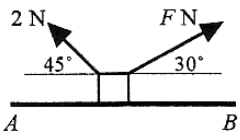
MECHANICS (C) UNIT 1 **TEST PAPER 10**

Take $g = 9{\cdot}8$ 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 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 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 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 ms^{-1}, where $v = \frac{1}{2}t^2 - 4t + 10$. Calculate

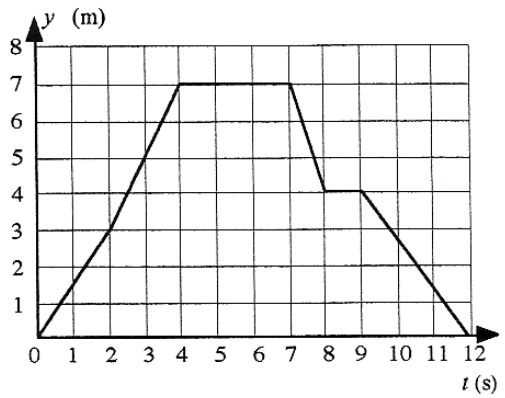
   (i) the velocity of P 6 seconds after it passes O, [1]

   (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. $108 \text{ km h}^{-1} = 30 \text{ ms}^{-1}$ $a = 30 \div 7{\cdot}5 = 4 \text{ ms}^{-2}$ 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) $250 = \frac{1}{2}(17 + 33)t$ $t = 500 \div 50 = 10$ s M1 A1 A1
   (ii) $v = u + at$: $33 = 17 + 10a$ $a = 1{\cdot}6 \text{ ms}^{-2}$ M1 A1
   (iii) $s = \frac{1}{2}(33 + 0) \times 6 = 99$ m M1 A1 7

4. Resolve horizontally : $F \cos 30° = 2 \cos 45° + 0{\cdot}25R$ M1 A1
   Resolve vertically : $R + 2 \sin 45° + F \sin 30° = 0{\cdot}3g$ M1 A1
   $0{\cdot}866F = 1{\cdot}414 + 0{\cdot}25(0{\cdot}3g - 1{\cdot}414 - 0{\cdot}5F)$ M1 A1
   $0{\cdot}991F = 1{\cdot}796$ $F = 1{\cdot}81$ A1 7

5. (i) $F = ma$ for R : $0{\cdot}5g - 2 = 0{\cdot}5a$ $a = 5{\cdot}8 \text{ ms}^{-2}$ M1 A1 A1
   (ii) $T - 0{\cdot}1g = 0{\cdot}1a$ $T = 0{\cdot}58 + 0{\cdot}98 = 1{\cdot}56$ N M1 A1
   $2 - T = ma$ $5{\cdot}8m = 0{\cdot}44$ $m = 0{\cdot}0759$ 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 $= 3 \text{ ms}^{-2}$ M1 A1 A1
   (iii) When $a = 0$, $t = 4$ $v(4) = 8 - 16 + 10 = 2 \text{ ms}^{-1}$ M1 A1 A1
   (iv) $s = \int_3^4 v \, dt = [\frac{1}{6}t^3 - 2t^2 + 10t]_3^4 = 18{\cdot}67 - 16{\cdot}5 = 2{\cdot}17$ m M1 A1 A1 M1 A1 12

7. (i) (a) $1{\cdot}5 \text{ ms}^{-1}$ (b) $-1\frac{1}{3} \text{ ms}^{-1}$ B1 B1
   (ii) 2×7 m $= 14$ 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 $= 3 \text{ ms}^{-1}$ M1 A1 A1 13