F=ma

Question Paper

Level	International A Level
Subject	Physics
Exam Board	Edexcel
Topic	Mechanics
Sub Topic	F=ma
Booklet	Question Paper

Time Allowed: **50 minutes**

Score: **/41**

Percentage: **/100**

Grade Boundaries:

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

1 A child throws a ball vertically upwards and then catches it when it falls back down. When the ball is caught, the ball exerts a force on the child's hand.

According to Newton's third law there will also be

☒ **A** a downwards force of the ball on the hand.

☒ **B** a downwards force of the hand on the ball.

☒ **C** an upwards force of the ball on the hand.

☒ **D** an upwards force of the hand on the ball.

(Total for Question 1 = 1 mark)

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2 The gravitational field strength on Jupiter is 2.6 times greater than the gravitational field strength on Earth.

The weight of 10 kg of matter on Jupiter would be approximately

☒ **A** 26 N

☒ **B** 38 N

☒ **C** 98 N

☒ **D** 260 N

(Total for Question 2 = 1 mark)

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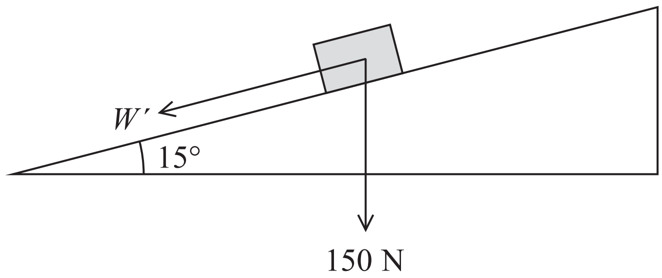
3 A box of weight 150 N is placed on an inclined plane. The component of the box's weight acting along the plane is W'.



W' in newtons is given by

- ☒ **A** $\dfrac{150}{\cos 15°}$
- ☒ **B** $150 \times \cos 15°$
- ☒ **C** $\dfrac{150}{\sin 15°}$
- ☒ **D** $150 \times \sin 15°$

(Total for Question 3 = 1 mark)

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4 A girl of mass 30 kg and a boy of mass 45 kg sit on a frictionless floor holding the two ends of a rope. The boy pulls on the rope. The girl moves towards the boy with an inital acceleration of 3 m s^{-2}.

The boy

- ☒ **A** moves towards the girl with an initial acceleration greater than 3 m s^{-2}.
- ☒ **B** moves towards the girl with an initial acceleration less than 3 m s^{-2}.
- ☒ **C** moves towards the girl with an initial acceleration of 3 m s^{-2}.
- ☒ **D** remains stationary.

(Total for Question 4 = 1 mark)

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5 A student carried out an experiment to obtain a value for the acceleration of free fall g.

A small ball was dropped from rest and the motion of the ball was captured using a digital camera. The student counted the frames from the recording to measure the time t for the ball to fall to the ground.

A ruler was visible on the recording to enable the student to measure the distance s fallen by the ball.

(a) Use Newton's second law of motion to show that the acceleration of the ball is independent of its mass.

(1)

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(b) (i) State the equation that the student should use to calculate the value of g.

(1)

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(ii) A value for g was obtained and was greater than expected.

Explain **one** possible source of error that would have produced a greater than expected value.

(2)

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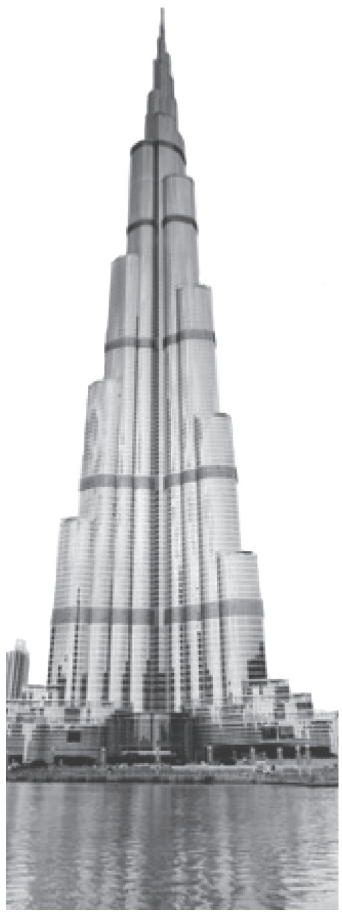
(Total for Question 5 = 4 marks)

6 The world's tallest building is the Burj Khalifa in Dubai, UAE.

The viewing gallery for the public is on the 124th floor. The lift that visitors use takes 56 seconds to reach this floor. The motion of the lift can be divided into three parts:

- acceleration
- constant velocity of 10 m s^{-1}
- deceleration.



(a) Draw a free-body force diagram for the forces acting on a passenger as the lift rises.

(2)

(b) A physics student of mass 60 kg decides to measure the initial acceleration of the lift. She places a set of scales on the floor of the lift and steps onto them. Whilst the lift is accelerating upwards the reading on the scales increases to 73 kg.

(i) Show that the initial acceleration of the lift is about 2 m s^{-2}.

(3)

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(ii) Near the end of the ascent, the velocity of the lift decreases from 10 m s^{-1} to rest in 5.3 seconds.

Calculate the deceleration.

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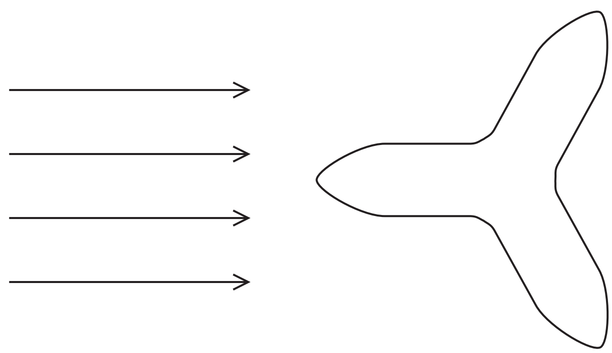
Deceleration = ...

(c) The effects of the wind had to be considered in the position and design of the building, due to its height. It has been shaped, as in the diagram, so that the wind deflects around the building in a way which minimises turbulence.

Aerial view of the Burj Khalifa building

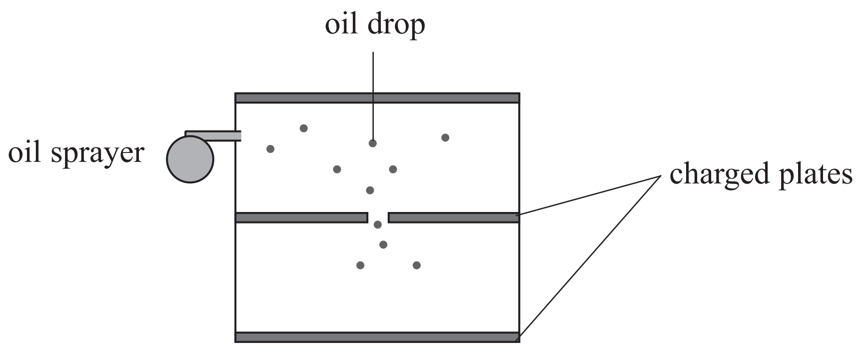


Add to the diagram above to show the air flow around the building, labelling regions of laminar and turbulent flow.

(2)

(Total for Question 6 = 9 marks)

7 In 1909 Robert Millikan did an experiment to find the charge on an electron. Tiny charged oil drops were dropped between two charged plates.



The radius of an oil drop had to be determined so that its weight could be calculated.

Before the plates were charged, Millikan observed how long it took for an oil drop to fall through the air between two fixed points. The terminal velocity and hence the radius could then be calculated.

(a) (i) Complete the free-body force diagram below for an oil drop falling freely through the air.

(2)

(ii) Explain why the oil drop reaches a terminal velocity.

(2)

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(b) An oil drop is travelling at terminal velocity.

(i) The oil drop takes 11.9 s to fall a distance of 10.2 mm.
Show that the terminal velocity of the oil drop is about 0.001 m s^{-1}.

(2)

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(ii) Assuming that the upthrust is negligible, show that the radius of the oil drop is about 3 µm.

density of oil = 920 kg m^{-3}
viscosity of air = 1.82×10^{-5} Pa s

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(iii) It is very difficult to measure the radius of such an oil drop directly.
Suggest why.

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(c) Explain why it was necessary for Millikan to maintain the air between the plates at a constant temperature.

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(d) A student tried to model Millikan's method for finding the radius of the oil drop. The student dropped a ball bearing and recorded the time it took to pass between two light gates, a known distance apart.

Explain why this is **not** a good model for Millikan's method.

(2)

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(Total for Question 7 = 16 marks)

8 The photograph shows a 'lava lamp'.

When the lamp is switched on, large drops of liquid wax are seen to rise and then fall within the clear liquid.

(a) As a wax drop is heated it expands, its density decreases and it rises through the clear liquid.

(i) Explain why the wax drop begins to move upwards as it is heated.

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(ii) The wax drop accelerates initially and then reaches a terminal velocity.

Write a word equation for the forces acting on the wax drop when it is moving upwards at its terminal velocity.

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(b) The wax drop is seen to slow down as it reaches the top of the lamp.

Explain this observation.

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(Total for Question 8 = 8 marks)