AQA · GCSE · PHYSICS • EXERCISE SHEET

5.7 Newton's laws

Name: _____ Class: _____ Date: _____ **Total: 26 marks**

KEY WORDS Inertia

Objective

State and apply Newton's three laws, use $F = ma$, and describe RP7's method and graphs. Original questions for spec statements 4.5.6.2.1–4.5.6.2.3.

1 Key knowledge and worked examples

First law: resultant force zero → a stationary object stays stationary; a moving object keeps the same velocity. Straight-line motion at steady speed means driving force = resistive forces. (HT) **Inertia** is the tendency to resist change of motion.

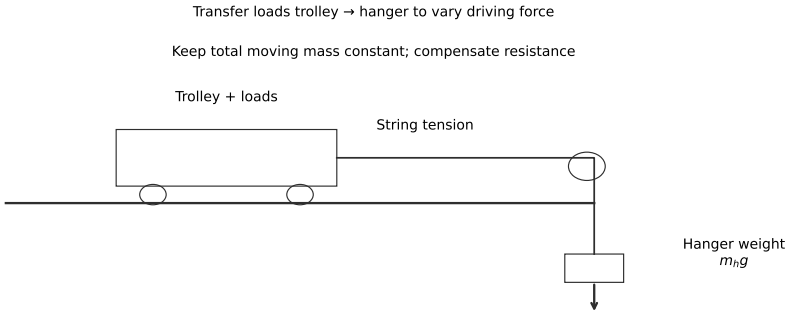
Second law: $a \propto F$ and $a \propto 1/m$, so:

$$F = ma$$

(HT) **Inertial mass** = F/a – how hard it is to change an object's velocity.

Third law: when two objects interact they exert **equal and opposite forces on each other** – same type, opposite directions, acting on different objects. (A book pushes down on the table; the table pushes up on the book.)

RP7 (force and mass effect on acceleration):



Compensate for friction by tilting the runway first.

- Set-up: trolley on a runway, thread over a pulley to a mass hanger, light gates (or ticker timer) measuring acceleration.
- **Part 1**: keep the **total moving mass** constant by moving masses from the trolley to the hanger; measure a for each driving force $F = m_h g$ on the combined trolley–hanger system, with resistance compensated or negligible; plot a against F – a straight line through the origin ($a \propto F$).
- **Part 2**: keep the **force** constant; add masses to the trolley; plot a against $1/m$ using the total moving mass – a straight line through the origin ($a \propto 1/m$).
- Controls: compensate friction (tilt until the trolley just runs steadily); same hanger mass in part 2; repeats and means.

Worked example. A 1500 kg car accelerates at 2.5 m/s^2.

$$F = ma = 1500 \times 2.5 = 3750 \text{ N}$$

2 Practice

2.1 State Newton's first law for a moving object. [1]

2.2 A resultant force of 48 N acts on a 12 kg trolley. Calculate the acceleration. [2]

2.3 State Newton's third law and give one example with names on both objects. [2]

3 Exam-style questions

3.1 A student investigates how the driving force on a trolley–hanger system affects its acceleration, keeping the total moving mass constant and resistance negligible or compensated.

(a) State the independent and dependent variables and one control. [3]

(b) Describe how the student obtains the force and the acceleration values. [3]

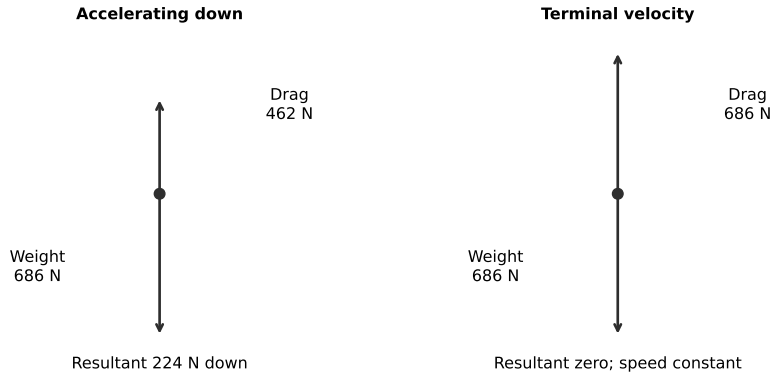
(c) The a–F graph is a straight line through the origin. State the relationship. [1]

3.2 A skydiver of mass 70 kg falls with acceleration 3.2 m/s^2 ($g = 9.8$ N/kg).

(a) Calculate the skydiver's weight. [2]

(b) Calculate the resultant force. [2]

(c) Calculate the drag force. [2]



3.3 A 1400 kg car travelling at 18 m/s brakes with constant deceleration and stops in a braking distance of 25 m.

(a) Calculate the deceleration using $v^2 - u^2 = 2as$. [3]

(b) Calculate the braking force. [2]

(c) (HT) State Newton's third-law pair for the braking force on the car, and explain why the two forces do not cancel out. [3]