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QUESTION WORKBOOK

Newton's laws and the resultant force

Mechanics · Year 12

AQA 3.4.1.5 · CIE 3.1.2, 3.1.5 · OCR A 3.2.1(a), 3.2.1(d), 3.2.1(e), 3.2.1(f), 3.5.1(a)

19 questions · 60 marks

NAVY SCREEN EDITION

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SECTION A · Warm-up

A1 State Newton's first law of motion. [2]

A2 A mass of 2.0 kg has an acceleration of 3.0 m s^{-2}. Calculate the resultant force acting on it. [2]

A3 Explain what is meant by the resultant force on an object. [2]

A4 A delivery van travels along a straight, level road at a constant velocity of 20 m s^{-1}. State the magnitude of the resultant force acting on it. [1]

A5 A model rocket has a mass of 250 g. At one instant during its flight its acceleration is 12 m s^{-2}. Calculate the resultant force on the rocket at this instant. [2]

A6 State Newton's third law of motion. [2]

SECTION B · Standard

B1 A block of mass 4.0 kg is pushed to the right by a horizontal force of 12 N while a frictional force of 4.0 N acts to the left. Calculate the resultant force on the block and its acceleration. [3]

B2 A person of mass 70 kg stands in a lift. Taking $g = 9.81\ \text{m s}^{-2}$, calculate (a) their weight and (b) the force the lift floor exerts on them when the lift accelerates upwards at $2.0\ \text{m s}^{-2}$. [4]

B3 A 3.0 kg block and a 2.0 kg block are in contact on a smooth surface. A horizontal force of 10 N pushes the 3.0 kg block, which pushes the 2.0 kg block. Calculate (a) the acceleration of the blocks and (b) the contact force between them. [4]

B4 A book rests on a table. Identify the Newton's third-law pair to the force of the table pushing up on the book, and explain why the book's weight is not that pair. [3]

B5 A crane raises a 350 kg load on a vertical cable. The tension in the cable is 3.65 kN. Taking g = 9.81 m s^{-2}, calculate the acceleration of the load. [3]

B6 An ice hockey puck of mass 160 g slides in a straight line across level ice. Its speed falls from 18 m s^{-1} to 12 m s^{-1} in 4.0 s. Calculate the average frictional force acting on the puck. [3]

B7 Explain, using Newton's third law, how a swimmer is able to accelerate forwards through the water. [3]

SECTION C · Stretch

C1 A 2.0 kg block slides down a smooth slope inclined at 30° to the horizontal. Taking g = 9.81 m s^{-2}, calculate its acceleration down the slope. [3]

C2 A 3.0 kg mass hangs from a light string that passes over a smooth pulley and connects to a 2.0 kg mass on a smooth horizontal table. Taking g = 9.81 m s^{-2}, calculate (a) the acceleration of the system and (b) the tension in the string. [5]

C3 A person stands at rest on horizontal ground. State the Newton's third-law pair to the force the person exerts on the ground, and explain why the person remains in equilibrium. [3]

C4 A packing crate of mass 12 kg rests on a ramp inclined at 25° to the horizontal. The maximum frictional force the ramp can exert on the crate is 55 N. Taking g = 9.81 m s^{-2}, deduce whether the crate remains at rest on the ramp. [4]

C5 A student of mass 62.0 kg stands on scales, calibrated in kilograms, on the floor of a lift. While the lift is moving, the scales read 56.5 kg. Taking g = 9.81 m s^{-2}, determine the magnitude and direction of the lift's acceleration, and state one possible motion of the lift at this moment. [5]

C6 A student says: “When a horse pulls a cart, Newton's third law means the cart pulls back on the horse just as hard, so the forces cancel and the pair can never accelerate.” Explain fully why the student's conclusion is wrong. Refer to the forces acting on the cart, the forces acting on the horse, and Newton's laws. [6]