

Solomon Practice Paper

Mechanics 1A

Time allowed: 90 minutes

Centre: www.CasperYC.club

Name:

Teacher:

Question	Points	Score
1	5	
2	6	
3	10	
4	10	
5	12	
6	14	
7	18	
Total:	75	

How I can achieve better:

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1. Two particles, P and Q , of mass 2 kg and 1.5 kg respectively are at rest on a smooth, horizontal surface. They are connected by a light, inelastic string which is initially slack. Particle P is projected away from Q with a speed of 7 ms^{-1} .

(a) Find the common speed of the particles after the string becomes taut.

[3]

(b) Calculate the impulse in the string when it jerks tight.

[2]

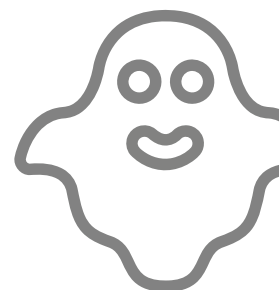
Total: 5



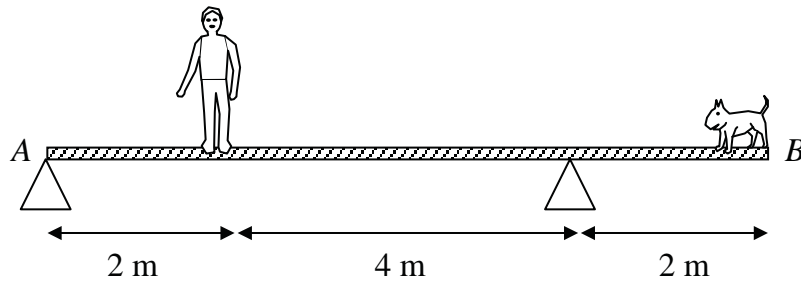
2. Particle A has velocity $(8\mathbf{i} - 3\mathbf{j}) \text{ ms}^{-1}$ and particle B has velocity $(15\mathbf{i} - 8\mathbf{j}) \text{ ms}^{-1}$ where \mathbf{i} and \mathbf{j} are perpendicular, horizontal unit vectors.

- (a) Find the speed of B . [2]
- (b) Find the velocity of B relative to A . [2]
- (c) Find the acute angle between the relative velocity found in part (b) and the vector \mathbf{i} , giving your answer in degrees correct to 1 decimal place. [2]

Total: 6



3. Figure shows a uniform plank AB of length 8 m and mass 30 kg.



It is supported in a horizontal position by two pivots, one situated at A and the other 2 m from B . A man whose mass is 80 kg is standing on the plank 2 m from A when his dog steps onto the plank at B .

Given that the plank remains in equilibrium and that the magnitude of the forces exerted by each of the pivots on the plank are equal,

- (a) calculate the magnitude of the force exerted on the plank by the pivot at A , [5]
- (b) find the dog's mass. [3]

If the dog was heavier and the plank was on the point of tilting,

- (c) explain how the force exerted on the plank by each of the pivots would be changed. [2]

Total: 10



4. A cyclist and her bicycle have a combined mass of 78 kg. While riding on level ground and using her greatest driving force, she is able to accelerate uniformly from rest to 10 ms^{-1} in 15 seconds against constant resistive forces that total 60 N.

(a) Show that her maximum driving force is 112 N.

[4]

The cyclist begins to ascend a hill, inclined at an angle α to the horizontal, riding with her maximum driving force and against the same resistive forces. In this case, she is able to maintain a steady speed.

(b) Find the angle α , giving your answer to the nearest degree.

[4]

(c) Comment on the assumption that the resistive force remains constant

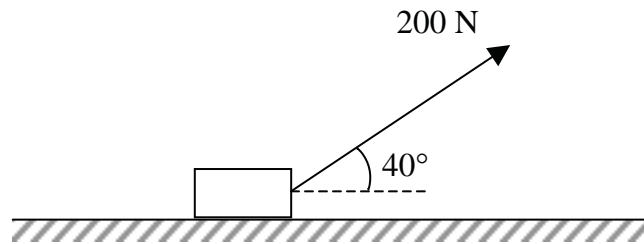
[2]

- i. in the case when the cyclist is accelerating,
- ii. in the case when she is maintaining a steady speed.

Total: 10



5. Figure shows a large block of mass 50 kg being pulled on rough horizontal ground by means of a rope attached to the block.



The tension in the rope is 200 N and it makes an angle of 40° with the horizontal. Under these conditions, the block is on the point of moving.

Modelling the block as a particle,

- (a) show that the coefficient of friction between the block and the ground is 0.424 correct to 3 significant figures. [6]

The angle with the horizontal at which the rope is being pulled is reduced to 30° . Ignoring air resistance and assuming that the tension in the rope and the coefficient of friction remain unchanged,

- (b) find the acceleration of the block. [6]

Total: 12



6. Anila is practising catching tennis balls. She uses a mobile computer-controlled machine which fires tennis balls vertically upwards from a height of 2.5 metres above the ground. Once it has fired a ball, the machine is programmed to move position rapidly to allow Anila time to get into a suitable position to catch the ball.

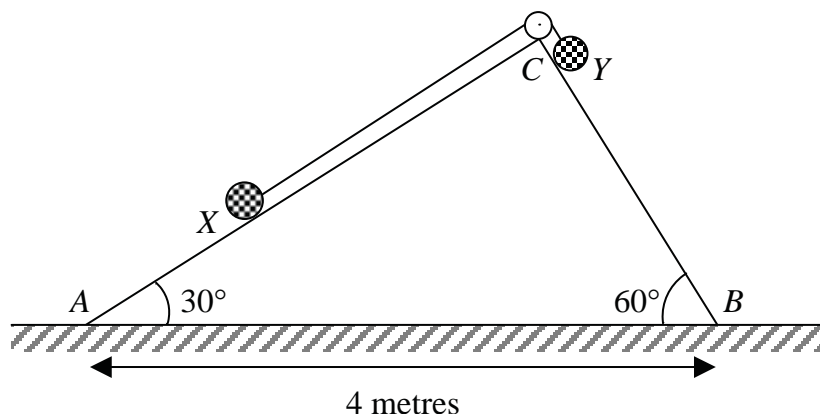
The machine fires a ball at 24 ms^{-1} vertically upwards and Anila catches the ball just before it touches the ground.

- (a) Draw a speed-time graph for the motion of the ball from the time it is fired by the machine to the instant before Anila catches it. [3]
- (b) Find, to the nearest centimetre, the maximum height which the ball reaches above the ground. [4]
- (c) Calculate the speed at which the ball is travelling when Anila catches it. [4]
- (d) Calculate the length of time that the ball is in the air. [3]

Total: 14



7. Figure shows a particle X of mass 3 kg on a smooth plane inclined at an angle 30° to the horizontal, and a particle Y of mass 2 kg on a smooth plane inclined at an angle 60° to the horizontal.



The two particles are connected by a light, inextensible string of length 2.5 metres passing over a smooth pulley at C which is the highest point of the two planes.

Initially, Y is at a point just below C touching the pulley with the string taut. When the particles are released from rest they travel along the lines of greatest slope, AC in the case of X and BC in the case of Y , of their respective planes. A and B are the points where the planes meet the horizontal ground and $AB = 4\text{ metres}$.

- Show that the initial acceleration of the system is given by $\frac{g}{10}(2\sqrt{3} - 3)\text{ ms}^{-2}$. [7]
- By finding the tension in the string, or otherwise, find the magnitude of the force exerted on the pulley and the angle that this force makes with the vertical. [7]
- Find, correct to 2 decimal places, the speed with which Y hits the ground. [4]

Total: 18

