1. A particle of mass 0.5 kg is projected vertically upwards from ground level with a speed of 20 m s^{-1}. It comes to instantaneous rest at a height of 10 m above the ground. As the particle moves it is subject to air resistance of constant magnitude R newtons. Using the work-energy principle, or otherwise, find the value of R.

(Total 6 marks)

2. A parcel of mass 2.5 kg is moving in a straight line on a smooth horizontal floor. Initially the parcel is moving with speed 8 m s^{-1}. The parcel is brought to rest in a distance of 20 m by a constant horizontal force of magnitude R newtons. Modelling the parcel as a particle, find

(a) the kinetic energy lost by the parcel in coming to rest,

(2)

(b) the value of R.

(3)
(Total 5 marks)

3. A particle P is projected up a line of greatest slope of a rough plane which is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The coefficient of friction between P and the plane is $\frac{1}{2}$.

The particle is projected from the point O with a speed of 10 m s^{-1} and comes to instantaneous rest at the point A.

By using the Work-Energy principle, or otherwise,

(a) find, to 3 significant figures, the length OA.

(7)

(b) Show that P will slide back down the plane.

(3)

(c) Find, to 3 significant figures, the speed of P when it returns to O.

(5)
(Total 15 marks)

1. $\frac{1}{2} \times 0.5 \times 20^2$; $0.5g \times 10$ B1 B1

$10R = \frac{1}{2} \times 0.5 \times 20^2 - 0.5g \times 10$ M1 A1

$\Rightarrow R = 5.1$ DM1 A1

[6]

2. (a) KE lost is $\frac{1}{2} \times 2.5 \times 8^2 = 80$ (J) M1A1 2

(b) Work energy $80 = R \times 20$ ft their (a) M1A1ft

$R = 4$ A1 3

Alternative

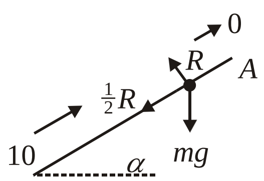
$0^2 = 8^2 - 2 \times a \times 20 \Rightarrow a = (-)1.6$

N2L $R = 2.5 \times 1.6$ ft their $a = 4$ M1 A1

$= 4$ A1 3

[5]

3. (a)

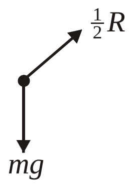


R (↖), $R = mg \cos \alpha = \frac{4}{5} mg$ M1 A1

$\frac{2}{5} mgd = \frac{1}{2} m \times 10^2 - mgd \sin \alpha$ M1 A3

$OA = d = \frac{50}{g} = 5.10$ m (3 s.f.) A1 7

(b)



At A, component of weight down plane =

$mg \sin \alpha = \frac{3mg}{5}$ B1

limiting friction up = $\frac{2mg}{5}$ B1

$\therefore$ slides down as $\frac{3mg}{5} > \frac{2mg}{5}$ M1 3

Work done against friction = KE loss

$2 \times \frac{2mg}{5} \times \frac{50}{g} = \frac{1}{2} m (10^2 - v^2)$ M1 A3

$v = \sqrt{20} = 4.47 \text{ m s}^{-1}$ A1 5

[15]

1. Most candidates showed a sound understanding of the mechanics involved in this question and gave a completely correct solution. Although candidates were allowed the choice of method, the work energy method was by far the most popular approach. Some candidates went wrong by considering both the change in potential energy and the work done against the weight. Some were clearly confused, and offered inconsistent equations involving forces and energy, usually because they had omitted the distance when considering the work done against the resistance. The alternative method of finding the acceleration and then using $F = ma$ was equally successful. The most common error was an incorrect sign in the equation of motion.

2. This proved to be a very straightforward "starter" for most candidates and full marks were generally scored. Where students lost marks this was usually due to a lack of appreciation that the kinetic energy lost and the value of R should both have been positive. The methods used for part (b) were divided equally between the method using work done against R and the method of calculating the acceleration. A small minority of students became confused about the nature of the horizontal force acting in part (b), and duplicated the force by considering the sum of both work-energy and Newton's 2nd law. It was not uncommon to see candidates using their own notation, with F frequently being used for R. Many candidates gave the final answer as 4 N rather than the number 4.

3. No Report available for this question.