Pearson BTEC Level 3 Nationals Diploma, Extended Diploma

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number

Learner Registration Number

Time 50 minutes

Paper reference **31627H/1P**

Applied Science

UNIT 5: Principles and Applications of Science II
Physics
SECTION C: THERMAL PHYSICS, MATERIALS AND FLUIDS

You must have:
A calculator and a ruler.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The exam comprises three papers worth 40 marks each.
  – Section A: Organs and systems (Biology).
  – Section B: Properties and uses of substances (Chemistry).
  – Section C: Thermal physics, materials and fluids (Physics).
- The total mark for this exam is 120.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- The formulae sheet can be found at the back of this paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

Pearson

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Figure 1 shows water flowing in a river.

Figure 1

The water flow in the river is turbulent.

(a) State **two** features of turbulent water flow.

(2)

1 ....

....

2 ....

....

(b) Figure 2 shows part of a water pipe that has a changing diameter.

The flow of water through the pipe is laminar (streamline).

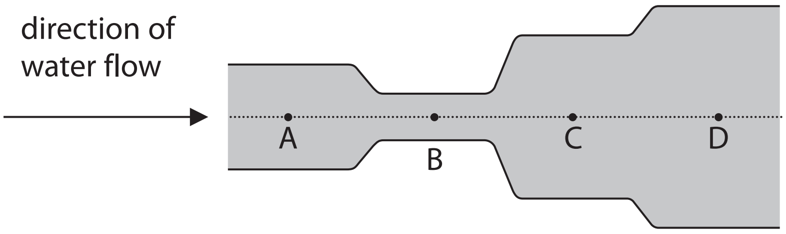

Figure 2

(i) Which point in Figure 2 is the flow of water fastest?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) Which point in Figure 2 is the water pressure greatest?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(iii) Add an X to Figure 2 to show the point in the pipe where the viscous drag is greatest.

(1)

(iv) Add an arrow to Figure 2 to show the direction of the viscous drag.

(1)

(c) A learner notices that honey flows faster when poured on a hot day than when poured on a cold day.

Explain why the honey flows faster on a hot day.

Your answer should refer to the change in viscosity.

(3)

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(Total for Question 1 = 9 marks)

2 Figure 3 shows three lifts in a building.

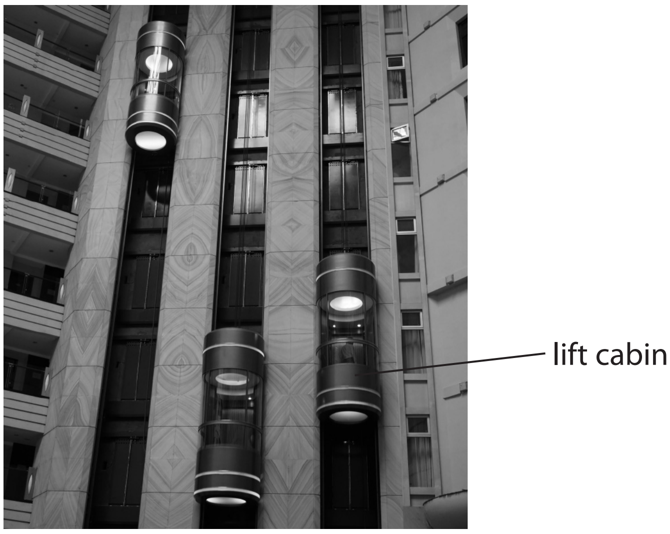

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Figure 3

Each lift motor has a power of 45 kW.

(a) Give the value of 45 kW in watts.

(1)

45 kW = ... W

(b) The lifts in the building rise through a height of 0.5 km.

The weight of **one** lift cabin is 12 500 N.

(i) Show that the motor does approximately 6 000 000 J of work raising the lift cabin 0.5 km.

Use the equation: $W = F\Delta x$

(3)

Show your working.

work output of the motor = ... J

(ii) The efficiency of the lift motor is 0.85.

Calculate the work input to the motor when raising the lift cabin.

If you did not get an answer for (b)(i), use the value 6 000 000 J for the work output.

(3)

Use the equation:

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

Show your working.

work input to the motor = ... J

(Total for Question 2 = 7 marks)

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3 Two beakers contain olive oil at the same temperature.

The first beaker contains 1 kg of olive oil.

The second beaker contains 0.5 kg of olive oil.

(a) (i) Which physical property is **different** for the olive oil in each beaker?

(1)

☒ **A** average density

☒ **B** kinetic energy

☒ **C** molecular separation

☒ **D** thermal capacity

(ii) A thermometer is used to measure the temperature of the olive oil in a beaker.

The thermometer is left in the olive oil for a few minutes until the olive oil and the thermometer reach the same temperature.

Explain why the thermometer and the olive oil are now at the same temperature.

(2)

....

....

....

....

(b) (i) A learner fills a container with some olive oil at room temperature.

The learner then places the container of olive oil in a freezer.

A few hours later the olive oil has frozen solid.

Describe the motion and arrangement of the molecules in the olive oil before freezing and after freezing.

(4)

Before freezing

....

....

....

....

After freezing

....

....

....

....

(ii) A 200 W electric heater is used to melt 500 g of frozen olive oil at its melting point.

Calculate the time in seconds for the heater to melt the olive oil.

(4)

Assume that all the energy from the heater is transferred to the olive oil.

Specific latent heat of fusion of olive oil = 267 000 J kg^{-1}

1 W = 1 J/s

Use the equation: $Q = mL$

Show your working.

time to melt the olive oil = ... s

(Total for Question 3 = 11 marks)

4 (a) Copper can be hammered into shape without breaking.

Which property allows copper to be hammered into shape?

(1)

- ☒ **A** brittleness
- ☒ **B** ductility
- ☒ **C** malleability
- ☒ **D** strength

(b) A rubber band is stretched when a weight is added.

A temperature probe attached to the rubber band records an increase in temperature when the band is stretched.

Explain why the temperature of the rubber band increases.

(2)

....

....

....

....

(c) (i) An engineer wants to support the floor of a building.

The engineer has the choice of using either steel or concrete beams to support the floor.

The engineer finds Figure 4, which shows the stress/strain characteristics of steel and concrete.

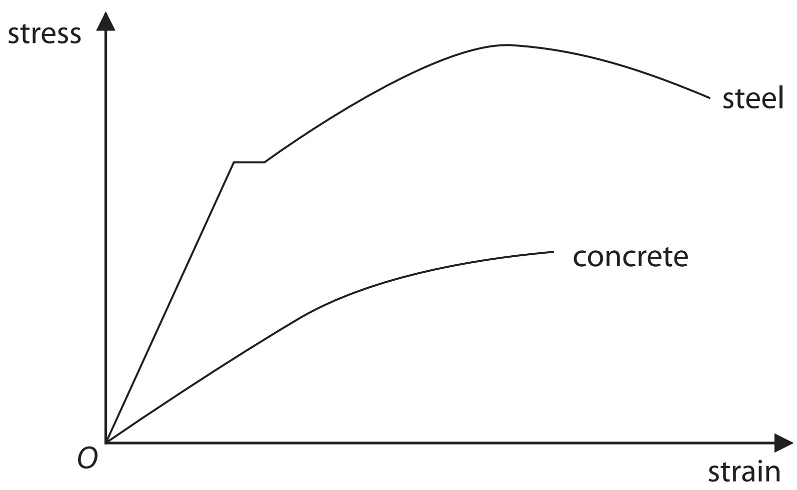

Figure 4

The engineer also finds Table 1.

Table 1 gives some other information about steel and concrete.

Beam material	Density (kg m^{-3})	Cost per material (£/m)	Corrosion resistance
steel	8 100	75	low
concrete	2 400	25	high

Table 1

Discuss which material, steel or concrete, would be most suitable to use to support the floor.

You should refer to the information in Figure 4 and Table 1 in your answer.

(6)

(ii) A steel girder of length 10 m and cross sectional area 3×10^{-4} m^2 increases in length by 5 mm when stretched.

Calculate the force acting on the girder.

(4)

Use the equation: $E = \dfrac{FL}{A\Delta x}$

The Young's Modulus E for steel is 2×10^{10} Pa.

Show your working.

force acting on the girder = ... N

(Total for Question 4 = 13 marks)

TOTAL FOR SECTION C = 40 MARKS
TOTAL FOR EXAM = 120 MARKS

Formulae Sheet

Mechanics

Work	$W = F\Delta x$
Work done by a gas	$W = p\Delta V$
Efficiency	$\text{efficiency} = \dfrac{\text{useful energy output}}{\text{total energy input}}$
Efficiency for heat engines	$\text{efficiency} = 1 - \dfrac{Q_{out}}{Q_{in}}$
Maximum theoretical efficiency	$\text{efficiency} = 1 - \dfrac{T_c}{T_H}$

Thermodynamics

Ideal gas equation	$pV = NkT$
First law of thermodynamics	$Q = \Delta U + W$
Specific heat capacity	$Q = mc\Delta T$
Specific latent heat	$Q = mL$

Materials

Density	$\rho = \dfrac{m}{V}$
Young's modulus	$E = \dfrac{\text{stress}}{\text{strain}}$ OR $E = \dfrac{FL}{A\Delta x}$
	$\text{stress} = \dfrac{F}{A}$
	$\text{strain} = \dfrac{\Delta x}{L}$
Hooke's law	$F = k\Delta x$
Work done in stretching / compressing a wire / spring	$\Delta E = \dfrac{1}{2} F\Delta x$
	$\Delta E = \dfrac{1}{2} k(\Delta x)^2$

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