

**Introduction to Mechanics (0J2)**  
**Example Sheet 3**

This sheet has three recent exam questions on 1D Dynamics, showing the mark scheme. For all questions take the acceleration due to gravity  $g = 9.81\text{ms}^{-2}$  where needed.

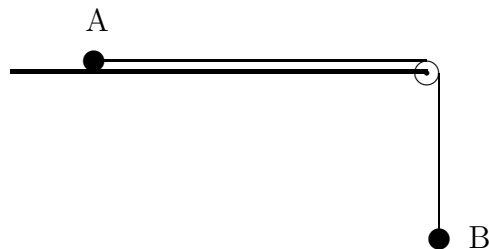
1. (June 2011) A hot air balloon is at rest at point  $A$  on the ground. When the balloon is released, it rises vertically at a constant acceleration to point  $B$  at height of 320 m in 80 s.
  - (i) Show that the acceleration of the balloon is  $0.1\text{ms}^{-2}$ . (2 marks)
  - (ii) Find the speed of the balloon when it reaches a height of 320 m. (1 marks)
  - (iii) The mass of the balloon is 450 kg. Show that the magnitude of the vertical lift force is 4459.5 N. (3 marks)

At  $B$  the vertical lift force is reduced so that the balloon rises at a constant speed to point  $C$  at a height of 400 m above  $A$ .

- (iv) Find the magnitude of the vertical lift force acting between  $B$  and  $C$  (2 marks)
- (v) the work done by this force from  $B$  to  $C$ . (2 marks)

Answers: (ii)  $8\text{ms}^{-1}$  quad (iv) 4414.5N (v) 353.16kJ

2. (June 2008) Two particles  $A$  and  $B$  are connected by a light inextensible string. Particle  $A$  has mass 20 kg and rests on a rough horizontal table. The coefficient of friction is 0.15. The string passes over a smooth pulley at the edge of the table. The other end is attached to particle  $B$  which has mass 5 kg and hangs vertically as shown.



The particles are released from rest and begin to move.

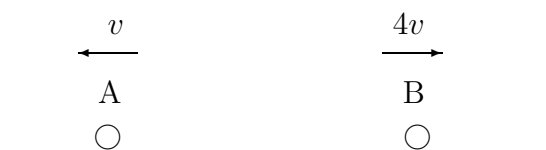
- (a) Find the magnitude of the friction force acting on  $A$ . (3 marks)
- (b) Show that the acceleration is  $0.785 \text{ ms}^{-2}$ . (4 marks)
- (c) Find the tension in the string, (1 mark)
- (d) Find the distance moved by  $A$  in the first 3 seconds (assuming it remains on the table). (2 marks)

Answers: (a) 29.4N (c) 45.1N (d) 3.53m

3. (June2009) A particle  $A$  with mass 2 kg moves in a straight line on a smooth horizontal surface at speed  $6 \text{ ms}^{-1}$ , from left to right. Another particle  $B$  with mass 3 kg is at rest. The particles collide.



- (a) If after the collision  $A$  is at rest and  $B$  moves to the right, find the speed of  $B$ . (2 marks)
- (b) If after the collision  $A$  is moving to the left with speed  $v \text{ ms}^{-1}$  and  $B$  is moving to the right with speed  $4v \text{ ms}^{-1}$  find the value of  $v$ . (3 marks)



- (c) Find the total loss in Kinetic Energy in the second case and also the coefficient of restitution  $e$ . (5 marks)

Answers: (a)  $4 \text{ ms}^{-1}$  (b)  $1.2 \text{ ms}^{-1}$  (c) 36J,  $e = 1$