

GCSE Physics (9 – 1)

Free Body Diagrams

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	/4
2	/8
3	/10
4	/7
5	/5
Total	/34
%	
Grade	

Information

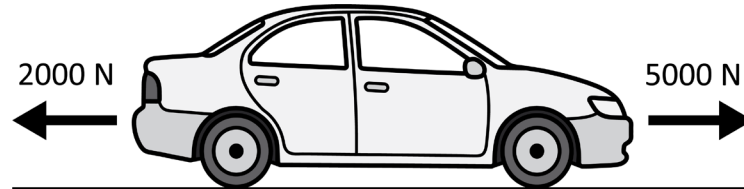
- The maximum mark for this paper is 34 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Free body diagrams simplify complex situations by using arrows to show the exact size and direction of every force acting on a single object.

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

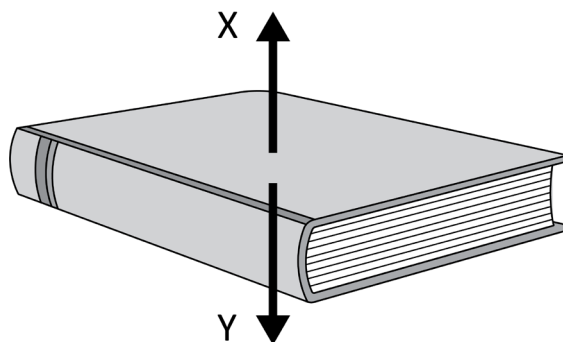
- a) The free body diagram shows the horizontal forces acting on a car.
What is the resultant force acting on the car?



- | | | | |
|-----------------|------------------|-----------------|-----------------|
| A | B | C | D |
| 7000 N forwards | 3000 N backwards | 3000 N forwards | 5000 N forwards |

(1 mark)

- b) Look at the free body diagram of a book resting on a horizontal desk.

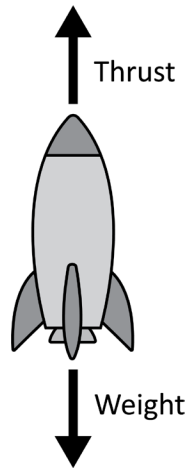


What do the forces represented by arrows X and Y represent?

	X	Y
A	Mass	Gravity
B	Normal contact force	Weight
C	Upthrust	Friction
D	Tension	Weight

(1 mark)

- c) A rocket has just launched from the launchpad and is accelerating vertically upwards through the sky. Look at the free body diagram showing the forces acting on the rocket.

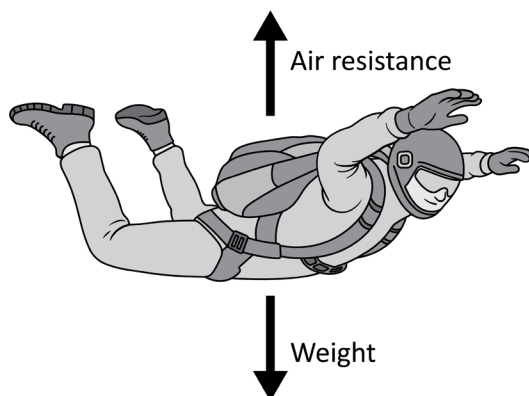


Which of the following statements about the arrows is correct?

- A The upward 'Thrust' arrow must be longer than the downward 'Weight' arrow.
- B The upward 'Thrust' arrow must be exactly the same length as the downward 'Weight' arrow.
- C The downward 'Weight' arrow must be longer than the upward 'Thrust' arrow.
- D There should only be an upward 'Thrust' arrow; there is no 'Weight' arrow when a rocket is flying.

(1 mark)

- d) The free body diagram shows the forces acting on a skydiver falling through the air. The upward and downward arrows are exactly the same length.



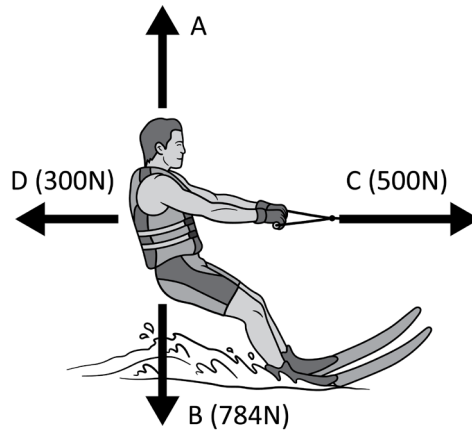
Which statement correctly describes the skydiver's motion?

- A The skydiver is accelerating downwards.
- B The skydiver is slowing down.
- C The skydiver is falling at a constant speed (terminal velocity).
- D The skydiver is stationary.

(1 mark)

(Total for Question 1 is 4 marks)

2. A boat is pulling a water skier across a lake.
The diagram shows the free body diagram for the water skier.



- a) Use the detailed picture to help you identify the specific forces labelled A and C on the free body diagram.

Force A = ...

Force C = ...

(2 marks)

- b) Forces A and B are balanced.
Calculate the magnitude and direction of the resultant force acting on the water skier.

Magnitude = ... N

Direction = ...

(2 marks)

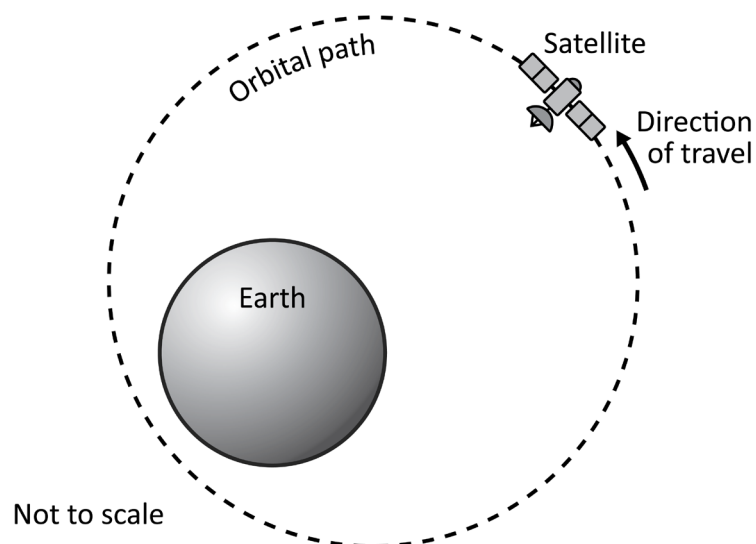
- c) The water skier has a mass of 80 kg.
Calculate the acceleration of the water skier. State the unit of acceleration in your answer.

Acceleration = ... Unit = ...

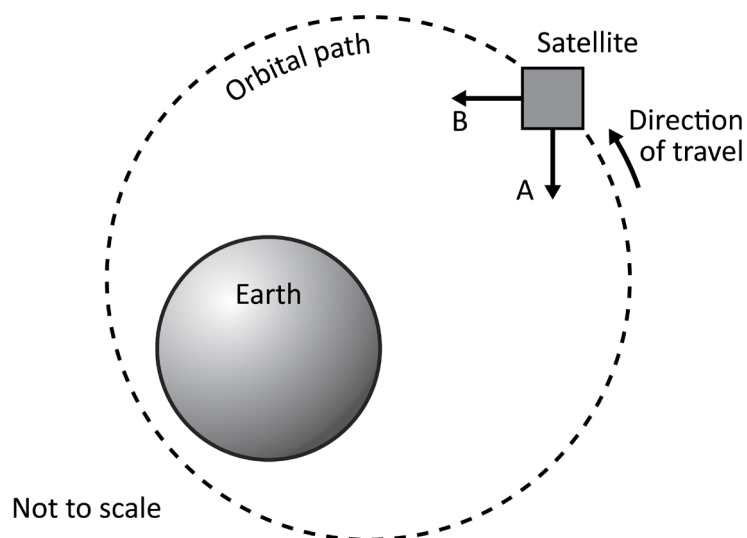
(4 marks)

(Total for Question 2 is 8 marks)

3. A satellite is moving at a constant speed in a circular orbit around the Earth. Its engines are switched off. The figure below shows the satellite orbiting Earth.



A student is asked to draw a free body diagram for the satellite. Their attempt is shown in the figure below.



- a) State the name of the non-contact force represented by Arrow A.

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(1 mark)

- b) The student's free body diagram is **incorrect**. Arrow B should not be there. Explain why there is no forward force acting on the satellite.

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(2 marks)

- c) The satellite is moving at a constant speed in its circular orbit.

Explain why the satellite is **accelerating**, even though it is moving at a constant speed.

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(2 marks)

- d) The satellite has a mass of 1200 kg. At this high altitude, the gravitational field strength (g) is 8.5 N/kg. Calculate the resultant force acting on the satellite.

Resultant force = ... N

(2 marks)

- e) Over many years, the satellite slowly loses altitude and enters the top of the Earth's atmosphere.

Describe how the free body diagram of the satellite will change, and explain how this will affect its motion.

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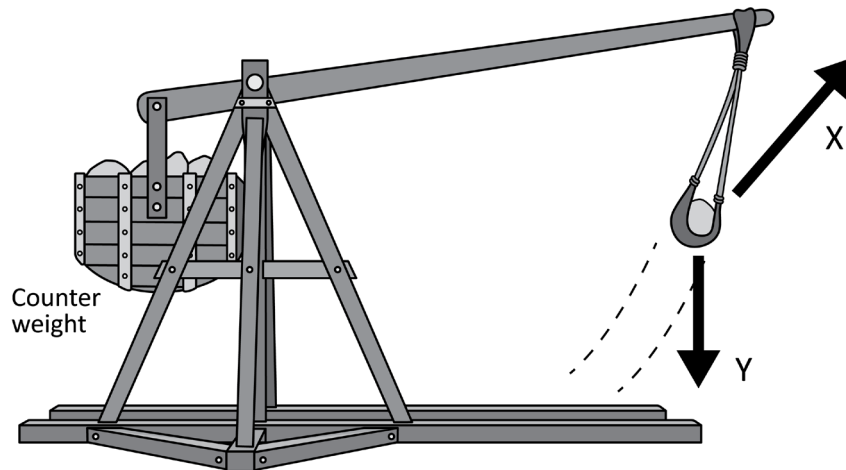
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(3 marks)

(Total for Question 3 is 10 marks)

4. Long before the invention of the cannon, the trebuchet was the medieval world's preferred method for aggressively taking down a neighbour's castle.

The figure below shows a trebuchet launching a stone.



- a) Identify the two forces acting on the stone in the figure above.

Force X = ...

Force Y = ...

(2 marks)

- b) The stone has a mass of 90 kg. The gravitational field strength (g) is 9.8 N/kg.
Calculate the size of Force Y.

Force Y = ... N

(2 marks)

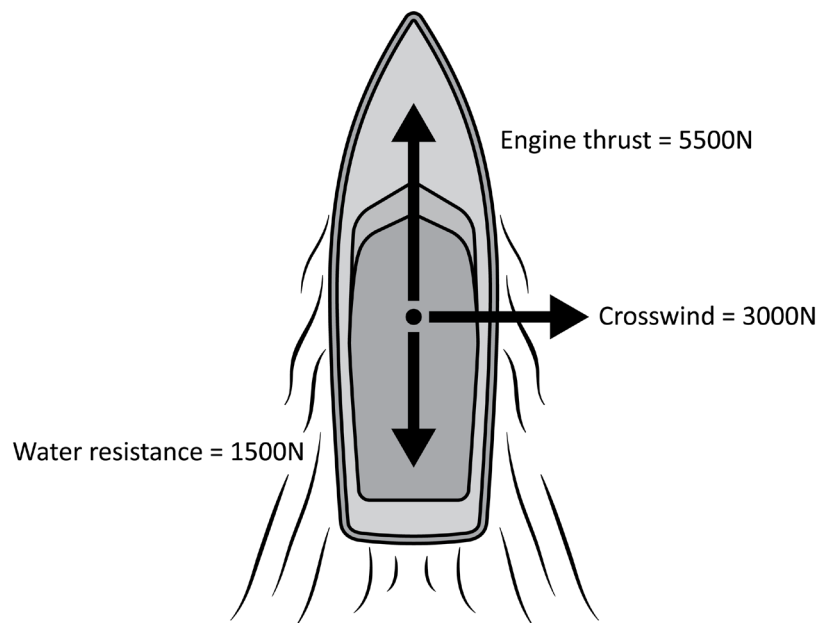
- c) As the stone is moving in the sling the resultant force acting on the stone is 3150 N.
Calculate the acceleration of the stone.

Acceleration = ... m/s^2

(3 marks)

(Total for Question 4 is 7 marks)

5. The free body diagram shows a plan view of the horizontal forces acting on a speedboat.



The speedboat has a mass of 800 kg.
Calculate the magnitude of the acceleration of the speedboat.

Acceleration = ... m/s^2

(5 marks)

(Total for Question 5 is 5 marks)