3.2 Mechanics: Forces and Newton's Laws: 30-minute Pack

Total Marks

EDEXCEL 9MA0 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A particle of mass 2 kg rests in equilibrium on a horizontal table. Take $g = 9.8$ m/s^2. Find the normal reaction between the particle and the table.

(Total for Question 1 is 1 mark)

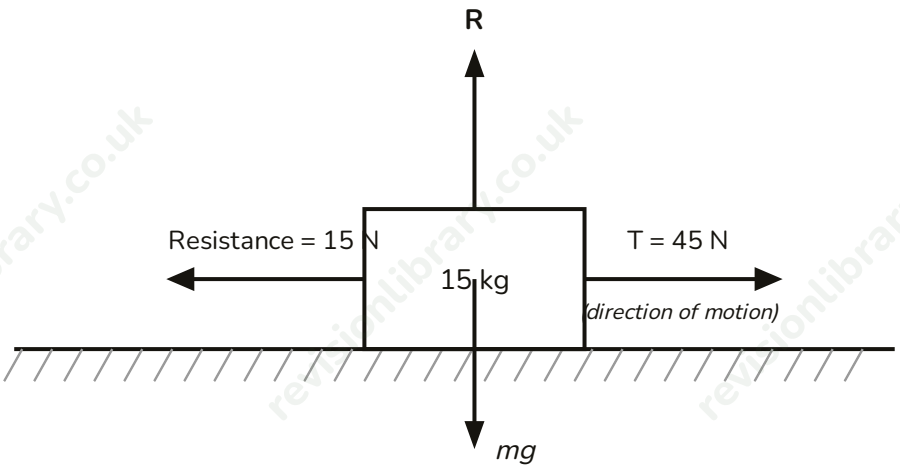
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2 A block of mass 10 kg rests on rough horizontal ground. The coefficient of friction between the block and the ground is 0.5. A horizontal force of magnitude 35 N is applied to the block, which remains in equilibrium. Take $g = 9.8$ m/s^2. Find the frictional force acting on the block.

(Total for Question 2 is 2 marks)

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3 A box of mass 15 kg is pulled in a straight line along rough horizontal ground by a light rope which is horizontal, attached to the box with tension 45 N. The resistance to motion from the ground is modelled as a constant force of 15 N. The box is modelled as a particle. Take $g = 9.8$ m/s^2.



(a) State the four forces acting on the box while it is moving. **(2)**

(b) Use Newton's second law to find the acceleration of the box. **(3)**

(c) Find the magnitude of the normal reaction between the box and the ground. **(2)**

(d) Given that the box starts from rest, find the distance it travels in the first 6 seconds of motion. **(3)**

(Total for Question 3 is 10 marks)

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4 A particle A of mass 5 kg lies on a rough horizontal table. It is attached to a particle B of mass 4 kg by a light inextensible string that passes over a smooth light pulley at the edge of the table. B hangs freely, and the system is released from rest with the string taut. The coefficient of friction between A and the table is 0.2. Take $g = 9.8$ m/s^2.

(a) Write down equations of motion for A and for B. **(3)**

(b) Hence find the acceleration of the system and the tension in the string, each to 2 significant figures. **(4)**

(c) B is 1.0 m above the floor when released. Find the speed of B as it reaches the floor, to 2 significant figures. **(2)**

(d) After B hits the floor it does not rebound, and A continues to move along the table. Find the further distance A travels before coming to rest, to 2 significant figures, assuming the table is long enough. **(3)**

(Total for Question 4 is 12 marks)

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Mark scheme · 3.2 Mechanics: Forces and Newton's Laws: 30-minute Pack

Question 1

19.6 cao **B1**

Answer: 19.6 N

Question 2

recognise the block remains in equilibrium, so friction balances the applied force (not μ R) (oe) **M1**

35 cao **A1**

Answer: 35 N

Question 3

(a) weight (mg, vertically down) and normal reaction (R, vertically up) identified **B1**

(a) tension (T = 45 N, horizontal, direction of motion) and resistance (15 N, opposing motion) identified **B1**

(a) Answer: Weight, normal reaction, tension (45 N), resistance (15 N)

(b) resolving horizontally: 45 - 15 = 15a (oe) **M1**

(b) net force = 30 N found **A1**

(b) a = 2 m/s^2 cao **A1**

(b) Answer: a = 2 m/s^2

(c) resolving vertically: R = mg (since rope is horizontal) **M1**

(c) R = 147 N cao **A1**

(c) Answer: R = 147 N

(d) correct suvat selected, s = ut + 1/2 a t^2 with u = 0, a = 2, t = 6 **M1**

(d) correct substitution s = 0.5 x 2 x 36 (oe) **A1**

(d) s = 36 m cao **A1**

(d) Answer: 36 m

Question 4

(a) for B: 4g - T = 4a **M1**

(a) for A: T - F = 5a with F = 0.2 x 5g **M1**

(a) both equations correct **A1**

(a) Answer: B: 4g - T = 4a; A: T - 0.2 x 5g = 5a

(b) adds the two equations to eliminate T **M1**

(b) a = 3.3 m/s^2 **A1**

(b) substitutes to find T = 4(g - a) **M1**

(b) T = 26 N **A1**

(b) Answer: a = 3.3 m/s^2, T = 26 N

(c) uses v^2 = u^2 + 2as with u = 0, a = 3.267, s = 1.0 **M1**

(c) v = 2.6 m/s **A1**

(c) Answer: 2.6 m/s

(d) deceleration of A is μ g **M1**

(d) uses v^2 = u^2 + 2as with final speed zero: 0 = 2.556^2 - 2(1.960)s **M1**

(d) s = 1.7 m **A1**

(d) Answer: 1.7 m

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