Solomon Practice Paper

Mechanics 1G

Time allowed: 90 **mintues**

Question	Points	Score
1	6	
2	9	
3	9	
4	9	
5	11	
6	12	
7	19	
Total:	75	

Centre:

Name:

Teacher:

How I can achieve better:

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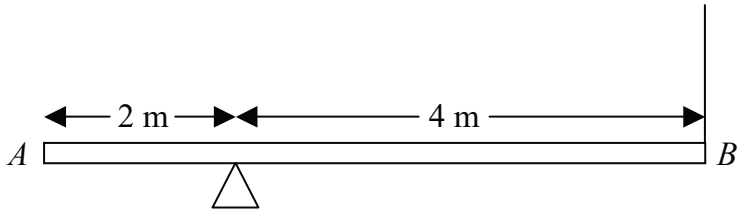
1. Figure shows a non-uniform beam AB of mass 10kg and length 6m resting in a horizontal position on a single support 2m from A. [6]



The beam is supported at B by a vertical string.

Given that the magnitude of the tension in the string is 1.5times the magnitude of the reaction at the support, find the distance of the centre of mass of the beam from A.

2. A ball of mass 2kg moves on a smooth horizontal surface under the action of a constant force, F. The initial velocity of the ball is $(2\mathbf{i} - 3\mathbf{j})$ ms^{-1} and 4 seconds later it has velocity $(10\mathbf{i} + 9\mathbf{j})$ ms^{-1} where $\mathbf{i}$ and $\mathbf{j}$ are perpendicular, horizontal unit vectors.

   (a) Making reference to the mass of the ball and the force it experiences, explain why it is reasonable to assume that the acceleration is constant. [2]

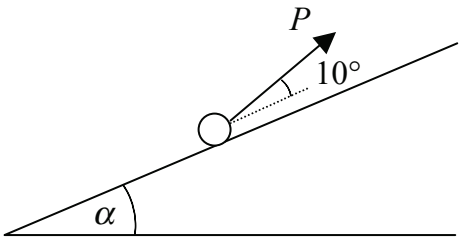
   (b) Find, giving your answers correct to 3 significant figures, [7]

      i. the magnitude of the acceleration experienced by the ball,

      ii. the angle which F makes with the vector $\mathbf{i}$.

Total: 9

3. Figure shows a ball of mass 3kg lying on a smooth plane inclined at an angle α to the horizontal where $\sin\alpha = \frac{3}{5}$.



The ball is held in equilibrium by a force of magnitude P newtons, which acts at an angle of 10° to the line of greatest slope of the plane.

(a) Suggest a suitable model for the ball. [1]

Giving your answers correct to 1 decimal place,

(b) find the value of P, [4]

(c) find the magnitude of the reaction between the ball and the plane. [4]

Total: 9

4. A bullet of mass 50g is fired horizontally at a wooden block of mass 4.95kg which is lying at rest on a rough horizontal surface. The bullet enters the block at 400ms^{-1} and becomes embedded in the block.

   (a) Find the speed with which the block begins to move. [3]

   Given that the block decelerates uniformly to rest over a distance of 4m,

   (b) show that the coefficient of friction is $\frac{2}{g}$. [6]

   Total: 9

5. Two dogs, Fido and Growler, are playing in a field. Fido is moving in a straight line so that at time t his position vector relative to a fixed origin, O, is given by $[(2t-3)\mathbf{i}+t\mathbf{j}]$ metres. Growler is stationary at the point with position vector $(2\mathbf{i}+5\mathbf{j})$ metres, where $\mathbf{i}$ and $\mathbf{j}$ are horizontal perpendicular unit vectors.

   (a) Find the displacement vector of Fido from Growler in terms of t. [2]

   (b) Find the value of t for which the two dogs are closest. [6]

   (c) Find the minimum distance between the two dogs. [3]

Total: 11

6. A particle moving in a straight line with speed $5U$ ms^{-1} undergoes a uniform deceleration for 6 seconds which reduces its speed to $2U$ ms^{-1}. It maintains this speed for 16 seconds before uniformly decelerating to rest in a further 2 seconds.

   (a) Sketch a speed-time graph displaying this information. [2]

   (b) Find an expression for each of the decelerations in terms of U. [4]

   Given that the total distance travelled by the particle during this period of motion is 220m,

   (c) find the value of U. [6]

Total: 12

7. A car of mass 1200kg tows a trailer of mass 800kg along a straight level road by means of a rigid towbar. The resistances to the motion of the car and the trailer are proportional to their masses.

   Given that the car experiences a resistance to motion of 300N,

   (a) find the resistance to motion which the trailer experiences. [2]

   Given that the engine of the car exerts a driving force of 3kN,

   (b) find the acceleration of the system, [3]

   (c) show that the tension in the towbar is 1200N. [3]

   When the system has reached a speed of 24ms^{-1}, it continues at constant speed until an electrical fault causes the engine of the car to switch off. The brakes are used to apply a constant retarding force until the system comes to rest.

   Given that the retarding force of the brakes has magnitude 1kN and assuming that the original resistances to motion of the car and the trailer remain constant,

   (d) calculate the distance that the system travels during the braking period, [5]

   (e) find the magnitude and direction of the force exerted by the towbar on the car. [4]

   (f) Comment on the assumption that the original resistances to motion of the car and the trailer remain constant throughout the motion. [2]

Total: 19