3.14 Forces, Newton's Laws and Momentum: Test Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A hockey puck is sliding across smooth ice at a constant velocity.

(a) State Newton's First Law. **(1)**

(b) State the resultant force acting on the puck while it slides at constant velocity. **(1)**

(c) The puck eventually slows down and stops. Explain, in terms of forces, why this happens. **(2)**

(Total for Question 1 is 4 marks)

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2 Higher tier only. A car of mass 900 kg is travelling at 12 m/s when it crashes into a wall and comes to rest in 0.15 s. Use the equation force = change in momentum / time taken, i.e. F = (m x change in v) / change in t.

(a) Calculate the magnitude of the change in momentum of the car during the crash. **(2)**

.....

(b) Calculate the average force on the car during the crash. **(2)**

.....

(c) The car is fitted with a crumple zone, which increases the collision time to 0.45 s for the same change in momentum. Calculate the new average force on the car. **(2)**

.....

(d) Explain why increasing the collision time reduces the force on the occupants of the car. **(2)**

(Total for Question 2 is 8 marks)

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3 Ryan drives a go-kart. The go-kart and Ryan have a combined mass of 150 kg. The engine provides a driving force, and resistive forces (friction and air resistance) act against the motion. Use the equation force = mass x acceleration (F = m x a).

(a) The driving force is 450 N and the total resistive force is 150 N. Calculate the resultant force on the go-kart. **(1)**

.....

(b) Calculate the acceleration of the go-kart. **(2)**

.....

(c) Ryan then carries a passenger, increasing the total mass to 200 kg. Assuming the resultant force stays the same as in part (a), calculate the new acceleration. **(2)**

.....

(Total for Question 3 is 5 marks)

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4 Stopping distance = thinking distance + braking distance.

(a) Define 'thinking distance'. **(1)**

.....

(b) Define 'braking distance'. **(1)**

.....

(c) Give two factors that increase a driver's reaction time, and so increase thinking distance. **(2)**

(d) Give two factors that increase braking distance for a given speed. **(2)**

(Total for Question 4 is 6 marks)

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Mark scheme · 3.14 Forces, Newton's Laws and Momentum: Test Pack

Question 1

(a) an object will remain at rest, or continue moving at a constant velocity in a straight line, unless it is acted on by a resultant (unbalanced) force, oe **B1**

(a) Answer: An object stays at rest, or keeps moving at a constant velocity in a straight line, unless a resultant force acts on it.

(b) zero (the forces on the puck are balanced) **B1**

(b) Answer: Zero N.

(c) a friction force from the ice acts on the puck, opposing its motion, oe **B1**

(c) this creates a resultant (unbalanced) force in the opposite direction to the puck's motion, causing it to decelerate, oe **B1**

(c) Answer: Friction from the ice acts against the puck's motion, creating a resultant force that decelerates it until it stops.

Question 2

(a) initial momentum = 900 x 12 = 10800 kg m/s; final momentum = 0 **M1**

(a) 10800 kg m/s cao (magnitude of the decrease) **A1**

(a) Answer: 10800 kg m/s (a decrease)

(b) ft substitutes: F = their (a) / 0.15 **M1**

(b) 72000 N cao ft **A1**

(b) Answer: 72000 N

(c) ft substitutes: F = their (a) / 0.45 **M1**

(c) 24000 N cao ft **A1**

(c) Answer: 24000 N

(d) for the same change in momentum, increasing the time taken decreases the rate of change of momentum, oe **B1**

(d) because force = change in momentum / time, a smaller rate of change of momentum means a smaller force, oe **B1**

(d) Answer: A longer collision time gives a smaller rate of change of momentum, and since force = change in momentum / time, this means a smaller force.

Question 3

(a) 300 N (450 - 150) **B1**

(a) Answer: 300 N

(b) ft substitutes: a = their (a) / 150 **M1**

(b) 2.0 m/s^2 cao ft **A1**

(b) Answer: 2.0 m/s^2

(c) ft substitutes: a = their (a) / 200 **M1**

(c) 1.5 m/s^2 cao ft **A1**

(c) Answer: 1.5 m/s^2

Question 4

(a) the distance a vehicle travels during the driver's reaction time, before the brakes are applied, oe **B1**

(a) Answer: The distance travelled during the driver's reaction time, before the brakes are applied.

(b) the distance a vehicle travels while decelerating, from when the brakes are applied until it stops, oe **B1**

(b) Answer: The distance travelled while decelerating, from applying the brakes until the vehicle stops.

(c) any one of: tiredness/fatigue, alcohol or drugs, distractions (e.g. mobile phone use), illness **B1**

(c) a second, different factor from the list above **B1**

(c) Answer: Any two of: tiredness, alcohol or drugs, distractions such as mobile phone use, illness.

(d) any one of: wet, icy or loose road surface, worn or faulty brakes, worn tyres (poor tread), a large mass/heavy load in the vehicle **B1**

(d) a second, different factor from the list above **B1**

(d) Answer: Any two of: a wet or icy road surface, worn brakes, worn tyres, a heavy load in the vehicle.

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