8MA0 Unit Test

Mechanics – Forces & Newton's laws

Time allowed: 45 minutes

Centre:

Name:

Teacher:

Question	Points	Score
1	7	
2	7	
3	9	
4	12	
5	15	
Total:	50	

How I can achieve better:

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1. A particle P is acted upon by three forces F_1, F_2 and F_3 given by $F_1 = (6\mathbf{i} - 4\mathbf{j})$ N, $F_2 = (-2\mathbf{i} + 9\mathbf{j})$ N and $F_3 = (a\mathbf{i} + b\mathbf{j})$ N, where a and b are constants. Given that P is in equilibrium,

   (a) find the value of a and the value of b. [2]

   The force F_2 is now removed. The resultant of F_1 and F_3 is $\mathbf{R}$.

   (b) Find the magnitude of $\mathbf{R}$. [3]

   (c) Find the angle, to 0.1°, that $\mathbf{R}$ makes with $\mathbf{i}$. [2]

Total: 7

2. A cyclist of mass 80 kg is travelling with speed 18 ms^{-1}. The cyclist stops peddling and comes to rest, without braking, due to resistance forces totalling 120 N.

   (a) Find how long it takes the cyclist to stop. [4]

   (b) Find the distance the cyclist travels before stopping. [2]

   (c) Describe one limitation in this model. [1]

Total: 7

3. A particle of mass 6 kg is initially at rest and is then acted upon by a force $\mathbf{R} = a\mathbf{i} + 10\mathbf{j}$ on a bearing of 300°.

   (a) Find the exact value of a. [3]

   (b) Calculate the magnitude of $\mathbf{R}$. [2]

   (c) Work out the magnitude of the acceleration of the particle. [2]

   (d) Find the time it takes for the particle to travel a distance of 640 m. [2]

Total: 9

4. A car of mass 1200 kg pulls a trailer of mass 400 kg along a straight horizontal road. The car and trailer are connected by a tow-rope modelled as a light inextensible rod. The engine of the car provides a constant driving force of 3200 N. The horizontal resistances of the car and the trailer are proportional to their respective masses. Given that the acceleration of the car and the trailer is 0.4 ms^{-2},

   (a) find the resistance to motion on the trailer, [4]

   (b) find the tension in the tow-rope. [3]

   When the car and trailer are travelling at 25 ms^{-1} the tow-rope breaks. Assuming that the resistances to motion remain unchanged,

   (c) find the distance the trailer travels before coming to a stop, [4]

   (d) state how you have used the modelling assumption that the tow-rope is inextensible. [1]

Total: 12

5. A box A of mass 0.8 kg rests on a rough horizontal table and is attached to one end of a light inextensible string. The string passes over a smooth pulley fixed at the edge of the table. The other end of the string is attached to a sphere B of mass 1.2 kg, which hangs freely below the pulley. The magnitude of the frictional force between A and the table is F N. The system is released from rest with the string taut. After release, B descends a distance of 0.9 m in 0.8 s. Modelling A and B as particles, calculate

   (a) the acceleration of B, [2]

   (b) the tension in the string, [3]

   (c) the value of F. [3]

   Sphere B is 0.9 m above the ground when the system is released. Given that it does not reach the pulley and the frictional force remains constant throughout,

   (d) find the total distance travelled by A. [7]

Total: 15