

Solomon Practice Paper

Mechanics 3C

Time allowed: 90 minutes

Centre:

Name:

Teacher:

Question	Points	Score
1	7	
2	7	
3	9	
4	11	
5	12	
6	14	
7	15	
Total:	75	



1. A light elastic string has natural length a and modulus of elasticity $4mg$. One end of the string is attached to a fixed point A and a particle of mass m is attached to the other end. [7]

The particle is released from rest at A and falls vertically until it comes to rest instantaneously at the point B .

Find the distance AB in terms of a .

2. A particle P of mass 0.25kg is moving on a horizontal plane.

At time t seconds the velocity, $v \text{ ms}^{-1}$, of P relative to a fixed origin O is given by

$$v = \ln(t + 1)\mathbf{i} - e^{-2t}\mathbf{j}, \quad t \leq 0,$$

where \mathbf{i} and \mathbf{j} are perpendicular unit vectors in the horizontal plane.

- (a) Find the acceleration of P in terms of t . [3]

- (b) Find, correct to 3 significant figures, the magnitude of the resultant force acting on P when $t = 1$. [4]

Total: 7

3. A coin of mass 5 grams is placed on a vinyl disc rotating on a record player. The distance between the centre of the coin and the centre of the disc is 0.1m and the coefficient of friction between the coin and the disc is μ . The disc rotates at 45 revolutions per minute around a vertical axis at its centre and the coin moves with it and does not slide.

By modelling the coin as a particle and giving your answers correct to an appropriate degree of accuracy, find

- (a) the speed of the coin, [2]

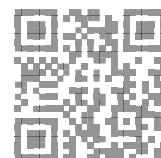
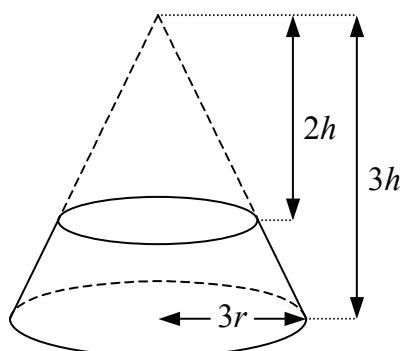
- (b) the horizontal and vertical components of the force exerted on the coin by the disc. [4]

Given that the coin is on the point of moving,

- (c) show that, correct to 2 significant figures, $\mu = 0.23$. [3]

Total: 9

4. A stand used to reach high shelves in a storeroom is in the shape of a frustum of a cone. It is modelled as a uniform solid formed by removing a right circular cone of height $2h$ from a similar cone of height $3h$ and base radius $3r$ as shown in Figure.



(a) Show that the centre of mass of the stand is a distance of $\frac{33}{76}h$ from its larger plane face. [7]

The stand is stored hanging in equilibrium from a point on the circumference of the larger plane face. Given that $h = 2r$,

(b) find, correct to the nearest degree, the acute angle which the plane faces of the stand make with the vertical. [4]

Total: 11

5. A particle of mass 0.8kg is moving along the positive x -axis at a speed of 5 ms^{-1} away from the origin O . When the particle is 2 metres from O it becomes subject to a single force directed towards O . The magnitude of the force is $\frac{k}{x^2} \text{ N}$ when the particle is x metres from O .

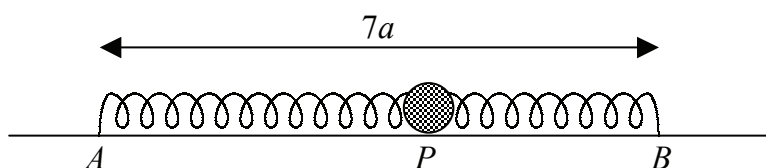
Given that when the particle is 4m from O its speed has been reduced to 3 ms^{-1} ,

(a) show that $k = \frac{128}{5}$, [8]

(b) find the distance of the particle from O when it comes to instantaneous rest. [4]

Total: 12

6. Figure shows a particle P of mass m which lies on a smooth horizontal table.



It is attached to a point A on the table by a light elastic spring of natural length $3a$ and modulus of elasticity λ , and to a point B on the table by a light elastic spring of natural length $2a$ and modulus of elasticity 2λ . The distance between the points A and B is $7a$.

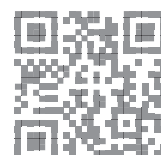
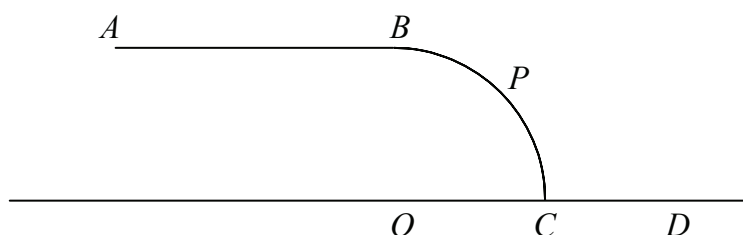
(a) Show that in equilibrium $AP = \frac{9}{2}a$. [5]

The particle is released from rest at a point Q where Q lies on the line AB and $AQ = 5a$.

(b) Prove that the subsequent motion of the particle is simple harmonic with a period of $\pi\sqrt{\frac{3ma}{\lambda}}$. [9]

Total: 14

7. Figure shows a vertical cross-section through part of a ski slope consisting of a horizontal section AB followed by a downhill section BC .



The point O is on the same horizontal level as C and BC is a circular arc of radius 30 m and centre O , such that $\angle BOC = 90^\circ$.

A skier of mass 60kg is skiing at 12ms^{-1} along AB .

- (a) Assuming that friction and air resistance may be neglected, find the magnitude of the loss in reaction between the skier and the surface at B . [4]

The skier subsequently leaves the slope at the point P .

- (b) Find, correct to 3 significant figures, the speed at which the skier leaves the slope. [8]
- (c) Find, correct to 3 significant figures, the speed of the skier immediately before hitting the ground again at the point D which is on the same horizontal level as C . [3]

Total: 15

