

Solomon Practice Paper

Mechanics 2B

Time allowed: 90 minutes

Centre:

Name:

Teacher:

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

How I can achieve better:

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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,

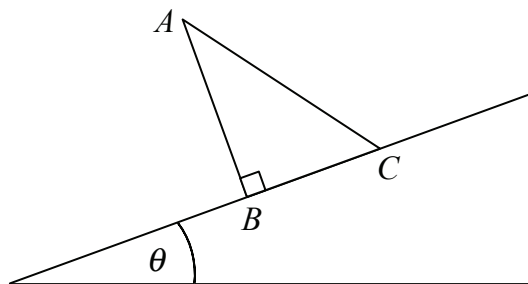
(b) find the mass of the car.

[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.



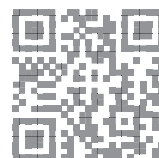
The lengths AC and BC are 15 cm and 9 cm respectively and $\angle ABC$ is a right angle.

- (a) Find the distance of the centre of mass of the lamina from
- AB ,
 - BC .
- [6]

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 $v \text{ ms}^{-1}$ 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]

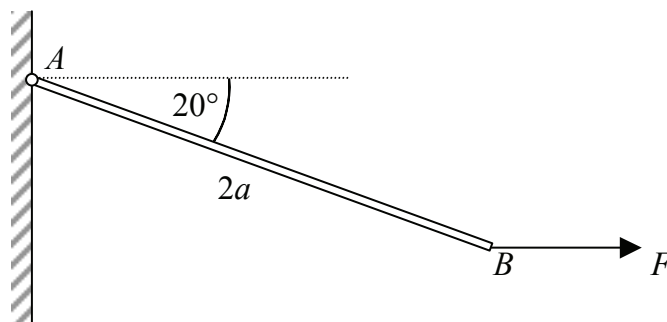
When $t = 0$, the displacement of P from a fixed origin O is $(6\mathbf{i} + 12\mathbf{j}) \text{ ms}^{-1}$, where \mathbf{i} and \mathbf{j} are perpendicular horizontal unit vectors.

(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



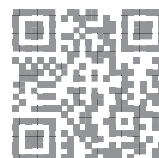
5. A uniform rod AB of length $2a$ and mass 8kg is smoothly hinged to a vertical wall at A .



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 $AB = \frac{gu^2 \sin(2\alpha)}{g}$. [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.

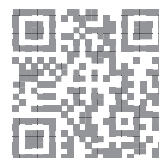
Given that the arrow hits the target,

(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

