InkPhysics

ANSWER BOOK

Mass and weight

Mechanics · Year 12

AQA 3.4.1.1 · CIE 3.1.1, 3.1.6 · OCR A 3.2.1(c)

18 questions · 53 marks

NAVY EDITION

inkphysics.co.uk/physics/ · youtube.com/@InkPhysics

SECTION A · Warm-up

A1 Mass is the amount of matter in an object, a scalar measured in kilograms (1). Weight is the gravitational force on it, a vector measured in newtons (1). [2]

A2 $W = mg = 5.0 \times 9.81$ (1)
$W = 49.1$ N (1) [2]

A3 A balance compares mass, in kg (1); a newton meter measures force, so it reads weight, in N (1). [2]

SECTION B · Standard

B1 Mass is unchanged at 5.0 kg (1)
Weight = $mg = 5.0 \times 1.62$ (1)
Weight = 8.1 N (1) [3]

B2 (a) $W = 80 \times 9.81$ (1)
$W = 784.8$ N (1)
(b) $W = 80 \times 3.70$ (1)
$W = 296$ N (1) [4]

B3 $mg - N = ma$ (1)
$N = m(g - a) = 60 \times (9.81 - 3.0)$ (1)
$N = 408.6$ N (1)
This is less than their true weight of 588.6 N, so they feel lighter (1) [4]

SECTION C · Stretch

C1 $g = GM/r^2$ (1)
$GM = 6.67 \times 10^{-11} \times 6.0 \times 10^{24}$ (1)
$g = GM / (6.4 \times 10^6)^2$ (1)
$g = 9.77 \text{ N kg}^{-1}$ (1) [4]

C2 Acceleration = weight/mass = $mg/m = g$, independent of mass (1). Both objects fall with the same acceleration g (1), so with no air resistance they land together, even though the hammer has far more mass and weight (1). [3]

C3 Kilograms measure mass, not weight (1). The object has a mass of 5 kg; its weight is a force of about 49 N on Earth, from W = mg (1). Weight should be quoted in newtons (1). [3]

SECTION A · Warm-up

A4 1 N = 1 kg m s^{-2} (from F = ma) (1), so N kg^{-1} = kg m s^{-2}/kg = m s^{-2} (1). [2]

A5 m = W/g = 34.3/9.81 (1) = 3.5 kg (1). [2]

A6 Vertically downwards, towards the centre of the Earth (1). [1]

SECTION B · Standard

B4 Her mass is unchanged at 70.0 kg; mass does not depend on location (1). ΔW = mΔg = 70.0 × (9.83 - 9.78) (1) = 3.5 N increase (1). [3]

B5 Total mass = 1.9 + 1.6 + 0.850 + 2.3 = 6.65 kg (850 g converted to 0.850 kg) (1). 6.65 kg is less than 7.0 kg, so the baggage is within the limit (1). W = mg = 6.65 × 9.81 = 65 N (1). [3]

B6 m = W/g = 12.0/9.81 = 1.22 kg, the same on Europa (1). Reading = mg_{Europa} = 1.22 × 1.31 (1) = 1.6 N (1). [3]

SECTION C · Stretch

C4 g = W/m = 53.2/6.00 (1) = 8.87 N kg^{-1} (1). This matches Venus; it is far too large for Mercury or Mars and too small for Earth (1). [3]

C5 The scales read the normal contact force between the student and the scales, not the weight itself (1). In free fall the student, scales and cabin all accelerate downwards at g (1), so no contact force is needed between the student and the scales and the reading falls to zero (1). The weight is unchanged at mg; gravity still acts throughout the fall (1). [4]

C6 A beam balance compares the sample with standard masses (1). Gravity acts equally on both sides of the balance, so its effect cancels and the balance still indicates 3.0 kg on the Moon (1). A newton meter measures the gravitational force on the sample directly, through the extension of its spring (1). On Earth it reads $W = 3.0 \times 9.81 = 29.4$ N, but on the Moon it reads $3.0 \times 1.62 = 4.9$ N, about one sixth as much (1). The mass is unchanged by the move; only the weight depends on g, and the two instruments measure different quantities (1). [5]