1.

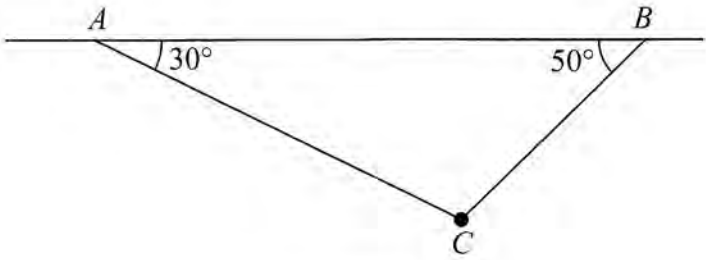


Figure 1

A particle of weight W newtons is attached at C to two light inextensible strings AC and BC. The other ends of the strings are attached to fixed points A and B on a horizontal ceiling. The particle hangs in equilibrium with AC and BC inclined to the horizontal at 30° and 50° respectively, as shown in Figure 1.

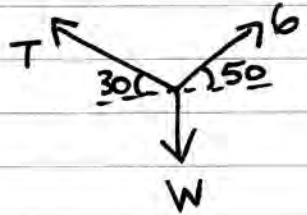
Given that the tension in BC is 6 N, find

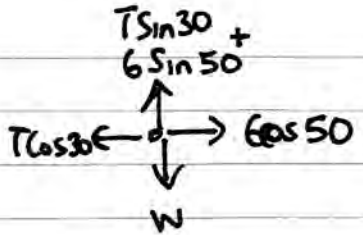
(a) the tension in AC,

(3)

(b) the value of W.

(3)





a) $\therefore T\cos 30 = 6\cos 50$

$T = 4.45N$ →

b) $\therefore W = \frac{1}{2}T + 6\sin 50$

$W = 6.82N$ ↑

2.

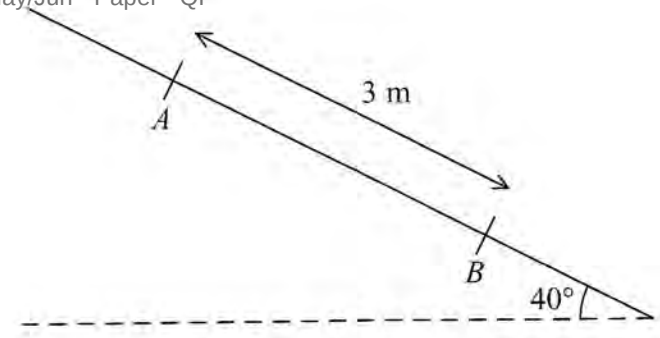


Figure 2

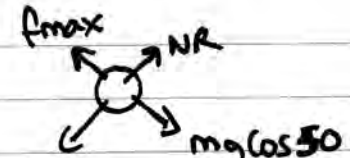
A rough plane is inclined at 40° to the horizontal. Two points A and B are 3 metres apart and lie on a line of greatest slope of the inclined plane, with A above B, as shown in Figure 2. A particle P of mass m kg is held at rest on the plane at A. The coefficient of friction between P and the plane is $\frac{1}{2}$. The particle is released.

(a) Find the acceleration of P down the plane.

(5)

(b) Find the speed of P at B.

(2)



$NR = mg\cos 40 \quad \therefore f_{max} = \mu NR$

$f_{max} = \frac{1}{2} mg\cos 40$

$R \uparrow \; ma \Rightarrow mg\cos 50 - \frac{1}{2} mg\cos 40 = ma$

$\therefore a = 2.5457\ldots$

$a = 2.55$ (3sf) →

b) $s = 3$
$u = 0$
v
$a = 2.5457\ldots$
t

$v^2 = u^2 + 2as \quad v^2 = 2(2.5457\ldots)3$

$\therefore v = 3.91$ (3sf)
2

3. A ball of mass 0.3 kg is released from rest at a point which is 2 m above horizontal ground. The ball moves freely under gravity. After striking the ground, the ball rebounds vertically and rises to a maximum height of 1.5 m above the ground, before falling to the ground again. The ball is modelled as a particle.

(a) Find the speed of the ball at the instant before it strikes the ground for the first time.

(2)

(b) Find the speed of the ball at the instant after it rebounds from the ground for the first time.

(2)

(c) Find the magnitude of the impulse on the ball in the first impact with the ground.

(2)

(d) Sketch, in the space provided, a velocity-time graph for the motion of the ball from the instant when it is released until the instant when it strikes the ground for the second time.

(3)

(e) Find the time between the instant when the ball is released and the instant when it strikes the ground for the second time.

(4)

a) $s = 2 \downarrow$ $\quad u = 0$ $\quad v$ $\quad a = 9.8 \downarrow\downarrow$ $\quad t$

$v^2 = u^2 + 2as \Rightarrow v^2 = 2(9.8)2$

$\therefore v = 2\sqrt{g} = 6.26099\ldots \quad 6.26$ (2)

b) $s = 1.5 \uparrow$ $\quad u$ $\quad v = 0$ $\quad a = -9.8 \uparrow\uparrow$ $\quad t$

$v^2 = u^2 + 2as \Rightarrow 0 = u^2 - 2(9.8)(1.5)$

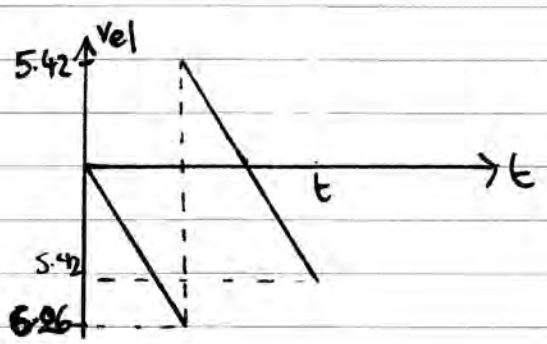
$\therefore u = \sqrt{3g} = 5.42$ (2)

c) Initial mom $= 0.3 \times 2\sqrt{g} = 1.878\ldots$

final mom $= 0.3 \times -\sqrt{3g} = -1.62665\ldots$

$\therefore$ Impulse $= 3.5$ (2)

d) let upwards = +vel



e) from part (a) suvat $v = u + at$ $6.26 = 9.8t$ $\therefore t = 0.638877$
time taken to hit ground the first time.

ii) $s = 0$ $\quad s = ut + \frac{1}{2}at^2$
$u = \sqrt{3g}$ $\quad 0 = \sqrt{3g}\,t - 4.9t^2$
v
$a = -9.8$ $\quad 0 = t(\sqrt{3g} - 4.9t)$ $\quad t = \frac{\sqrt{3g}}{4.9} = 1.106567$
t $\quad t = 0$

$\therefore$ total time $= 1.75$ sec