InkPhysics

QUESTION WORKBOOK

Work, energy and power

Mechanics · Year 12

AQA 3.4.1.7 · CIE 5.1.1, 5.1.3, 5.1.4, 5.1.5, 5.1.6, 5.1.7
OCR A 3.3.1(a), 3.3.1(b), 3.3.1(e), 3.3.3(a), 3.3.3(b), 3.3.3(c)

19 questions · 54 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 A force of 20 N moves an object 3.0 m in the direction of the force. Calculate the work done. [2]

A2 Define power and state its SI unit. [2]

A3 State the equations for kinetic energy and for the change in gravitational potential energy near the Earth's surface. [2]

A4 A shopper carries a bag at constant height across a level floor. State and explain the work done on the bag by the upward force from the shopper's hand. [2]

A5 A kettle transfers energy at a rate of 2.5 kW. Calculate the energy it transfers in 3.0 minutes. [2]

A6 State the quantity represented by the area under a force-displacement graph. [1]

SECTION B · Standard

B1 A force of 50 N pulls a crate 4.0 m along the ground, acting at 30° above the horizontal. Calculate the work done by the force. [3]

B2 A 2.0 kg object moves at 6.0 m s^{-1}. Calculate (a) its kinetic energy and (b) the distance it travels before stopping if a constant 12 N resistive force acts on it. [4]

B3 A motor raises a 20 kg load through a height of 5.0 m in 4.0 s at steady speed. Taking g = 9.81 m s^{-2}, calculate the useful output power of the motor. [3]

B4 A machine has an input power of 800 W and a useful output power of 600 W. Calculate its efficiency. [2]

B5 The force needed to stretch a spring increases linearly from zero to 12 N as its extension increases from zero to 80 mm. Determine the work done in stretching the spring. [3]

B6 A sprinter of mass 62 kg accelerates from rest to 9.0 m s^{-1} in 3.5 s. Calculate the average useful power she develops. [3]

B7 A van of mass 900 kg climbs a straight road at a steady 15 m s^{-1}. The road rises 1.0 m for every 20 m travelled along it. Taking g = 9.81 m s^{-2}, calculate the additional output power the engine must supply against gravity, compared with driving at the same speed on a level road. [3]

SECTION C · Stretch

C1 A car engine develops a useful output power of 40 kW while the car travels at a steady 25 m s^{-1}. Calculate the driving force provided by the engine. [3]

C2 A 10 kg box is pushed at steady speed a distance of 4.0 m up a slope inclined at 30° to the horizontal, against a constant frictional force of 15 N. Taking g = 9.81 m s^{-2}, calculate (a) the gain in gravitational potential energy, (b) the work done against friction, and (c) the force applied parallel to the slope. [5]

C3 Explain why the efficiency of a real machine is always less than 100%, and where the 'lost' energy goes. [3]

C4 A borehole pump raises 120 kg of water through a vertical height of 15 m every minute; the water leaves the outlet with negligible kinetic energy. The pump's electrical input power is 500 W, and the manufacturer claims an efficiency of at least 65%. Taking $g = 9.81\ \text{m s}^{-2}$, deduce whether the pump meets the manufacturer's claim. [4]

C5 A resultant force acts on a 0.50 kg trolley, initially at rest, along a straight track. The force is a constant 6.0 N for the first 2.0 m of travel, then decreases linearly to zero over the next 2.0 m. Determine the speed of the trolley after it has travelled 4.0 m. [4]

C6 Estimate the useful power a student develops against gravity when running up a flight of stairs. State the estimated values you use. [3]