A small block is pulled along a rough horizontal floor at a constant speed of 1.5 m s\(^{-1}\) by a constant force of magnitude 30 N acting at an angle of \(\theta^\circ\) upwards from the horizontal. Given that the work done by the force in 20 s is 720 J, calculate the value of \(\theta\). [3]

Three coplanar forces act at a point. The magnitudes of the forces are 5 N, 6 N and 7 N, and the directions in which the forces act are shown in the diagram. Find the magnitude and direction of the resultant of the three forces. [6]

A and B are points on the same line of greatest slope of a rough plane inclined at 30° to the horizontal. A is higher up the plane than B and the distance AB is 2.25 m. A particle P, of mass \(m\) kg, is released from rest at A and reaches B 1.5 s later. Find the coefficient of friction between P and the plane. [6]

Particles A and B, of masses 0.2 kg and 0.3 kg respectively, are connected by a light inextensible string. The string passes over a smooth pulley at the edge of a rough horizontal table. Particle A hangs freely and particle B is in contact with the table (see diagram).

(i) The system is in limiting equilibrium with the string taut and A about to move downwards. Find the coefficient of friction between B and the table. [4]

A force now acts on particle B. This force has a vertical component of 1.8 N upwards and a horizontal component of \(X\) N directed away from the pulley.

(ii) The system is now in limiting equilibrium with the string taut and A about to move upwards. Find \(X\). [3]

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A particle $P$ moves along the $x$-axis in the positive direction. The velocity of $P$ at time $t$ s is $0.03t^2$ m s$^{-1}$. When $t = 5$ the displacement of $P$ from the origin $O$ is 2.5 m.

(i) Find an expression, in terms of $t$, for the displacement of $P$ from $O$. [4]

(ii) Find the velocity of $P$ when its displacement from $O$ is 11.25 m. [3]

The diagram shows the velocity-time graph for a lift moving between floors in a building. The graph consists of straight line segments. In the first stage the lift travels downwards from the ground floor for 5 s, coming to rest at the basement after travelling 10 m.

(i) Find the greatest speed reached during this stage. [2]

The second stage consists of a 10 s wait at the basement. In the third stage, the lift travels upwards until it comes to rest at a floor 34.5 m above the basement, arriving 24.5 s after the start of the first stage. The lift accelerates at 2 m s$^{-2}$ for the first 3 s of the third stage, reaching a speed of $V$ m s$^{-1}$. Find

(ii) the value of $V$, [2]

(iii) the time during the third stage for which the lift is moving at constant speed, [3]

(iv) the deceleration of the lift in the final part of the third stage. [2]

A car of mass 1200 kg travels along a horizontal straight road. The power provided by the car’s engine is constant and equal to 20 kW. The resistance to the car’s motion is constant and equal to 500 N. The car passes through the points $A$ and $B$ with speeds 10 m s$^{-1}$ and 25 m s$^{-1}$ respectively. The car takes 30.5 s to travel from $A$ to $B$.

(i) Find the acceleration of the car at $A$. [4]

(ii) By considering work and energy, find the distance $AB$. [8]