

MECHANICS (C) UNIT 1

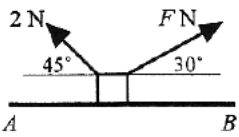
TEST PAPER 10

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

1. A car accelerates from 0 to 108 km h^{-1} in 7.5 seconds. Find its acceleration in ms^{-2} . [4]
2. Two trucks P and Q , of masses 18 000 kg and 16 000 kg respectively, collide while moving towards each other in a straight line. Immediately before the collision, both trucks are travelling at the same speed, $u \text{ ms}^{-1}$. Immediately after the collision, P is moving at half its original speed, its direction of motion having been reversed.
 - (i) Find, in terms of u , the speed of Q immediately after the collision. [5]
 - (ii) State, with a reason, whether the direction of Q 's motion has been reversed. [1]
3. A body moves in a straight line with constant acceleration. Its speed increases from 17 ms^{-1} to 33 ms^{-1} while it travels a distance of 250 m. Find
 - (i) the time taken to travel the 250 m, [3]
 - (ii) the acceleration of the body. [2]

The body now decelerates at a constant rate from 33 ms^{-1} to rest in 6 seconds.

 - (iii) Find the distance travelled in these 6 seconds. [2]

4. 

A small packet of mass 0.3 kg rests on a rough horizontal surface. The coefficient of friction between the packet and the surface is $\frac{1}{4}$. Two strings are attached to the packet, making angles of 45° and 30° with the horizontal, and when forces of magnitude 2 N and $F \text{ N}$ are exerted through the strings as shown, the packet is on the point of moving in the direction \overrightarrow{AB} .

Find the value of F . [7]

5. A particle P of mass $m \text{ kg}$, at rest on a smooth horizontal table, is connected to particles Q and R , of mass 0.1 kg and 0.5 kg respectively, by light inextensible strings which pass over smooth fixed pulleys at the edges of the table. The system is released from rest with Q and R hanging freely and it is found that the tension in the section of the string between P and R is 2 N.
 - (i) Show that the acceleration of the particles has magnitude 5.8 ms^{-2} . [3]
 - (ii) Find the value of m . [4]

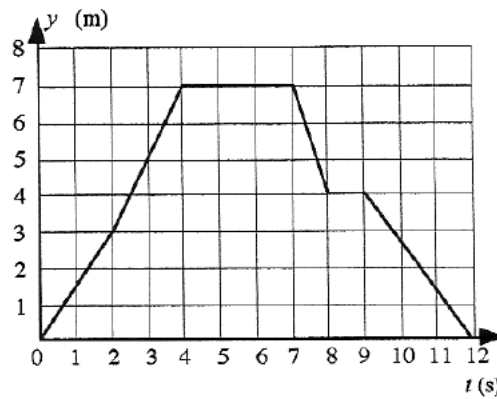
Modelling assumptions have been made about the pulley and the strings.

 - (iii) Briefly describe these assumptions. For each one, state how the mathematical model would be altered if the assumption were not made. [4]

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6. A point of light, P , is moving along a straight line in such a way that, t seconds after passing through a fixed point O on the line, its velocity is $v \text{ ms}^{-1}$, where $v = \frac{1}{2}t^2 - 4t + 10$. Calculate
- (i) the velocity of P 6 seconds after it passes O , [1]
 - (ii) the magnitude of the acceleration of P when $t = 1$, [3]
 - (iii) the minimum speed of P , [3]
 - (iv) the distance travelled by P in the fourth second after it passes O . [5]

7. A particle P moves in a straight line such that its displacement from a fixed point O at time t s is y metres. The graph of y against t is as shown.



- (i) Write down the velocity of P when
 - (a) $t = 1$, (b) $t = 10$. [2]
- (ii) State the total distance travelled by P . [2]
- (iii) Write down a formula for y in terms of t when $2 \leq t < 4$. [3]
- (iv) Sketch a velocity-time graph for the motion of P during the twelve seconds. [3]
- (v) Find the maximum speed of P during the motion. [3]

MECHANICS 1 (C) TEST PAPER 10 : ANSWERS AND MARK SCHEME

1. $108 \text{ km h}^{-1} = 30 \text{ ms}^{-1}$ $a = 30 \div 7.5 = 4 \text{ ms}^{-2}$ M1 A1 M1 A1 4
2. (i) Momentum : $18u - 16u = -18(u/2) + 16v$ M1 A1 A1
 $2u = -9u + 16v$ $11u = 16v$ $v = \frac{11u}{16}$ M1 A1
- (ii) Velocity of Q was negative, now positive, so direction reversed B1 6
3. (i) $250 = \frac{1}{2}(17 + 33)t$ $t = 500 \div 50 = 10 \text{ s}$ M1 A1 A1
(ii) $v = u + at : 33 = 17 + 10a$ $a = 1.6 \text{ ms}^{-2}$ M1 A1
- (iii) $s = \frac{1}{2}(33 + 0) \times 6 = 99 \text{ m}$ M1 A1 7
4. Resolve horizontally : $F \cos 30^\circ = 2 \cos 45^\circ + 0.25R$ M1 A1
Resolve vertically : $R + 2 \sin 45^\circ + F \sin 30^\circ = 0.3g$ M1 A1
 $0.866F = 1.414 + 0.25(0.3g - 1.414 - 0.5F)$ M1 A1
 $0.991F = 1.796$ $F = 1.81$ A1 7
5. (i) $F = ma$ for $R : 0.5g - 2 = 0.5a$ $a = 5.8 \text{ ms}^{-2}$ M1 A1 A1
(ii) $T - 0.1g = 0.1a$ $T = 0.58 + 0.98 = 1.56 \text{ N}$ M1 A1
 $2 - T = ma$ $5.8m = 0.44$ $m = 0.0759$ M1 A1
- (iii) String inextensible : if not, accelerations different B1 B1
Pulleys smooth : if not, tensions different either side of pulley B1 B1 11
6. (i) $v(6) = 18 - 24 + 10 = 4 \text{ ms}^{-1}$ B1
(ii) $a = t - 4 = -3 \text{ ms}^{-2}$ when $t = 1$ magnitude = 3 ms^{-2} M1 A1 A1
(iii) When $a = 0, t = 4$ $v(4) = 8 - 16 + 10 = 2 \text{ ms}^{-1}$ M1 A1 A1
(iv) $s = \int_3^4 v \, dt = \left[\frac{1}{6}t^3 - 2t^2 + 10t \right]_3^4 = 18.67 - 16.5 = 2.17 \text{ m}$ M1 A1 A1 M1 A1 12
7. (i) (a) 1.5 ms^{-1} (b) $-1\frac{1}{3} \text{ ms}^{-1}$ B1 B1
(ii) $2 \times 7 \text{ m} = 14 \text{ m}$ M1 A1
(iii) Line from (2, 3) to (4, 7) is $y - 3 = 2(t - 2)$ $y = 2t - 1$ M1 A1 A1
(iv) Graph sketched : 6 horizontal line segments B3
(v) Steepest section has gradient -3 , so max. speed = 3 ms^{-1} M1 A1 A1 13