GPE and Conservation of Mechanical Energy

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

HOMEWORK Consolidation

1 A car of mass 1500 kg is driven to the top of a car-park ramp 20 m above the ground. Take $g = 9.8$ m s^{-2}. Find its gain in GPE.

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2 An apple of mass 0.25 kg falls from rest from a branch 3.2 m above the ground. Take $g = 9.8$ m s^{-2}.

(a) Find its loss in GPE.

(b) Use conservation of energy to find its speed as it hits the ground.

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3 A ball is thrown vertically upwards at 9 m s^{-1} from a point 1.2 m above the ground. Take $g = 9.8$ m s^{-2}. Find the greatest height of the ball above the ground.

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4 A particle is projected up a line of greatest slope of a smooth plane inclined at $30°$ to the horizontal, with speed 8 m s^{-1}. Take $g = 9.8$ m s^{-2}. Find the distance it travels up the slope before it comes to rest.

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5 A bead threaded on a smooth wire passes point A at 2 m s^{-1}. Point B is 1.8 m below A. Take $g = 9.8$ m s^{-2}. Find the speed of the bead at B.

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6 A pendulum bob of mass 0.3 kg hangs on a light inextensible string of length 0.6 m. It passes through its lowest point at 1.5 m s^{-1}. Take $g = 9.8$ m s^{-2}. Find the greatest angle that the string makes with the vertical.

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7 A stone is thrown from the top of a cliff 45 m above the sea, with speed 15 m s^{-1}. Ignore air resistance. Take $g = 9.8$ m s^{-2}. Find the speed of the stone when it hits the sea.

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8 A toy car runs on a smooth track. It must pass over a hump whose top is 0.5 m higher than the point where it starts. Take $g = 9.8$ m s^{-2}. Find the least speed the car needs at its starting point.

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9 A box of mass 50 kg starts from rest and is pulled 12 m up a slope inclined at $10°$ to the horizontal by a force of 250 N parallel to the slope. A constant friction force of 60 N acts. Take $g = 9.8$ m s^{-2}. Find the speed of the box after 12 m.

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10 A child of mass 30 kg slides from rest down a playground slide. The top of the slide is 2.4 m above the bottom. The child reaches the bottom at 5 m s^{-1}. Take $g = 9.8$ m s^{-2}. Find the work done against the resistances.

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11 *AQA-style*. A particle P of mass 0.5 kg is attached to one end of a light inextensible string of length 1.6 m. The other end is attached to a fixed point O. P is held with the string taut at $60°$ to the vertical and released from rest. Take $g = 9.8$ m s^{-2}.

(a) Find the speed of P as it passes through its lowest point. [3 marks]

(b) Find the speed of P when the string makes an angle of $25°$ with the vertical. [2 marks]

(c) Explain why the tension in the string does no work on P. [1 mark]

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12 *Edexcel-style*. A particle P of mass 2 kg is projected with speed 10 m s^{-1} up a line of greatest slope of a rough plane inclined at an angle α to the horizontal, where $\sin\alpha = 3/5$. P moves 5 m up the plane before it comes to rest. The frictional force on P has constant magnitude R newtons. Take $g = 9.8$ m s^{-2}.

(a) Use the work–energy principle to find the work done against friction. [3 marks]

(b) Find R. [1 mark]

(c) P then slides back down the plane. Find its speed when it returns to its starting point. [2 marks]

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