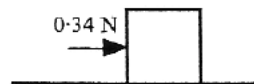


MECHANICS (C) UNIT 1

TEST PAPER 6

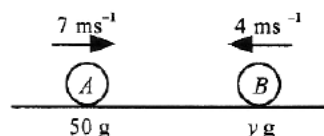
Take $g = 9.8 \text{ ms}^{-2}$ and give all answers correct to 3 significant figures where necessary.

1. A small box, of mass 0.5 kg , is initially at rest on a horizontal table-top. A horizontal force of magnitude 0.34 N is applied to the box as shown. Modelling the box as a particle, find the acceleration with which the box starts to move if



- (i) the contact between the box and the table is smooth, [2]
 (ii) the contact is rough, the coefficient of friction being 0.05 . [3]

2. Two particles A and B , of masses 50 grams and $y \text{ grams}$, are moving in the same straight line, in opposite directions, with speeds 7 ms^{-1} and 4 ms^{-1} respectively, and collide.



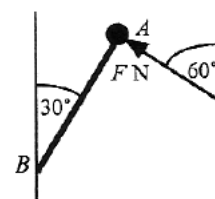
Find the value of y in each of the following separate cases :

- (i) after impact the particles move together with speed 2.25 ms^{-1} ; [3]
 (ii) after impact the particles move in opposite directions with speed 5 ms^{-1} . [3]

3. A particle passes through a point O with speed 9 ms^{-1} and moves in a straight line with constant acceleration 3.6 ms^{-2} for t seconds until it reaches the point P . The acceleration is then reduced to 2 ms^{-2} and this is maintained for another t seconds until the particle passes the point Q with speed 16 ms^{-1} . Calculate

- (i) the time taken by the particle to travel from O to Q , [4]
 (ii) the distance OQ . [3]

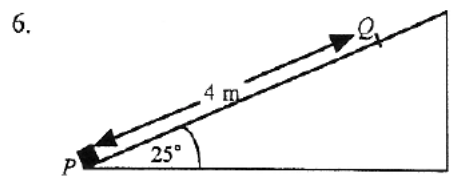
4. A lump of clay, of mass 0.8 kg , is attached to the end A of a light rod AB , which is pivoted at the other end B so that it can rotate smoothly in a vertical plane. A force is applied to A at an angle of 60° to the vertical, as shown, the magnitude $F \text{ N}$ of this force being just enough to hold the lump of clay in equilibrium with AB inclined at an angle of 30° to the upward vertical. Making suitable modelling assumptions, find



- (i) the value of F , [5]
 (ii) the magnitude of the force in the rod AB . [2]

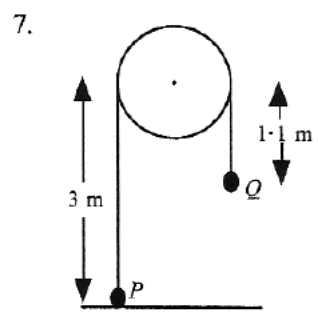
MECHANICS 1 (C) TEST PAPER 6 Page 2

5. A particle P moves in a straight line so that its displacement s metres from a fixed point O at time t seconds is given by the formula $s = t^3 - 7t^2 + 8t$.
- (i) Find the values of t when the velocity of P equals zero, and briefly describe what is happening to P at these times. [5]
 - (ii) Find the distance travelled by P between the times $t = 3$ and $t = 5$. [3]
 - (iii) Find the value of t when the acceleration of P is -2 ms^{-2} . Briefly explain the significance of a negative acceleration at this time. [3]



A small stone, of mass 0.2 kg is projected with speed 7 ms^{-1} from P , the bottom of a rough plane inclined at 25° to the horizontal, and moves up a line of greatest slope of the plane until it comes to instantaneous rest at Q , where $PQ = 4 \text{ m}$.

- (i) Show that the deceleration of the stone as it moves up the plane has magnitude $\frac{49}{8} \text{ ms}^{-2}$. [2]
- (ii) Find the coefficient of friction between the stone and the plane, [4]
- (iii) Find the speed with which the stone returns to P . [4]
- (iv) Name one force which you have ignored in your mathematical model, and state whether the answer to (iii) would be larger or smaller if that force were taken into account. [2]



A particle P , of mass 4 kg , rests on horizontal ground and is attached by a light, inextensible string to another particle Q of mass 4.5 kg . The string passes over a smooth pulley whose centre is 3 m above the ground. Initially Q is 1.1 m below the level of the centre of the pulley. The system is released from rest in this position.

- (i) Find the acceleration of the two particles. [4]
- (ii) Find the speed with which Q hits the ground. [2]

- Given that, while the string is slack, Q does not rebound from the ground and P does not hit the pulley, find
- (iii) the time for which P continues to rise, [2]
 - (iv) the speed with which Q leaves the ground when the string again becomes taut. [4]

MECHANICS 1 (C) TEST PAPER 6 : ANSWERS AND MARK SCHEME

1. (i) $0.34 = 0.5a$ $a = 0.68 \text{ ms}^{-2}$ M1 A1
(ii) $R = 0.5g$ so frictional force $= 0.05R = 0.245 \text{ N}$ M1
Acc. force $= 0.095 \text{ N}$, so $a = 0.19 \text{ ms}^{-2}$ A1 A1 5
2. (i) Momentum : $7 \times 50 - 4y = 2.25(50 + y)$ $6.25y = 237.5$ $y = 38$ M1 A1 A1
(ii) Momentum : $7 \times 50 - 4y = -5 \times 50 + 5y$ $9y = 600$ $y = 66\frac{2}{3}$ M1 A1 A1 6
3. (i) At P, $v = 9 + 3.6t$ At Q, $v = 9 + 3.6t + 2t = 9 + 5.6t$ M1 A1
 $9 + 5.6t = 16$ $5.6t = 7$ $t = 1.25$ O to Q : 2.5 s M1 A1
(ii) $\frac{1}{2} \times 1.25 \times (9 + 13.5 + 13.5 + 16) = 32.5 \text{ m}$ M1 A1 A1 7
4. (i) Resolve : $F \sin 60^\circ = T \sin 30^\circ$, $F \cos 60^\circ + T \cos 30^\circ = 0.8g$ M1 A1 A1
Hence $F\sqrt{3} = T$, $F + T\sqrt{3} = 1.6g$ $4F = 1.6g$ $F = 3.92 \text{ N}$ M1 A1
(ii) $T = 3.92\sqrt{3} = 6.79 \text{ N}$ M1 A1 7
5. (i) $v = 3t^2 - 14t + 8 = (3t - 2)(t - 4)$ $v = 0 : t = \frac{2}{3}, t = 4$ M1 A1 M1 A1
P is turning round (changing direction) A1
(ii) $s(3) = -12$, $s(4) = -16$, $s(5) = -10$, so dist $= 4 + 6 = 10 \text{ m}$ M1 A1 A1
(iii) $a = 6t - 14$ $a = -2$ when $t = 2$ M1 A1
Negative acceleration acting on negative velocity, so speeding up B1 11
6. (i) $0 = 7^2 - 2a(4)$ $a = \frac{49}{8} \text{ ms}^{-2}$ M1 A1
(ii) Acc down plane $= g \sin 25^\circ + \mu g \cos 25^\circ = 9.8(\sin 25^\circ + \mu \cos 25^\circ)$ M1 A1
Hence $\sin 25^\circ + \mu \cos 25^\circ = 0.625$ $\mu = 0.223$ M1 A1
(iii) Now down plane, acc. $= g \sin 25^\circ - \mu g \cos 25^\circ = 0.220g$ M1 A1
 $v^2 = 0 + 2(4)(0.220g) = 17.27$ $v = 4.16 \text{ ms}^{-1}$ M1 A1
(iv) Air resistance, which would make the answer smaller B1 B1 12
7. (i) $4.5g - T = 4.5a$, $T - 4g = 4a$ B1 B1
Add : $0.5g = 8.5a$ $a = 0.576 \text{ ms}^{-2}$ M1 A1
(ii) $v^2 = 2as = 2(0.576)(1.9) = 2.191$ $v = 1.48 \text{ ms}^{-1}$ M1 A1
(iii) Under gravity P rises for t s where $0 = 1.48 - 9.8t$ $t = 0.151$ M1 A1
(iv) P returns to 1.9 m above ground with speed 1.48 ms^{-1} B1
Momentum conserved : $4(1.48) + 4.5(0) = 8.5v$ M1 A1
 $v = 0.697 \text{ ms}^{-1}$ A1 12