OCR
Oxford Cambridge and RSA

Friday 11 January 2019 – Morning

LEVEL 3 CAMBRIDGE TECHNICAL IN ENGINEERING

05822/05823/05824/05825/05873 Unit 2: Science for engineering

Duration: 1 hour 30 minutes

C302/1901

C302/1901

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 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.

FOR EXAMINER USE ONLY	
Question No	**Mark**
1	/10
2	/10
3	/10
4	/10
5	/9
6	/11
Total	**/60**

Answer **all** the questions.

1 **(a)** Complete the table below showing the SI units for some physical quantities. The first row has been completed as an example.

SI Unit	Symbol	Physical Quantity
metre	m	length
Ampere		
	K	
	cd	

[3]

(b) Fig. 1 shows an enlarged view of a Vernier caliper scale measuring the diameter of a ball bearing. The scale reads in mm.

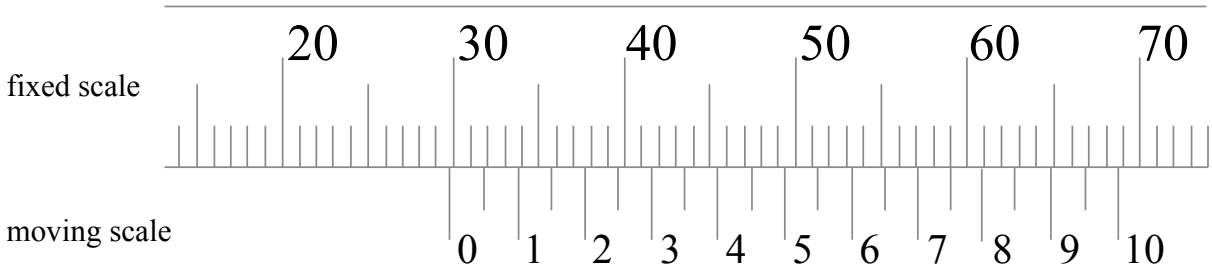

Fig. 1

State the diameter of the ball bearing.

Diameter = …… mm **[1]**

(c) Several measurements of the depth of a groove are recorded as shown below.

Measurement no.	1	2	3	4	5
Depth (mm)	12.11	11.95	12.03	11.99	11.97

(i) If the true value for depth is 12.00 mm, calculate the percentage error of measurement number 3.

Percentage error = …… **[2]**

(ii) Show that the mean value is 12.01 mm.

[1]

(iii) Calculate the standard deviation of the measurements.

Give your answer to 4 significant figures.

Standard deviation = ……**[3]**

2 (a) Fig. 2 shows a parked vehicle of mass 1000 kg on a slope at a height of 7 m above a surface.

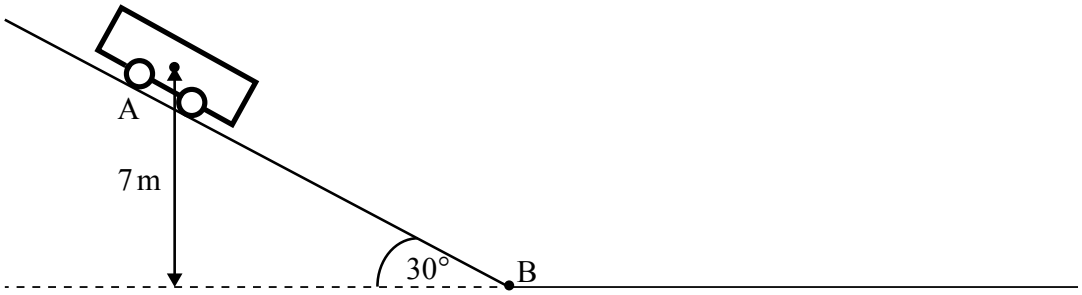

Fig. 2

(i) Calculate the gravitational potential energy of the vehicle.

Potential energy = ……J **[1]**

(ii) The handbrake is released, and the vehicle travels from point A to point B.

Ignore the effect of friction on the slope.

Show that the velocity of the vehicle at point B is about 12 m s^{-1}.

Velocity = …… m s^{-1} **[2]**

(iii) After point B the vehicle continues moving along the horizontal surface.

The average friction force acting on the vehicle is 2.94 kN.

Calculate the time it takes for the vehicle to stop.

Time to stop = …… s **[3]**

(b) Fig. 3 shows how the position of an object moving along a horizontal plane varies with time.

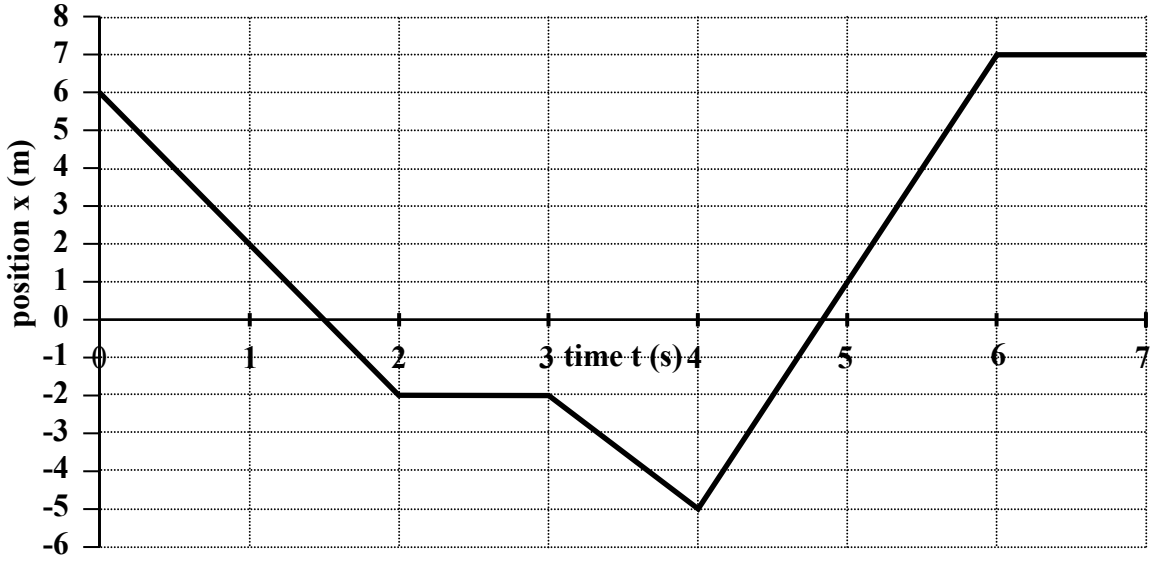

Fig. 3

Use Fig. 3 to determine the following;

(i) the displacement between $t = 0$ s and $t = 7$ s,

Displacement = …… m **[1]**

(ii) the total distance travelled between $t = 0$ s and $t = 7$ s,

Distance travelled = …… m **[1]**

(iii) the average velocity between $t = 4$ s and $t = 7$ s.

Average velocity = …… m s^{-1} **[2]**

3 **(a)** A power tool is connected to a battery pack. The tool operates with a normal power output of 1 kW. The efficiency of the system is 85%.

(i) Calculate, in watts, the input power required to operate the power tool.

Input power = ……W **[1]**

(ii) The tool operates for a duration of 30 minutes.

Calculate the energy input in kWh.

E = ……kWh **[2]**

(b) Fig 4 shows current-potential difference curves (***X***, ***Y*** and ***Z***) for three different components.

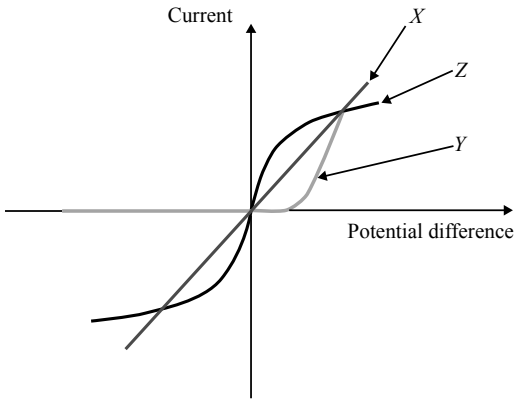

Fig. 4

Complete the table below to match the curve (***X***, ***Y*** and ***Z***)) to the component.

Component	**Curve (*X*, *Y* or *Z*)**
Resistor at constant temperature	
Filament lamp	
Diode	

[2]

(c) Fig. 5 shows a simple RL circuit.

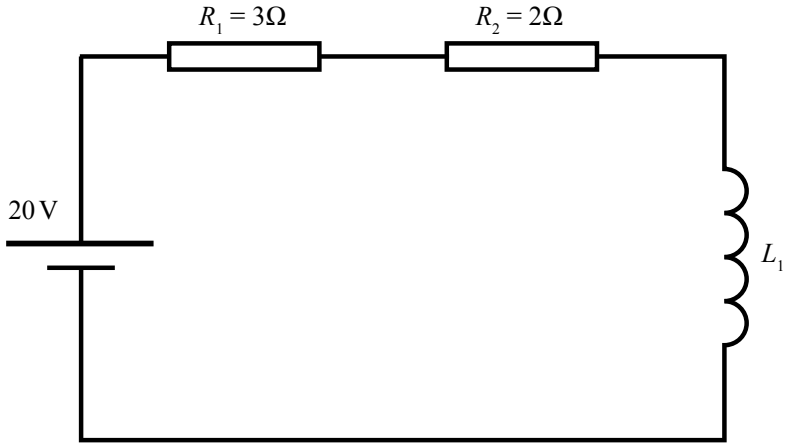

Fig. 5

(i) Calculate the equivalent resistance R_{eq} from the two resistors R_1 and R_2.

R_{eq} = ... Ω **[1]**

(ii) The power source provides a voltage of 20 V.

Calculate the current circulating through the coil.

Current = ... A **[1]**

(iii) The coil is made up of 100 turns and produces a magnetic flux of 10 mWb for this current.

Calculate the self-inductance of the coil. Include a unit in your answer.

Self-inductance = ... **[3]**

4 **(a)** Explain the difference between **resilience** and **toughness** of materials.

.....

.....

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

(b) Explain the difference between the **malleability** and **ductility** of materials.

.....

.....

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

(c) A cylindrical rod of diameter 26 mm is subjected to a tensile load of 18 kN.
The original length of the rod is 150 mm and the extension is measured as 24 μm.

(i) Calculate the Young's modulus of the material. Include a unit in your answer.

Young's modulus = …… **[4]**

(ii) The yield strength of the material is 350 MPa.
Calculate the maximum elongation of the rod before plastic deformation occurs.

Maximum elongation = …… mm **[2]**

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Turn over for the next question

5 **(a)** A gas and a liquid are both fluids, but they behave differently under applied pressure.
Explain this difference in behaviour.

.....

.....

.....

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

(b) Fig. 6 shows the cross section of two pipes.
Sketch diagrams on Fig. 6 to show laminar and turbulent flow through the pipes.

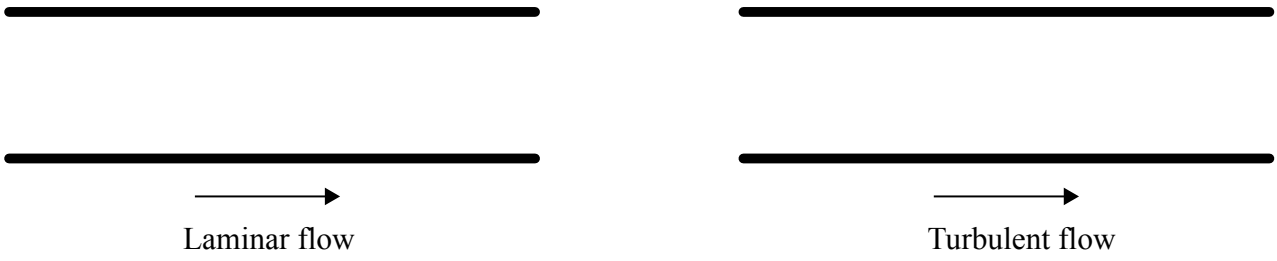

Fig. 6

[2]

(c) Fig. 7 shows a cuboid of mass 2.0 kg.

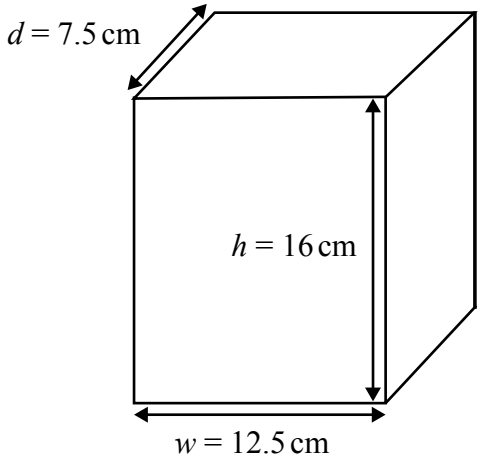

Fig. 7

(i) Calculate the density of the cuboid.

Density = …… kg m^{-3} **[2]**

(ii) The cuboid is dropped into water which has a density of 1000 kg m^{-3}.
State whether the cuboid floats or sinks. Justify your answer.

.....

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

(iii) Calculate the upthrust force acting on the cuboid.

Upthrust force = …… N **[2]**

6 (a) Fig. 8 shows a tank filled with helium, at an initial temperature of 70 °C.

The initial internal energy of the system is 1200 J.

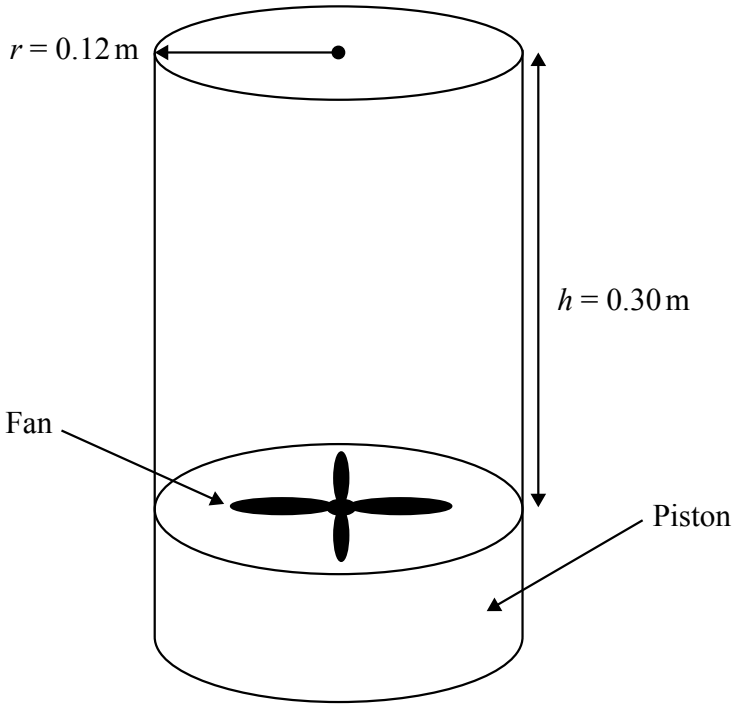

Fig. 8

(i) The fan at the bottom of the cylinder does work on the helium at a rate of 1.5 W for 5 minutes.

The final internal energy of the helium is measured at 900 J.

Calculate the energy lost by the helium.

Energy lost = …… J **[2]**

(ii) Calculate the new temperature of the helium in the cylinder.

Density of helium = 0.16 kg m^{-3}.

Specific heat capacity of helium = 5200 J kg^{-1} K^{-1}.

Temperature = …… °C **[4]**

(iii) The fan stops and the piston on which it is attached moves upwards a distance of 0.18 m.

If the temperature of the helium remains constant, calculate the percentage increase in pressure inside the cylinder.

Percentage increase in pressure = …… % **[3]**

(b) A bedding manufacturer is selecting a new fabric for use in electric blankets.

Fabric	Specific Heat Capacity (J kg^{-1} K^{-1})
A	1700
B	900

State and explain which is the most suitable fabric, assuming the blankets produced from both fabrics have the same mass.

.....

.....

.....

.....

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

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown – for example 1(a) or 4(b).