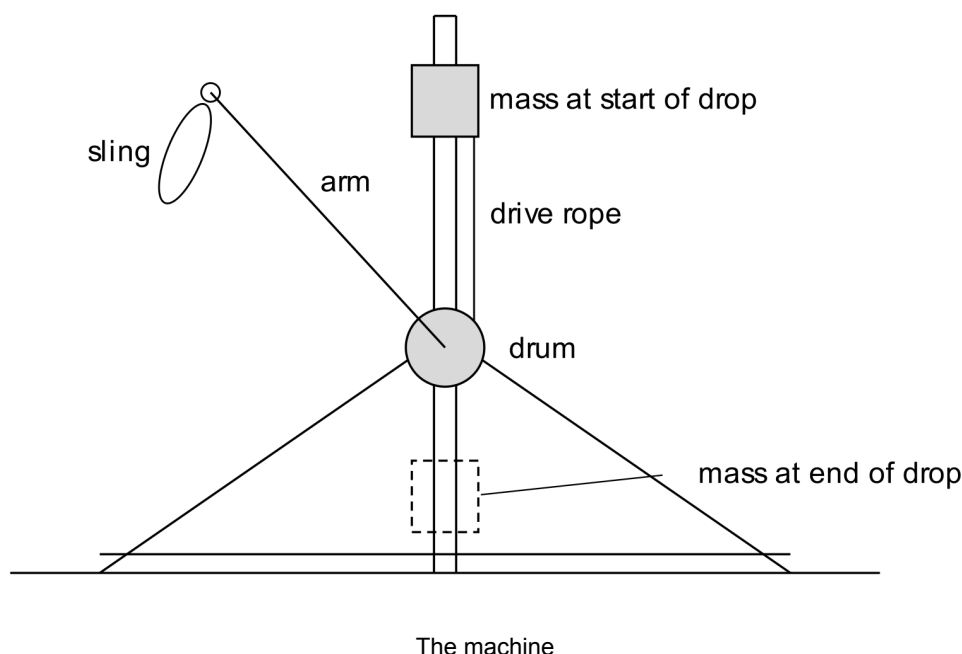


Free practice paper from Fenwick Tutoring. Mark scheme: fenwicktutoring.com/trebuchet-physics-exam

This paper is set around a real machine: a gravity-powered trebuchet built to launch a projectile faster than the speed of sound. Every value needed to answer a question is given in that question or in its figure.



A mass slides down the mast. A drive rope connects the mass to a drum on the axle of the arm, so the falling mass spins the arm. The sling is wound around the arm as it spins, and unwraps to release the projectile.

You do *not* need to watch the video to answer this paper, but the build is worth watching:

youtube.com/watch?v=Co57SfcT-h0

Answer all questions. A calculator is required for this paper. A clean copy of the physics data booklet is required for this paper. The maximum mark for this examination paper is **[26 marks]**.

1. A trebuchet launches a projectile using a falling counterweight.

A counterweight is released from rest at a height of 2.0 m above the ground. Air resistance is negligible.

- (a) Show that the counterweight reaches the ground at a speed of about 6.3 m s^{-1} . [2]

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- (b) The counterweight is replaced by one of twice the mass. It is released from the same height. Explain why it reaches the ground at the same speed. [2]

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- (c) Other than air resistance, state **one** assumption made in (a) that does not hold for a real trebuchet. [1]

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2. A counterweight of mass 10 kg is raised, and is then released to launch a projectile of mass 6.0 g.

The following data are given:

Gravitational potential energy stored when the counterweight is raised = 192 J

Potential energy of the counterweight at the moment of release = 22 J

Kinetic energy of the counterweight at the moment of release = 10 J

Energy stored in the rotating assembly at the moment of release = 78 J

Kinetic energy of the projectile immediately after release = 65 J

- (a) Show that the counterweight is raised through a height of about 2.0 m. [2]

- (b) Determine the energy dissipated between the release of the counterweight and the release of the projectile. [2]

- (c) Calculate the overall efficiency of the trebuchet. [2]

3. A trebuchet stands at the edge of a vertical cliff above a horizontal plain. It launches a projectile of mass 4.0 g at 346 m s^{-1} out over the plain.

At the moment of release the projectile is moving in a circle of radius 1.5 m about the axle of the arm.

- (a) Determine the magnitude and the direction of the resultant force on the projectile at the moment of release. [3]

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Figure 1 shows the path of the projectile.

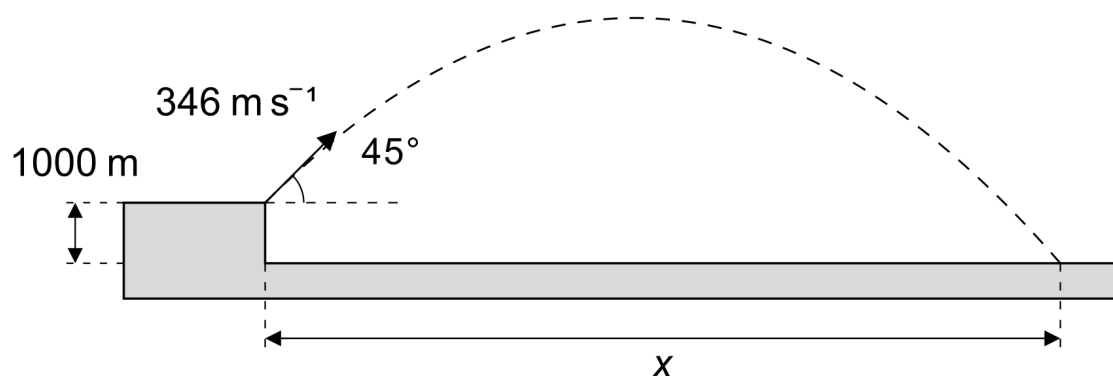


Figure 1

Air resistance is negligible for (b) to (f).

- (b) Show that the initial vertical component of the velocity of the projectile is about 245 m s^{-1} . [2]

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(c) Determine the maximum height of the projectile above the plain. [2]

(d) Determine the time of flight of the projectile. [3]

(e) Determine the distance x . [2]

(f) Launched at the same speed and angle from ground level, the projectile travels 12.2 km.
Comment on the effect of the cliff on the distance travelled. [1]

(g) In an experiment with a real trebuchet the projectile travels a much shorter distance than your answer to (e).
Explain this difference. [2]

Want the mark scheme?

This paper is free to use and free to share. The full mark scheme — with the marking points, the accepted alternatives and the examiner notes on what does *not* earn the mark — is at the link below.

Get the mark scheme at

fenwicktutoring.com/trebuchet-physics-exam

Stuck on any of this?

Rotational dynamics, projectiles from a height and the Doppler effect are exactly the places HL Physics students lose marks they should be keeping. I teach IB Physics one to one, online, and I have been doing it for ten years — whether you are aiming to move a 5 to a 6 or to secure a 7, get in touch.

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