1)

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.

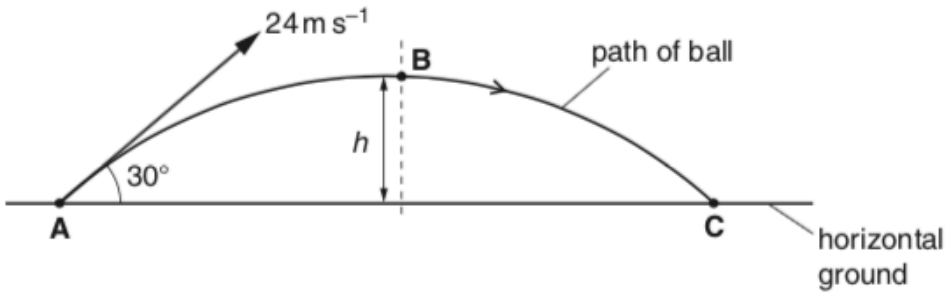

Fig. 2.1

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 450 g.

(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**.

.....

.....

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

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

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

[Total: 7]

2)

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

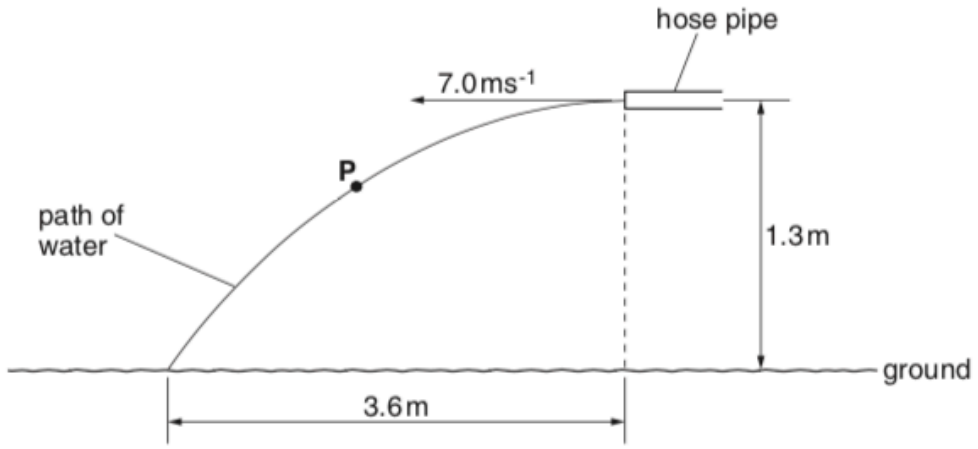

Fig. 2.1

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.

.....

.....

.....

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

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

.....

..... **[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]

[Total: 8]

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.

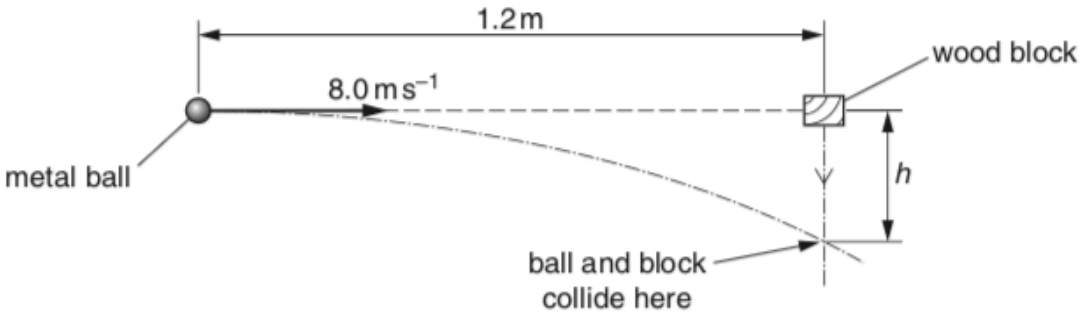

Fig. 8.1

(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.

.....

.....

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

[Total: 4]

4)

Fig. 2.2 shows a jet of water from the end of a hosepipe.

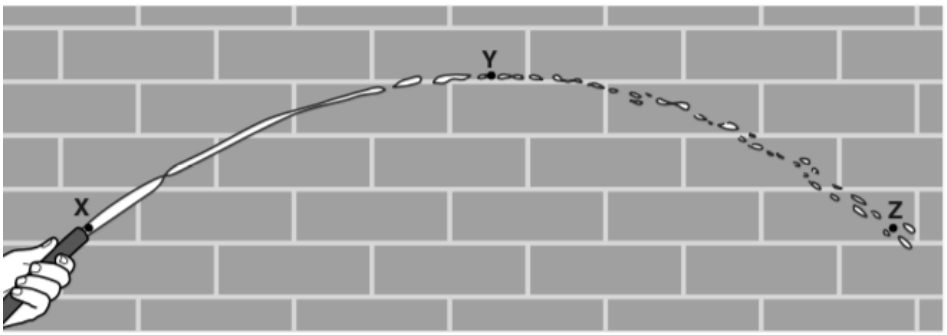

Fig. 2.2

Air resistance has negligible effect on the motion of the water jet. The water jet reaches maximum height at point **Y**.

(i) State the direction of the force acting on the water at **Y**.

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

(ii) Describe and explain how the horizontal component of the velocity of the water varies from point **X** to point **Y**.

.....

.....

.....

.....

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

(iii) Describe how the vertical component of the velocity of the water varies from point **X** to point **Z**.

.....

.....

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.....

.....

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

5)

Fig. 3.1 shows a stunt rider on a powerful motorbike at **X** at the top of a ramp.

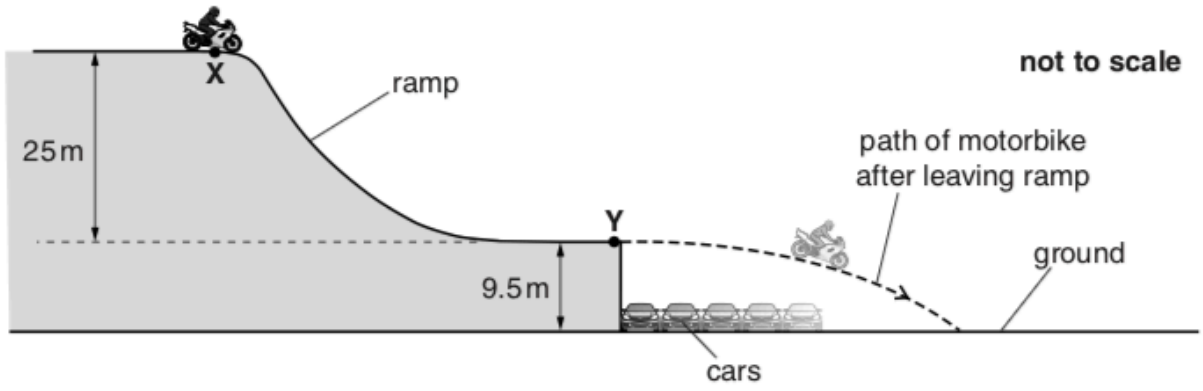

Fig. 3.1

The total mass of motorbike and rider is 190 kg. The height difference between the top and the bottom of the ramp is 25 m. The rider uses the engine to accelerate down the ramp. He leaves the end of the horizontal section of the ramp at **Y** with a speed of 30 m s^{-1}.

(a) Calculate the loss of gravitational potential energy E_p of the rider and motorbike from **X** to **Y**.

E_p = ... J **[1]**

(b) Calculate the kinetic energy E_k of the rider and motorbike at **Y**.

E_k = ... J **[1]**

(c) Explain why your answer to **(b)** is **greater** than your answer to **(a)**.

.....

.....

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

(d) The total distance travelled by the motorbike from **X** to **Y** along the ramp is 120 m. Calculate the average accelerating force that the motorbike engine provides along the ramp.

force = ... N **[2]**

(e) The end of the ramp at **Y** is at a height of 9.5 m above the ground. The motorbike travels through the air after leaving the ramp and flies over a number of cars lined up side by side. Assume air resistance has negligible effect on the motion of the rider and motorbike.

(i) Show that the time taken for the motorbike to travel from **Y** to the ground is 1.4 s.

[2]

(ii) Each of the cars has a width of 1.8 m. Estimate the number of cars the motorbike can clear.

number = ... **[2]**

6)

(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**.

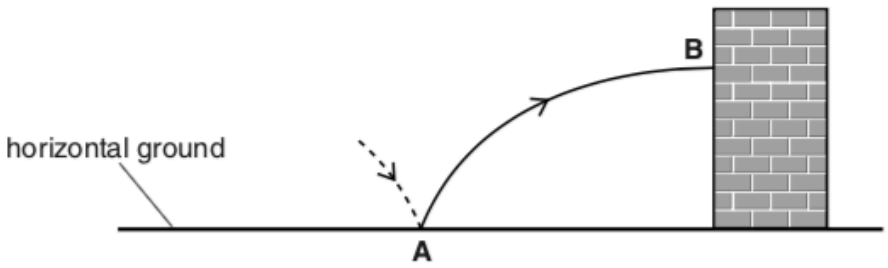

Fig. 4.1

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**.

.....

..... **[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.

.....

.....

.....

[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 $t = 0$.

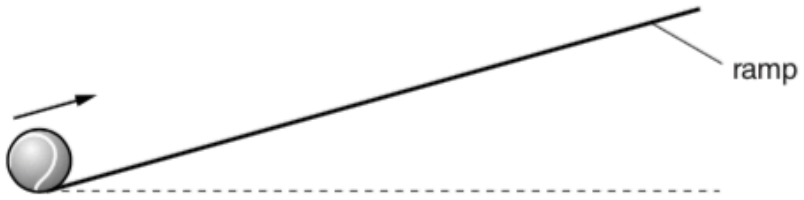

Fig. 4.2

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

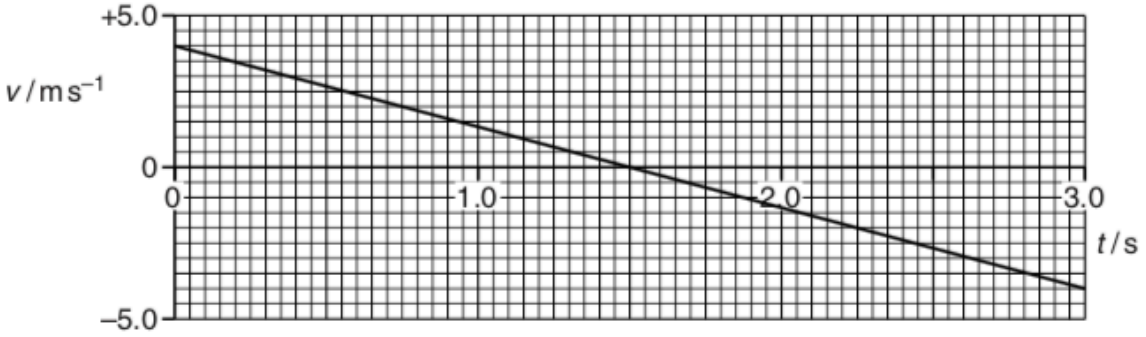

Fig. 4.3

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

.....

.....

.....

.....

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

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

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

[Total: 12]

7)

(a) A student holds a golf ball and a table tennis ball out of an upper window of a tall building. The balls are released at the same time. Both balls have the same size. The golf ball has a **greater mass** than the tennis ball. One of the balls reaches a greater terminal velocity.

(i) State and explain the acceleration of the golf ball immediately after it is released.

.....

.....

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

(ii) By referring to the forces acting on the golf ball, explain what is meant by *terminal velocity*.

.....

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

(iii) Explain which of the two balls reaches the greater terminal velocity.

.....

.....

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

(b) Fig. 5.1 shows a graph of drag D against speed v for a lorry.

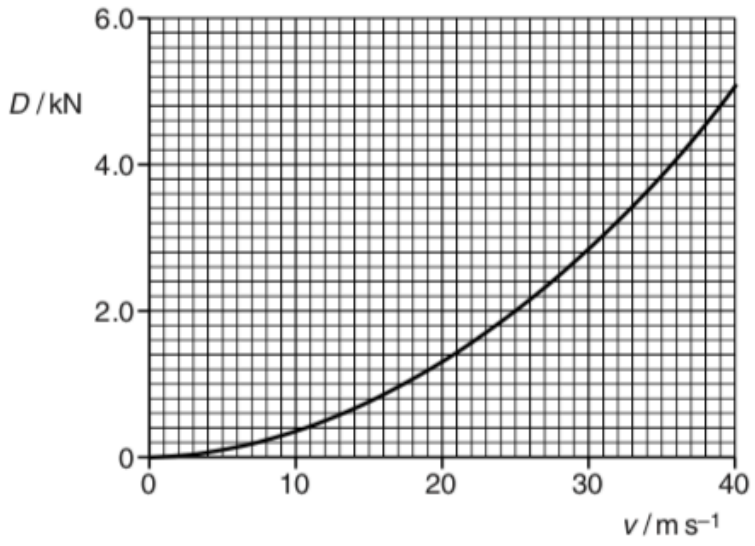

Fig. 5.1

The lorry has mass 8000 kg. Its engine provides a **constant** forward force of 3200 N.

(i) Calculate the instantaneous acceleration of the lorry when travelling on a level road at a speed of 25 $m s^{-1}$.

acceleration = ... $m s^{-2}$ **[3]**

(ii) Explain why this lorry cannot travel at a speed of 40 $m s^{-1}$ on a level road.

.....

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

(c) The lorry driver wears a seat belt. Describe and explain how a seat belt reduces the force on a driver during the impact in an accident.

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.....

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.....

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.....

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

[Total: 13]