Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

Helium is available in small metal canisters. The helium can be used to fill party balloons.

Student X and Student Y discuss the weight of the canister and its contents after a number of balloons have been filled.

Student X suggests that the weight will have increased, because the upthrust exerted on the canister by the helium will be reduced.

Student Y suggests that the weight will have decreased, because helium has been released from the canister.

Assess which student's suggestion is correct.

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(Total for question = 4 marks)

Q2.

The suspension system in a car includes a spring attached to each wheel as shown.

The car, of mass 1100 kg, is stationary. Each spring is compressed by 152 mm due to a quarter of the weight of the car. Each spring is well within both the limit of proportionality and the elastic limit.

(i) Show that the stiffness of each spring is about 18 000 N m^{-1}.

(3)

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(ii) A force is applied to the car which results in a further small compression of each spring. The force is then removed, and the body of the car oscillates with simple harmonic motion.

Determine the frequency of the oscillations.

(3)

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Frequency = ...

(Total for question = 6 marks)

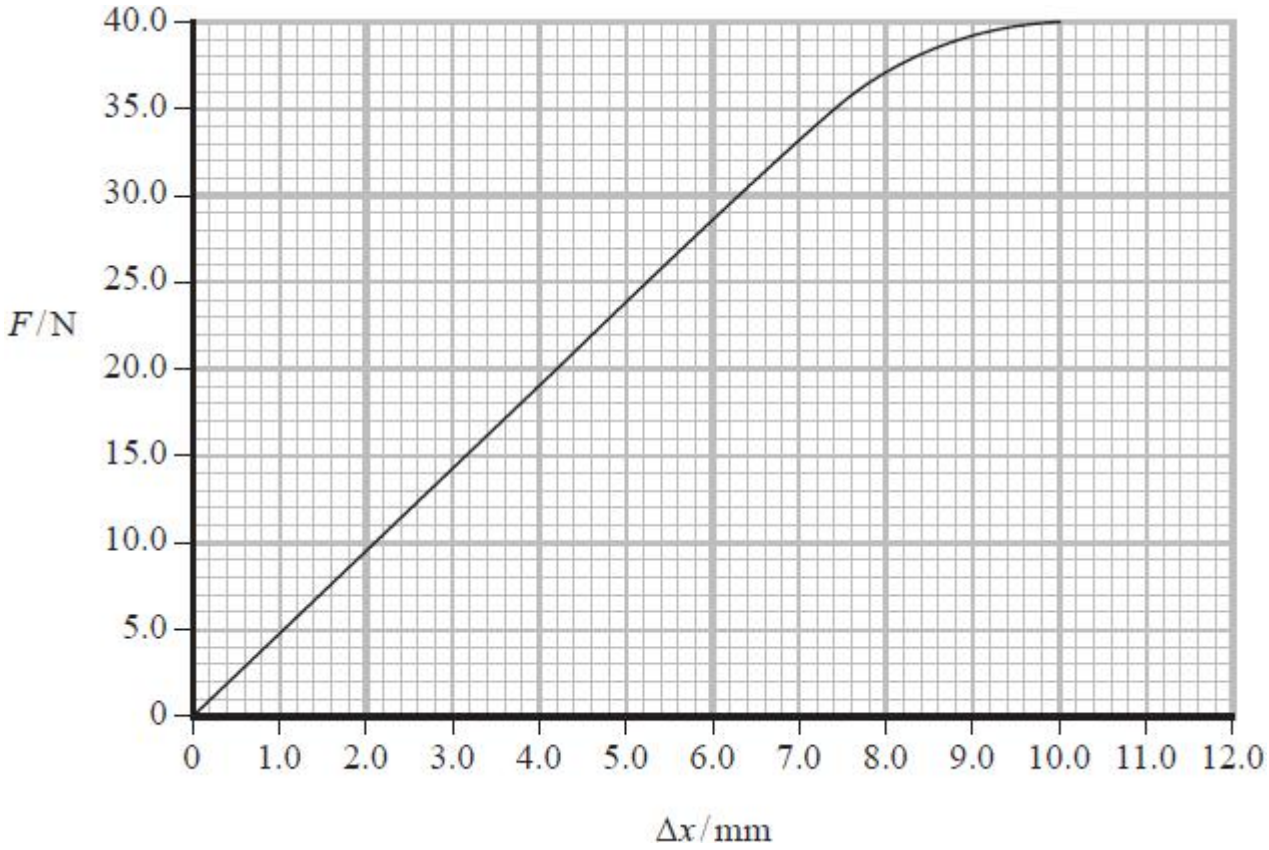
Q3.

A student investigated the properties of metal wires.

The student applied increasing force *F* and determined the corresponding extensions Δ*x* of the wire.

The force was applied in increments of 5 N, up to a maximum value of 40 N.

The student plotted a graph of F against Δx, as shown.



The Young modulus E of the material of the wire is given by the expression

$$E = \text{gradient} \times \frac{x}{A}$$

where A is the cross-sectional area of the wire and x is the original length of the wire.

(i) Derive the expression

$$E = \text{gradient} \times \frac{x}{A}$$

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(ii) The values of the Young modulus for some metals are shown.

Metal	Young modulus / GPa
aluminium	67
copper	117
steel	184
tin	47

Deduce which metal the student's wire was made from.
x = 3.00 m
$A = 1.14 \times 10^{-7}$ m^2

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(iii) The student repeated measurements of force and extension using a thinner wire of the same metal and length. He changed the values of the force he applied to the wire.

Explain **two** changes that the student should make to the values of the force he applied to the wire.

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(Total for question = 10 marks)