3 An object is falling at terminal velocity.

Which of the following is **not** a valid conclusion from this statement?

☒ **A** The acceleration of the object is zero.

☒ **B** There is a resistive force acting on the object.

☒ **C** There is a resultant force acting on the object.

☒ **D** The object has weight.

(Total for Question 3 = 1 mark)

6 Which of the following are the base units for impulse?

☒ **A** $kg\,m\,s^{-1}$

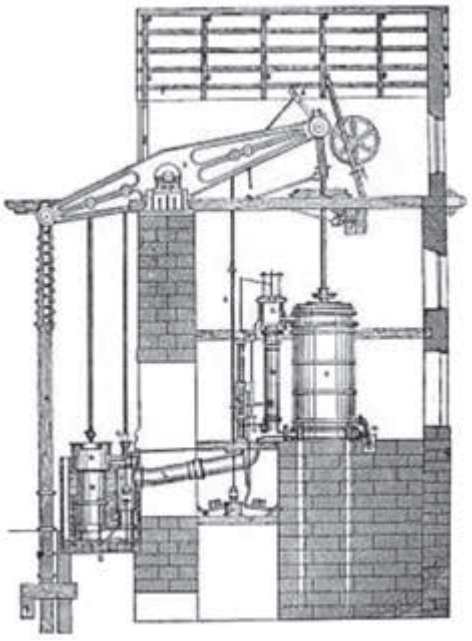
☒ **B** $kg\,m\,s^{-2}$

☒ **C** $N\,m$

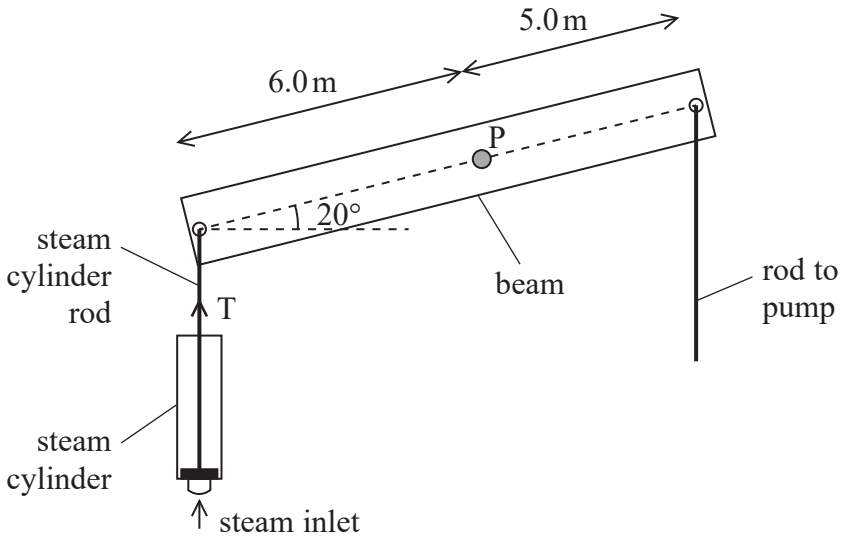
☒ **D** $N\,s$

(Total for Question 6 = 1 mark)

13 Beam engines contributed to powering the Industrial Revolution in Britain in the 18th century. A beam engine consisted of a beam which could rock to and fro around a well-oiled pivot. Attached to the beam there are two rods, one connected to a piston in a steam cylinder and the other connected to a pump.



The diagram below shows a simplified arrangement of a beam engine.



(a) The beam has a constant thickness and a mass of 3.05×10^4 kg. The length of the beam is 11.0 m. The pivot P is positioned 6.0 m from the steam cylinder end of the beam.

In its resting position the steam cylinder rod is supported by the base of the steam cylinder with the beam at an angle of 20° to the horizontal.

The steam cylinder rod exerts a force T on the beam. The force exerted on the beam by the pump rod can be neglected.

Calculate the force T.

(4)

$T =$ .....

(b) The engine, which ran continuously, could lift a mass of 2500 kg of water through 12 m each minute.
The engine used 1250 kg of coal a day. 1 kg of coal can release 22.3 MJ of energy.
The beam engine was said to have an efficiency of 10 %.

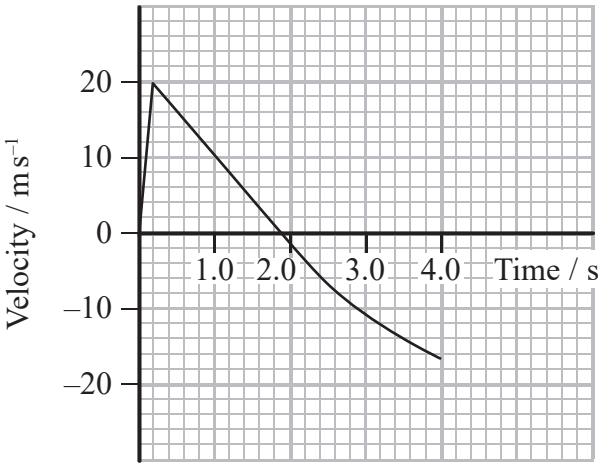
Deduce whether this claim for efficiency was correct.

(5)

(Total for Question 13 = 9 marks)

14 A physics class made a toy rocket. A drinks bottle was partially filled with water and inverted over a valve. An air pump delivered air to the bottle until the pressure forced the bottle from the valve and the water was ejected from the bottle at high speed.

A velocity-time graph for the bottle for the first 4 s after take-off is shown.



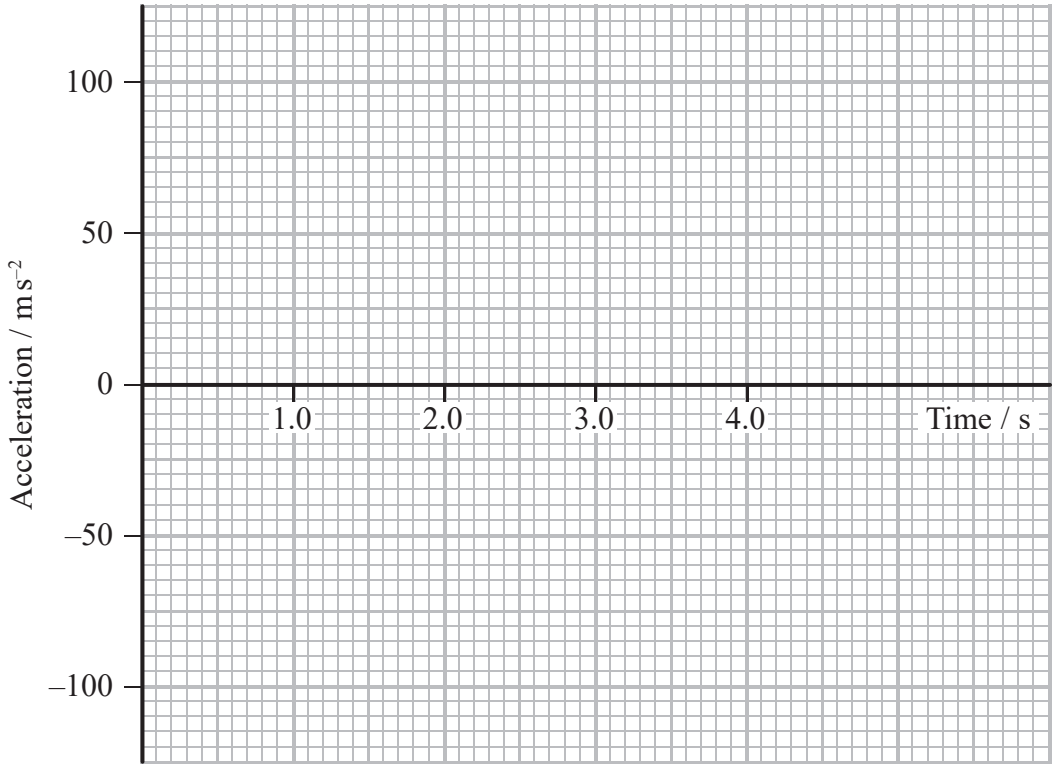
(a) Determine the height to which the rocket travelled.

(2)

Height = ...

(b) Sketch the corresponding acceleration-time graph on the axes below.

(5)



(Total for Question 14 = 7 marks)