InkPhysics

QUESTION WORKBOOK

Conservation of energy

Mechanics · Year 12

AQA 3.4.1.8 · CIE 5.1.2, 5.2.1, 5.2.2, 5.2.3, 5.2.4
OCR A 3.3.1(c), 3.3.1(d), 3.3.2(a), 3.3.2(b), 3.3.2(c)

19 questions · 61 marks

NAVY SCREEN EDITION

SECTION A · Warm-up

A1 State the principle of conservation of energy. [2]

A2 Describe the main energy transfer that takes place as a ball falls freely towards the ground. [2]

A3 Calculate the kinetic energy of a 4.0 kg object moving at 5.0 m s^{-1}. [2]

A4 A pendulum bob swings from its highest point on one side, through the lowest point, to its highest point on the other side. Air resistance is negligible. Describe the energy transfers during this swing. [2]

A5 The speed of a car doubles. State the factor by which its kinetic energy changes, and justify your answer. [2]

A6 State the condition under which the sum of an object's kinetic and gravitational potential energy stays constant as it falls. [1]

SECTION B · Standard

B1 An object is dropped from rest and falls 1.8 m. Using energy conservation and taking g = 9.81 m s^{-2}, calculate its speed just before it lands (ignore air resistance). [3]

B2 A 0.20 kg ball is dropped from a height of 2.5 m. Taking g = 9.81 m s^{-2}, calculate (a) its gravitational potential energy at the start and (b) its speed just before impact. [4]

B3 A ball leaves the ground moving vertically upwards at 6.0 m s^{-1}. Using energy conservation with g = 9.81 m s^{-2}, calculate the maximum height it reaches. [3]

B4 A 5.0 kg block slides 4.0 m down a slope inclined at 30°, against a constant frictional force of 10 N. Taking g = 9.81 m s^{-2}, use energy conservation to determine its kinetic energy and speed at the bottom. [4]

B5 A light child and a heavy adult start from rest at the top of identical smooth slides. Explain, using energy conservation, why they reach the bottom with the same speed. [3]

B6 A cyclist and bicycle, of total mass 85 kg, travel at 12 m s^{-1} along a level road. The brakes provide a constant total resistive force of 340 N. Using energy conservation, determine the distance travelled while coming to rest. [3]

B7 A stone is thrown at 8.0 m s^{-1} from a bridge 12 m above a river. Air resistance is negligible; g = 9.81 m s^{-2}. (a) Calculate the speed of the stone as it enters the water. (b) Explain why the answer does not depend on the direction in which the stone is thrown. [4]

SECTION C · Stretch

C1 A roller-coaster car starts from rest at the top of a 25 m drop and passes a point 10 m above the ground. Ignoring friction and taking g = 9.81 m s^{-2}, calculate its speed at that point. [4]

C2 A ball is dropped from a height of 2.0 m and bounces back to a height of 1.5 m. Taking g = 9.81 m s^{-2}, calculate (a) the fraction of its energy retained in the bounce and (b) its speed just after leaving the ground. [4]

C3 Energy is always conserved, yet we still talk about 'wasting' energy. Explain this apparent contradiction. [3]

C4 A skateboarder of mass 68 kg claims that her ramp is almost frictionless. She starts from rest at the top of the ramp, 3.2 m above the bottom, and a speed gate at the bottom records 6.0 m s^{-1}. Taking g = 9.81 m s^{-2}, deduce whether her claim is justified. [5]

C5 A pendulum bob of mass 0.15 kg is released from a point 80 mm above its lowest position. After 20 complete swings the bob rises only 30 mm above the lowest position. Taking g = 9.81 m s^{-2}, calculate the average energy dissipated per swing. [4]

C6 The car of a roller coaster is hauled by a motor to the top of the first hill, then released and runs unpowered over several lower hills before brakes bring it to rest at the end of the ride. Describe fully the energy transfers throughout the ride, and explain why each successive hill must be lower than the one before. [6]