

Solomon Practice Paper

Mechanics 3F

Time allowed: 90 minutes

Centre: www.CasperYC.club

Name:

Teacher:

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

How I can achieve better:

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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 $(4t + 3)\text{N}$ 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]

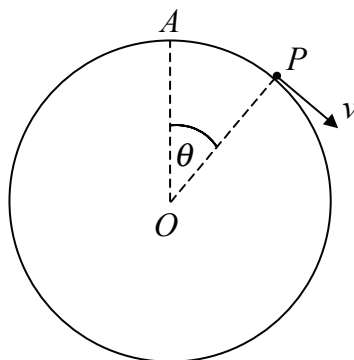
Given that at time T seconds, P has a speed of 22 ms^{-1} ,

(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 $v\text{ ms}^{-1}$ 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, $V \text{ ms}^{-1}$, before decelerating and coming to rest again at the point A .

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

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

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

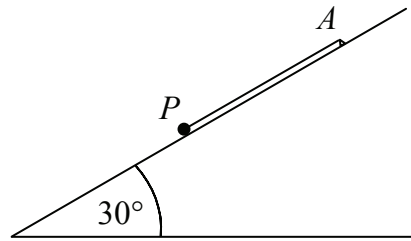
Using this model and given that the car is travelling at 16 ms^{-1} when it is 40 m from O ,

- (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]

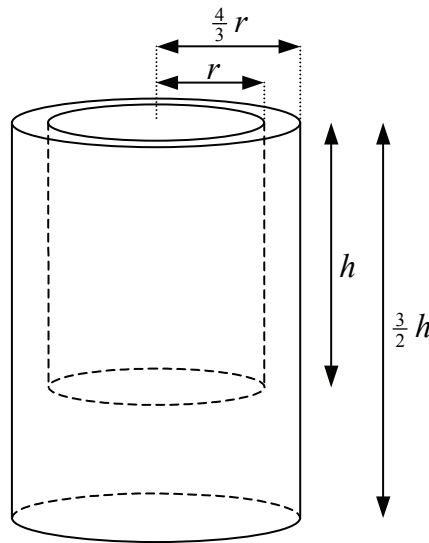
By using the work-energy principle, or otherwise,

(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 8ms^{-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

