Solomon Practice Paper

Mechanics 3F

Time allowed: 90 **mintues**

Question	Points	Score
1	8	
2	8	
3	12	
4	12	
5	16	
6	19	
Total:	75	

Centre:

Name:

Teacher:

1. A particle P of mass 1.5kg moves from rest at the origin such that at time t seconds it is subject to a single force of magnitude $(4t + 3)$N in the direction of the positive x-axis.

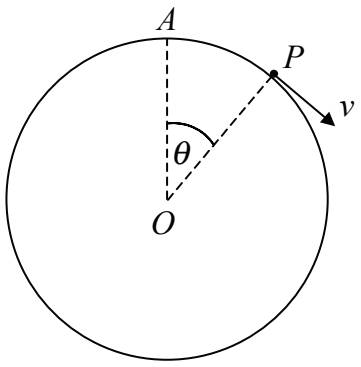
   (a) Find the magnitude of the impulse exerted by the force during the interval $1 \leq t \leq 4$. [3]

   Given that at time T seconds, P has a speed of 22 ms^{-1},

   (b) find the value of T correct to 3 significant figures. [5]

   Total: 8

2. A particle P of mass 0.5kg is at rest at the highest point A of a smooth sphere, centre O, of radius 1.25 m which is fixed to a horizontal surface.



   When P is slightly disturbed it slides along the surface of the sphere. Whilst P is in contact with the sphere it has speed v ms^{-1} when $\angle AOP = \theta$ as shown in Figure.

   (a) Show that $v^2 = 24.5(1 - \cos\theta)$. [3]

   (b) Find the value of $\cos\theta$ when P leaves the surface of the sphere. [5]

   Total: 8

3. A car starts from rest at the point O and moves along a straight line. The car accelerates to a maximum velocity, V ms^{-1}, before decelerating and coming to rest again at the point A.

   The acceleration of the car during this journey, a ms^{-2}, is modelled by the formula

$$a = \frac{500 - kx}{150},$$

   where x is the distance in metres of the car from O.

   Using this model and given that the car is travelling at 16 ms^{-1} when it is 40 m from O,

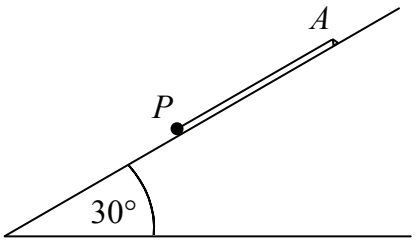
   (a) find k, [6]

   (b) show that $V = 41$, correct to 2 significant figures, [3]

   (c) find the distance OA. [3]

   Total: 12

4. A particle P of mass 2kg is attached to one end of a light elastic string of natural length 1.5m and modulus of elasticity λ.



The other end of the string is fixed to a point A on a rough plane inclined at an angle of 30° to the horizontal as shown in Figure. The coefficient of friction between P and the plane is $\frac{1}{6}\sqrt{3}$.

P is held at rest at A and then released. It first comes to instantaneous rest at the point B, 2.2m from A. For the motion of P from A to B,

(a) show that the work done against friction is 10.78J, [5]

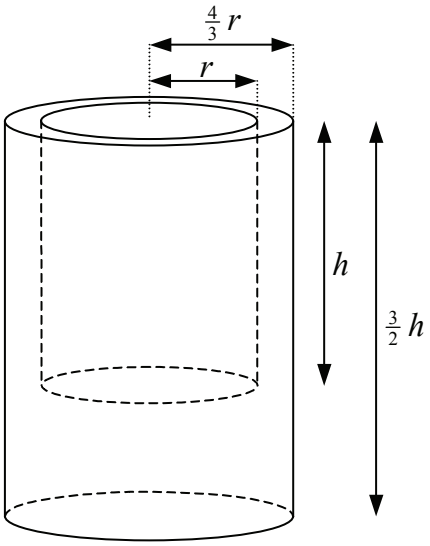
(b) find the change in the gravitational potential energy of P. [2]

By using the work-energy principle, or otherwise,

(c) find λ. [5]

Total: 12

5. A flask is modelled as a uniform solid formed by removing a cylinder of radius r and height h from a cylinder of radius $\frac{4}{3}r$ and height $\frac{3}{2}h$ with the same axis of symmetry and a common plane as shown in Figure.



(a) Show that the centre of mass of the flask is a distance of $\frac{9}{10}h$ from the open end of the flask. [7]

The flask is made from a material of density ρ and is filled to the level of the open plane face with a liquid of density $k\rho$. Given that the centre of mass of the flask and liquid together is a distance of $\frac{15}{22}h$ from the open end of the flask,

(b) find the value of k. [7]

(c) Explain why it may be advantageous to make the base of the flask from a more dense material. [2]

Total: 16

6. A particle P of mass 2.5kg is moving with simple harmonic motion in a straight line between two points A and B on a smooth horizontal table. When P is 3m from O, the centre of the oscillations, its speed is 6ms^{-1}. When P is 2.25m from O, its speed is 8 ms^{-1}.

   (a) Show that $AB = 7.5\text{m}$. [8]

   (b) Find the period of the motion. [4]

   (c) Find the kinetic energy of P when it is 2.7m from A. [3]

   (d) Show that the time taken by P to travel directly from A to the midpoint of OB is $\frac{\pi}{4}$. [4]

Total: 19