1 In an investigation of the jump of fleas, measurements were taken from a high speed video.

The body of a flea can provide a maximum power of 660 watts per kilogram.

(a) A flea of mass 0.70 mg takes 0.85 ms to take-off from rest.

(i) Show that the maximum velocity of the flea is about 1 m s^{-1}.

(4)

(ii) Calculate the average acceleration of the flea at take-off.

(2)

Average acceleration = ...

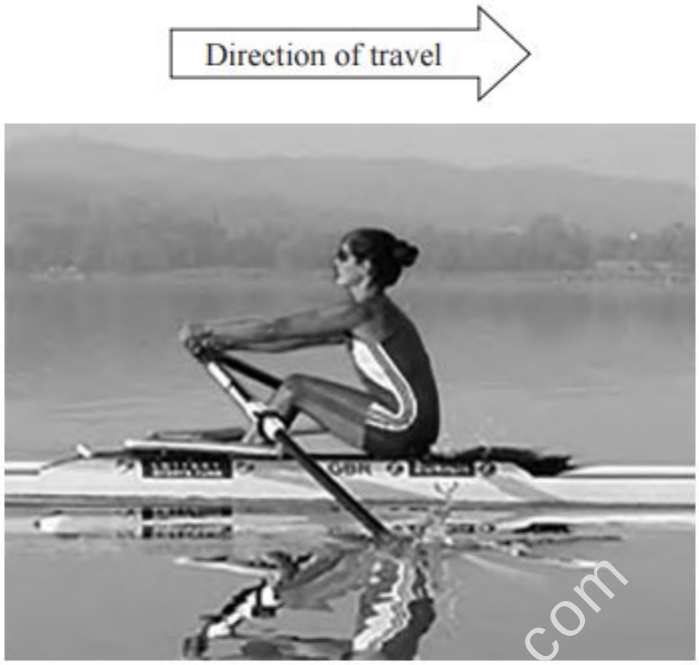
(b) The measurements were repeated with many fleas. The average initial velocity of the fleas at take-off was 1.2 m s^{-1} at 39° to the horizontal.

Calculate the average horizontal distance that a flea would travel.

(4)

Average horizontal distance = ...

2 The photograph shows a rower during a race. During each stroke the rower applies a force to the end of each oar. The other end of each oar exerts a force on the water.

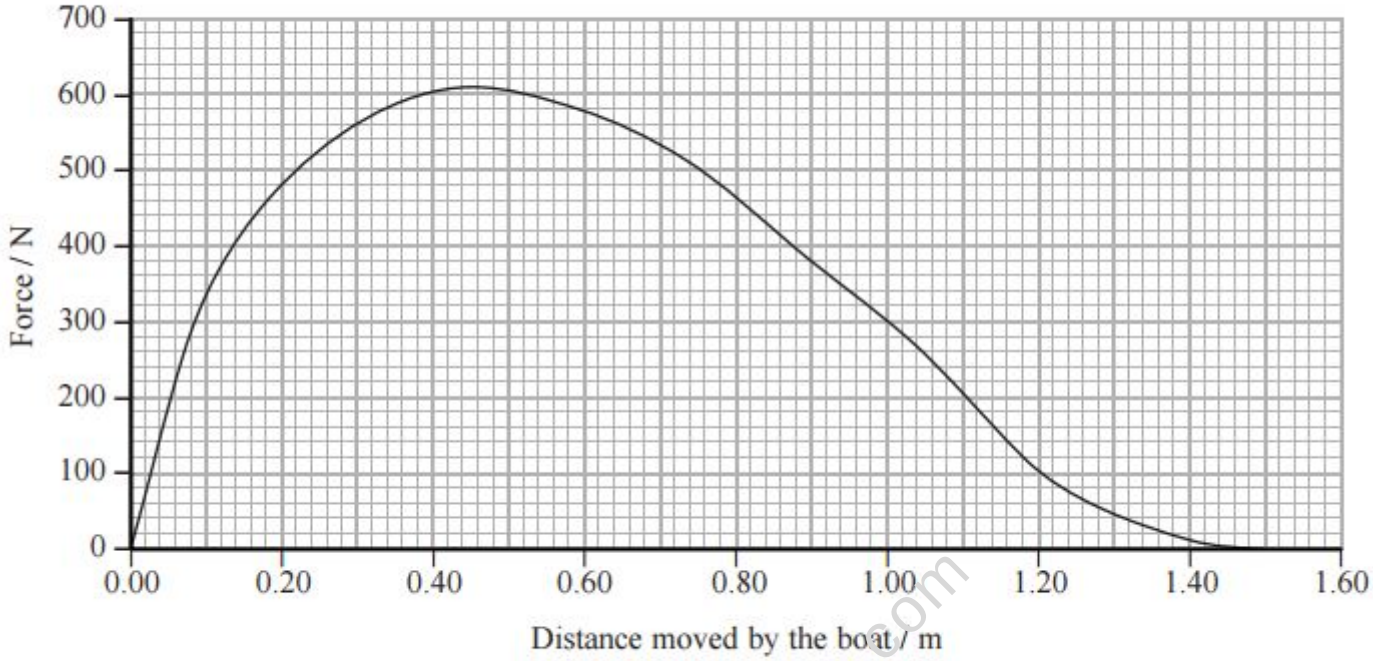


*(a) At the start of the race the boat is stationary.

Using Newton's laws of motion, explain why the boat begins to move through the water as the rower applies a force.

(4)

(b) The graph shows how the force applied to the boat varies with the distance moved by the boat during one complete stroke.



(i) Use the graph to show that the work done on the boat during one stroke is about 500 J.

(3)

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(ii) Hence calculate the average power developed.

average stroke rate = 24 strokes per minute

(3)

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Average power = ...

(c) The work done by the rower is greater than the kinetic energy gained by the rower and the boat.

Suggest **two** reasons why.

(2)

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(d) Suggest why the rower and the boat gain different amounts of kinetic energy during each stroke.

(1)

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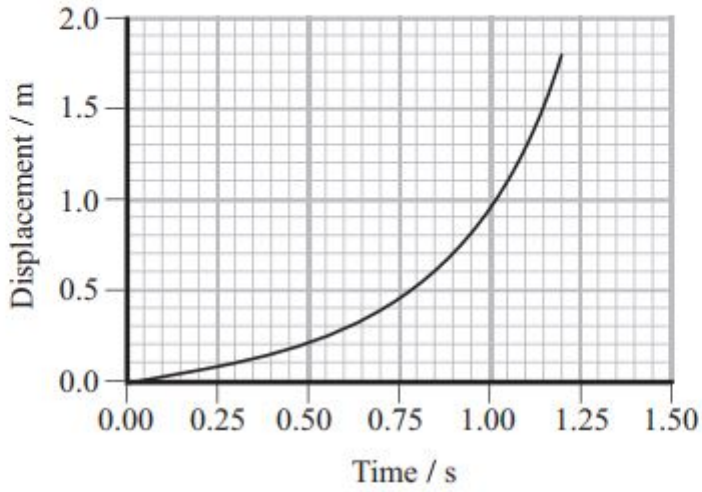
3 A small, gas-filled balloon was dropped from a height. The displacement-time graph for the balloon is shown.



As the displacement of the balloon from its point of release increased, gravitational potential energy was transferred to kinetic energy and thermal energy.

(a) State why the rate of energy transfer was greatest at 1.20 s.

(1)

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(b) By calculating the change in gravitational potential energy of the balloon between 1.05 s and 1.20 s, show that the average rate at which the gravitational potential energy was transferred during this time interval was about 0.2 W.

mass of balloon and air = 0.004 kg

(3)

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4 (a) State what is meant by work done.

(1)

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(b) A car of mass 1.5×10^3 kg is travelling on a country road towards a village at 55 miles per hour. The speed limit in the village is 30 miles per hour.

When the brakes are applied, there is a constant braking force of 3750 N.

Calculate the minimum distance before reaching the village that the driver should apply the brakes to avoid exceeding the speed limit.

55 miles per hour = 24.6 m s^{-1}

30 miles per hour = 13.4 m s^{-1}

(3)

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Minimum distance = ...