

7.3 Work, energy and power

Name: _____ Class: _____ Date: _____

Total: 31 marks

KEY WORDS kinetic energy • power

Work, energy and power

Objective

Use the work-energy principle and conservation of mechanical energy on slopes, with power $P = Fv$ for constant-rate engines, and close projectile problems by energy (objectives 1.2, 3.1).

1 Key knowledge and worked examples

Energy bookkeeping. $KE = \frac{1}{2}mv^2$; $PE = mgh$; work by a force $= Fs$ along the motion (resistance does $-Rs$ over the SLOPE distance; gravity $\pm mgd \sin \alpha$). Power: $P = Fv$ – at maximum constant speed F balances all resistance; otherwise $F - R - mg \sin \alpha = ma$. A perpendicular impact fixes a velocity's DIRECTION, then energy gives the height.

Worked example – car and projectile (WME02 June 2025 Q4, Q7). (i) 750 kg car on a slope $\sin \alpha = \frac{1}{7}$, resistance 200 N, engine 20 kW: constant speed $\frac{20000}{V} = 1050 + 200$ gives $V = 16$; at 10: $2000 - 1250 = 750a$ gives $a = 1$; engine off: $37500 = 1250d$ gives $d = 30$ m. (ii) Stone at 20 m s^{-1} ($g = 10$), 11 m up with components V and $2V$: $200 = 2.5V^2 + 110$ gives $V = 6$; hitting a 60° plane perpendicularly (velocity 30° below horizontal, speed $12/\cos 30^\circ = 8\sqrt{3}$): $200 = 96 + 10H$ gives $H = 10$ m.

2 Practice

2.1 A crate of mass 20 kg is pushed 5 m up a slope at 30° to the horizontal against a frictional force of 15 N. Find the total work done against gravity and friction. [3]

3.2 (*Edexcel IAL WME02 June 2025 Q7.*) A small stone is projected from a point O on horizontal ground with speed 20 m s^{-1} at an angle α above the horizontal. The stone is modelled as a particle moving freely under gravity with $g = 10 \text{ m s}^{-2}$. When the stone is 11 m above the ground, the magnitude of the vertical component of its velocity is $V \text{ m s}^{-1}$ and the magnitude of the horizontal component is $2V \text{ m s}^{-1}$. (a) Using conservation of mechanical energy, show that $V = 6$. (b) The stone hits a fixed plane, inclined at 60° to the horizontal, at the point A, the first point of contact, perpendicularly to the plane. Find the height of A above the ground (2 s.f.). [10]
