# Newton's Laws of Motion

## Mark Scheme 1

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| **Level** | International A Level |
| **Subject** | Physics |
| **Exam Board** | CIE |
| **Topic** | Dynamics |
| **Sub Topic** | Newton's Laws of Motion |
| **Paper Type** | Theory |
| **Booklet** | Mark Scheme 1 |

**Time Allowed:** **72 minutes**

**Score:** **/60**

**Percentage:** **/100**

| A* | A | B | C | D | E | U |
|---|---|---|---|---|---|---|
| >85% | '77.5% | 70% | 62.5% | 57.5% | 45% | <45% |

1 **(a** a body / mass / object continues (at rest or) at constant / uniform velocity unless acted on by a resultant force B1 [1]

**(b) (i)** weight vertically down B1
normal / reaction / contact (force) perpendicular / normal to the slope B1 [2]

**(ii) 1.** acceleration = gradient *or* $(v - u)/t$ *or* $\Delta v/t$ C1
$= (6.0 - 0.8)/(2.0 - 0.0) = 2.6\ \text{m s}^{-2}$ M1 [2]

**2.** $F = ma$
$= 65 \times 2.6$
$= 169$ N (allow to 2 or 3 s.f.) A1 [1]

**3.** weight component seen: $mg \sin\theta$ (218 N) C1
$218 - R = 169$ C1
$R = 49$ N (require 2 s.f.) A1 [3]

2 **(a) (i)** acceleration = change in velocity / time (taken)
or acceleration = rate of change of velocity B1 [1]

**(ii)** a body continues at constant velocity unless acted on by a resultant force B1 [1]

**(b) (i)** distance is represented by the area under graph C1
distance = ½ × 29.5 × 3 = 44.3 m (accept 43.5 m for 29 to 45 m for 30) A1 [2]

**(ii)** resultant force = weight – frictional force B1
frictional force increases with speed B1
at start frictional force = 0 / at end weight = frictional force B1 [3]

**(iii) 1.** frictional force increases B1 [

**2.** frictional force (constant) and then decreases B1 [1]

**(iv) 1.** acceleration = $(v_2 - v_1) / t = (20 - 50) / (17 - 15)$ C1
$= (-)\ 15\ \text{m s}^{-2}$ A1 [2]

**2.** $W - F = ma$ C1
$W = 95 \times 9.81$ (= 932) C1
$F = (95 \times 15) + 932 = 2400$ (2360) (2357) N A [3]

3 **(a** (resultant) force = rate of change of momentum / allow proportional to
or change in momentum / time (taken) B1 [1]

**(b) (i)** $\Delta p = (-)\ 65 \times 10^{-3}\ (5.2 + 3.7)$ C1

$= (-)\ 0.58$ N s A1 [2]

**(ii)** $F = 0.58 / 7.5 \times 10^{-3}$

$= 77(.3)$ N A [1]

**(c) (i) 1.** force on the wall from the ball is equal to the force on ball from the wall M1
but in the opposite direction A1 [2]
(statement of Newton's third law can score one mark)

**2.** momentum change of ball is equal and opposite to momentum change
of the wall / change of momentum of ball and wall is zero B1 [1]

**(ii)** kinetic energy (of ball and wall) is reduced / not conserved so inelastic B1 [1]
(Allow relative speed of approach does not equal relative speed of separation.)

4 **(a)** A body continues at rest or constant velocity unless acted on by a resultant
(external) force B1 [1]

**(b) (i)** constant velocity/zero acceleration and therefore no resultant force M1
no resultant force (and no resultant torque) hence in equilibrium A1 [2]

**(ii)** component of weight = 450 × 9.81 × sin 12° (= *917.8*) C1
tension = 650 + 450 *g* sin12° = (650 + 917.8) C1
= 1600 (1570) N A1 [3]

**(iii)** work done against frictional force or friction between log and slope M1
output power greater than the gain in PE / s A1 [2]

5 **(a)** displacement is a vector, distance is a scalar B1
displacement is straight line between two points / distance is sum of lengths moved / example showing difference B1 [2]
(either one of the definitions for the second mark)

**(b)** a body continues at rest or at constant velocity unless acted on by a <u>resultant</u> (external) force B1 [1]

**(c)** **(i)** sum of $T_1$ and $T_2$ equals frictional force B1
these two forces are in opposite directions B1 [2]
*(allow for 1/2 for travelling in straight line hence no rotation / no resultant torque)*

**(ii)** **1.** scale vector triangle with correct orientation / vector triangle with correct orientation both with arrows B1
scale given or mathematical analysis for tensions B1 [2]

**2.** $T_1 = 10.1 \times 10^3 (\pm 0.5 \times 10^3)$ N A1
$T_2 = 16.4 \times 10^3 (\pm 0.5 \times 10^3)$ N A1 [2]

6 **(a)** **(i)** base units of $D$:
force: $\text{kg m s}^{-2}$ B1
radius: m velocity: $\text{m s}^{-1}$ B1

base units of $D$: $[F / (R \times v)]$ $\text{kg m s}^{-2} / (\text{m} \times \text{m s}^{-1})$ M
$= \text{kg m}^{-1} \text{s}^{-1}$ A0 [3]

**(ii)** **1.** $F = 6\pi \times D \times R \times v = [6\pi \times 6.6 \times 10^{-4} \times 1.5 \times 10^{-3} \times 3.7]$
$= 6.9 \times 10^{-5}$ N A1 [1]

**2.** $mg - F = ma$ hence $a = g - [F / m]$
$m = \rho \times V = \rho \times 4/3\ \pi R^3 = (1.4 \times 10^{-5})$ C1
$a = 9.81 - [6.9 \times 10^{-5}] / \rho \times 4/3\ \pi \times (1.5 \times 10^{-3})^3$ (9.81 – 4.88) M1
$a = 4.9(3)\ \text{m s}^{-2}$ A1 [3]

**(b)** **(i)** $a = g$ at time $t = 0$ B1
$a$ decreases (as time increases) B1
$a$ goes to zero B1 [3]

**(ii)** Correct shape below original line M1
sketch goes to terminal velocity earlier A1 [2]