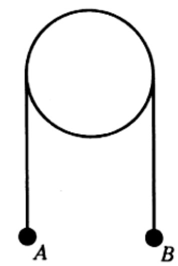
Paper 4 - Sample 1

Q1 A man pushes a trolley loaded with bricks in a straight line, along horizontal ground at a building site. He starts from a point A and stops at a point B. He exerts a force on the trolley of 50 N, acting in a direction 15° below horizontal. The work done by the man is 4.8 kJ. Find the distance AB. [3]

Q2 Two particles A and B have masses 0.65 kg and 0.35 kg respectively. The particles are attached to the ends of a light inextensible string which passes over a fixed smooth pulley. B is held at rest with the string taut and both straight parts of the string vertical (see diagram). B is released and the particles move vertically with acceleration of magnitude a m s^{-2}. Find:



(i) the value of a and the tensions in the string [4]

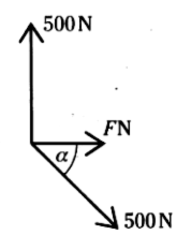
(ii) the magnitude of the resultant force exerted on the pulley by the string. [1]

Q3 A particle is falling vertically under gravity. It passes through points A and B with speeds 5.5 m s^{-1} and 30.5 m s^{-1} respectively. Find:

(i) the distance AB [2]

(ii) the average speed of the particle while falling from A to B. [3]

Q4 Three coplanar forces of magnitudes 500 N, F N and 500 N act at a point in the directions shown in the diagram, where $\tan \alpha = 0.75$. The resultant of the three forces has magnitude 520 N. Find:



(i) the value of F [4]

(ii) the direction of the resultant of the three forces. [2]

Q5 A cyclist and a motorist start from rest on the starting line of a track at the same instant. They move in the same direction along a straight section of the track. The cyclist moves with constant acceleration, reaching a speed of 6 m s^{-1} after 100 s. The motorist moves with speed v m s^{-1} at time t s after leaving the starting line where $v = kt(200 - t)$ and k is a constant. The initial acceleration of the car is 0.48 m s^{-2}.

(i) Find the value of k and the value of v when $t = 100$. [3]

(ii) Sketch velocity–time graphs for the car and the cyclist, for $0 < t < 100$, using the same axes for both. [3]

(iii) Find the distance between the car and the cyclist when $t = 100$. [4]

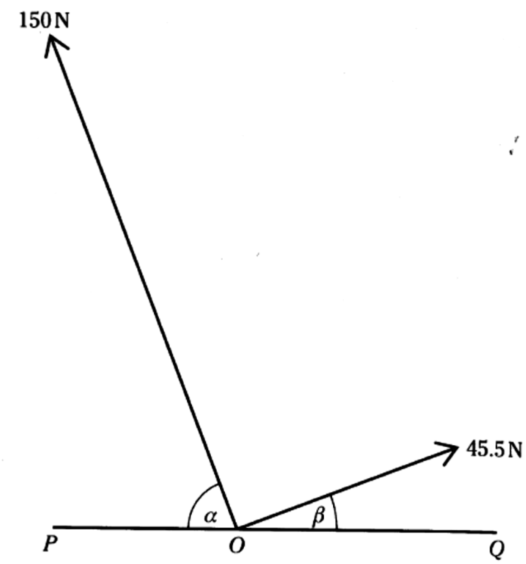
Q6 A lorry of mass 12 500 kg moves along a horizontal straight road, with the power of its engine constant and equal to 250 kW. The resistance to the lorry's motion is constant and equal to 5000 N.

(i) Find the acceleration of the lorry when its speed is 12.5 m s^{-1}. [4]

The lorry passes through points A and B with speeds 14 m s^{-1} and 30 m s^{-1} respectively, and takes 40 s to travel from A to B.

(ii) Find the distance AB. [6]

Q7 Two light strings are attached to a small block of mass 25 kg. The block is in equilibrium at a point O of a straight line PQ which is on a horizontal surface. The strings are taut and in the same vertical plane as PQ. The tension in one of the strings is 150 N and the string makes an angle α with OP. The tension in the other string is 45.5 N and the string makes an angle β with OQ (see diagram), where $\cos\beta = \frac{12}{13}$.



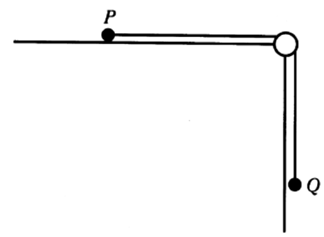
(i) Given that the horizontal surface is smooth, find $\cos\alpha$ and the magnitude of the contact force acting on the block. [6]

(ii) It is given instead that the tension in the string that makes angle β with OQ is doubled (to 91 N) and that the horizontal surface is rough and the equilibrium is limiting. Find the coefficient of friction between the block and the horizontal surface, giving your answer correct to 2 decimal places. [5]

Sample Paper 1	Sample Paper 2
1 99.4 m **2** (i) $a = 3$ and the tension is 4.55 N (ii) 9.1 N **3** (i) 45 m (ii) 18 m s^{-1} **4** (i) $F = 80$ (ii) 22.6° anticlockwise from the force of F N **5** (i) $k = 0.0024$ $v = 24$ (iii) 1300 m **6** (i) 1.2 m s^{-1} (ii) 1120 m **7** (i) $\cos\alpha = 0.28$ at a force of 88.5 N (ii) 0.59	**1** Magnitude of acceleration is 2 m s^{-2} and the tension is 3.2 N **2** 180 J **3** (i) $F = 32.5$, $\theta = 6.3$ (ii) 10 N and direction is opposite to the original 3.6 N force **4** (i) 2160 J (ii) Power is 3000 W or 3 kW **5** (i) Component has magnitude 128 N (ii) $X = 32$ and the coefficient of friction is 0.5 (iii) 2 m s^{-2} **6** (i) 0.168 m s^{-2} (ii) 2240 m (iii) 300 **7** (i) 1.5 (ii) Speed is 10.5 m s^{-1} downwards, speed is 9.5 m s^{-1} upwards (iii) 1.93 s

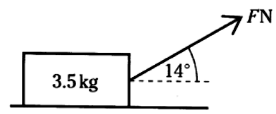
Paper 4 – Sample 2

Q1 Particles P and Q, of weights 16 N and 4 N respectively, are connected by a light inextensible string. P is held on a smooth horizontal table with the string taut and passing over a small smooth pulley fixed at the edge of the table. Q hangs at rest vertically below the pulley (see diagram). P is released and the particles start to move. Find the magnitude of the acceleration of the particles and the tension in the string.



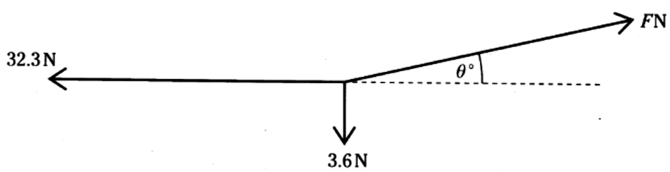
[4]

Q2 A crate of mass 3.5 kg is pulled at constant speed along a horizontal floor. The pulling force has magnitude F N and acts at an angle of 14° above the horizontal (see diagram). The normal component of the contact force acting on the crate is 20 N.
Find the work done by the pulling force in moving the crate a distance of 3 m.



[4]

Q3



(i) A particle P is in equilibrium when acted on by the three forces shown in the diagram. Find the values of F and θ. [4]

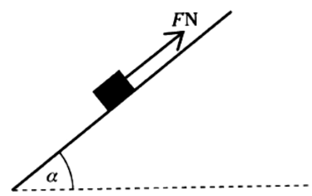
(ii) The force of magnitude 3.6 N is now replaced by a force of magnitude 6.4 N in the opposite direction. Assuming there is no change in magnitude or direction of the other two forces, state the magnitude and direction of the resultant force on P. [2]

Q4 A load of mass 120 kg passes through points P and Q as it is raised vertically by a crane whose output power is constant. Q is 2 m above P, and the speed of the load is 2.5 m s^{-1} at P and 1.5 m s^{-1} at Q. Find:

(i) the work done by the crane as the load moves from P to Q [4]

(ii) the output power of the crane, given that the load takes 0.72 s to move from P to Q. [2]

Q5 A box of mass 16 kg is at rest on a plane inclined at an angle α to the horizontal, where $\sin\alpha = 0.6$. A force of magnitude F N acts on the box in an upward direction parallel to a line of greatest slope (see diagram).



(i) Show that the normal component of the contact force on the box has magnitude 128 N. [2]

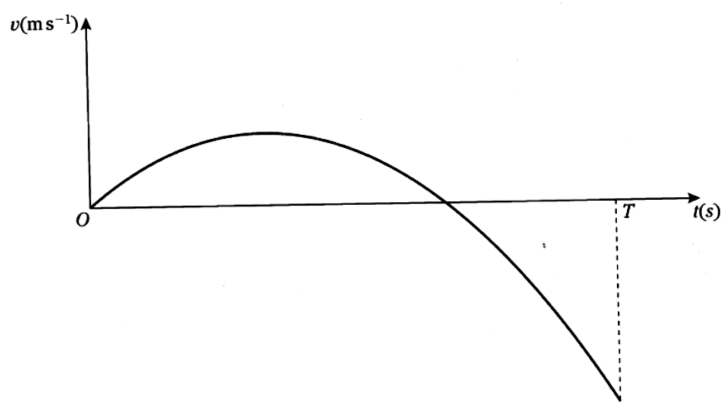
When $F = X$ the box is on the point of moving down the plane, and when $F = 5X$ the box is on the point of moving up the plane.

(ii) Find the value of X and the coefficient of friction between the box and the plane. [5]

The force of magnitude F N is now removed.

(iii) Find the acceleration of the box down the plane. [1]

Q6



A particle travels in a straight line. It starts to move from a point O and T s later it returns to O. The velocity of the particle, t s after leaving O, is v m s^{-1} where $v = 0.168t - 0.00084t^2$. The diagram shows the velocity–time graph for $0 < t < T$. Find:

(i) the magnitude of the acceleration of the particle at the instant that it changes its direction of motion [5]

(ii) the total distance travelled by the particle [4]

(iii) the value of T. [2]

Q7 A smooth sphere of radius 2 m is attached to the top of a fixed vertical pole, with the highest point of the sphere at a height of 10 m above horizontal ground. A particle P is projected horizontally from the highest point of the sphere, with speed V m s^{-1}. P remains in contact with the sphere until it reaches a point on the sphere's horizontal circumference. At this point P leaves the sphere with speed 6.5 m s^{-1}.

(i) Find the value of V.

At the same instant that P leaves the sphere a particle Q is projected vertically upward from the ground with a speed of 13.5 m s^{-1}. [3]

(ii) Find the speed and direction of motion of each of the particles P and Q, at the instant when they are at the same height. [6]

(iii) Find the time interval between P's arrival on the ground and Q's arrival on the ground. [2]