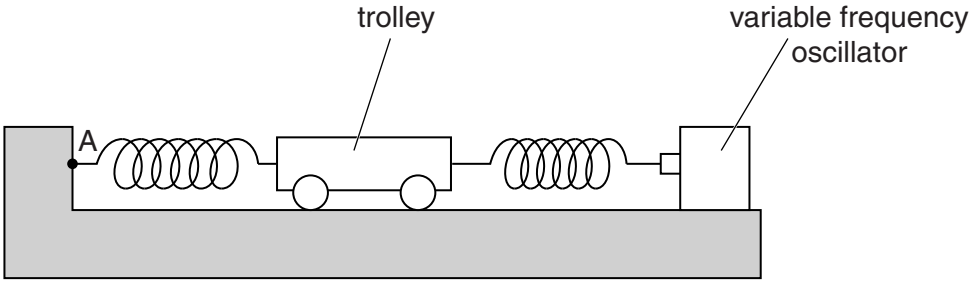

Fig. 2.1

Both springs remain extended within the limit of proportionality.
Initially, the oscillator is switched off. The trolley is displaced horizontally along the line joining the two springs and is then released.
The variation with time t of the velocity v of the trolley is shown in Fig. 2.2.

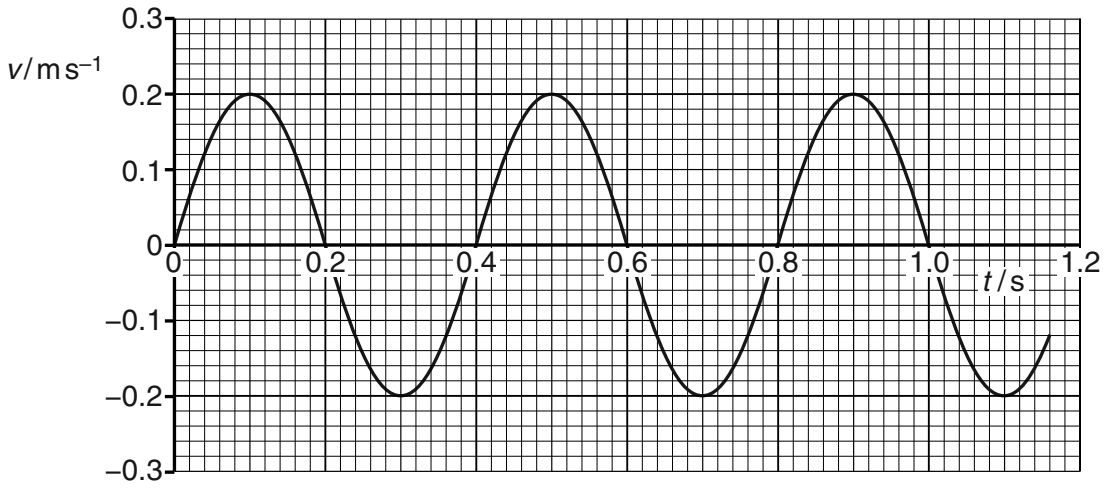

Fig. 2.2

(a) (i) Using Fig. 2.2, state two different times at which

1. the displacement of the trolley is zero,

time = ... s and time = ... s [1]

2. the acceleration in one direction is maximum.

time = ... s and time = ... s [1]

(ii) Determine the frequency of oscillation of the trolley.

frequency = ... Hz [2]

(iii) The variation with time of the displacement of the trolley is sinusoidal. The variation with time of the velocity of the trolley is also sinusoidal.

State the phase difference between the displacement and the velocity.

phase difference = ... [1]

(b) The oscillator is now switched on. The amplitude of vibration of the oscillator is constant. The frequency f of vibration of the oscillator is varied.
The trolley is forced to oscillate by means of vibrations of the oscillator.
The variation with f of the amplitude a_0 of the oscillations of the trolley is shown in Fig. 2.3.

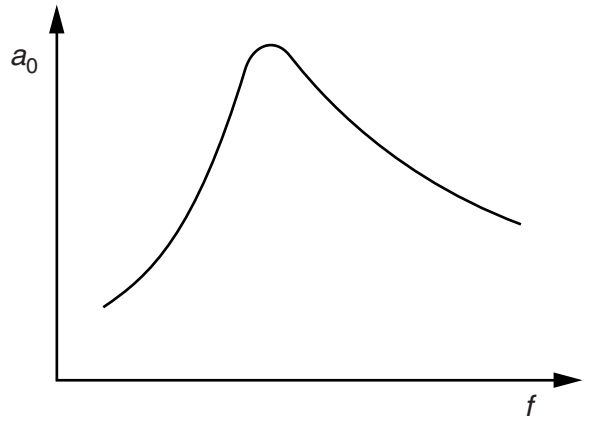

Fig. 2.3

By reference to your answer in **(a)**, state the approximate frequency at which the amplitude is maximum.

frequency = ... Hz [1]

(c) The amplitude of the oscillations in **(b)** may be reduced without changing significantly the frequency at which the amplitude is a maximum. State how this may be done and give a reason for your answer.
You may draw on Fig. 2.1 if you wish.

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.....[2]