Solomon Practice Paper

Mechanics 2C

Time allowed: 90 **mintues**

Question	Points	Score
1	7	
2	8	
3	9	
4	9	
5	13	
6	14	
7	15	
Total:	75	

Centre:

Name:

Teacher:

1. A particle P of mass 2kg is subjected to a force F such that its displacement, r metres, from a fixed origin, O, at time t seconds is given by

$$r = (3t^2 - 4)\mathbf{i} + (3 - 4t^2)\mathbf{j}.$$

   (a) Show that the acceleration of P is constant. [4]

   (b) Find the magnitude of F. [3]

Total: 7

2. A pump raises water from a well 12 metres below the ground and ejects the water through a pipe of diameter 10 cm at a speed of 6 ms^{-1}.

   Given that the mass of 1 m^3 of water is 1000kg,

   (a) find, in terms of π, the mass of water discharged by the pipe every second, [4]

   (b) find in kJ, correct to 3 significant figures, the total mechanical energy gained by the water per second. [4]

Total: 8

3. A particle moves in a straight horizontal line such that its velocity, v ms^{-1}, at time t seconds is given by $v = 2t^2 - 9t + 4$. Initially, the particle has displacement 9 m from a fixed point O on the line.

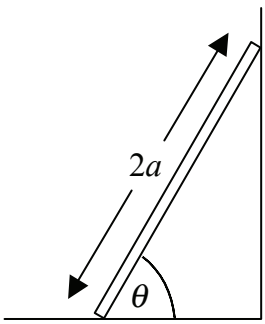
   (a) Find the initial velocity of the particle. [1]

   (b) Show that the particle is at rest when $t = 4$ and find the other value of t when it is at rest. [3]

   (c) Find the displacement of the particle from O when $t = 6$. [5]

Total: 9

4. Figure shows a uniform ladder of mass m and length $2a$ resting against a rough vertical wall with its lower end on rough horizontal ground. The coefficient of friction between the ladder and the wall is $\frac{1}{2}$ and the coefficient of friction between the ladder and the ground is $\frac{1}{3}$. [9]



   Given that the ladder is in limiting equilibrium when it is inclined at an angle θ to the horizontal, show that $\tan\theta = \frac{5}{4}$.

5. A firework company is testing its new brand of firework, the Sputnik Special. One of the company's employees lights a Sputnik Special on a large area of horizontal ground and it takes off at a small angle to the vertical. After a flight lasting 8 seconds it lands at a distance of 24 metres from the point where it was launched.

   The employee models the firework as a particle and ignores air resistance and any loss of mass which the Sputnik Special experiences.

   Using this model, find for this flight of the Sputnik Special,

   (a) the horizontal and vertical components of the initial velocity, [5]

   (b) the initial speed, correct to 3 significant figures, [2]

   (c) the maximum height attained. [3]

   (d) Comment on the suitability of the modelling assumptions made by the employee. [3]

   Total: 13

6. Three uniform spheres A, B and C of equal radius have masses $3m, 2m$ and $2m$ respectively. Initially, the spheres are at rest on a smooth horizontal table with their centres in a straight line and with B between A and C. Sphere A is projected directly towards B with speed u.

   Given that the coefficient of restitution between A and B is $\frac{2}{3}$,

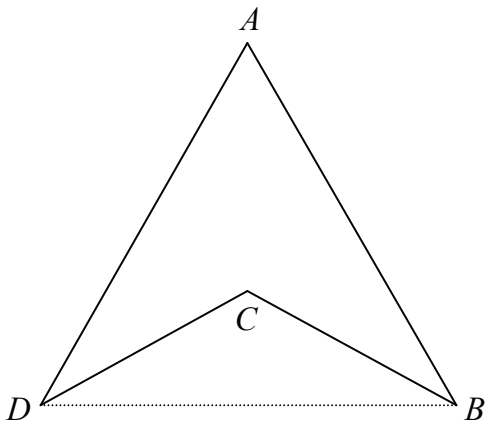
   (a) show that the speeds of A and B after the collision are $\frac{1}{3}u$ and u respectively. [6]

   The coefficient of restitution between B and C is e. Given that A and B collide again,

   (b) show that $\mathrm{e} > \frac{1}{3}$. [8]

   Total: 14

7. Figure shows a uniform lamina $ABCD$ formed by removing an isosceles triangle BCD from an equilateral triangle ABD of side $2d$.



   The point C is the centroid of triangle ABD.

   (a) Find the area of triangle BCD in terms of d. [3]

(b) Show that the distance of the centre of mass of the lamina from BD is $\frac{4}{9}\sqrt{3}d$. [8]

The lamina is freely suspended from the point B and hangs at rest.

(c) Find in degrees, correct to 1 decimal place, the acute angle that the side AB makes with the vertical. [4]

Total: 15