Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE AS Physics

Topic 4: Materials

Paper 1

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

1

9 In an investigation to determine the Young modulus of a material in the form of a wire, a tensile force of 14 N was applied to the wire. The length of the wire was 2.0 m. The diameter of the wire was 2.5 mm. The length of the wire increased by 0.20%.

(a) Calculate the Young modulus of the material.

(3)

$r = \frac{2.5 \times 10^{-3}}{2} = 1.25 \times 10^{-3}$

$A = \pi r^2 = (1.25 \times 10^{-3})^2 \pi$

$E = \frac{F/A}{\Delta L/L} = \frac{FL}{\Delta L A} = \frac{14 \times 2}{4 \times 10^{-3} \times (1.25 \times 10^{-3})^2 \pi}$

$= 14260028290 = 1.4 \times 10^9 \text{ Nm}^{-2}$ (2sf) // Pa

$\Delta L = 2 \times 0.002 = 4 \times 10^{-3}$

2x1.002 = 2.004
2.004 − 2 = 4×10^{-3}

Young modulus = $1.4 \times 10^9 \text{ Nm}^{-2}$

(b) Calculate the energy stored in the stretched wire.

(2)

$E = \frac{1}{2} F \Delta L = \frac{1}{2} \times 14 \times (2 \times 0.002)$

$= 7 \times 4 \times 10^{-3}$

$= 0.028 \text{ J}$

Energy stored = $2.8 \times 10^{-2} \text{ J}$

(c) Explain why the wire chosen should be as long as possible.

(2)

So that the extension in the wire can be as large as possible.

So percentage error is less significant.

(Total for Question 9 = 7 marks)

2

10 A student is investigating the extension of a spring.

A force of 29 N is applied to the spring and it extends by 32 cm. The spring obeys Hooke's law.

(a) Calculate the work done on the spring.

(2)

$WD = \frac{1}{2} F \Delta L = \frac{1}{2} \times 29 \times \frac{32}{100}$

$= 4.64$

≈ 4.6 (2sf)

Work done = 4.6 J

(b) Calculate the extension of the spring when a force of 27 N is applied.

(2)

$F = k\Delta L$ $\quad \frac{F}{k} = \Delta L$

$\frac{F}{\Delta L} = \frac{29}{32 \times 10^{-2}} = K \longrightarrow \frac{27}{90.625} = \Delta L = 0.2979$ m

$K = 90.625$ $\quad = 29.798...$ cm

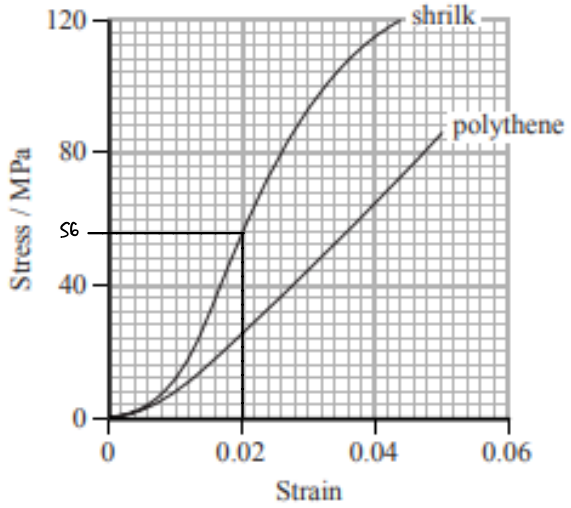
Extension = 30 cm (2sf)

(Total for Question 10 = 4 marks)

3

10 Shrilk is a new material made from discarded shrimp shells. It is biodegradable and is easily moulded into different shapes. Shrilk is an alternative to polythene and could be used to make waste bags in the future.

The graph shows a stress-strain curve for a 25.0 cm length of shrilk and for a similar length of polythene, up to breaking point.



(a) (i) Calculate the force applied to the shrilk at a strain of 0.02

cross-sectional area = 1.2×10^{-6} m^2

(3)

Stress = $\frac{F}{A}$ → stress × A = F

let:
Stress = 56×10^6 (from the graph)
A = 1.2×10^{-6}

$56 \times 10^6 \times (1.2 \times 10^{-6}) = 67.2$ N

≈ 67 N (2SF)

Force = 67 N

(ii) Determine the extension of the shrilk at a strain of 0.04

(2)

Strain = $\frac{\Delta L}{L}$ → $0.04 = \frac{\Delta L}{25/100} = \frac{\Delta L}{0.25}$

$0.01 = \Delta L$

0.010 m = 1 cm

Extension = 1.0 cm (2SF)

4 (c) (i) A raindrop is falling vertically through the air.

The free-body force diagram shows the forces acting on the raindrop.

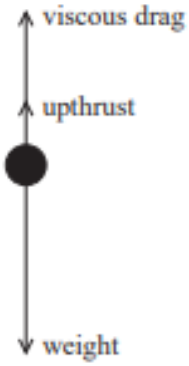


Diagram **NOT** drawn to scale

The raindrop is travelling at terminal velocity. The raindrop is spherical with a radius of 0.10 mm and a weight of 4.1×10^{-8} N.

Calculate the magnitude of the terminal velocity.

viscosity of air = 1.3×10^{-5} Pa s
density of air = $1.2\,\text{kg m}^{-3}$

(4)

STOKES' LAW: $F_D = 6\pi r\eta v$, Weight = 4.1×10^{-8}

Upthrust = $\frac{4}{3}\pi r^3 \rho g$

$$6\pi r\eta v = (4.1 \times 10^{-8}) - \frac{4}{3}\pi \left(\frac{0.1}{1000}\right)^3 (1.2)(9.81)$$

$$v = \frac{(4.1 \times 10^{-8}) - \frac{4}{3}\pi \left(\frac{0.1}{1000}\right)^3 (1.2)(9.81)}{6\pi \frac{0.1}{1000}\, 1.3 \times 10^{-5}}$$

$= 1.671155043$

$\simeq 1.7$

Magnitude of terminal velocity = 1.7 m s^{-1} (2sf)

TOTAL FOR PAPER IS 25 MARKS