Name of the Student:_____
Max. Marks : 28 Marks **Time : 28 Minutes**

Q1.

A student investigated the physics of football.

(a) She used the equations of motion to model the behaviour of a ball when kicked at different angles to the horizontal. She predicted the height of the ball when it reached the goal, presuming it was kicked from the same place, with the same initial speed, each time. The results are shown in the table below.

Angle to the horizontal / °	Height of the ball when it reached the goal / m
10	–0.78
20	1.0
30	2.8
40	4.7

(i) State the significance of the negative value of height for an angle of 10°.

(1)

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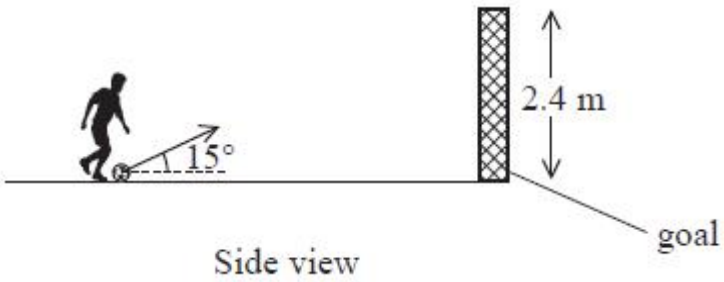
(ii) On the diagram below, sketch and label the predicted path of the ball for angles of 20° and 40°.

(2)



(b) (i) During a football match the ball is kicked towards the goal, at an angle of 15° to the horizontal, from a distance of 11 m as shown.

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Side view

The ball has a diameter of 0.22 m and an initial speed of 26 m s^{-1}.
By means of a calculation, determine whether or not the ball will pass into the goal. You may ignore the effects of air resistance.

(6)

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(ii) Air resistance would cause an additional force on the ball.
Explain the effect this would have on the ball's motion.

(2)

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Q2.

The discovery of the Higgs particle was an important contribution to our understanding of particle physics.

(a) Describe the standard model for subatomic particles. You should identify the fundamental particles and the composition of the particles we can observe.

(5)

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(b) The mass of the Higgs particle is 2.2×10^{-25} kg.

Calculate this mass in GeV/c^2.

(3)

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Mass = ... GeV/c^2

(c) The Higgs particle was discovered using the Large Hadron Collider (LHC) in 2012. Two beams of very high energy protons, moving in opposite directions, were made to collide.

(i) Explain the need for such high energy collisions.

(3)

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(ii) The beams of protons are contained within a ring of superconducting magnets.

Calculate the momentum of a proton in a beam.

(3)

magnetic field strength = 8.3 T
circumference of the ring = 27 km

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Momentum = ...

(iii) State the total momentum of the products of the collision between the two beams of protons.

(1)

Total momentum = ...

(d) A student used the equation $E_k = \frac{p^2}{2m}$ to predict the energy of a proton in the beam, using the momentum calculated in (c)(ii), but found the energy was far higher than 7 TeV.

Explain why.

(2)

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(Total for question = 17 marks)

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