Solomon Practice Paper

Mechanics 3A

Time allowed: 90 mintues

Question	Points	Score
1	7	
2	7	
3	10	
4	11	
5	13	
6	13	
7	14	
Total:	75	

Centre:

Name:

Teacher:

How I can achieve better:

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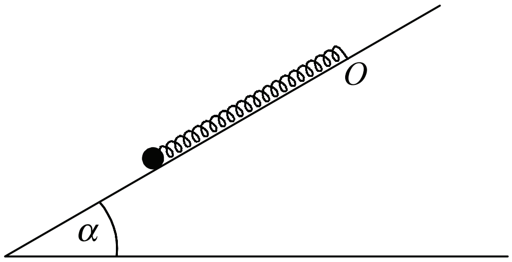
1. A particle of mass 0.6kg is attached to one end of a light elastic spring of natural length 1m and modulus of elasticity 30N. The other end of the spring is fixed to a point O which lies on a smooth plane inclined at an angle α to the horizontal where $\tan\alpha = \frac{3}{4}$ as shown in Figure.



The particle is held at rest on the slope at a point 1.2m from O down the line of greatest slope of the plane.

(a) Find the tension in the spring. [2]

(b) Find the initial acceleration of the particle. [5]

Total: 7

2. A particle P of mass 0.5kg moves along the positive x-axis under the action of a single force directed away from the origin O. When P is x metres from O, the magnitude of the force is $3x^{\frac{1}{2}}$N and P has a speed of v ms^{-1}.

   Given that when $x = 1$, P is moving away from O with speed 2 ms^{-1},

   (a) find an expression for v^2 in terms of x, [5]

   (b) show that when $x = 4$, P has a speed of 7.7ms^{-1}, correct to 1 decimal place. [2]

Total: 7

3. A particle is performing simple harmonic motion along a straight line between the points A and B where $AB = 8$ m. The period of the motion is 12 seconds.

   (a) Find the maximum speed of the particle in terms of π. [4]

   The points P and Q are on the line AB at distances of 3m and 6m respectively from A.

   (b) Find, correct to 3 significant figures, the time it takes for the particle to travel directly from P to Q. [6]

Total: 10

4. Whilst in free-fall a parachutist falls vertically such that his velocity, v ms^{-1}, when he is x metres below his initial position is given by

$$v^2 = kg\left(1 - \mathrm{e}^{-\frac{2x}{k}}\right),$$

where k is a constant.

Given that he experiences an acceleration of f ms^{-2},

(a) show that $f = g\mathrm{e}^{-\frac{2x}{k}}$. [4]

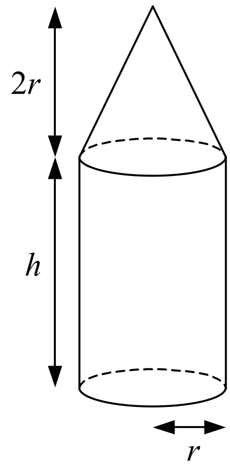
After falling a large distance, his velocity is constant at 49 ms^{-1}.

(b) Find the value of k. [3]

(c) Hence, express f in the form $(\lambda - \mu v^2)$ where λ and μ are constants which you should find. [4]

Total: 11

5. A firework is modelled as a uniform solid formed by joining the plane surface of a right circular cone of height $2r$ and base radius r, to one of the plane surfaces of a cylinder of height h and base radius r as shown in Figure.



Using this model,

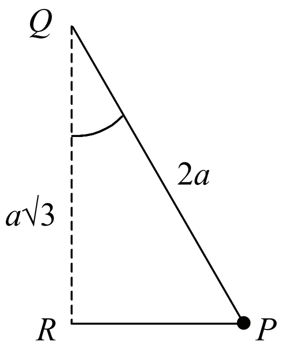
(a) show that the distance of the centre of mass of the firework from its plane base is [9]

The firework is to be launched from rough ground inclined at an angle α to the horizontal. Given that the firework does not slip or topple and that $h = 4r$,

(b) Find, correct to the nearest degree, the maximum value of α. [4]

Total: 13

6. The two ends of a light inextensible string of length $3a$ are attached to fixed points Q and R which are a distance of $a\sqrt{3}$ apart with R vertically below Q. A particle P of mass m is attached to the string at a distance of $2a$ from Q.



P is given a horizontal speed, u, such that it moves in a horizontal circle with both sections of the string taut as shown in Figure.

(a) Show that $\angle PRQ$ is a right angle. [2]

(b) Find $\angle PQR$ in degrees. [1]

(c) Find, in terms of a, g, m and u, the tension in the section of string [7]

i. PQ,

ii. PR.

(d) Show that $u^2 \geq \dfrac{ga}{\sqrt{3}}$. [3]

Total: 13

7. A particle of mass 2kg is attached to one end of a light elastic string of natural length 1m and modulus of elasticity 50N. The other end of the string is attached to a fixed point O on a rough horizontal plane and the coefficient of friction between the particle and the plane is $\frac{10}{49}$.

   The particle is projected from O along the plane with an initial speed of 5 ms^{-1}.

   (a) Show that the greatest distance from O which the particle reaches is 1.84 m. [9]

   (b) Find, correct to 2 significant figures, the speed at which the particle returns to O. [5]

Total: 14