3.2 Mechanics: Forces and Newton's Laws: 1-hour Pack

Total Marks

EDEXCEL 9MA0 · Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Two forces, of magnitude 8 N and 5 N, act on a particle in the same direction along a straight line. Find the magnitude of the resultant force.

(Total for Question 1 is 1 mark)

2 A resultant force of 15 N acting on a particle produces an acceleration of 2.5 m/s^2. Find the mass of the particle.

(Total for Question 2 is 1 mark)

3 A parcel has mass 12 kg. Take g = 9.8 m/s^2. Find the weight of the parcel.

(Total for Question 3 is 1 mark)

4 Two forces, of magnitude 17 N and 6 N, act on a particle in opposite directions along the same straight line. Find the magnitude of the resultant force.

(Total for Question 4 is 1 mark)

5 A car of mass 1000 kg experiences a driving force of 2400 N and a constant resistance force of 400 N as it moves along a straight horizontal road. Find the acceleration of the car.

(Total for Question 5 is 2 marks)

6 A box of mass 6 kg is pushed along smooth horizontal ground by a horizontal force of 18 N. Find the acceleration of the box.

(Total for Question 6 is 2 marks)

7 Two forces of magnitude 20 N and 8 N act on a particle of mass 3 kg in opposite directions along the same straight line. Find the acceleration of the particle.

(Total for Question 7 is 2 marks)

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8 A block of mass 5 kg rests on rough horizontal ground. The coefficient of friction between the block and the ground is 0.2. Take $g = 9.8$ m/s^2. Find the maximum possible friction force before the block slips.

(Total for Question 8 is 2 marks)

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9 Two forces, F1 = (3i - 2j) N and F2 = (-1i + 5j) N, act on a particle, where i and j are perpendicular unit vectors. Find the resultant force acting on the particle, giving your answer in the form (ai + bj) N.

(Total for Question 9 is 1 mark)

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10 Two forces act on a particle at right angles to each other, of magnitude 9 N and 12 N. Find the magnitude of the resultant force.

(Total for Question 10 is 2 marks)

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11 A block of mass 12 kg is placed on a rough plane inclined at an angle α to the horizontal, where $\sin \alpha = 3/5$. The coefficient of friction between the block and the plane is 0.2. The block is modelled as a particle. Take $g = 9.8$ m/s^2.

(a) Find the normal reaction between the block and the plane. **(3)**

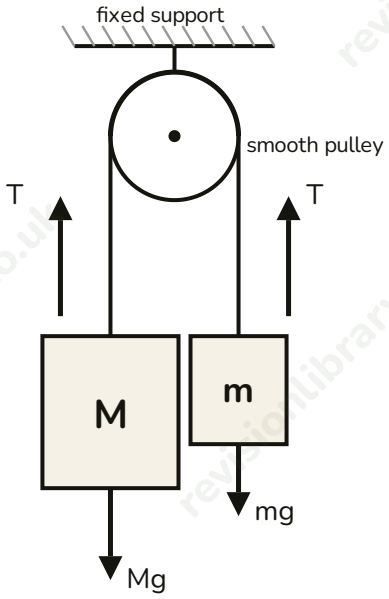
(b) Find the maximum friction force available, and determine whether the block remains at rest if it is released from rest. **(4)**

(c) Find the acceleration of the block down the plane, to 2 significant figures. **(2)**

(Total for Question 11 is 9 marks)

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12 Two particles, of mass M kg and m kg (M > m), are connected by a light inextensible string which passes over a smooth fixed pulley. The particles hang freely on either side of the pulley and are released from rest. Take $g = 9.8$ m/s^2.



(a) By writing separate equations of motion for each particle, show that the acceleration of the system is $a = g(M - m)/(M + m)$. **(4)**

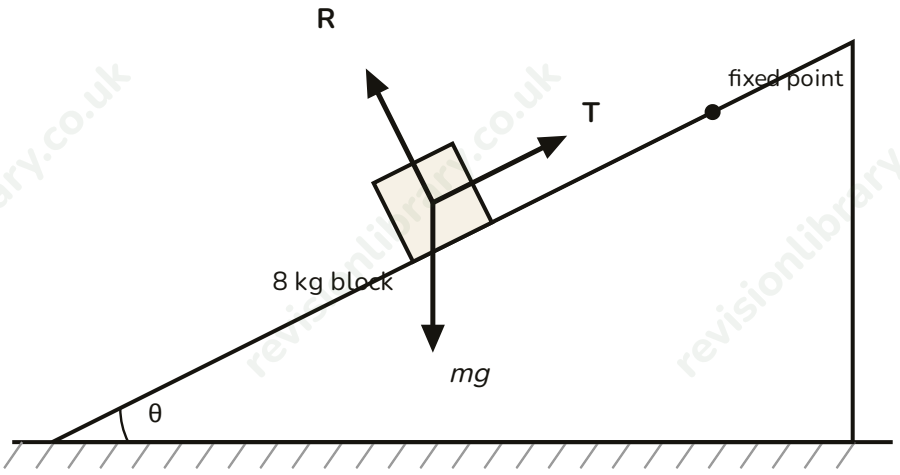
(b) Given that M = 5 kg and m = 3 kg, find the acceleration of the system and the tension in the string. **(4)**

(c) State two modelling assumptions used in this problem, and explain the effect on the acceleration if the pulley were not smooth. **(2)**

(Total for Question 12 is 10 marks)

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13 A block of mass 8 kg rests in equilibrium on a smooth plane inclined at angle θ to the horizontal, held by a light inextensible string parallel to the line of greatest slope, attached to a fixed point higher up the plane. Take g = 9.8 m/s^2.



(a) Given that θ = 20 degrees, find the tension in the string. **(3)**

(b) Find the normal reaction between the block and the plane. **(3)**

(c) The plane is replaced by one inclined at 35 degrees (all else unchanged). Find the new tension in the string. **(2)**

(d) Explain why the normal reaction decreases as the angle of the incline increases. **(2)**

(Total for Question 13 is 10 marks)

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14 A block of mass 8 kg rests on a rough plane inclined at 30 degrees to the horizontal. The coefficient of friction between the block and the plane is 0.3. A force P, acting parallel to the plane and directed up the line of greatest slope, is applied to the block so that it is on the point of sliding up the plane. Take g = 9.8 m/s^2. Find the value of P, giving your answer to 3 significant figures.

(Total for Question 14 is 4 marks)

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Mark scheme · 3.2 Mechanics: Forces and Newton's Laws: 1-hour Pack

Question 1

13 cao **B1**

Answer: 13 N

Question 2

6 cao **B1**

Answer: 6 kg

Question 3

117.6 cao **B1**

Answer: 117.6 N

Question 4

11 cao **B1**

Answer: 11 N

Question 5

resultant force = 2400 - 400 = 2000, then a = 2000/1000 **M1**

2 m/s^2 cao **A1**

Answer: 2 m/s^2

Question 6

use F = ma with F=18, m=6 **M1**

3 m/s^2 cao **A1**

Answer: 3 m/s^2

Question 7

resultant force = 20 - 8 = 12 N **M1**

4 m/s^2 cao **A1**

Answer: 4 m/s^2

Question 8

friction = μ R with R = mg = 5(9.8) = 49 **M1**

9.8 N cao **A1**

Answer: 9.8 N

Question 9

(2i + 3j) cao **B1**

Answer: (2i + 3j) N

Question 10

use of Pythagoras: R^2 = 9^2 + 12^2 (oe) **M1**

15 cao **A1**

Answer: 15 N

Question 11

(a) resolves perpendicular to the plane: R = mg cos α **M1**

(a) cos α = 4/5 **A1**

(a) R = 94.1 N **A1**

(a) Answer: 94.1 N

(b) F_{max} = μ R **M1**

(b) F_{max} = 18.8 N **A1**

(b) compares with the component of weight down the plane: mg sin α **M1**

(b) 70.6 N is greater than 18.8 N, so the block slides down **A1**

(b) Answer: slides down the plane

(c) F = ma down the plane: mg sin α - μ R = ma **M1**

(c) a = 4.3 m/s^2 **A1**

(c) Answer: 4.3 m/s^2

Question 12

(a) equation of motion for M: Mg - T = Ma **M1**

(a) equation of motion for m: T - mg = ma **M1**

(a) eliminate T by adding the two equations: Mg - mg = (M+m)a **dM1**

(a) cso: a = g(M-m)/(M+m) correctly rearranged and shown **A1**

(a) Answer: a = g(M - m)/(M + m) (given, shown)

(b) substitute M=5, m=3 into a = g(M-m)/(M+m) **M1**

(b) a = 2.45 m/s^2 (awrt 2.45) **A1**

(b) substitute into T = M(g-a) or T = m(g+a) **M1**

(b) T = 36.75 N (awrt 36.8) **A1**

(b) Answer: a = 2.45 m/s^2, T = 36.75 N

(c) assumptions stated: string is light and inextensible; pulley is smooth and light (any two) **B1**

(c) if the pulley were not smooth, friction at the pulley would resist the string's motion over it, reducing the net driving force and so the acceleration would be smaller than 2.45 m/s^2 **B1**

(c) Answer: Assumptions: light inextensible string; smooth, light pulley. A rough pulley reduces the acceleration.

Question 13

(a) resolving parallel to the plane: T = mg sin(θ) **M1**

(a) T = 8(9.8) sin20 (oe) **A1**

(a) T = 26.8 N (awrt) **A1**

(a) Answer: T = 26.8 N

(b) resolving perpendicular to the plane: R = mg cos(θ) **M1**

(b) R = 78.4 cos20 (oe) **A1**

(b) R = 73.7 N (awrt) **A1**

(b) Answer: R = 73.7 N

(c) T = 78.4 sin35 **M1**

(c) T = 45.0 N (awrt) **A1**

(c) Answer: T = 45.0 N

(d) R = mg cos(θ), and cos(θ) decreases as θ increases for 0 < θ < 90 degrees **B1**

(d) so the component of weight perpendicular to the plane decreases as the plane steepens, reducing R **B1**

(d) Answer: R = mg cos(θ) decreases because cos(θ) decreases as θ increases.

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Question 14

resolve perpendicular to the plane: R = mg cos30	**M1**
resolve parallel to the plane, with friction acting down the slope: P = mg sin30 + μ R	**M1**
correct substitution P = 39.2 + 0.3(67.9) (oe)	**A1**
awrt 59.6 N	**A1**

Answer: 59.6 N (3 s.f.)

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