GPE and Conservation of Mechanical Energy

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

INDEPENDENT **You do**

A · Gravitational potential energy GPE = mgh, with h measured from the zero level.

1 A diver of mass 70 kg stands on a board 10 m above the water. Taking the water surface as the zero level, find the GPE of the diver. Take $g = 9.8$ m s^{-2}.

2 A lift raises a load of mass 600 kg through a height of 25 m. Find the gain in GPE of the load. Take $g = 9.8$ m s^{-2}.

3 A particle of mass 2 kg moves 5 m up a line of greatest slope of a plane inclined at 30° to the horizontal. Find its gain in GPE. Take $g = 9.8$ m s^{-2}.

4 A ball of mass 0.6 kg is at the bottom of a well, 4 m below ground level. Take ground level as the zero level. Take $g = 9.8$ m s^{-2}.
(a) Find the GPE of the ball.
(b) The ball is lifted to 1.5 m above ground level. Find its gain in GPE.

B · Conservation of energy Only the weight does work: GPE lost = KE gained.

5 A ball is dropped from rest from a height of 7.2 m. Use conservation of energy to find its speed as it hits the ground. Take $g = 9.8$ m s^{-2}.

6 A particle is released from rest on a smooth curved slide, 3 m vertically above the bottom of the slide. Find its speed at the bottom. Take $g = 9.8$ m s^{-2}.

7 A ball is thrown vertically upwards at 15 m s^{-1}. Use conservation of energy to find the greatest height it reaches above the point of projection. Take $g = 9.8$ m s^{-2}.

8 A bead slides along a smooth wire. It passes point P at 6 m s^{-1}. Point Q is 2 m below P. Find the speed of the bead at Q. Take $g = 9.8$ m s^{-2}.

C · Reasoning (no calculator) Explain in words as well as numbers.

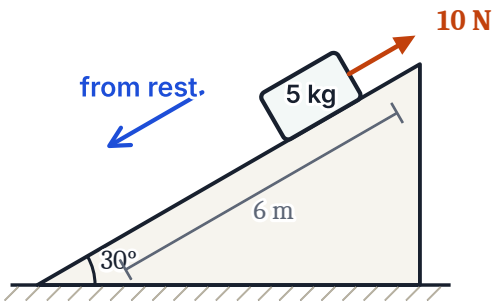
9 Two particles, of mass 1 kg and 3 kg, are released from rest at the same point on a smooth curved track. Compare their speeds when they reach the bottom. Explain.

10 A stone is thrown from the top of a cliff at speed u, first horizontally and then at 40° above the horizontal. Ignoring air resistance, explain why it hits the sea at the same speed both times.

11 A particle on a smooth track passes its lowest point at 7 m s^{-1}. Find the greatest height above the lowest point that it can reach. Take $g = 9.8$ m s^{-2}.

D · Other forces, projectiles and a show-that Work done by other forces = change in KE + change in GPE.

12 A box of mass 5 kg slides from rest 6 m down a slope inclined at 30° to the horizontal. A constant resistance of 10 N acts on the box. Find the speed of the box after 6 m. Take $g = 9.8$ m s^{-2}.



13 A ball is kicked from the ground at 18 m s^{-1} at 35° above the horizontal. It lands on the top of a wall 2.5 m high. Ignore air resistance. Take $g = 9.8$ m s^{-2}.
(a) Use energy to find its speed as it lands on the wall.
(b) Explain why the angle 35° is not needed in (a).

14 A particle hangs on a light inextensible string of length l. It is released from rest with the string taut at an angle α to the vertical.
(a) Show that its speed v at the lowest point is given by $v^2 = 2gl(1 - \cos\alpha)$.
(b) The string is 0.8 m long and $v = 2$ m s^{-1}. Find α. Take $g = 9.8$ m s^{-2}.

15 A car of mass 900 kg travels 150 m up a straight road inclined at 4° to the horizontal. Its speed falls from 20 m s^{-1} to 15 m s^{-1}. The resistance to motion is a constant 400 N and the driving force is a constant D N. Find D. Take $g = 9.8$ m s^{-2}.

E · Exam-style question Show your method: marks are for working.

16 A skier of mass 70 kg starts from rest at A and skis down a slope to B, 30 m vertically below A. Take $g = 9.8$ m s^{-2}.

(a) Modelling the slope as smooth, use conservation of energy to find the speed at B. [3]

(b) In fact the skier reaches B at 18 m s^{-1}. Find the work done against the resistances. [3]

(c) The path from A to B is 120 m long. Find the mean resistance. [1]

(d) State one modelling assumption. [1]

