1. This question is about circular motion.
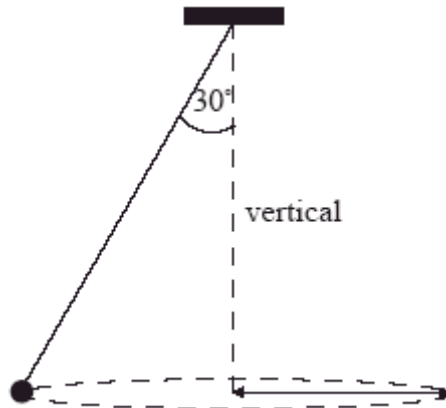
A ball of mass 0.50 kg is attached to a string and is made to rotate with constant speed v along a horizontal circle of radius $r = 0.8$ m. The string is attached to the ceiling and makes an angle of 30° with the vertical.

(a) (i) On the diagram above, draw and label arrows to represent the forces on the ball in the position shown.

(2)

(ii) State and explain whether the ball is in equilibrium.

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(2)

(b) Determine the speed of rotation of the ball.

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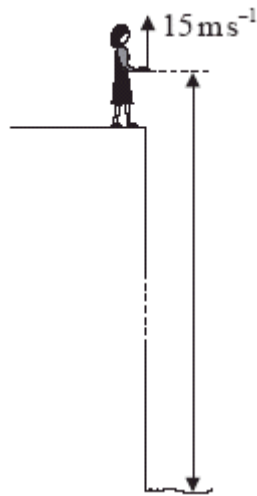
(3)

(Total 7 marks)

2. This question is about kinematics.

Lucy stands on the edge of a vertical cliff and throws a stone vertically upwards.

The stone leaves her hand with a speed of 15 m s^{-1} at the instant her hand is 100 m above the surface of the sea. Air resistance is negligible and the acceleration of free fall is 9.8 m s^{-2}.

(a) Calculate the maximum height reached by the stone as measured from the point where it is thrown.

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(2)

(b) Determine the time for the stone to reach the surface of the sea after leaving Lucy's hand.

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(3)
(Total 5 marks)

3. This question is about nuclear processes.

(a) A nucleus of radium-91 ($^{226}_{91}$Ra) undergoes alpha particle decay to form a nucleus of radon (Rn).

(i) Identify the proton number and nucleon number of the nucleus of Rn.

Proton number: ....

Nucleon number: ....

(2)

(ii) The half-life of radium-91 is 1600 years. Determine the length of time taken for 93.75 % of the radium to disintegrate.

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(2)

4. This question is about the emf induced in a coil.

(a) Define *magnetic flux*.

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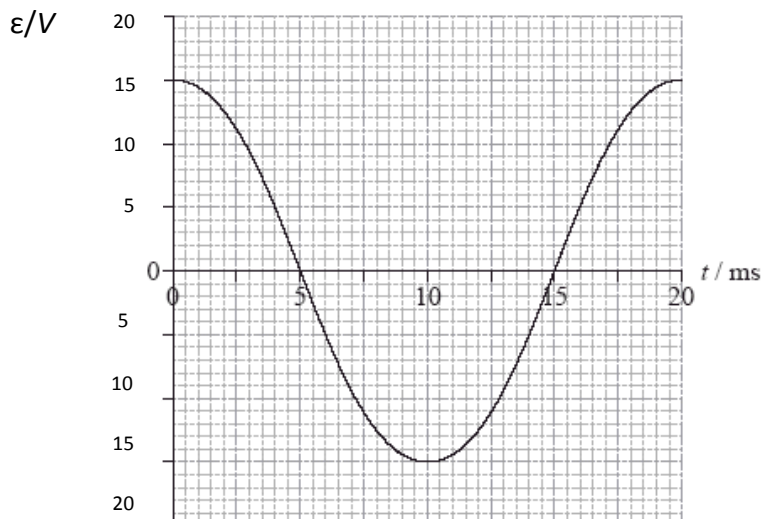...

(2)

(b) A coil is rotated at constant speed in a region of uniform magnetic field.

The graph shows the variation with time t of the emf ε induced in the coil for one cycle of rotation.

(i) On the graph label, with the letter T, a time at which the flux linkage in the coil is a maximum.

(1)

(ii) Use the graph to determine the rate of change of flux at $t = 8.0$ ms. Explain your answer.

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(2)

(iii) Calculate the root mean square value of the induced emf.

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(1)
(Total 6 marks)