

GCSE Physics (9 – 1)

Newton's Laws

Name:

Group:



Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.

For markers use	
Question	Mark
1	/5
2	/11
3	/10
4	/6
5	/10
6	/6
7	/7
Total	/55
%	
Grade	

Information

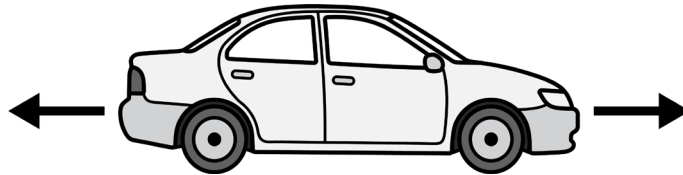
- The maximum mark for this paper is 55 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Newton's three laws of motion provide the essential rules for predicting how forces will affect an object, whether it is resting in equilibrium, accelerating under a resultant force, or colliding with another object.

For each of the following questions **circle** the letter of the correct answer.

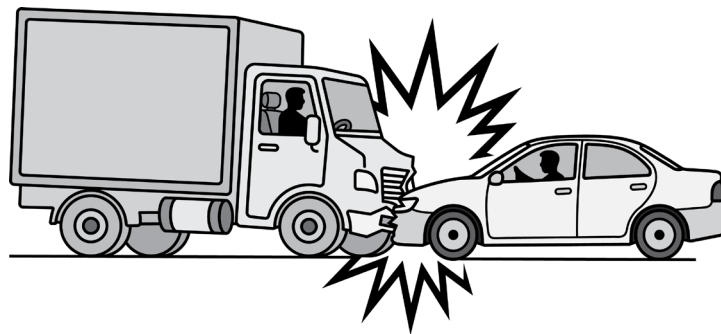
- a) A car is travelling along a straight motorway at a constant velocity of 25 m/s.
Which statement correctly describes the forces acting on the car?



- A The driving force is greater than the resistive forces.
- B The resultant force acting on the car is exactly zero.
- C There are no forces acting on the car at all.
- D The resistive forces are steadily increasing.

(1 mark)

- b) A heavy truck collides with a small, stationary car.
Which statement correctly describes the forces exerted during the impact?



- A The truck exerts a larger force on the car because it has a larger mass.
- B The car exerts a larger force on the truck because it absorbs more damage.
- C The truck and the car exert exactly equal and opposite forces on each other.
- D Neither vehicle exerts a force because the momenta cancel out.

(1 mark)

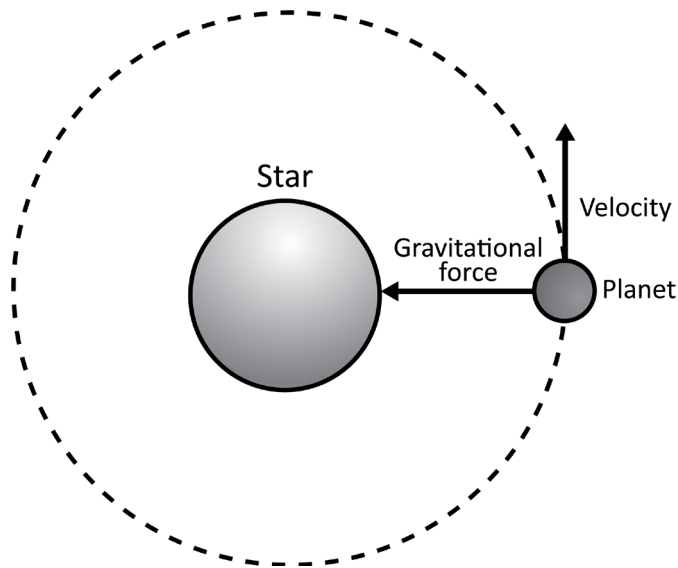
- c) According to Newton's Second Law, the acceleration of an object is directly proportional to the resultant force acting on it.

If a constant resultant force of 20 N causes a box to accelerate at 2 m/s^2 , what will the acceleration be if the force is increased to 40 N?

- | A | B | C | D |
|-------------------|-------------------|-------------------|-------------------|
| 1 m/s^2 | 2 m/s^2 | 4 m/s^2 | 8 m/s^2 |

(1 mark)

- d) A planet orbits a star at a constant speed in a circular path.



According to Newton's First Law, why must there be a resultant force acting on the planet?

- A** Its mass is constantly changing.
- B** It's moving through a vacuum.
- C** The star's gravity is pushing it away.
- D** Its direction, and therefore its velocity, is constantly changing.

(1 mark)

- e) Which of the following is the correct definition of inertial mass?

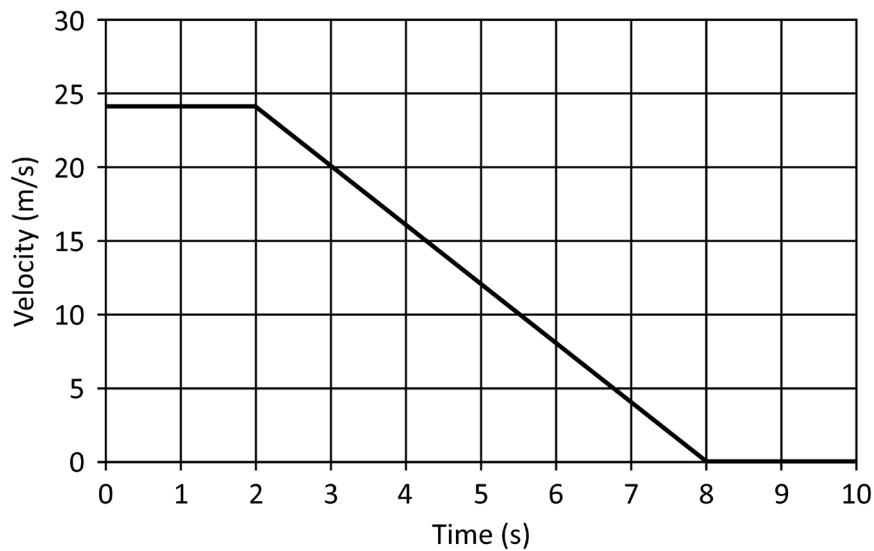
- A** The total amount of matter contained within an object.
- B** The force of gravity acting on an object.
- C** A measure of how difficult it is to change the velocity of an object.
- D** The product of an object's mass and its velocity.

(1 mark)

(Total for Question 1 is 5 marks)

2. A car is travelling along a straight road at a constant velocity.
The driver sees a hazard ahead and applies the brakes to stop the car.

The velocity-time graph below shows the motion of the car.



- a) State the time at which the driver first applied the brakes.

Time = ... s
(1 mark)

- b) Calculate the deceleration of the car while it is braking.

Deceleration = ... m/s^2
(3 marks)

- c) The total mass of the car and the driver is 1400 kg.
Calculate the resultant braking force required to stop the car.

Braking force = ... N
(3 marks)

d) State which of Newton's Laws you used to complete the calculation in part (c).

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(1 mark)

e) A second, identical car is travelling on the same road at the same speed.
However, this car is towing a heavy trailer.
The driver of the second car applies the exact same braking force as the first car.

Explain how towing the heavy trailer will affect the acceleration and the stopping distance of the car.

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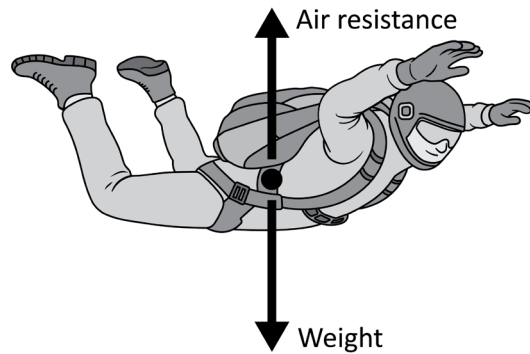
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(3 marks)

(Total for Question 2 is 11 marks)

3. A skydiver jumps from a plane. The figure below shows the forces acting on the skydiver shortly after jumping.



- a) State what is happening to the speed of the skydiver at this exact moment.
Explain your answer using Newton's First Law.

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(2 marks)

- b) As the skydiver continues to fall, their speed increases.
Describe what happens to the upward force of air resistance as their speed increases.

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(2 marks)

- c) Eventually, the skydiver reaches a constant top speed called terminal velocity.
Explain why the skydiver reaches terminal velocity and stops accelerating.

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(3 marks)

- d) The downward force on the skydiver is their weight.
This is caused by the Earth pulling downwards on the skydiver.

According to Newton's Third Law, there must be an equal and opposite reaction force.

Identify this reaction force.

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(1 mark)

- e) A different skydiver, who has a much larger mass, jumps from the plane.
Explain why the heavier skydiver will reach a higher terminal velocity than the first skydiver.

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(3 marks)

(Total for Question 3 is 10 marks)

4. A large space rocket is launched vertically upwards from a launchpad.



As the rocket rises through the atmosphere, its engines provide a constant upward thrust. However, the upward acceleration of the rocket increases as it gets higher.

Explain the forces acting on the rocket during its launch and explain why its acceleration increases as it travels upwards.

In your answer you should refer to:

- Newton's laws
- The forces acting on the rocket
- Why the acceleration is not constant.

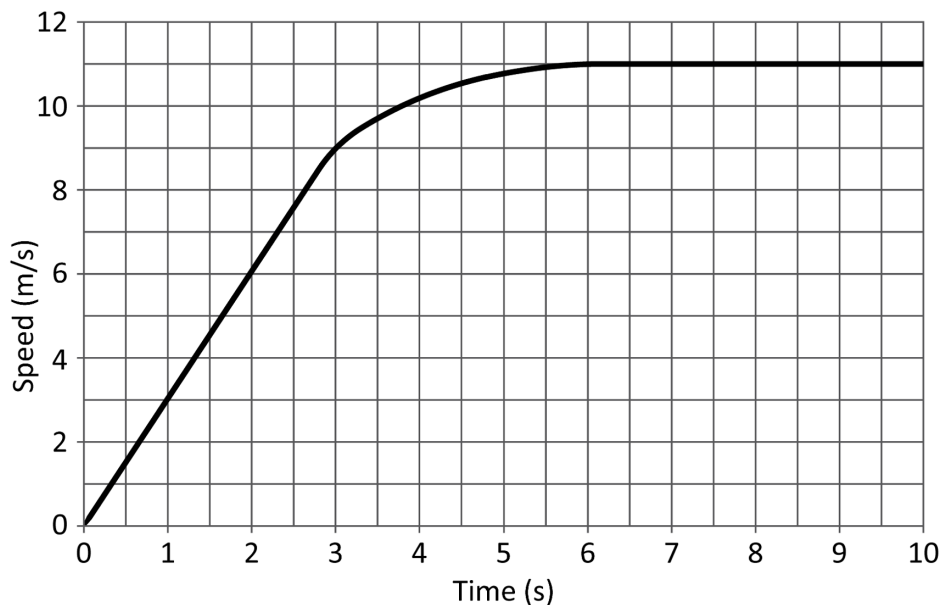
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(6 marks)

(Total for Question 4 is 6 marks)

5. An athlete is competing in a 100 m sprint.

The speed-time graph below shows the first 10 seconds of the athlete's race.



- a) The athlete has a mass of 75 kg.

Use the graph to calculate the acceleration of the athlete during the first 3 seconds of the race.

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Acceleration = ... m/s^2
(3 marks)

- b) State the equation that links acceleration (a), mass (m), and resultant force (F).

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(1 mark)

- c) Calculate the resultant force acting on the athlete during the first 3 seconds of the race.

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Resultant force = ... N
(2 marks)

- d) Look at the graph between 3 seconds and 6 seconds.

The athlete is still applying the exact same forward driving force with their legs.

Explain why the athlete's acceleration decreases between 3 seconds and 6 seconds.

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(2 marks)

- e) State the resultant force acting on the athlete at 8 seconds.

Give a reason for your answer.

Resultant Force = ... N

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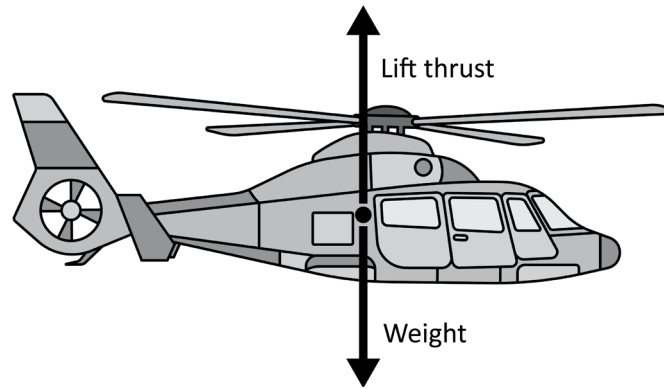
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(2 marks)

(Total for Question 5 is 10 marks)

6. A helicopter is hovering perfectly still at a constant altitude. The diagram shows the vertical forces acting on the helicopter.



A student looks at the diagram and states:

"The Earth pulls down on the helicopter with gravity, and the rotors push up with an equal and opposite thrust force. Therefore, these two forces are a Newton's third law action-reaction pair."

The student's statement is **incorrect**.

Explain why the student is wrong. In your answer, you should:

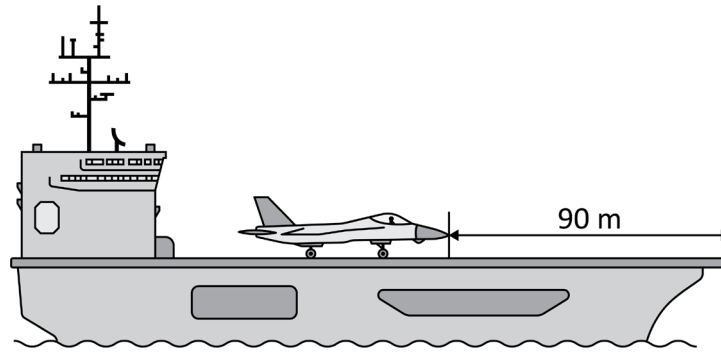
- explain why the two forces mentioned by the student are **not** a Newton's Third Law pair.
- identify the true Newton's third law pair for the downward **weight** force.
- identify the true Newton's third law pair for the upward **lift thrust** force.

This image shows a full page of white paper with horizontal dashed lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(6 marks)

(Total for Question 6 is 6 marks)

7. A fighter jet is launched from the deck of an aircraft carrier using a steam catapult. The figure below shows the jet leaving the aircraft carrier.



The fighter jet has a mass of 2.4×10^4 kg.

It starts from rest and must reach a take-off velocity of 75 m/s by the time it reaches the end of the 90 m runway.

- a) Calculate the acceleration required for the jet to reach take-off velocity.

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Acceleration = ... m/s²

(3 marks)

- b) During the launch, the jet's own engines provide a constant forward thrust of 150,000 N.

Calculate the additional force that the steam catapult must apply to the jet to achieve the required acceleration.

Additional force that the steam catapult = ... N

(4 marks)

(Total for Question 7 is 7 marks)