Solomon Practice Paper

Mechanics 2B

Time allowed: 90 **mintues**

Question	Points	Score
1	7	
2	7	
3	10	
4	10	
5	10	
6	15	
7	16	
Total:	75	

Centre:

Name:

Teacher:

1. A bullet of mass 25g is fired directly at a fixed wooden block of thickness 4cm and passes through it. When the bullet hits the block, it is travelling horizontally at 200 ms^{-1}. The block exerts a constant resistive force of 8000N on the bullet.

   (a) Find the work done by the block on the bullet. [2]

   By using the Work-Energy principle,

   (b) show that the bullet emerges from the block with speed 120 ms^{-1}. [5]

   Total: 7

2. A car is travelling along a straight horizontal road against resistances to motion which are constant and total 2000 N. When the engine of the car is working at a rate of H kilowatts, the maximum speed of the car is 30 ms^{-1}.

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

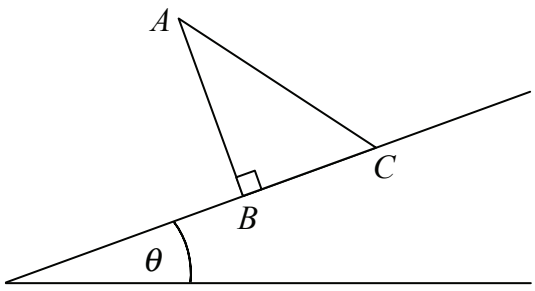
   The car driver wishes to overtake another vehicle so she increases the rate of working of the engine by 20% and this results in an initial acceleration of 0.32 ms^{-2}.

   Assuming that the resistances to motion remain constant,

   (b) find the mass of the car. [4]

   Total: 7

3. Figure shows a uniform triangular lamina ABC placed with edge BC along the line of greatest slope of a plane inclined at an angle θ to the horizontal.



   The lengths AC and BC are 15 cm and 9 cm respectively and $\angle ABC$ is a right angle.

   (a) Find the distance of the centre of mass of the lamina from [6]

   i. AB,

   ii. BC.

   Assuming that the plane is rough enough to prevent the lamina from slipping,

   (b) find in degrees, correct to 1 decimal place, the maximum value of θ for which the lamina remains in equilibrium. [4]

   Total: 10

4. The velocity v ms^{-1} of a particle P at time t seconds is given by $v = 3t\mathbf{i} - t^2\mathbf{j}$.

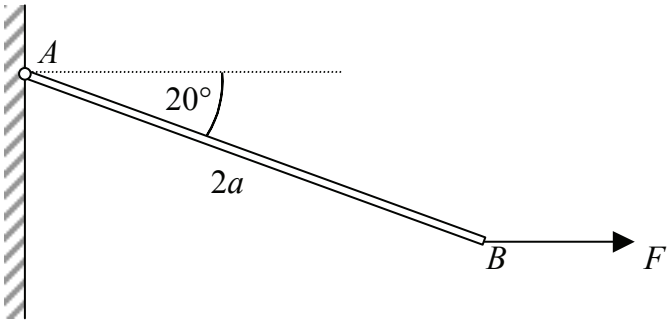
(a) Find the magnitude of the acceleration of P when $t = 2$. [4]

When $t = 0$, the displacement of P from a fixed origin O is $(6\mathbf{i} + 12\mathbf{j})$ ms^{-1}, where $\mathbf{i}$ and $\mathbf{j}$ are perpendicular horizontal unit vectors.

(b) Show that the displacement of P from O when $t = 6$ is given by $k(\mathbf{i} - \mathbf{j})m$, where k is an integer which you should find. [6]

Total: 10

5. A uniform rod AB of length $2a$ and mass 8kg is smoothly hinged to a vertical wall at A.



The rod is held in equilibrium inclined at an angle of 20° to the horizontal by a force of magnitude F newtons acting horizontally at B which is below the level of A as shown in Figure.

(a) Find, correct to 3 significant figures, the value of F. [4]

(b) Show that the magnitude of the reaction at the hinge is 133 N, correct to 3 significant figures, and find to the nearest degree the acute angle which the reaction makes with the vertical. [6]

Total: 10

6. A particle P is projected from a point A on horizontal ground with speed u at an angle of elevation α and moves freely under gravity.

P hits the ground at the point B.

(a) Show that $AB = gu2\sin(2\alpha)$. [6]

An archer fires an arrow with an initial speed of 45 ms^{-1} at a target which is level with the point of projection and at a distance of 80 m.

Given that the arrow hits the target,

(b) find in degrees, correct to 1 decimal place, the two possible angles of projection. [5]

(c) Write down, with a reason, which of the two possible angles of projection would give the shortest time of flight. [2]

(d) Show that the minimum time of flight is 1.8 seconds, correct to 1 decimal place. [2]

Total: 15

7. A smooth sphere A of mass $4m$ is moving on a smooth horizontal plane with speed u. It collides directly with a stationary smooth sphere B of mass $5m$ and with the same radius as A.

   The coefficient of restitution between A and B is $\frac{1}{2}$.

   (a) Show that after the collision the speed of B is 4 times greater than the speed of A. [7]

   Sphere B subsequently hits a smooth vertical wall at right angles. After rebounding from the wall, B collides with A again and as a result of this collision, B comes to rest.

   Given that the coefficient of restitution between B and the wall is e,

   (b) find e. [9]

Total: 16