An electron moves in circular motion in a uniform magnetic field.

The velocity of the electron at point P is $6.8 \times 10^5$ m s$^{-1}$ in the direction shown. The magnitude of the magnetic field is 8.5 T.

1a. State the direction of the magnetic field.  
1b. Calculate, in N, the magnitude of the magnetic force acting on the electron.  
1c. Explain why the electron moves at constant speed.
1d. Explain why the electron moves on a circular path. [2 marks]

A small ball of mass $m$ is moving in a horizontal circle on the inside surface of a frictionless hemispherical bowl.

The normal reaction force $N$ makes an angle $\theta$ to the horizontal.

2a. State the direction of the resultant force on the ball. [1 mark]

2b. On the diagram, construct an arrow of the correct length to represent the weight of the ball. [2 marks]
2c. Show that the magnitude of the net force $F$ on the ball is given by the following equation.

\[ F = \frac{mg}{\tan \theta} \]

2d. The radius of the bowl is 8.0 m and $\theta = 22^\circ$. Determine the speed of the ball.
2e. Outline whether this ball can move on a horizontal circular path of radius equal to the radius of the bowl. [2 marks]

2f. A second identical ball is placed at the bottom of the bowl and the first ball is displaced so that its height from the horizontal is equal to 8.0 m. [3 marks]

The first ball is released and eventually strikes the second ball. The two balls remain in contact. Determine, in m, the maximum height reached by the two balls.
A satellite powered by solar cells directed towards the Sun is in a polar orbit about the Earth.

The satellite is orbiting the Earth at a distance of 6600 km from the centre of the Earth.

3a. Determine the orbital period for the satellite. [3 marks]

Mass of Earth = 6.0 x 10^{24} \text{ kg}

The satellite carries an experiment that measures the peak wavelength emitted by different objects. The Sun emits radiation that has a peak wavelength \( \lambda_S \) of 509 nm. The peak wavelength \( \lambda_E \) of the radiation emitted by the Earth is 10.1 \( \mu \text{m} \).

3b. Determine the mean temperature of the Earth. [2 marks]
3c. Suggest how the difference between $\lambda_S$ and $\lambda_E$ helps to account for the greenhouse effect. [3 marks]

3d. Not all scientists agree that global warming is caused by the activities of man. [1 mark]
Outline how scientists try to ensure agreement on a scientific issue.
4a. From A to B, 24 % of the gravitational potential energy transferred to kinetic energy. [2 marks]
Show that the velocity at B is 12 m s\(^{-1}\).

4b. Some of the gravitational potential energy transferred into internal energy of the skis, [2 marks]
slightly increasing their temperature. Distinguish between internal energy and temperature.
4c. The dot on the following diagram represents the skier as she passes point B. Draw and label the vertical forces acting on the skier.

![Diagram of a point with forces labeled]

4d. The hill at point B has a circular shape with a radius of 20 m. Determine whether the skier will lose contact with the ground at point B.

![Diagram of a circular hill]

4e. The skier reaches point C with a speed of 8.2 m s\(^{-1}\). She stops after a distance of 24 m at point D. Determine the coefficient of dynamic friction between the base of the skis and the snow. Assume that the frictional force is constant and that air resistance can be neglected.

![Diagram of a skier reaching point C and stopping at point D]
At the side of the course flexible safety nets are used. Another skier of mass 76 kg falls normally into the safety net with speed 9.6 m s$^{-1}$.

4f. Calculate the impulse required from the net to stop the skier and state an appropriate unit for your answer.  

4g. Explain, with reference to change in momentum, why a flexible safety net is less likely to harm the skier than a rigid barrier.

5a. (i) Define gravitational field strength.  
(ii) State the SI unit for gravitational field strength.
5b. A planet orbits the Sun in a circular orbit with orbital period $T$ and orbital radius $R$. The mass of the Sun is $M$.

(i) Show that $T = \sqrt{\frac{4\pi^2R^3}{GM}}$.

(ii) The Earth’s orbit around the Sun is almost circular with radius $1.5 \times 10^{11}$ m. Estimate the mass of the Sun.
The two arrows in the diagram show the gravitational field strength vectors at the position of a planet due to each of two stars of equal mass $M$. Each star has mass $M = 2.0 \times 10^{30}$ kg. The planet is at a distance of $6.0 \times 10^{11}$ m from each star.

6a. Show that the gravitational field strength at the position of the planet due to one of the stars is $g = 3.7 \times 10^{-4}$ N kg$^{-1}$.

6b. Calculate the magnitude of the resultant gravitational field strength at the position of the planet.