OCR
Oxford Cambridge and RSA

Level 3 Cambridge Technical in Engineering
05822/05823/05824/05825/05873

Unit 2: Science for engineering

Wednesday 11 January 2017 – Morning
Time allowed: 1 hour 30 minutes

You must have:
- the formula booklet for Level 3 Cambridge Technical in Engineering (inserted)
- a ruler (cm/mm)
- a protractor
- a scientific calculator

First Name		Last Name	
Centre Number		Candidate Number	
Date of Birth			

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided.
- Additional paper may be used if required but you must clearly show your candidate number centre number and question number(s).

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- An answer may receive no marks unless you show sufficient detail of the working to indicate that a correct method is being used.
- Final answers should be given to a degree of accuracy appropriate to the context.
- This document consists of **12** pages.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/10
2	/10
3	/10
4	/10
5	/10
6	/10
Total	**/60**

Answer **all** questions.

1 **(a)** Assign the appropriate power of ten to the following prefixes.

μ (micro)	
M (mega)	
k (kilo)	
m (milli)	

[4]

(b) Define the term relative error in the context of engineering measurements.

.....

..... **[1]**

(c) You are given that $X = 0.002362$.

Find the relative error if X is written to

(i) 3 significant figures,

.....

.....

..... **[3]**

(ii) 3 decimal places.

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.....

..... **[2]**

2 Use $g = 9.8\,\text{m s}^{-2}$ in this question.

(a) A 20 kg ball shown in Fig. 1 is suspended in equilibrium from the ceiling on a wire and has a force $F = 80\,\text{N}$ acting on it in horizontal direction. The wire makes an angle of α with the vertical.

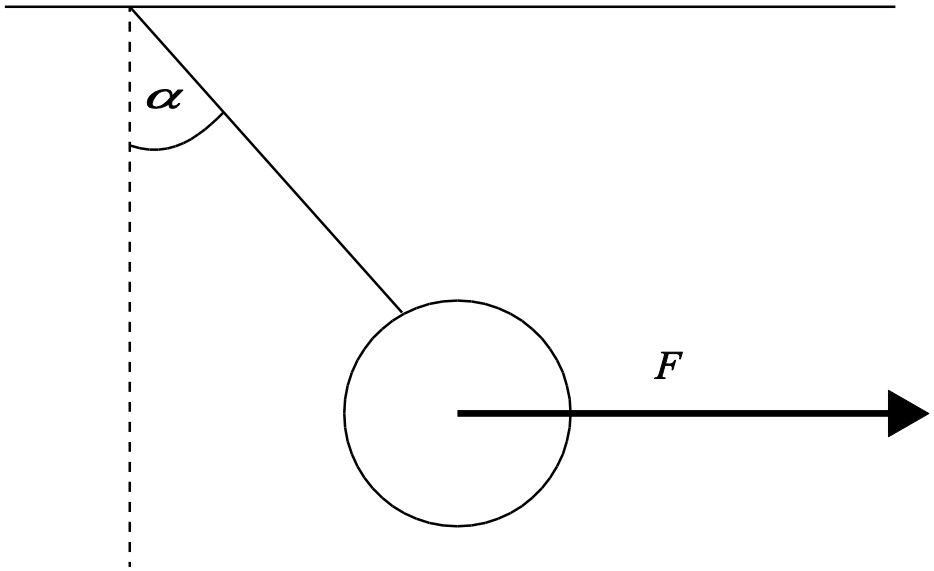

Fig. 1

(i) Calculate the weight of the ball.

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..... **[1]**

(ii) Calculate the tension in the wire.

.....

.....

..... **[2]**

(iii) Calculate the angle, α, between the vertical and the wire.

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..... **[3]**

(b) Fig. 2 shows how the velocity of a moving object changes over a few seconds.

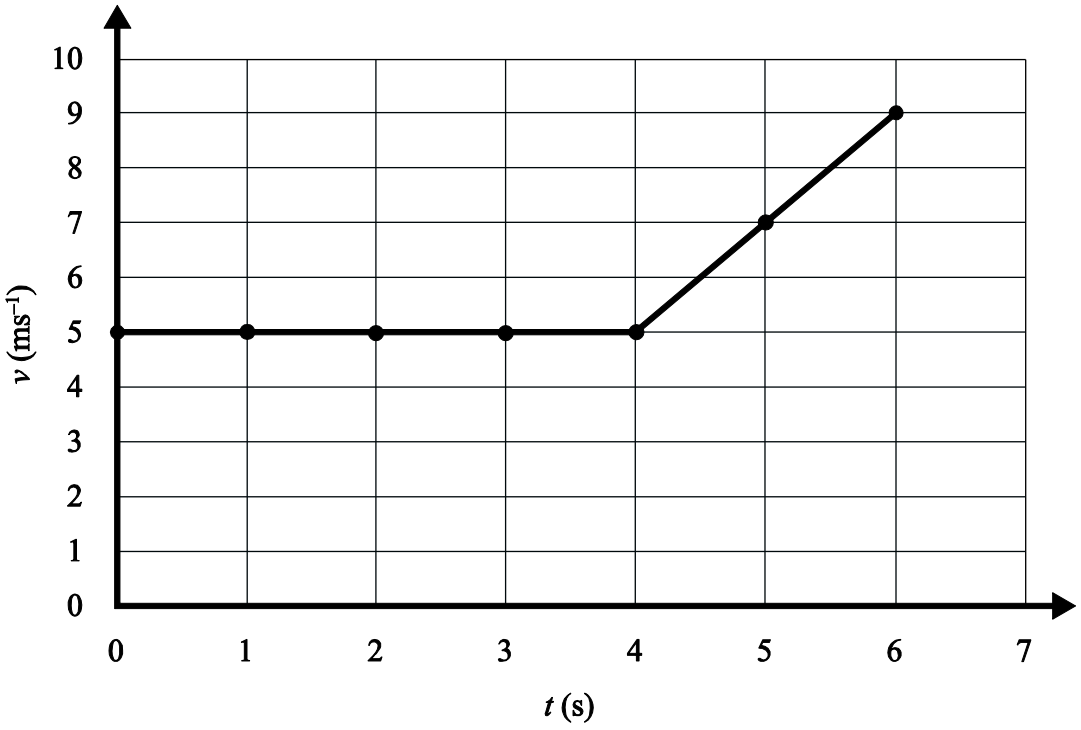

Fig. 2

(i) Calculate the distance covered by the object in the first 4 seconds.

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..... **[1]**

(ii) Calculate the acceleration of the object between 4 and 6 seconds.

.....

..... **[1]**

(iii) From time t = 6 seconds the object has constant deceleration, coming to rest in 3 seconds. Find the value of the constant deceleration.

.....

.....

..... **[2]**

3 **(a)** The current flowing through the circuit shown in Fig. 3 is $I = 2\,A$.

The potential differences across R_1, R_2 and R_3 are 5 V, 2 V and 10 V respectively.

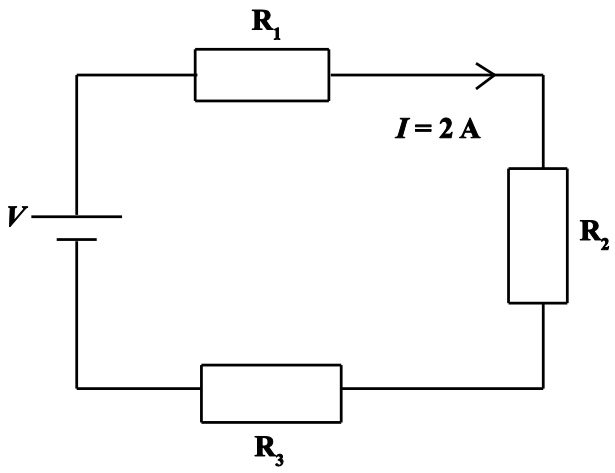

Fig. 3

Calculate

(i) the total voltage supplied to the circuit,

..... **[1]**

(ii) the total resistance in the circuit,

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..... **[2]**

(iii) the resistance of the individual resistors R_1, R_2 and R_3,

.....

.....

.....

..... **[3]**

(iv) the power lost across resistor R_1.

.....

.....

..... **[2]**

(b) **(i)** State the SI unit for inductance.

..... **[1]**

(ii) Which of the following expressions in base SI units is equivalent to the SI unit for inductance?
Put a ring round the correct response.

$kgm^{-2}\ s^{-2}\ A^{-1}$ $kgm^{2}s^{-1}A^{-2}$ $kgm^{2}\ s^{-2}A^{-2}$ $kgm\ s^{-2}A^{-1}$

[1]

4 **(a)** Fig. 4 shows a stress-strain curve for a metal.

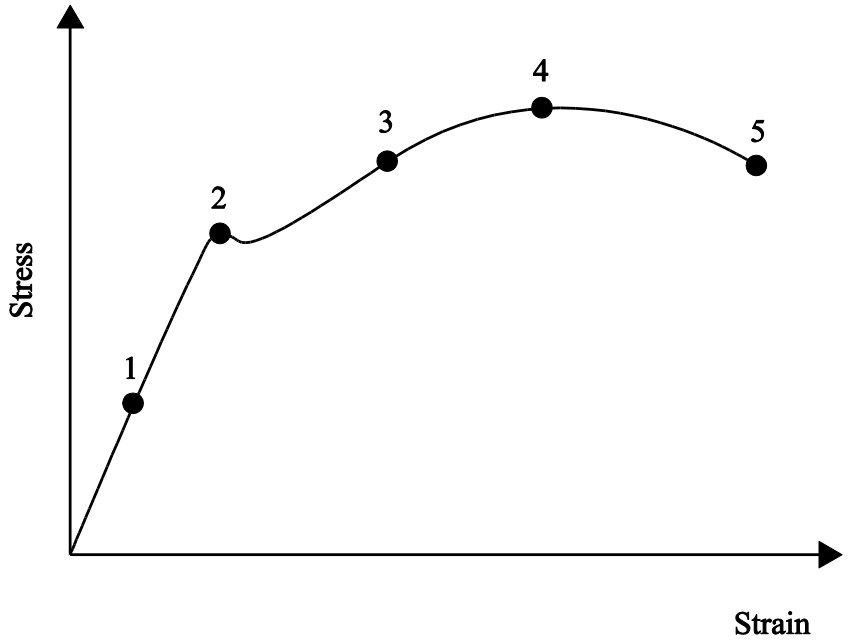

Fig. 4

Complete the table to show which point (1, 2, 3, 4 or 5) represents the features of the stress-strain graph.

Feature	Point number
Ultimate Tensile Stress (UTS)	
Yield Stress	
Fracture Point	
Elastic deformation	

[4]

(b) Fig. 5 shows a square section beam subjected to a tensile load of 85 kN.

The stress normal to section A-A is 105 MPa
The strain of the beam is 500 x 10^{-6}.
The yield strength of the material is 210 MPa.

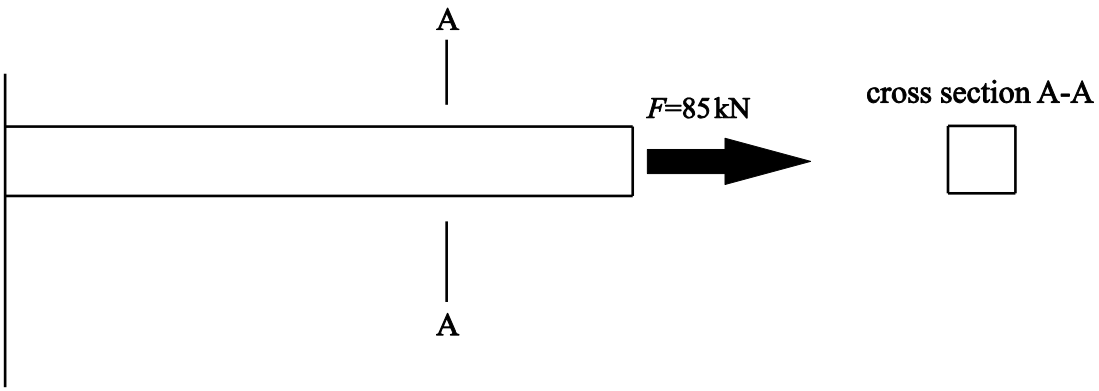

Fig. 5

(i) Calculate the cross sectional area of the beam.

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..... **[2]**

(ii) Calculate the load required to plastically deform the beam.

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..... **[2]**

(iii) Calculate Young's modulus of the material.

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..... **[2]**

5 **(a)** Define ‘viscosity’ of a fluid.

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..... **[1]**

(b) Fluid flow is described as being either laminar or turbulent.

Explain the difference in the behaviour of particles in laminar and turbulent flow.

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..... **[2]**

(c) Fig. 6 shows a cross section of a tank filled with water, mercury and air.

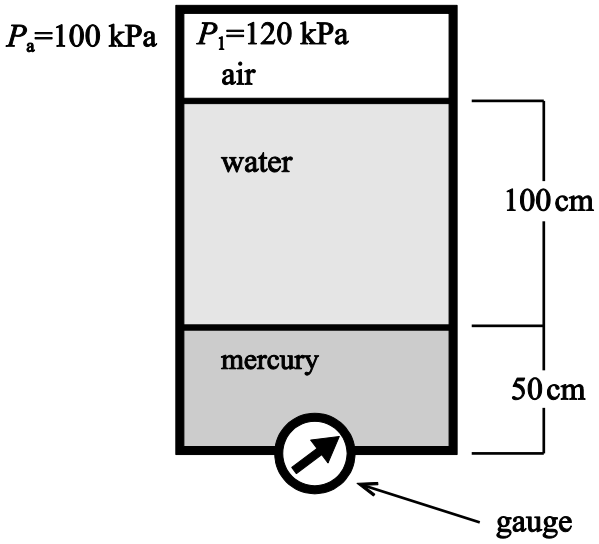

Fig. 6

Density of water ρ_w = 1000 kg m^{-3}
Density of mercury ρ_m = 13500 kg m^{-3}
Air pressure in the tank = 120 kPa

(i) Calculate the hydrostatic pressure due to the column of water in the tank.

.....

..... **[2]**

(ii) Calculate the hydrostatic pressure due to the column of mercury in the tank.

.....

..... **[2]**

(iii) What is the absolute pressure at the gauge?

..... **[1]**

(iv) If the atmospheric pressure is 100 kPa, what is the gauge pressure?

.....

..... **[2]**

6 A thermally insulated rigid box shown in Fig. 7 contains air at 12 °C and pressure P_1=100 kPa.
The internal dimensions of the box are 3 m by 3 m by 10 m.
Heat is supplied to the interior of the box at 1500 W.

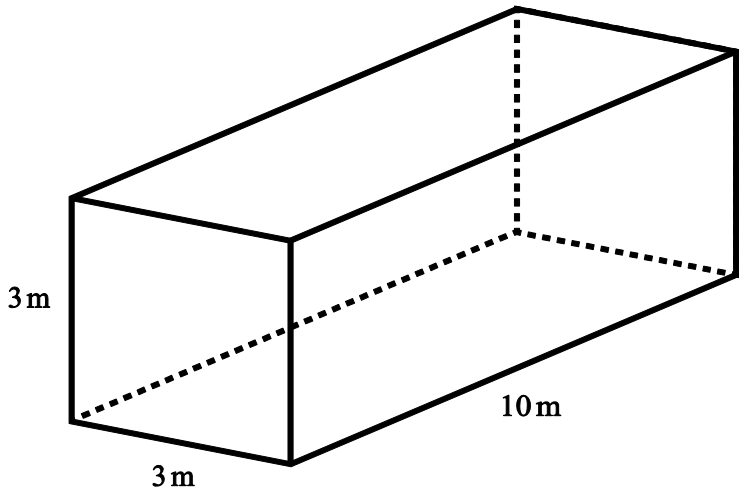

Fig. 7

Specific gas constant R_{air} for air is 287 J kg^{-1}K^{-1}.
Specific heat capacity of air c_{air} = 718 J kg^{-1}K^{-1}.

(i) Show that the mass of air in the box is approximately 110 kg.

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..... **[4]**

(ii) What is the air pressure in the box once the temperature reaches 300 K?

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..... **[2]**

(iii) Calculate the energy which needs to be supplied to the box to heat the air inside to 300 K.

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..... **[2]**

(iv) How long will it take to heat up the air to 300K?

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..... **[2]**

END OF QUESTION PAPER