Name: ____

Edexcel_Newtons_Laws

Date:

Time:

Total marks available:

Total marks achieved: ______

Questions

Q1.

Answer the question with a cross in the box you think is correct (☒). If you change your mind about an answer, put a line through the box (☒) and then mark your new answer with a cross (☒).

An object is falling at terminal velocity.

Which of the following is **not** a valid conclusion from this statement?

☐ **A** The acceleration of the object is zero.

☐ **B** There is a resistive force acting on the object.

☐ **C** There is a resultant force acting on the object.

☐ **D** The object has weight.

(Total for question = 1 mark)

Q2. Which of the following is a derived SI quantity?

☐ **A** force

☐ **B** length

☐ **C** second

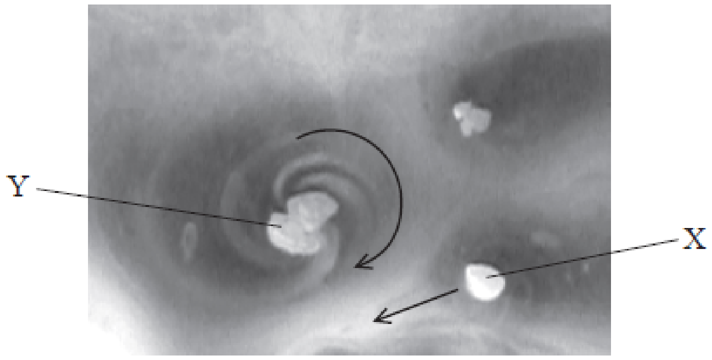
☐ **D** watt

(Total for Question = 1 mark)

Q3.

Solid carbon dioxide changes state directly from solid to gas. This process is called sublimation. Solid carbon dioxide, when placed on water, will move rapidly across the surface due to jets of ejected gas.

The diagram below shows the direction of movement for two large pieces of solid carbon dioxide placed on water.



*(a) When placed at rest on water, piece X begins to move rapidly in the direction shown.

With reference to Newton's laws of motion explain the motion of piece X.

(5)

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(b) When placed at rest on water, piece Y remained in one position whilst spinning around.

Suggest why piece Y remains in one position.

(2)

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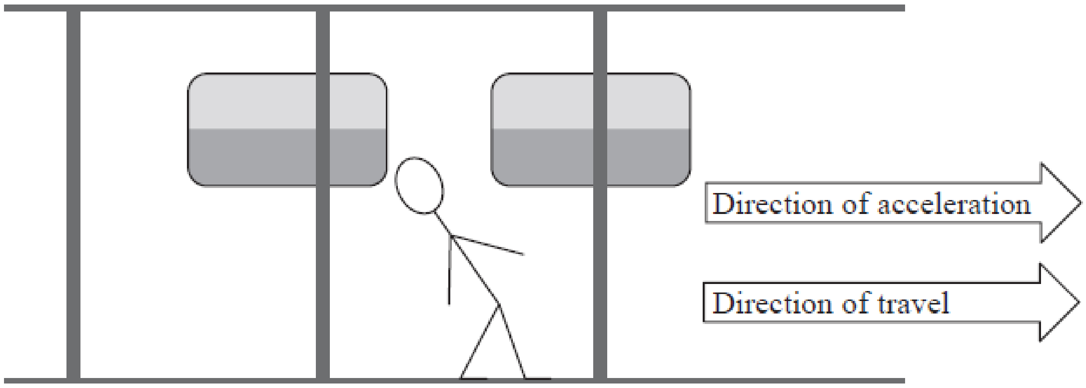
(Total for question = 7 marks)

Q4.

A passenger is standing in a train.

(a) The train accelerates and he falls backwards.



Use Newton's first law of motion to explain why he falls backwards.

(3)

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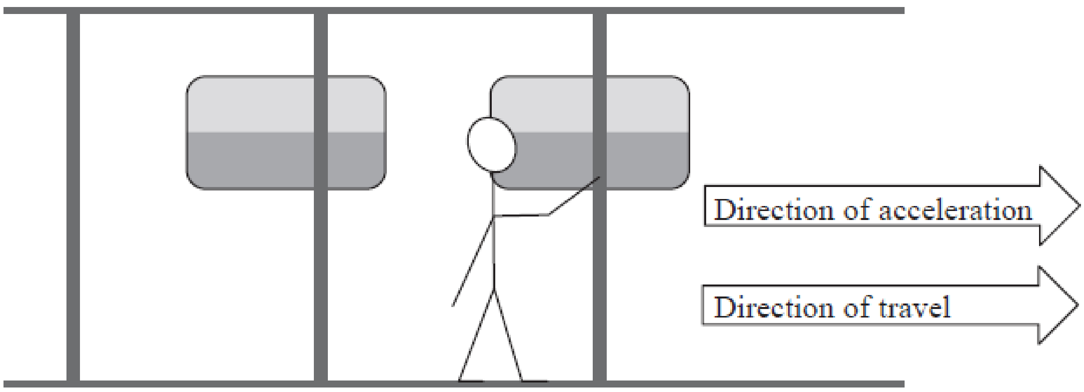
*(b) As the train leaves the station the passenger holds on to a vertical support as the train accelerates. This prevents the passenger falling backwards.



With reference to Newton's laws of motion, explain why holding on to a vertical support prevents the passenger falling backwards.

(5)

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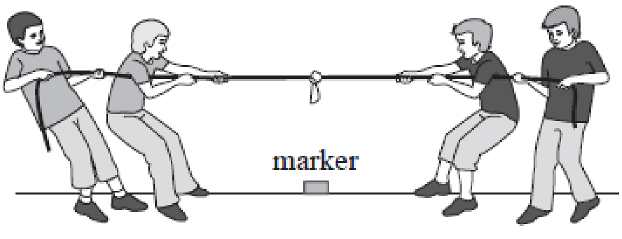
(Total for question = 8 marks)

Q5.

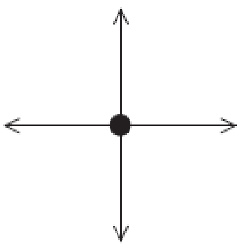
In a game of tug-of-war two teams of children pull on opposite ends of a rope. The team that pulls the other team over a marker wins the game.



(a) Initially Team A and Team B are stationary.

Add labels to the free-body force diagram for the child at the end of the rope for Team A at this instant.

(3)



*(b) Team B wins by pulling Team A over the marker.

By considering the forces on the children and on the rope explain, in terms of Newton's laws, the process by which Team A loses the game.

(6)

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(Total for question = 9 marks)

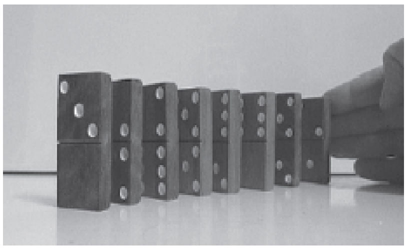
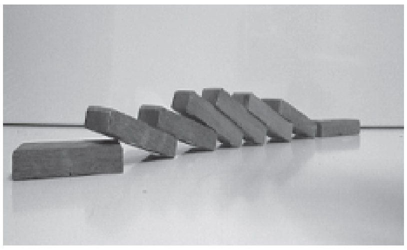
Q6.

A teacher sets up two experiments for her students to complete.

The outcome of each experiment can be explained using Newton's laws.

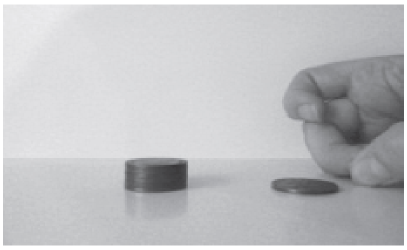
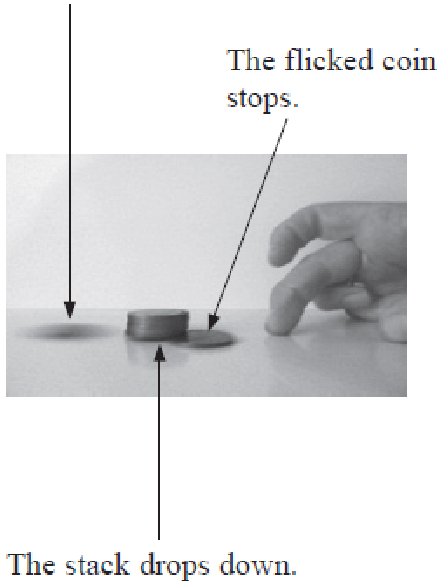
(a) Use Newton's first law of motion to explain the behaviour of the dominoes in experiment 1.

(2)

Experiment 1	Explanation
Falling dominoes The first domino is given a gentle push.  **Observation** The domino falls, knocking the next domino; one by one the dominoes fall. 	....

*(b) Apply Newton's laws of motion to explain the three observations in experiment 2.

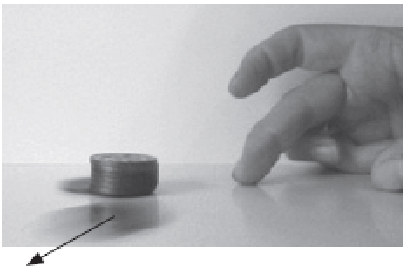
(6)

Experiment 2	Explanation
Stacked coins A coin is flicked towards a stack of coins.  **Observations** The bottom coin is knocked out from under the stack. 	

(c) Whilst carrying out the stacked coins experiment, the student sometimes observed that the flicked coin did not stop but changed its direction of travel.

Suggest a reason for this observation.

(2)

Observation	Reason
 The coin that was flicked changes its direction.	....

(Total for question = 10 marks)

Q7. The 'Stealth' roller coaster at the Thorpe Park theme park is advertised as reaching 135 km hour^{-1} from rest in 2.3 seconds.

Most roller coasters are driven slowly up to the top of a slope at the start of the ride. However the carriages on 'Stealth' are initially accelerated horizontally from rest at ground level by a hydraulic launch system, before rising to the top of the first slope.

(a) (i) Calculate the average acceleration of the carriages.

135 km hour^{-1} = 37.5 m s^{-1}

(2)

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Average acceleration = ...

(ii) Calculate the minimum average power which must be developed by the launch system.

mass of carriages and passengers = 10 000 kg

(3)

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Minimum average power = ...

(iii) Suggest why the power in (ii) is a minimum value.

(1)

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*(b) The force required to launch 'Stealth' is not always the same. The ride is monitored and the data from preceding launches is used to calculate the required force.

If the mass of the passengers for a particular ride is significantly more than for preceding launches, this can lead to 'rollback'. This is when the carriages do not quite reach the top of the first slope and return backwards to the start.

Explain why 'rollback' would occur in this situation.

(3)

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(c) Suggest why roller coasters may have a greater acceleration when the lubricating oil between the moving parts has had time to warm up.

(2)

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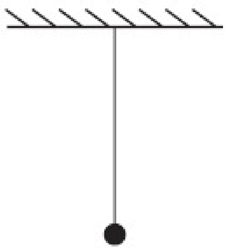
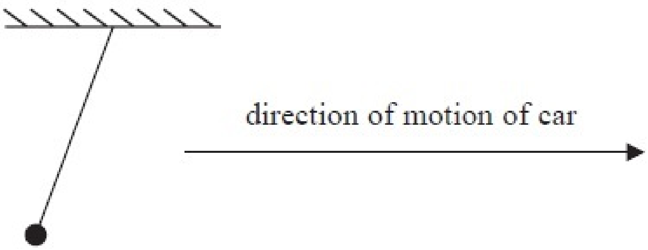
(Total for Question = 11 marks)

Q8. Many hand held devices such as smartphones and tablet computers contain accelerometers. These allow changes in orientation of the device to be tracked.

A student models a simple accelerometer by attaching a small mass on a string to the roof of a car.



When the car starts moving, the string is seen to change position as shown below.



(a) (i) Complete a free body force diagram for the mass when the car starts moving.

(2)

(ii) Draw a vector diagram, in the space below, to show how the resultant force on the mass is produced.

(2)

(iii) When the string is at 7° to the vertical, show that the acceleration of the car is about 1 m s^{-2}.

(2)

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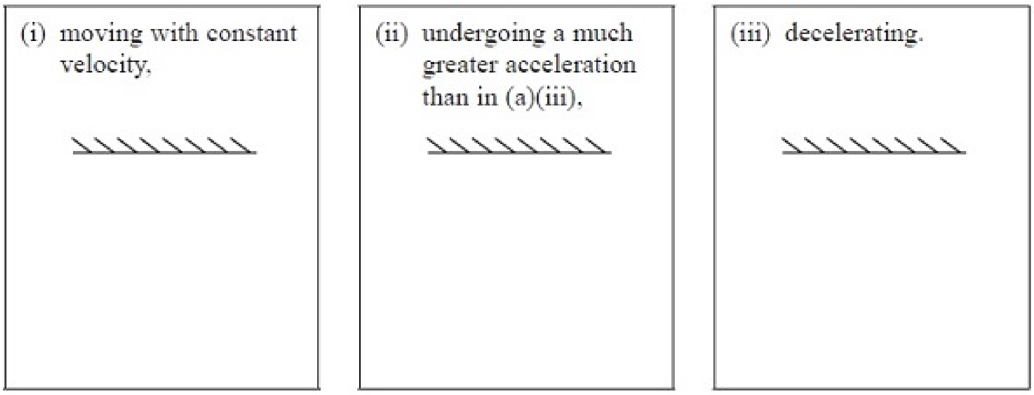
(b) Sketch the positions of the mass and string when the car is moving in the same direction and is:

(i) moving with constant velocity,

(ii) undergoing a much greater acceleration than in (a)(iii),

(iii) decelerating.

(3)



(c) Explain why the string would **not** become horizontal, however great the acceleration.

(2)

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(d) Suggest why many devices contain 3 accelerometers, arranged at right angles to each other.

(1)

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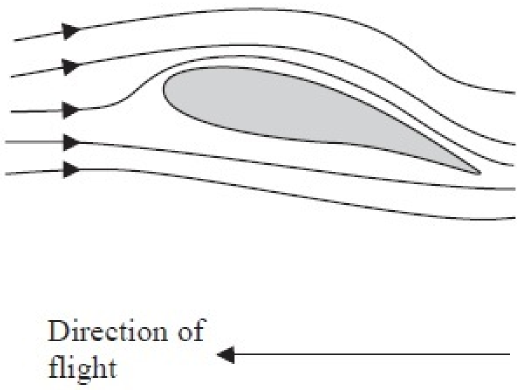
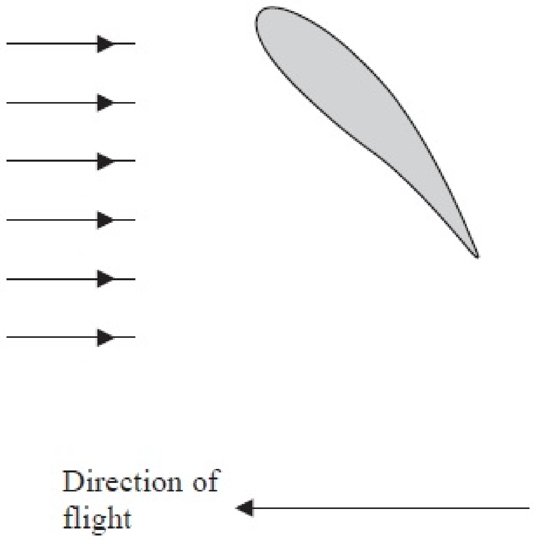
(Total for Question = 12 marks)

Q9. The cross section of the wing of a bird is an aerofoil shape.



In order to fly higher, a bird can tilt its wings more. If it tilts them too much, as shown in the diagram below, the air flow above the wing becomes turbulent.



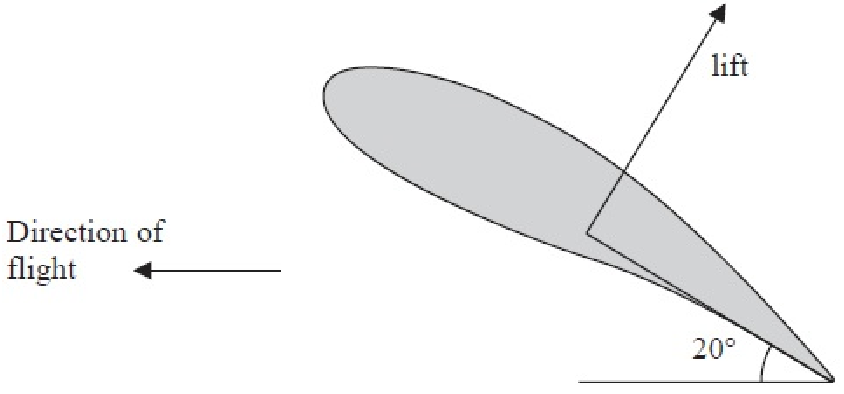
(a) Complete the diagram above to show the airflow around the wing.

(2)

(b) The tilting of the wing results in the air exerting a force on the wing which is called lift. The lift force acts perpendicular to the wing.

The total vertical component of the lift produced by both wings when tilted at an angle of 20° to the horizontal is enough to keep the bird flying at a constant height.

mass of bird = 0.063 kg



(i) Show that the total lift acting on the bird is about 1 N.

(3)

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(ii) Assuming that the only forces acting on the bird are the weight and lift, calculate its acceleration at this instant.

(3)

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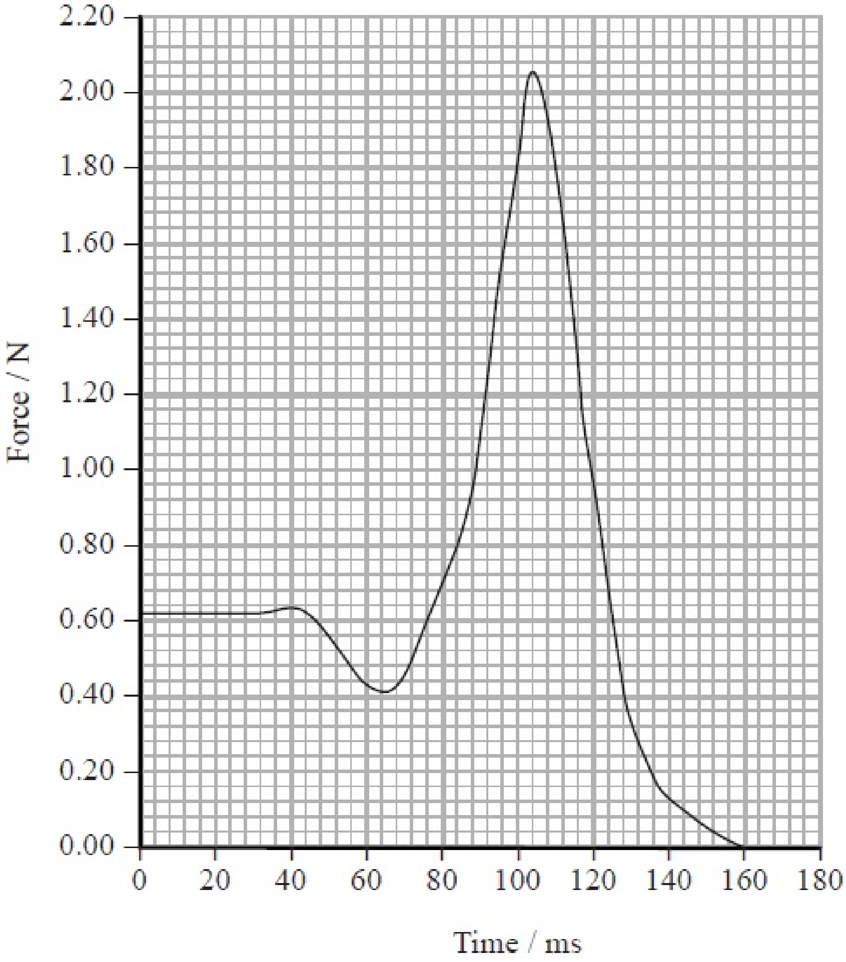
Acceleration = ...

(c) When some birds take off from the ground there is no lift initially. These birds push off from the ground with their legs.

The following graph shows the downward force exerted by the leg on the ground during take off.



(i) With reference to Newton's laws explain how the downward force from the leg enables the bird to take off.

(4)

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(ii) Use the graph to calculate the maximum acceleration of the bird during take off.

mass of bird = 0.063 kg

(3)

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Maximum acceleration = ...

(Total for Question = 15 marks)