Work against Resistance: the Energy Audit

Specification: AQA 7367: MC1, MC2, MC3 · Edexcel 9FM0: FM1 Work, energy and power

HOMEWORK Consolidation

1 A crate of mass 8 kg is pushed 12 m across a rough horizontal floor. The coefficient of friction is 0.35. Take $g = 9.8$ m s^{-2}. Find the work done against friction.
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2 A particle of mass 1.5 kg is released from rest on a rough plane inclined at 40° to the horizontal. The coefficient of friction is 0.3. Take $g = 9.8$ m s^{-2}. Find its speed after it has slid 2.5 m.
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3 A particle is projected at 6 m s^{-1} up a line of greatest slope of a rough plane inclined at 30° to the horizontal. The coefficient of friction is 0.2. Take $g = 9.8$ m s^{-2}. Find the distance it travels before it stops.
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4 A box of mass 3 kg slides down a rough plane inclined at 25° to the horizontal. Its speed increases from 2 m s^{-1} to 5 m s^{-1} while it slides 4 m. Take $g = 9.8$ m s^{-2}. Find the coefficient of friction.
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5 A child of mass 35 kg slides from rest down a water slide. The top is 8 m above the bottom, the slide is 20 m long, and the child reaches the bottom at 10 m s^{-1}. Take $g = 9.8$ m s^{-2}.
(a) Find the work done against the resistances.
(b) Find the mean resistance along the slide.
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6 A particle is projected at 10 m s^{-1} up a line of greatest slope of a rough plane inclined at 20° to the horizontal. The coefficient of friction is 0.15. Take $g = 9.8$ m s^{-2}.
(a) Find the distance it travels before it stops.
(b) It then slides back. Find its speed when it returns to its starting point.
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7 A sack of mass 25 kg starts from rest and is pulled 6 m up a rough plane inclined at 12° to the horizontal by a rope parallel to the plane. The tension is 150 N and the coefficient of friction is 0.3. Take $g = 9.8$ m s^{-2}. Find the speed of the sack after 6 m.
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8 A car of mass 1000 kg travels down a straight road inclined at 5° to the horizontal. The driver brakes and the car slows from 20 m s^{-1} to rest in 40 m. Ignoring other resistances, find the constant braking force. Take $g = 9.8$ m s^{-2}.
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9 A particle is released from rest on a rough plane inclined at 35° to the horizontal. The coefficient of friction is 0.4. Take $g = 9.8$ m s^{-2}.
(a) Use energy to find its speed after it has slid 3 m.
(b) Find the time it takes to slide the 3 m.
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10 A particle is released from rest on a rough plane inclined at θ to the horizontal. After sliding a distance d its speed is v.
(a) Show that the coefficient of friction is $\mu = (2gd\sin\theta - v^2)/(2gd\cos\theta)$.
(b) Find μ when $\theta = 30°$, $d = 4$ m and $v = 5$ m s^{-1}. Take $g = 9.8$ m s^{-2}.
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11 *AQA-style*. A particle P of mass 4 kg is projected with speed 9 m s^{-1} up a line of greatest slope of a rough plane inclined at 30° to the horizontal. The coefficient of friction between P and the plane is 0.3. Take $g = 9.8$ m s^{-2}.
(a) Show that the friction force on P is 10.2 N, correct to 3 significant figures. [2 marks]
(b) Use an energy method to find the distance P travels up the plane before it comes to rest. [3 marks]
(c) Explain why P then slides back down the plane. [1 mark]
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12 *Edexcel-style*. A particle P of mass 2 kg is released from rest at a point A on a rough plane inclined at an angle α to the horizontal, where $\tan\alpha = 5/12$. P slides down a line of greatest slope to the point B, where $AB = 6.5$ m. The coefficient of friction between P and the plane is $1/3$. Take $g = 9.8$ m s^{-2}.
(a) Find the work done against friction as P moves from A to B. [3 marks]
(b) Use the work–energy principle to find the speed of P at B. [3 marks]
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