

Level 3 Cambridge Technical in Engineering

05822/05823/05824/05825/05873

Unit 2: Science for engineering

Thursday 18 May 2017 – Afternoon
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	D	D	M	M	Y	Y	Y	Y		

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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- The acceleration due to gravity is denoted by $g \text{ m s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$

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 **16** pages. Any blank pages are indicated.

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Question No	Mark
1	/10
2	/10
3	/10
4	/10
5	/10
6	/10
Total	/60

Answer **all** the questions.

1 (a) Convert the following units into their base SI units.

(i) Pa (Pascal)

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

(ii) W (Watt)

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

(b) Define the terms error and uncertainty in the context of measurement.

(i) Error

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

(ii) Uncertainty

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

(c) Name a property of fluids measured using a barometer.

..... [1]

- (d) The current flowing through a circuit was measured a number of times. The results are given in the table below.

Current (A)	Frequency
10.0	1
10.2	2
10.4	4
10.6	3

- (i) Find the mean current.

.....

 [2]

- (ii) Find the standard deviation of these values.

.....

 [2]

- (e) A large component of steel bars is known to have a mean length of 425 mm with standard deviation 7.5 mm.

The length of the bars is tested by taking random samples of 10 bars.

What is the standard error of the mean?

.....
 [1]

2 (a) A 1500kg car drives along a horizontal road at 72 km h^{-1} .

(i) Calculate the kinetic energy of the car.

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

(ii) If the resistive forces equate to a total of 500N calculate the power generated by the engine while the car is travelling at 72 km h^{-1} .

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

(iii) Once the brakes are applied and the power removed the car comes to a standstill within 30m. Calculate the braking force generated by the disc brakes. Consider the car as a point mass and assume that the resistive forces remain at 500N.

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

- (b) A spider hangs on a strand of silk AB connected at 45° to strands CB and DB as shown in Fig. 1.

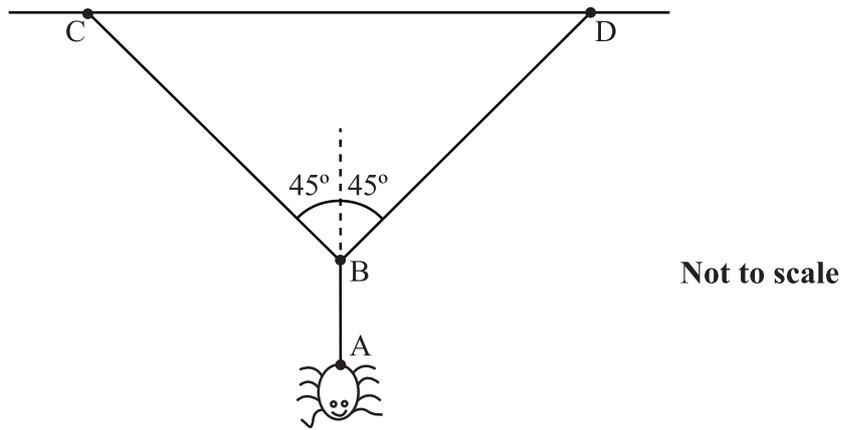


Fig. 1

- (i) The mass of the spider is 30g. Calculate the weight of the spider.

.....
 [2]

- (ii) Calculate the tension in the strands CB and DB.

.....

 [2]

- 3 (a) Three resistors R_1 , R_2 and R_3 are connected to a 50V power supply as shown in Fig. 2.

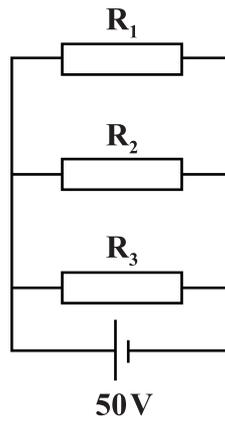


Fig. 2

You are given that $R_1 = 20 \Omega$, $R_2 = 40 \Omega$ and $R_3 = 50 \Omega$.

Calculate

- (i) the effective resistance in the circuit,

.....

 [2]

- (ii) the total current flowing through the power supply,

.....
 [2]

- (iii) the current flowing through R_2 ,

.....
 [2]

- (iv) the power dissipated in R_2 .

.....
 [2]

- (b) Calculate the electric resistance of a 10 metre long copper wire with a cross section area of 3.15mm^2 .

Resistivity of copper is $\rho = 1.68 \times 10^{-8} \Omega \text{ m}$.

.....

.....

..... [2]

- 4 (a) Fig. 3 shows a beam subjected to a tensile load of 70 kN.
 The beam has a square cross section 10 mm by 10 mm and an initial length of 1 m.

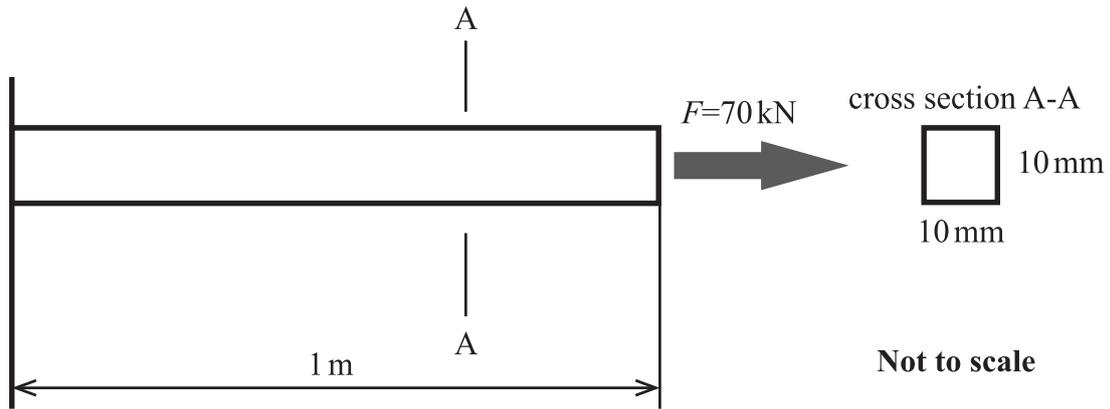


Fig. 3

The length of the beam increases by $100 \mu\text{m}$ due to loading.

Calculate

- (i) the strain on the beam,

.....

 [2]

- (ii) the stress across section A-A,

.....

 [2]

- (iii) Young's modulus of the material of the beam.

.....

 [2]

- (b) Fig. 4 shows the stress-strain curves for three different materials A, B and C.

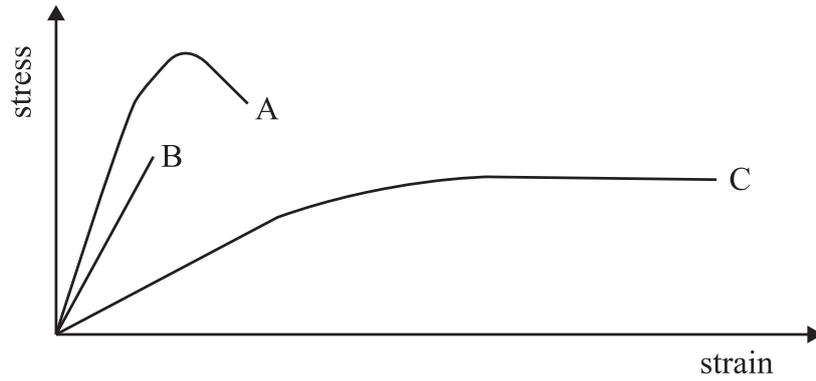


Fig. 4

- (i) Which material has the highest ultimate tensile strength?

..... [1]

- (ii) Which material is the most brittle?

..... [1]

- (iii) Which material is the most ductile?

..... [1]

- (iv) Which material has the highest Young's Modulus?

..... [1]

5 (a) The three containers in Fig. 5 are filled with the same fluid to the same level.

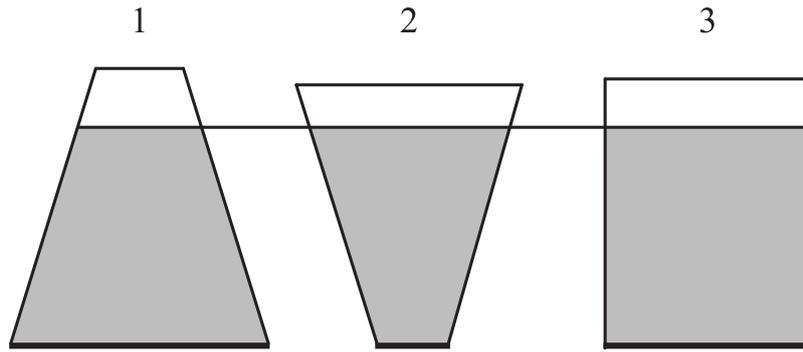


Fig. 5

Which of the following statements is true?

Put a tick (✓) in the box next to the correct statement.

Pressure at bottom of container 1 is the highest.

Pressure at bottom of container 2 is the highest.

Pressure at bottom of container 3 is the highest.

The pressure at the bottom of all three containers is identical.

[1]

(b) Explain the terms ‘gauge pressure’ and ‘absolute pressure’.

.....

.....

.....

..... [2]

(c) Fig. 6a shows a cube suspended from a spring force meter in air. The meter reading is 50 N.

Fig. 6b shows the cube submerged in water. The meter now reads 20 N.

Density of water = 1000 kg m^{-3}

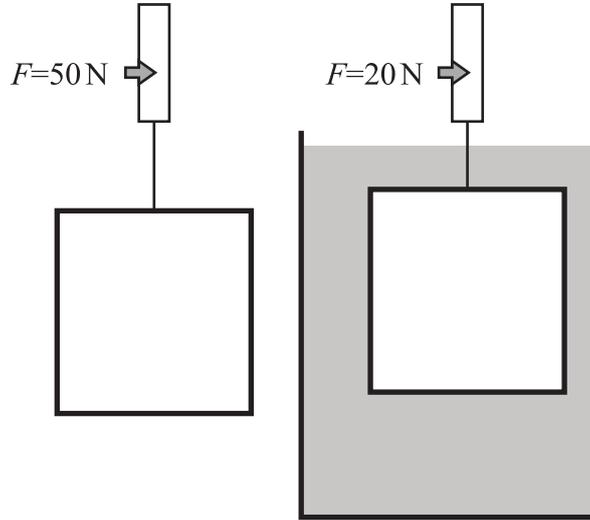


Fig. 6a

Fig. 6b

(i) What is the upthrust force acting on the cube when it is submerged in water?

..... [1]

(ii) Calculate the volume of the cube.

.....

 [3]

(iii) Calculate the density of the material of the cube.

.....

 [2]

(iv) What is the direction of hydrostatic pressure in respect to the surface of the submerged cube?

.....
 [1]

6 (a) (i) Explain the term 'latent heat' in context of thermodynamics.

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

(ii) Fig. 7 shows a temperature/time graph for a material.
Which section of the graph (1, 2 or 3) represents latent heat absorption?

..... [1]

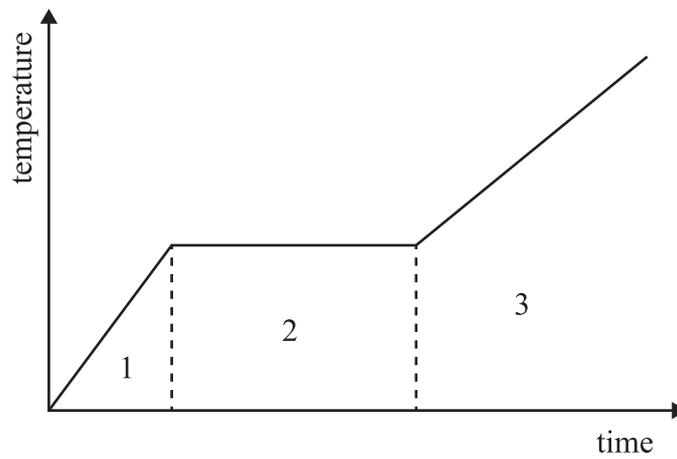


Fig. 7

(b) A 2kW heater is used to heat 10kg of air within a rigid box.

The efficiency of the heater is 85%.

The box loses heat energy to the surroundings at a constant rate of 600 J s^{-1} .

Specific heat capacity of air, $c = 718 \text{ J kg}^{-1} \text{ K}^{-1}$.

(i) Calculate the amount of power supplied by the heater.

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

(ii) How much heat energy is required to heat up 10kg of air by 10°C ?

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

(iii) Calculate the time taken to heat the air by 10°C .

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined pages. The question number(s) must be clearly shown – for example 1(d) or 6(b).

A large vertical rectangular area containing 25 horizontal dotted lines for writing answers.

A series of horizontal dotted lines for writing, spanning the width of the page. A solid vertical line is positioned on the left side of the page, serving as a margin.



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