Candidate Name	Centre Number	Candidate Number

WJEC CBAC

eduqas

AS PHYSICS

COMPONENT 1

Motion, Energy and Matter

SPECIMEN PAPER

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	10	
2.	15	
3.	10	
4.	10	
5.	10	
6.	10	
7.	10	
Total	75	

ADDITIONAL MATERIALS

In addition to this examination paper,
you will require a calculator and a **Data Booklet**.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Answer **all** questions.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question 5*(a)*.
No certificate will be awarded to a candidate detected in any unfair practice during the examination.

*Answer **all** questions.*

1. A student carried out an experiment to investigate the principle of moments. The equipment was set up as shown, with the uniform metre ruler suspended at the 0.10 m mark, by a thread at one end, and by a newtonmeter on the 0.90 m mark at the other end. A 250 g mass was then looped around the ruler on the 0.70 m mark.
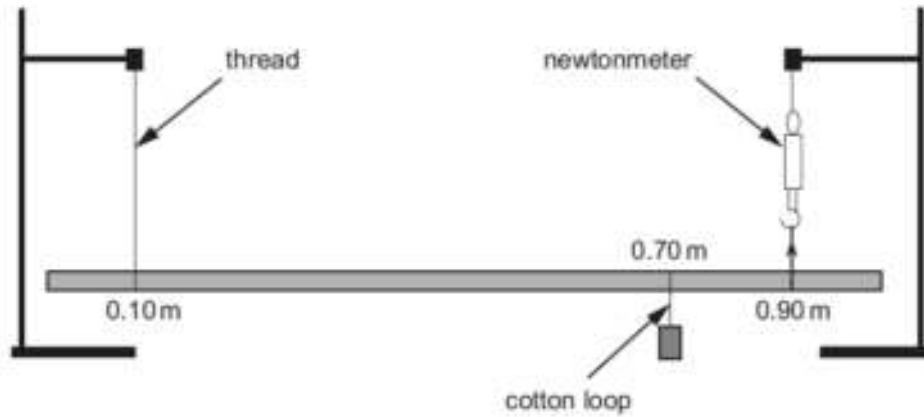
(a) When the weight was added the height of the newtonmeter was readjusted until the ruler was horizontal. Explain how this was done.   [1]

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(b) Draw an arrow, **labelled W**, on the diagram to represent the weight of the ruler acting through the centre of gravity.   [1]

(c) State the principle of moments.   [2]

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(d) (i) The reading on the newtonmeter was found to be 2.8 N. Determine a value for the weight of the ruler. [3]

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(ii) Calculate the tension in the thread supporting the ruler at the 0.10 m point. [1]

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(iii) The newtonmeter is replaced by a thin wire whose resistance changes as it is stretched. Explain how this wire combined with an ohmmeter could be used to measure the force. [2]

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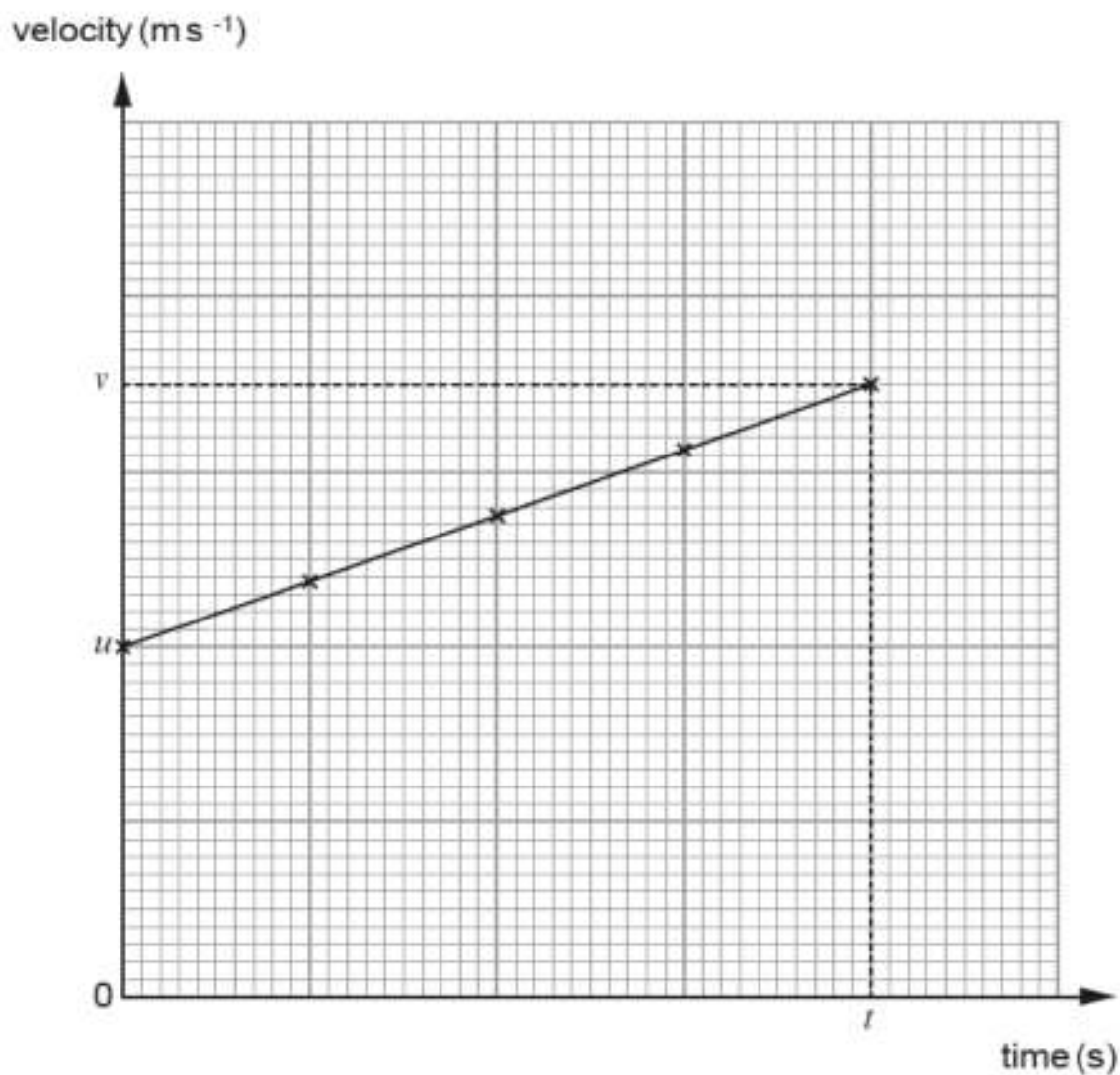...

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2.   *(a)*   A velocity-time graph is given for a toy car which is accelerating in a straight line in a laboratory.

velocity (m s^{-1})

(i)   Using the symbols given on the graph, write down an expression for the area under the graph and state what it represents.   [2]

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(ii)   In practice, distance and time can be measured accurately with a video recorder and metre ruler. Explain how velocity (speed) can be measured accurately.   [2]

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(b)   A stone is kicked horizontally from the top edge of a cliff. Measured data for the flight of the stone are provided in the table.

Time of flight (s)	Distance from foot of cliff to point of impact (m)	Height of cliff (m)	Vertical velocity on impact $(m\,s^{-1})$	Initial horizontal velocity $(m\,s^{-1})$
5.00	10.00			

(i)   Complete the table by filling in the gaps. Ignore air resistance.   [6]

   (Space is provided for your calculations.)

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(ii)   Plot, on the grid below, lines to represent **both** the vertical **and** horizontal velocities of the stone for the time of flight.   [3]

velocity (m s^{-1})

time (s)
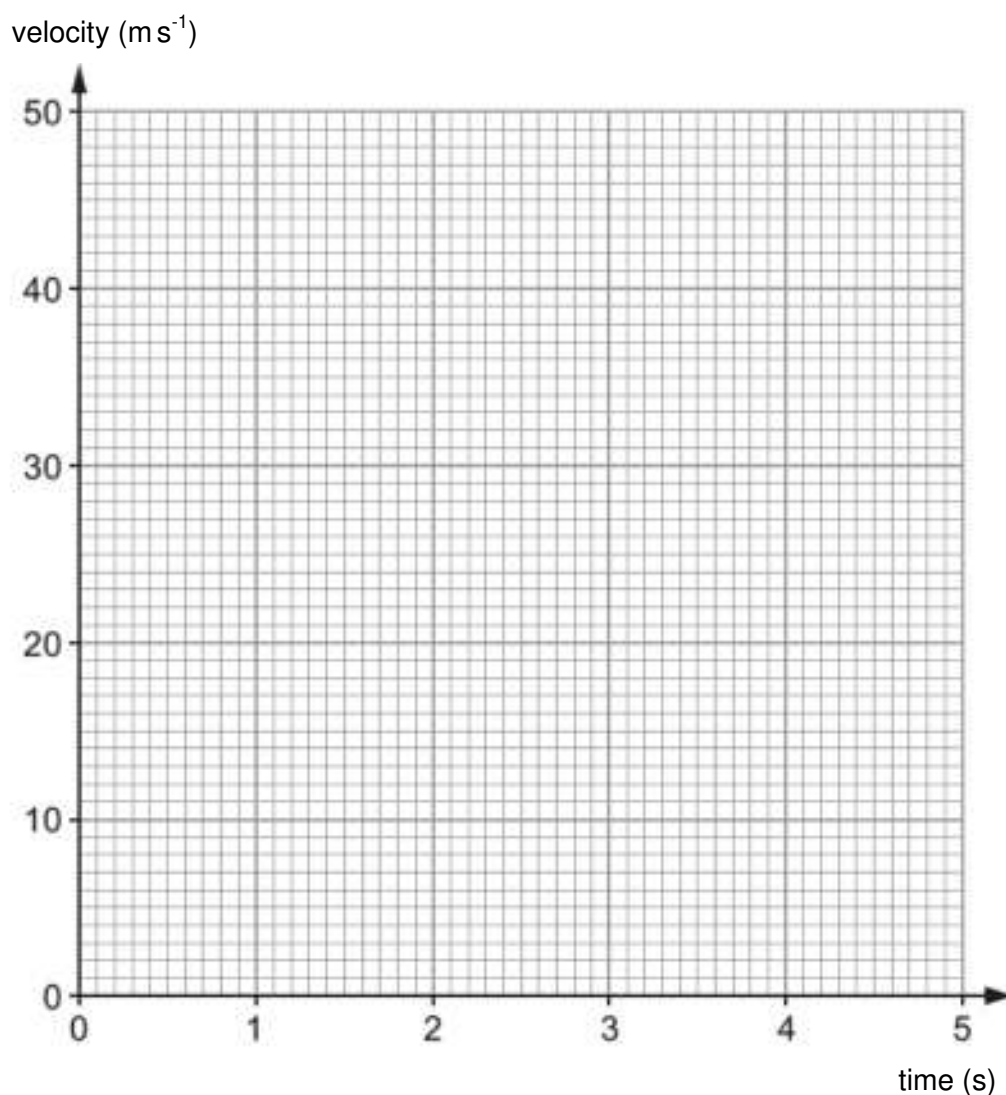
(c)   Discuss the effect that air resistance would have on the motion of the stone.   [2]

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3.   In a laboratory experiment two gliders **A** and **B** lie on a linear air track (friction free). Glider **A**, of mass 0.200 kg, is initially moving with a velocity of 2.25 m s^{-1} to the right. Glider **B** is initially stationary.

BEFORE COLLISION
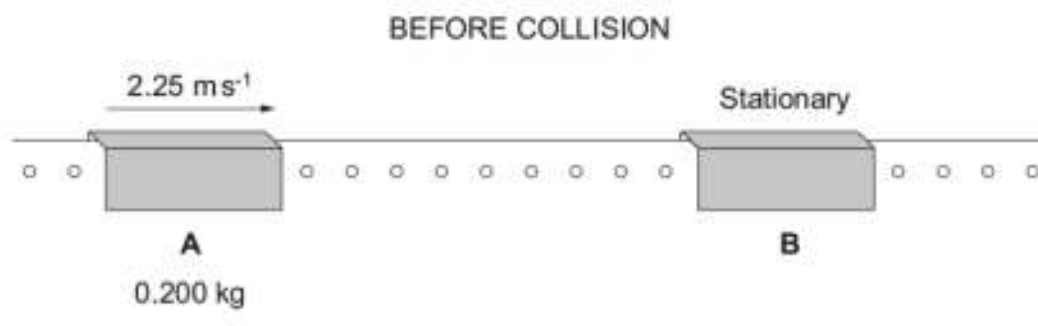
2.25 m s^{-1}

Stationary

A

0.200 kg

B

(a)   (i)   The *principle of conservation of momentum* states that the momentum of a system remains constant provided that no external resultant force acts. State how friction and the effects of gravity are eliminated in the air track set-up.   [2]

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(ii)   When the two gliders collide they stick together and move with a velocity of 1.20 m s^{-1} to the right. Use the principle of conservation of momentum to find the mass of glider **B**.   [2]

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(iii)   Show clearly that the collision is *inelastic* and account for the loss in kinetic energy.   [3]

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(b) A student claims that a law of physics is contradicted if the Glider A remains stationary after the collision even if conservation of momentum applies. Determine whether or not this statement is true. [3]

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4.   *(a)*   State the principle of conservation of energy.   [1]

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(b)   A bobsleigh run in Norway has a curving track of overall length 1.4 km from start to finish. During a run, the bobsleigh drops through a vertical height, *h,* of 120 m.

h = 120 m

(i)   Assuming no resistive forces, show that the maximum possible speed, *v*, of a bobsleigh at the finish line is given by: [2]

$$v = \sqrt{2gh}$$

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(ii)   Hence calculate the maximum possible speed of a bobsleigh at the finishing line.   [1]

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(c)   The mass of the bobsleigh and riders is 280 kg. Determine the mean resistive force experienced by the bobsleigh from start to finish **and** give an example of a resistive force acting on the bobsleigh. Assume the speed of the bobsleigh is 20% of its maximum possible speed.   [6]

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5.   *(a)*   Explain in detail how you would carry out an experiment to measure the
             Young modulus of a metal in the form of a long wire.   [6 QER]

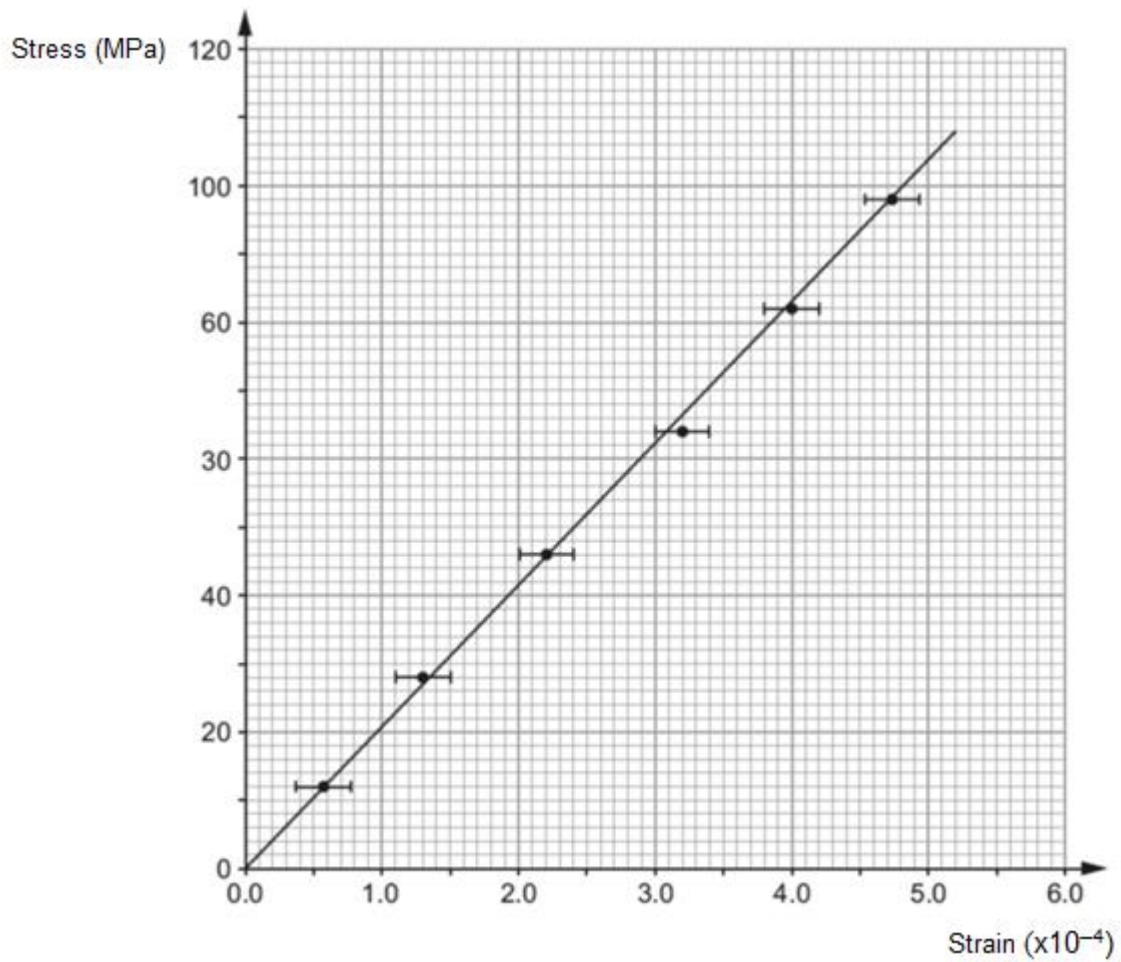..

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(b) A graph of stress against strain is drawn for a metal.

Stress (MPa)

Strain (x10^{-4})

(i) Use the graph to determine the Young modulus of the metal. [2]

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(ii) A student repeats this experiment with a wire of thickness 10 mm instead of 0.1 mm. Evaluate the associated benefits and risks of this additional experiment. [2]

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6.   *(a)*   A table of astronomical data includes the following about a star in the *Cassiopeiae* system:

Radius = 7.22×10^8 m, Temperature = 5 970 K, Luminosity = 4.74×10^{26} W.

(i)   Determine whether the data above is consistent with the star radiating as a black body. Show your working clearly, and give your conclusion.   [3]

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(ii)   The star is 1.84×10^{17} m from the Earth. Calculate the intensity (energy per second per m^2) of electromagnetic radiation reaching the Earth from the star.   [2]
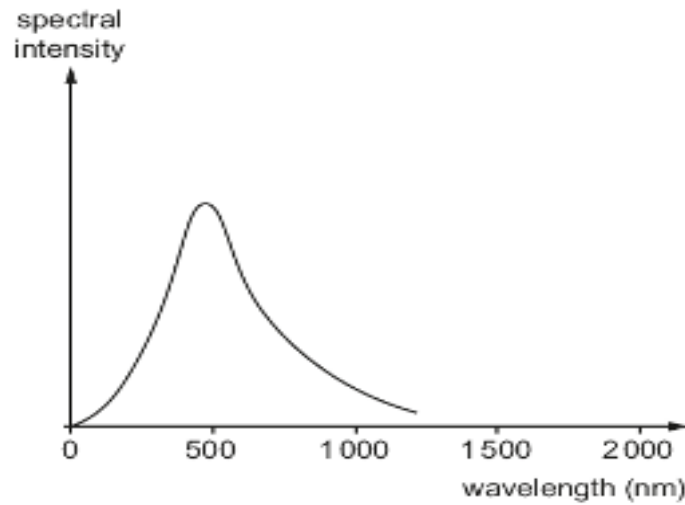
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(iii)   Calculate the wavelength of the star's peak spectral intensity.   [1]

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(iv)   The light from this star can be detected with a large telescope. This light can then be passed through a diffraction grating to produce the spectrum shown. Explain using the relevant equation why a spectrum is produced at the order $n = 1$.   [2]

spectral intensity

wavelength (nm)

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(b)   Astronomers assign to each star a position on a chart, according to the star's luminosity and temperature. During one stage in the life of *Alpha Centauri A*, its position on the chart will move as shown by the dotted line.
Use Stefan's law to show clearly what happens to the size of the star during this stage. [No calculations are required.]   [2]

temperature (10^3 K)

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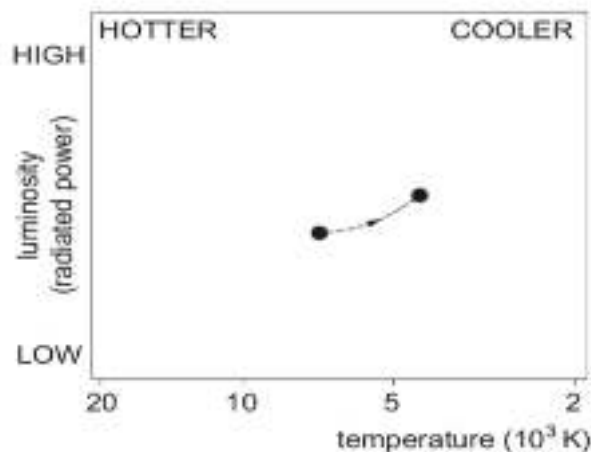
7.   (a)   Put ticks in the boxes in the table to show which of the particles listed can take part in the interactions named.   [3]

	strong interaction	weak interaction	electromagnetic interaction
neutrino (ν_e)			
electron (e⁻)			
u quark (u)			

(b)   The π^- meson has quark make-up $d\bar{u}$ and the Δ^- baryon has quark make-up ddd.

(i)   Show that the magnitudes of the charges of the π^- and Δ^- particles are the same.   [1]

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(ii)   The $\Delta-$ baryon has a very short lifetime (about 6×10^{-24} s), almost always decaying into a neutron and a π^-, as shown:

$$\Delta^- \rightarrow n + \pi^-$$

Show clearly whether or not up quark number and down quark number are separately conserved in this decay.   [2]

up quark number

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down quark number

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(iii)   Is the interaction in (b)(ii) a weak interaction? Justify your answer, using two pieces of evidence.   [2]

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(c)   The Δ^{++} baryon has a charge equal to that of two protons.

     (i)   Write down the quark make-up which the Δ^{++} baryon must have.   [1]

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     (ii) Δ^{++} baryon decays into a proton and a pion (π meson) by a similar mechanism to that for the Δ^- baryon in *(b)*. Determine the quark make-up of the pion.   [1]

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