Support Worksheet – Topic 2, Worksheet 4

1 A ball moves on a horizontal table and then falls off. The height of the table is 0.80 m from the floor. Calculate the time it takes the ball to fall to the floor. (Ignore air resistance and take $g = 9.8\ \text{m s}^{-2}$.) [2]

2 For question **1** the speed of the ball as it leaves the table is $4.6\ \text{m s}^{-1}$. Calculate the horizontal distance travelled by the ball when it lands on the floor. (Ignore air resistance and take $g = 9.8\ \text{m s}^{-2}$.) [1]

3 A ball is launched with speed $18\ \text{m s}^{-1}$ at an angle of 54° above the horizontal. Calculate

a the maximum height reached by the ball. [2]

b the horizontal distance travelled by the ball. (Ignore air resistance and take $g = 9.8\ \text{m s}^{-2}$.) [2]

4 A projectile is launched with speed $28\ \text{m s}^{-1}$ at an angle of 38° above the horizontal from the edge of a cliff. The cliff is 45 m above sea level. Calculate (ignore air resistance and take $g = 9.8\ \text{m s}^{-2}$.)

a the maximum height reached by the ball. [2]

b the time to reach the maximum height. [1]

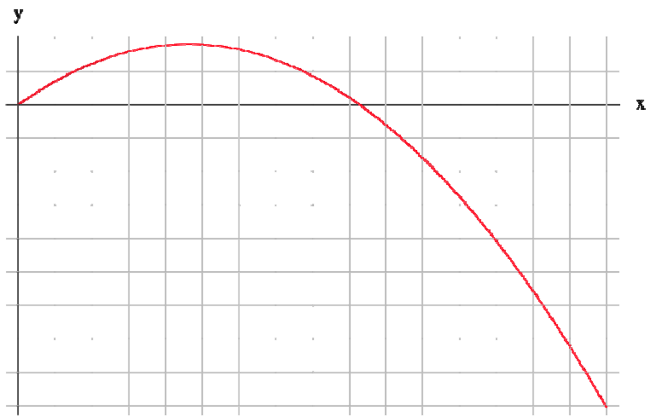
c the horizontal distance travelled by the ball as it lands into the sea. [2]

5 For question **4**, make graphs to show the variation with time of

a the horizontal component of velocity. [1]

b the vertical component of velocity. [2]

6 The graph below shows the path of the projectile of question **4**.



On the same axes draw the expected path of this projectile in the presence of air resistance. [2]

Copyright Cambridge University Press 2012. All rights reserved.

7 Two point particles each of mass M are separated by a distance r. Calculate, for the mid-point of the line joining the particles, the value of

a the gravitational potential [1]

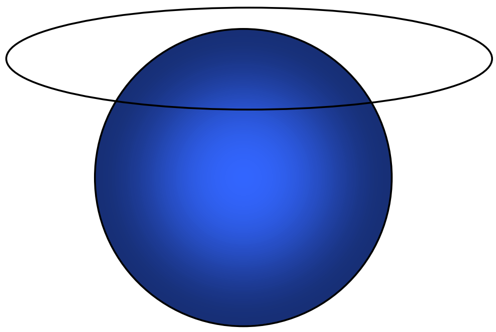
b the magnitude of the gravitational field strength. [1]

8 The mass of the moon is about 81 times less than the mass of the Earth. The magnitude of the gravitational field strength is zero at a point on the line joining the Earth to the moon. The distance of this point from the centre of the Earth is r_1 and from the centre of the moon it is r_2. Determine the ratio $\frac{r_1}{r_2}$. [2]

9 **a** A satellite orbits a planet of mass M and radius R in a grazing orbit i.e. an orbit of radius $r = R$. Show that the period of revolution of the satellite is given by $T = 2\pi\sqrt{\frac{R}{g}}$ where g is the gravitational field strength at the surface of the planet. [2]

b For Earth $R = 6.4 \times 10^6$ m and $g = 9.8\ \text{N kg}^{-1}$. Evaluate the period in **a**. [1]

10 It is proposed to put a satellite in orbit around the Earth as shown in the diagram.



Discuss whether this is possible. [2]

11 A satellite orbits a planet of mass M in an orbit of radius r.

a Show that the speed v of the satellite is given by $v = \sqrt{\frac{GM}{r}}$. [2]

b Using your answer to **a** derive an expression for the kinetic energy of the satellite. [1]

c Hence show that the total energy of the satellite is given by $E = -\frac{GMm}{2r}$. [1]

12 **a** By reference to the formula for the total energy of a satellite in orbit, explain why a frictional force opposing the motion of a satellite will bring the satellite closer to the Earth. [2]

b Hence deduce that the satellite's kinetic energy will increase. [1]

c Explain where the extra kinetic energy comes from. [1]

Copyright Cambridge University Press 2012. All rights reserved.