Revision - Projectiles 1

1.

A ski jumper skis down a runway and projects himself into the air, landing on the ground a short time later. The mass of the ski jumper and his equipment is 80 kg. Fig. 5.1 shows the skier just before he leaves the runway where his velocity is 20 m s^{-1} in a horizontal direction.

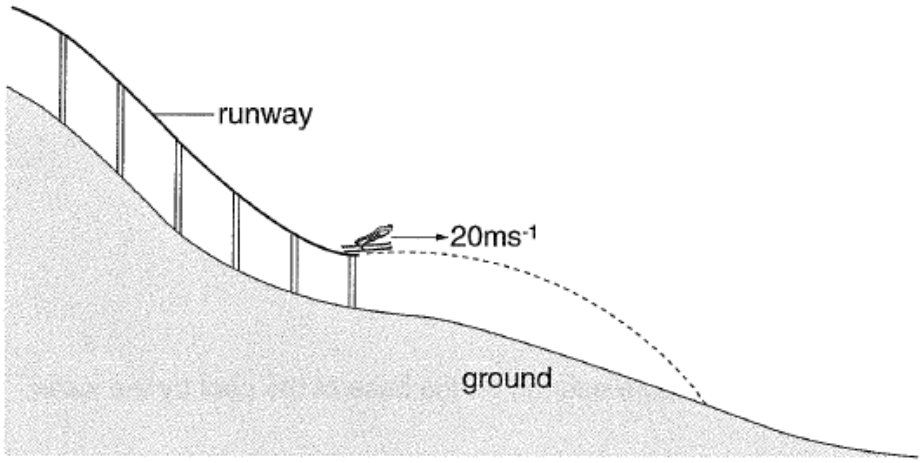

Fig. 5.1

(a) The skier lands 4.0 s after leaving the runway. Assume that only a gravitational force acts on the skier. Calculate

(i) the horizontal distance travelled by the skier in 4.0 s

horizontal distance = ... m [1]

(ii) the vertical fall of the skier in this 4.0 s

vertical fall = ... m [3]

(iii) the horizontal component of the skier's velocity immediately before he lands

horizontal component = ...$m\,s^{-1}$ [1]

(iv) the vertical component of the skier's velocity immediately before he lands.

vertical component = ... $m\,s^{-1}$ [2]

(b) (In this question, marks are available for the quality of written communication.)

Take **all** the forces that act on the skier into account.

(i) State the forces that act on the skier when he is in the air.

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..... [2]

(ii) Discuss the energy changes that occur as the skier travels down the runway and explain how the skier attempts to increase the horizontal distance he travels before landing on the ground.

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[7]

2.

Fig. 2.1 shows the path of water from a hose pipe.

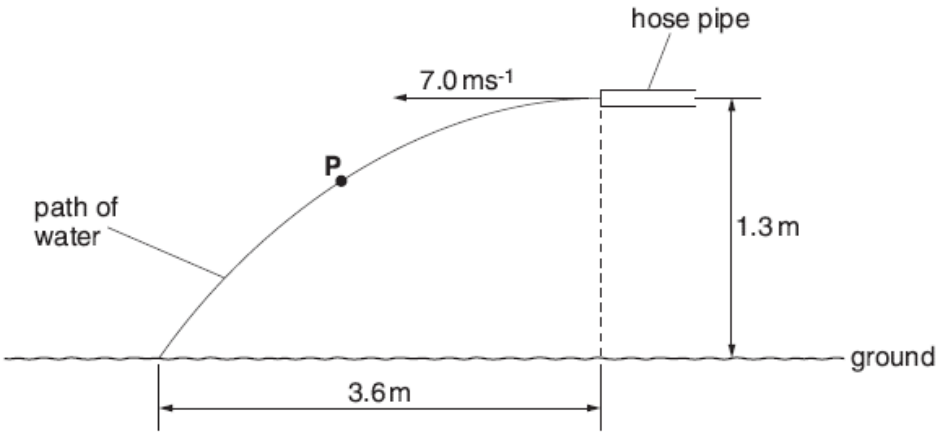

Fig. 2.1

The end of the horizontal hose pipe is at a height of 1.3 m from the ground. The initial horizontal velocity of the water is 7.0 m s^{-1}. The horizontal distance from the end of the hose pipe to the point where the water hits the ground is 3.6 m. You may assume that air resistance has negligible effect on the motion of the water jet.

(a) On Fig. 2.1, draw an arrow to show the direction of the acceleration of the water at point **P**. (Mark this arrow **A**). **[1]**

(b) Describe the energy conversion that takes place as the water travels from the end of the hose pipe to the ground.

In your answer, you should use appropriate technical terms, spelled correctly.

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..... **[2]**

(c) Explain why the horizontal component of the velocity remains constant at 7.0 m s^{-1}.

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..... **[1]**

(d) Show that the water takes about 0.5 s to travel from the end of the pipe to the ground.

[1]

(e) Show that the speed of the water when it hits the ground is $8.6\,m\,s^{-1}$.

[3]

3.

A small block of wood is held at a horizontal distance of 1.2 m from a metal ball. The metal ball is fired horizontally towards the block at a speed of $8.0\,m\,s^{-1}$. At the same instant the ball is fired, the block is released and it falls vertically under gravity.

Fig. 8.1 shows the paths of the metal ball and the block. The ball collides with the block. Air resistance is negligible.

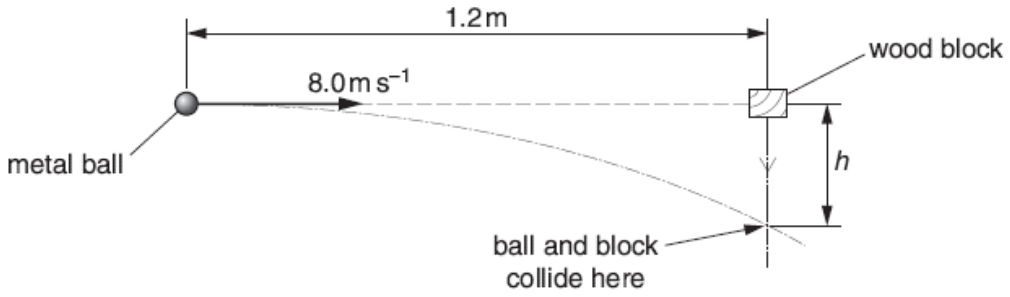

Fig. 8.1

(a) Show that the time between firing the ball and it colliding with the block is 0.15 s.

[1]

(b) Calculate the vertical distance *h* fallen by the wooden block when it collides with the metal ball.

h = ... m **[2]**

(c) Briefly explain why the metal ball will always collide with the wood block, even if the speed of the ball or the horizontal distance is changed.

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..... **[1]**

4.

Fig. 2.1 shows the path of a metal ball fired at a velocity of $24\,m\,s^{-1}$ at an angle of 30° to the horizontal.

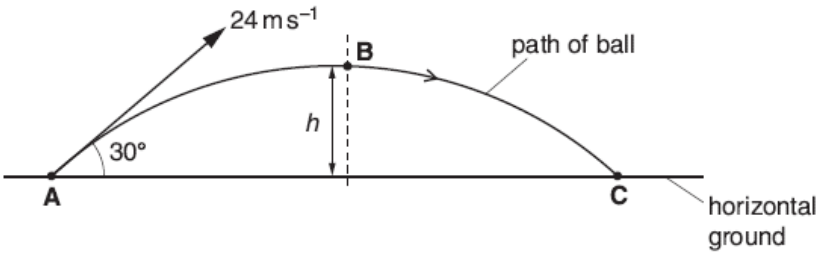

Fig. 2.1

Air resistance has negligible effect on the motion of the metal ball. The ball is fired from point **A** and it reaches its maximum height at point **B**. The mass of the ball is 450g.

(a) State the direction of the acceleration of the ball during its flight.

..... **[1]**

(b) Calculate the horizontal and vertical components of the velocity of the ball at **A**.

horizontal velocity = ... $m\,s^{-1}$

vertical velocity = ... $m\,s^{-1}$ **[2]**

(c) Explain why the gravitational potential energy gained by the ball as it moves from **A** to **B** is not equal to its initial kinetic energy at **A**.

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..... **[1]**

(d) Calculate the maximum vertical height *h* of the ball.

h = ... m **[3]**

5.

(a) Fig. 4.1 shows the path of a tennis ball after bouncing on the ground at **A** and hitting a vertical wall at **B**.

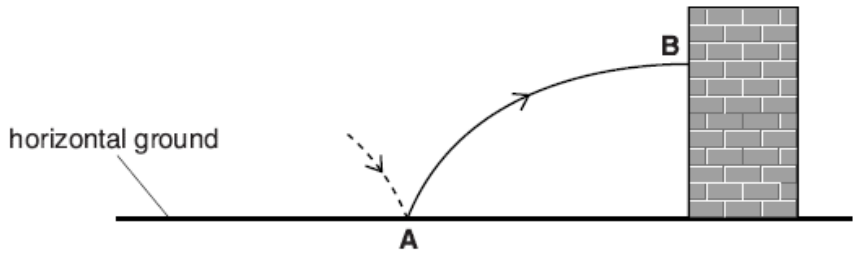

Fig. 4.1

The ball is travelling horizontally as it hits the wall at **B**. Air resistance has negligible effect on the motion of the ball.

(i) Explain why the horizontal component of the velocity of the ball remains constant as it moves from **A** to **B**.

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..... **[1]**

(ii) The ball loses some of its kinetic energy when it hits the wall at **B**. It leaves the wall horizontally.

1 On Fig. 4.1, sketch the path of the ball between bouncing at the wall and hitting the ground.

2 Explain how the time taken for the ball to travel from **A** to **B** compares with the time it takes to travel from **B** to the ground.

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[3]

(b) A student is given a metre rule, a stopwatch and a tennis ball.
Explain how this equipment can be used to determine an **approximate** value for the acceleration *g* of free fall.

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..... **[3]**

(c) Fig. 4.2 shows a tennis ball moving up a smooth ramp at time $t = 0$.

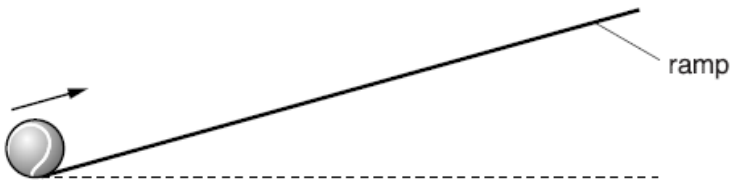

Fig. 4.2

Fig. 4.3 shows a graph of velocity *v* against time *t* for this ball.

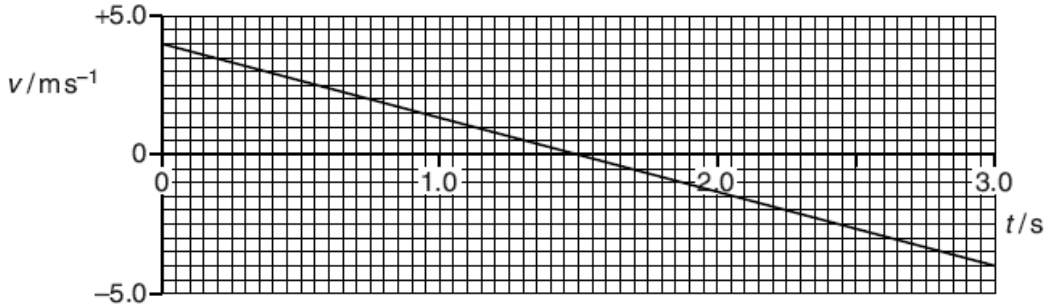

Fig. 4.3

(i) Describe, without calculation, the motion of the ball between $t = 0$ and $t = 3.0$ s.

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..... **[3]**

(ii) Calculate the maximum distance D travelled by the ball up the ramp.

$D =$ ..... m **[2]**