

## Questions

Q1.

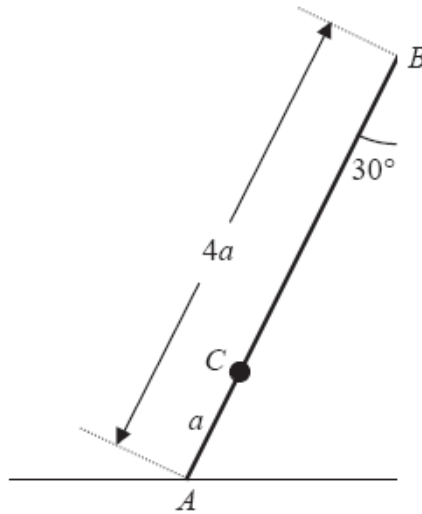


Figure 2

A ladder  $AB$ , of mass  $m$  and length  $4a$ , has one end  $A$  resting on rough horizontal ground. The other end  $B$  rests against a smooth vertical wall. A load of mass  $3m$  is fixed on the ladder at the point  $C$ , where  $AC = a$ . The ladder is modelled as a uniform rod in a vertical plane perpendicular to the wall and the load is modelled as a particle. The ladder rests in limiting equilibrium making an angle of  $30^\circ$  with the wall, as shown in Figure 2.

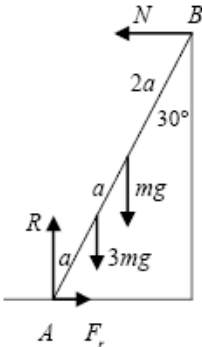
Find the coefficient of friction between the ladder and the ground.

(10)

(Total 10 marks)

## Mark Scheme

Q1.

Question Number	Scheme	Marks
(a)	<div style="text-align: center;">  </div> <p> <math>M(A) \quad N \times 4a \cos 30^\circ = 3mg \times a \sin 30^\circ + mg \times 2a \sin 30^\circ</math>  <math>N = \frac{5}{4} mg \tan 30^\circ \quad (= \frac{5}{4\sqrt{3}} mg = 7.07\dots m)</math>  <math>\rightarrow F_r = N, \quad \uparrow R = 4mg</math>            Using <math>F_r = \mu R</math>  <math>\frac{5}{4\sqrt{3}} mg = \mu R</math> for their <math>R</math>  <math>\mu = \frac{5}{16\sqrt{3}} \quad \text{awrt } 0.18</math> </p> <p>Alternative method:</p> <p> <math>M(B): mg \times 2a \sin 30 + 3mg \times 3a \sin 30 + F \times 4a \cos 30 = R \times 4a \sin 30</math>  <math>11mga \sin 30 + F \times 4a \cos 30 = R \times 4a \sin 30</math>  <math>\frac{11mg}{2} + F \frac{4\sqrt{3}}{2} = 2R</math>  <math>\uparrow R = 4mg,</math>            Using <math>F_r = \mu R</math>  <math>8\mu\sqrt{3} = \frac{5}{2}, \quad \mu = \frac{5}{16\sqrt{3}}</math> </p>	<p>M1 A2(1,0)</p> <p>DM1 A1</p> <p>B1, B1</p> <p>B1</p> <p>M1</p> <p>A1 (10)</p> <p>[10]</p> <p>M1A3(2,1,0)</p> <p>DM1A1</p> <p>B1</p> <p>B1</p> <p>M1 A1</p>