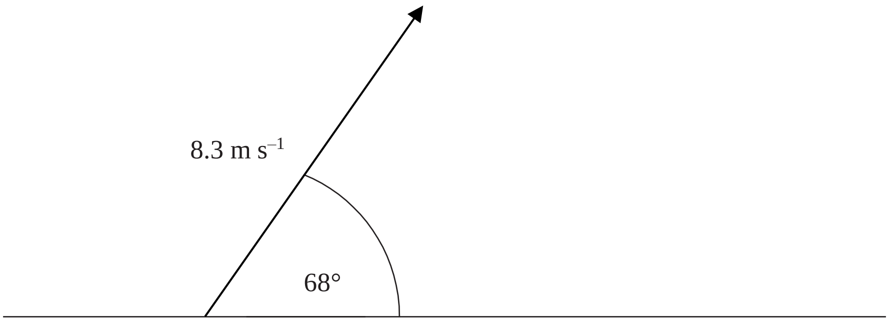
Stage 2 Physics

The following examination-style questions are suitable for assessing evidence of learning in **Topic 1**.

They do not constitute a complete test.

1. After bouncing, a ball leaves the ground with an initial velocity of $8.3\ \mathrm{m\,s^{-1}}$, at an angle of $68°$ above the horizontal, as shown in the diagram below.

   Ignore air resistance in all parts of this question.



[*This diagram is not drawn to scale.*]

(a) Show that the magnitude of the vertical component of the initial velocity is $7.7\ \mathrm{m\,s^{-1}}$.

(1 mark)

(b) Show that the time taken for the ball to reach its maximum height is $0.79\ \mathrm{s}$.

(2 marks)

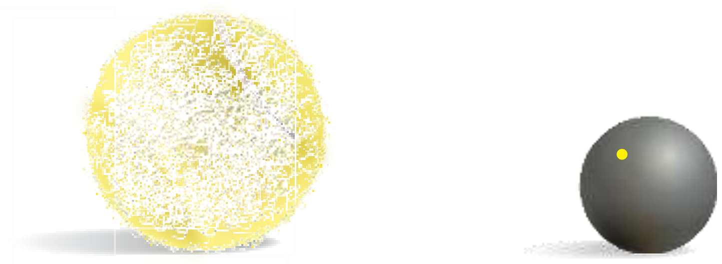
(c) Calculate the maximum height of the ball, after bouncing.

(3 marks)

(d) Calculate the range of the ball.

(3 marks)

2. A rough tennis ball and a smooth squash ball are shown in the diagram below.



tennis ball **squash ball**

[*This diagram is drawn to scale.*]

Source: Adapted from Tennis Shot | Vexels.com

Various properties of a ball affect the magnitude of the force of air resistance acting on the ball.

(a) Identify *one* property of a ball that affects the air resistance acting on it.

____ (1 mark)

(b) Compare how the property you identified in part (a) affects the air resistance acting on the tennis ball with how it affects the air resistance acting on the squash ball. Justify your answer.

____ (3 marks)

3. The photograph below shows a typical cycle-racing track, which has sections that are straight and sections that are banked curves.

Source: © Zhukovsky | Dreamstime

(a) Explain how a cyclist can travel around a banked curve without relying on friction.

(3 marks)

(b) A newly designed cycle-racing track (track 2) enables the cyclist to travel around a banked curve at a higher speed than on the old track 1, without relying on friction.

State *one* difference between the banked curve on track 2 and the banked curve on track 1 that enables the cyclist to travel at a higher speed. Justify your answer.

(3 marks)

4. The satellite *Luna 19* was put into a circular orbit of radius 1.9×10^6 m around the Moon in the 1970s.

Source: Adapted from © Svietlanan | Dreamstime

(a) The mass of the Moon is 7.3×10^{22} kg.

Show that the speed of *Luna 19* in orbit was 1.6×10^3 m s^{-1}.

(1 mark)

(b) Calculate the period of Luna 19.

(3 marks)

5. A spacecraft of mass 2.48×10^3 kg is at a distance of 5.62×10^4 m from Phobos, a natural satellite of Mars. The mass of Phobos is 1.07×10^{16} kg, and the mass of Mars is 6.42×10^{23} kg.

(a) Calculate the magnitude of the gravitational force that Phobos exerts on the spacecraft.

(3 marks)

(b) The spacecraft then travels to a location between Mars and Phobos where no net gravitational force acts on it.

[*This diagram is not drawn to scale.*]

(i) Explain why this location must be between Mars and Phobos.

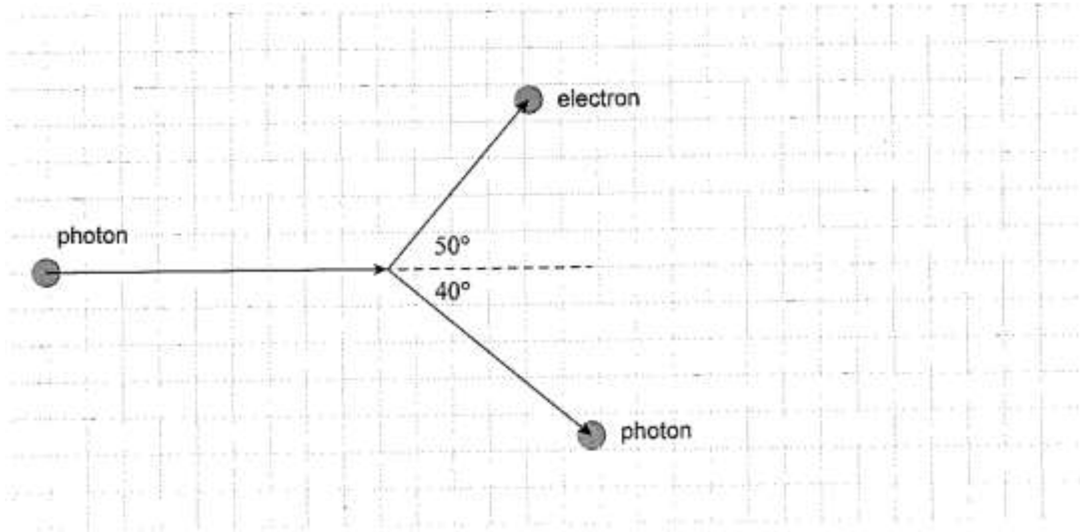
(2 marks)

(ii) Explain why this location must be closer to Phobos than it is to Mars.

(2 marks)

6. When a photon collides with an electron, momentum is transferred to the electron, and the frequency of the photon is reduced.

The diagram below shows the momentum vector of a photon before it collides with a stationary electron. The diagram also shows the momentum vectors of the electron and the photon after the collision.



(a) With the aid of a labelled vector diagram *that you draw on the grid above*, show that momentum is conserved in this collision.

(4 marks)

(b) The momentum of the photon after the collision is $3.55 \times 10^{-23}\,\mathrm{kg\ ms^{-1}}$.

Using the law of conservation of momentum, calculate the speed of the electron after the collision.

(4 marks)