Forces

SCAN ME

REVISE THIS TOPIC

1 A particle P has mass 4 kg.

The particle is pulled along a rough horizontal surface by a horizontal force of magnitude 30 N against a constant friction force of magnitude 8 N.

(a) Find

(i) the weight of P. **(1)**

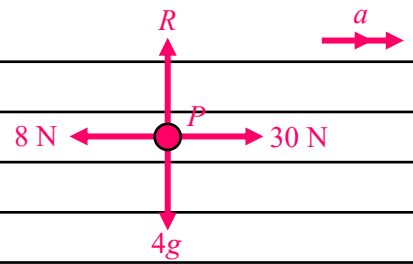
(ii) the magnitude of the normal reaction force between P and the surface. **(1)**

(iii) the acceleration of P. **(2)**

(b) Given that P starts from rest, find

(i) the distance travelled by P in the first 4 seconds. **(2)**

(ii) the speed of P after 4 seconds. **(1)**



(a) (i) $W = mg$

$W = 4 \times 9.8$

$W = \mathbf{39.2\ N}$

(ii) **39.2 N**

(iii) $F = ma$

$30 - 8 = 4a$

$22 = 4a$

$a = \mathbf{5.5\ ms^{-2}}$

(b) (i) $s = s$ $\quad s = ut + \frac{1}{2}at^2$

$u = 0$ $\quad s = (0)(4) + \frac{1}{2}(5.5)(4)^2$

$v = v$ $\quad s = \mathbf{44\ m}$

$a = 5.5$

$t = 4$

(ii) $v = u + at$

$v = 0 + 5.5(4)$

$v = \mathbf{22\ ms^{-1}}$

(Total for Question 1 is 7 marks)

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2 The mass of particle P is h kg and the mass of particle Q is $5h$ kg, where h is a constant.

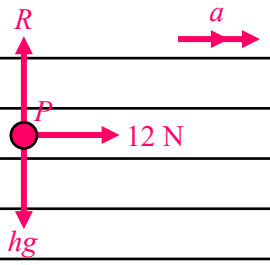
Particle P moves on a smooth horizontal surface under the action of a single horizontal force of magnitude 12 N.

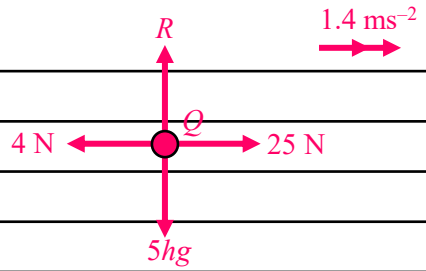
Particle Q moves on a rough horizontal surface under the action of a horizontal force of magnitude 25 N and a frictional force of magnitude 4 N.

(a) Given that the acceleration of Q is 1.4 ms^{-2}, find
(i) the value of h. **(2)**
(ii) the acceleration of P. **(2)**

At the instant when the force of magnitude 12 N is first applied to P, P is moving with speed 5 ms^{-1}, in the direction of the force.

(b) Find the distance travelled by P in the first 3 seconds after the force is applied. **(2)**





(a) (i) $F = ma$

$25 - 4 = (5h) \times 1.4$

$21 = 7h$

$h = 3$

(ii) $F = ma$

$12 = h \times a$

$12 = 3a$

$a = \mathbf{4\ ms^{-2}}$

(b) $s = s$ $\quad s = ut + \frac{1}{2}at^2$

$u = 5$ $\quad s = (5)(3) + \frac{1}{2}(4)(3)^2$

$v = v$ $\quad s = \mathbf{33\ m}$

$a = 4$

$t = 3$

(Total for Question 2 is 6 marks)

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3 A particle P, of mass 6 kg is moving along a rough horizontal surface.

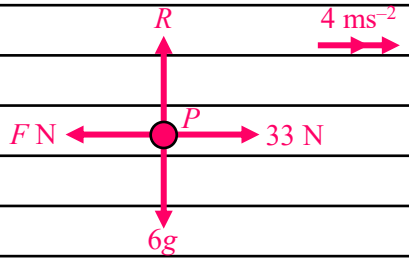
A horizontal force of magnitude 33 N acts on P in the direction of motion.

(a) Given that P accelerates at 4 ms^{-2}, find the magnitude of the frictional force acting on P. **(2)**

When P reaches a speed of 12 ms^{-1}, the horizontal force of magnitude 33 N is removed.

(b) Assuming that the frictional force remains constant, find the time taken for P to come to rest. **(3)**

(a)



$F = ma$

$33 - F = 6 \times 4$

$33 - F = 24$

$33 - 24 = F$

$F =$ **9 N**

(b) $F = ma$

$-9 = 6a$

$a = -1.5$ ms^{-2}

$s = s$	$v = u + at$
$u = 12$	$0 = 12 - 1.5t$
$v = 0$	$1.5t = 12$
$a = -1.5$	$t =$ **8 seconds**
$t = t$	

(Total for Question 3 is 5 marks)

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4 A particle P is moving horizontally at a constant speed of 8 ms^{-1}.

A horizontal force of magnitude 90 N acts on P in the direction of motion.
A constant resistance force of magnitude k N also acts on P.

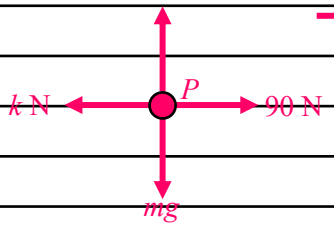
(a) Find the value of k. **(1)**

The horizontal force is then increased to 150 N while the resistance force remains constant.
P accelerates uniformly and reaches a speed of 14 ms^{-1} after 3 seconds.

(b) Find the acceleration of P. **(2)**

(c) Find the mass of P. **(2)**

(a)



$F = ma$

$90 - k = m \times 0$

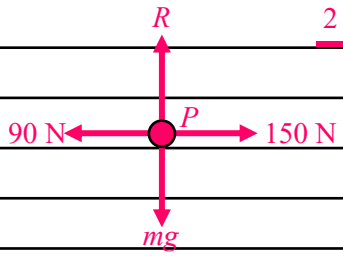
$90 - k = 0$

$k = \mathbf{90}$

(b)

$s = s$	$v = u + at$
$u = 8$	$14 = 8 + 3a$
$v = 14$	$6 = 3a$
$a = a$	$a = \mathbf{2\ ms^{-2}}$
$t = 3$	

(c)



$F = ma$

$150 - 90 = m \times 2$

$60 = 2m$

$m = \mathbf{30\ kg}$

(Total for Question 4 is 5 marks)

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5 A lift of mass 800 kg is attached to a vertical cable.

The lift starts from rest and accelerates vertically upwards at 1.5 ms^{-2} for 4 seconds.

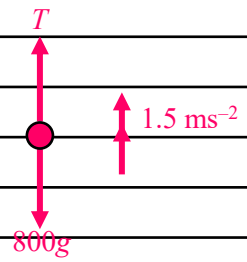
(a) Find the tension in the cable during these 4 seconds. **(2)**

(b) Find the speed of the lift after 4 seconds. **(1)**

The lift then continues to move vertically upwards but decelerates uniformly, coming to rest 3 seconds later.

(c) Find the tension in the cable during the 3 seconds when the lift decelerates. **(3)**

(a)



$F = ma$

$T - 800g = 800 \times 1.5$

$T - 7840 = 1200$

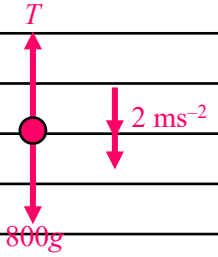
$T =$ **9040 N**

(b)

$s = s$	$v = u + at$
$u = 0$	$v = 0 + (1.5)(4)$
$v = v$	$v =$ **6 ms^{-1}**
$a = 1.5$	
$t = 4$	

(c)

$s = s$	$v = u + at$
$u = 6$	$0 = 6 + 3a$
$v = 0$	$3a = -6$
$a = a$	$a =$ **-2 ms^{-2}**
$t = 3$	



$F = ma$

$800g - T = 800 \times 2$

$7840 - T = 1600$

$7840 - 1600 = T$

$T =$ **6240 N**

(Total for Question 5 is 6 marks)

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6 A car of mass 1200 kg is travelling at 10 ms^{-1} along a straight horizontal road.

The car accelerates uniformly and reaches a speed of 22 ms^{-1} after travelling 96 m.

A constant resistance of 500 N acts on the car.

(a) Find the acceleration of the car. **(2)**

(b) Find the driving force acting on the car. **(2)**

The driver applies the brakes. The driving force is removed and the brakes exert an additional force of 2500 N opposing the motion of the car. The resistance force remains constant at 500 N.

(c) Find the magnitude of the deceleration of the car. **(2)**

(d) Find the distance travelled by the car before it comes to rest. **(2)**

(a) $s = 96$ $v^2 = u^2 + 2as$

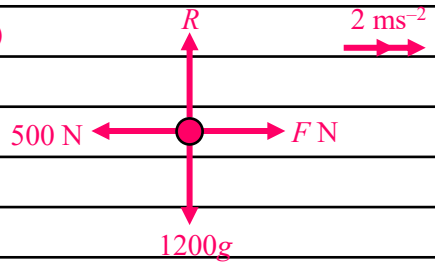
$u = 10$ $(22)^2 = (10)^2 + 2a(96)$

$v = 22$ $484 = 100 + 192a$

$a = a$ $384 = 192a$

$t = t$ $a = \mathbf{2\ ms^{-2}}$

(b)

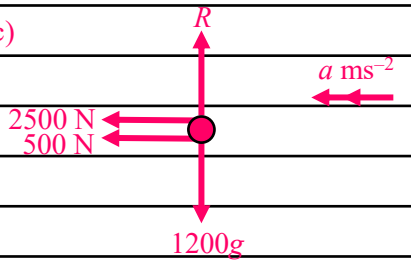


$F - 500 = 1200 \times 2$

$F - 500 = 2400$

$F = \mathbf{2900\ N}$

(c)



$2500 + 500 = 1200 \times a$

$3000 = 1200a$

$a = \mathbf{2.5\ ms^{-2}}$

(d) $s = s$ $v^2 = u^2 + 2as$

$u = 22$ $(0)^2 = (22)^2 + 2(-2.5)s$

$v = 0$ $0 = 484 - 5s$

$a = -2.5$ $5s = 484$

$t = t$ $s = \mathbf{96.8\ m}$

(Total for Question 6 is 8 marks)

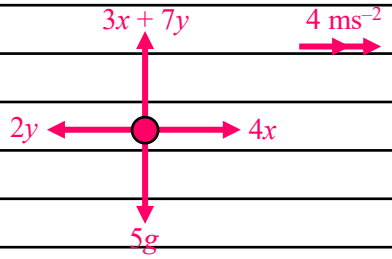
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7 A particle P, of mass 5 kg is moving along a rough horizontal surface.

A horizontal force of magnitude $4x$ N acts on P in the direction of motion. The frictional force acting on P has magnitude $2y$ N, where x and y are constants.

The magnitude of the normal reaction on P is $(3x + 7y)$ N.

Given that P accelerates at 4 ms^{-2}, find the values of x and y.



Normal Reaction = weight

$3x + 7y = 5 \times 9.8$

$3x + 7y = 49$

$F = ma$

$4x - 2y = 5 \times 4$

$4x - 2y = 20$

$3x + 7y = 49$

$4x - 2y = 20$

Solving simultaneous equations using calculator gives

$x = 7$ $y = 4$

(Total for Question 7 is 4 marks)

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8 A ball is falling vertically.

When $t = 3$,

- the weight of the ball is $2c^2$ N, where c is a constant
- the air resistance has magnitude $(17c - 30)$ N
- the acceleration of the ball is 0 ms^{-2}
- the speed of the ball is 30 ms^{-1}
- the ball is 18 m above the ground.

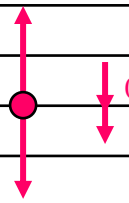
(a) Find two possible values of c. **(3)**

(b) Given that the mass of the ball is less than 2 kg, find the mass of the ball. **(2)**

After $t = 3$, the acceleration of the ball remains 0 ms^{-2}

(c) find the value of t when the ball hits the ground. **(2)**

(a)



$F = ma$

$2c^2 - (17c - 30) = m \times 0$

$2c^2 - 17c + 30 = 0$

$(2c - 5)(c - 6) = 0$

$c = 2.5 \quad c = 6$

(b) $W = mg$

$2c^2 = m \times 9.8$

$m = \frac{2c^2}{9.8}$

If $c = 2.5$ $\quad m = \frac{2(2.5)^2}{9.8} = 1.275510204$ kg

If $c = 6$ $\quad m = \frac{2(6)^2}{9.8} = 7.346938776$ kg

$m < 2$ so $m =$ **1.3 kg**

(c) $s = 18$

$u = 30$

$v = v$

$a = 0$

$t = t$

$s = ut + \frac{1}{2}at^2$

$18 = 30t + \frac{1}{2}(0)t^2$

$18 = 30t$

$t = 0.6$ seconds to hit the ground from when $t = 3$

$t = 3 + 0.6$

$t =$ **3.6 seconds**

(Total for Question 8 is 7 marks)

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