Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson BTEC Level 3 Nationals Certificate

Centre Number | Learner Registration Number

Wednesday 16 January 2019

Afternoon (Time: 40 minutes) | Paper Reference **31617H/1P**

Applied Science / Forensic and Criminal Investigation

Unit 1: Principles and Application of Science I

Physics

SECTION C: WAVES IN COMMUNICATION

You will need:
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 total mark for this exam is 90.
- The exam comprises three papers worth 30 marks each.
  Section A: Structure and functions of cells and tissues (Biology).
  Section B: Periodicity and properties of elements (Chemistry).
  Section C: Waves in communication (Physics).
- 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 ▶

1/1/1/1/1/1/C2

P 6 1 8 0 6 A 0 1 1 6

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 A slinky spring can be used to show different types of wave.

Figure 1a shows a longitudinal wave on a slinky spring.

The wave travels from P to Q.

Figure 1b shows a 120 mm ruler.

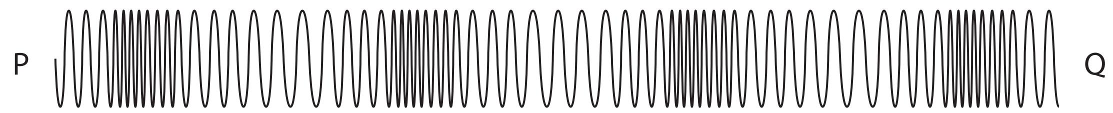

Figure 1a

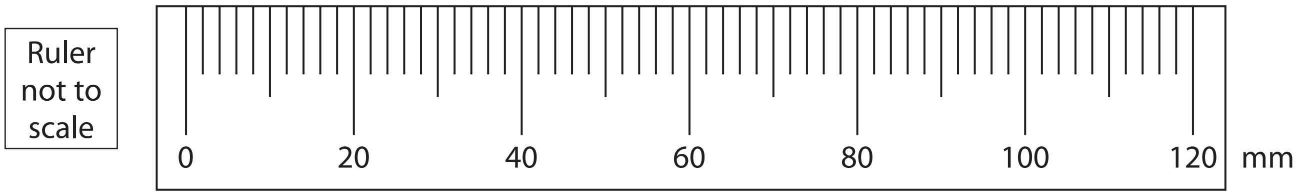

Figure 1b

(a) (i) Label a rarefaction in Figure 1a.

(1)

(ii) Give the wavelength of the longitudinal wave in the slinky spring.

Use the ruler in Figure 1b.

(1)

wavelength = ... mm

(iii) Describe how a longitudinal wave is produced on a slinky spring.

(2)

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(b) Figure 2 shows a transverse wave travelling along a slinky spring.

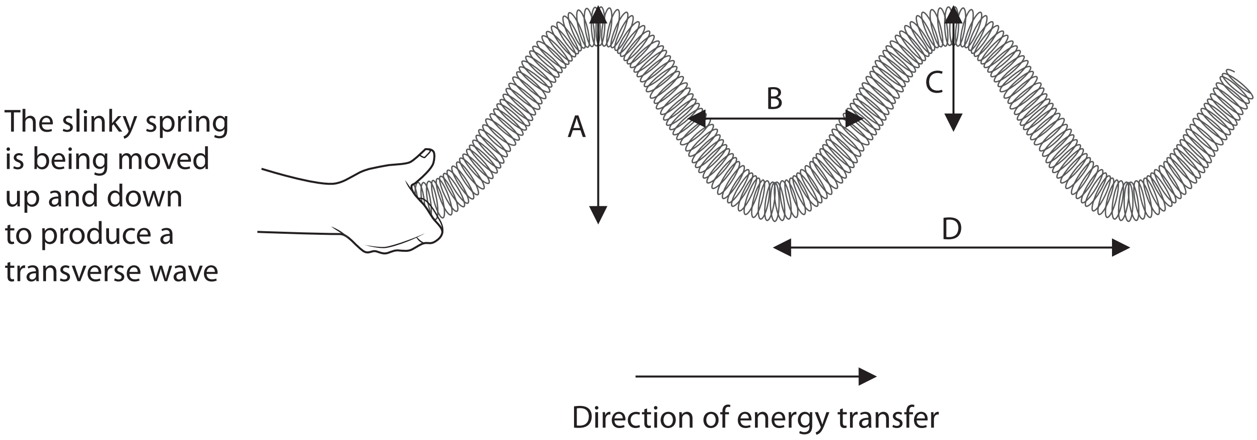

Figure 2

Which of the arrowed lines, A, B, C and D, shows the amplitude of the wave?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 1 = 5 marks)

2 (a) Figure 3 shows the emission spectra of four different gases, A, B, C and D.

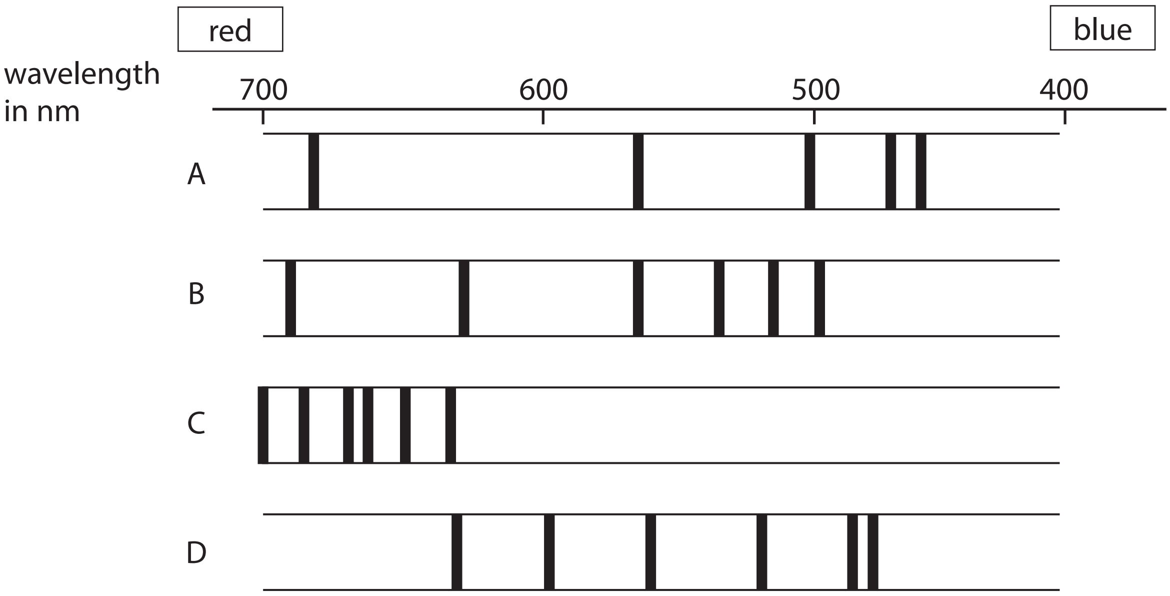

Figure 3

Neon has two spectral lines that are about 10 nm apart.

These spectral lines are at the red end of the spectrum.

Which is the emission spectrum of neon?

(1)

☐ **A**

☐ **B**

☐ **C**

☐ **D**

(b) A diffraction grating is used to analyse the light from a star.

The diffraction grating produces a spectrum of the light.

Figure 4 shows the emission spectra of elements P, Q, R and S, which can be found in the star.

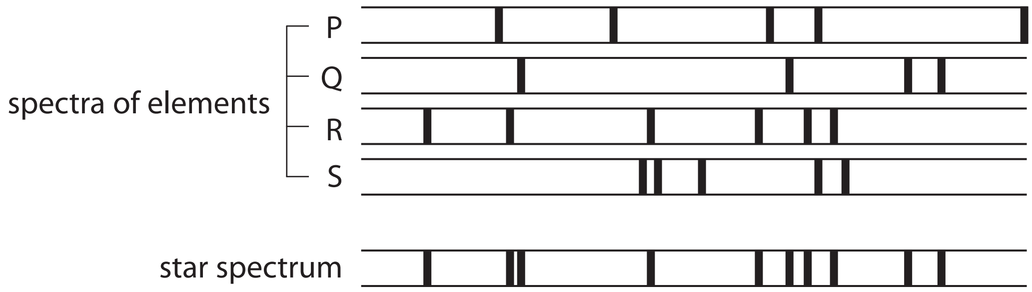

Figure 4

Identify, and justify, which of the elements P, Q, R, S, are found in the star spectrum in Figure 4.

(3)

You may add to Figure 4 to support your answer.

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(c) Figure 5 shows rays of light passing through part of a diffraction grating.

The diffraction grating produces a bright line on the screen.

The distance travelled from the diffraction grating to the screen is different for each ray of light.

This is called the path difference.

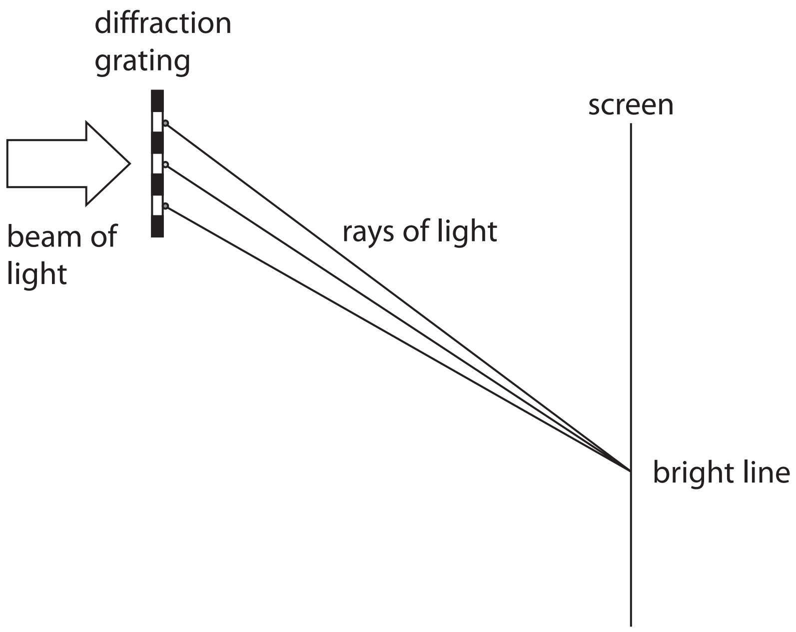

Figure 5

Which path difference between the rays of light gives the bright line?

(1)

☒ **A** quarter of a wavelength

☒ **B** half a wavelength

☒ **C** three quarters of a wavelength

☒ **D** one wavelength

(Total for Question 2 = 5 marks)

3 Mobile phones should receive a signal when the user is in range of a transmitter.

There are places where mobile phone signals cannot be received even when the user is in range of a transmitter. Figure 6 shows a mobile phone with no signal.

Figure 6

(a) Explain why a mobile phone might not receive a signal when in range of a transmitter.
(2)

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(b) For a mobile phone to receive a signal, the intensity must be above 9×10^{-10} Wm^{-2}.

At a distance of 1.1 m from the transmitter, the output signal has an intensity of 1.5 Wm^{-2} and the power given by the constant k is 1.8 W.

Calculate the maximum distance from the transmitter that a signal of intensity 9×10^{-10} Wm^{-2} can be received by a mobile phone.

Give your answer in kilometres (km).

Use the equation $I = k/r^2$

Show your working.

(4)

maximum distance = ... km

(c) (i) Bluetooth© and Wi-Fi use the same frequency band.
Give **one** reason why a Bluetooth© signal does not interfere with a Wi-Fi signal.

(1)

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(ii) State **two** useful applications of Bluetooth© technology.

(2)

1 ....

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2 ....

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(Total for Question 3 = 9 marks)

4 Light passes through an optical fibre.

The optical fibre is made of glass.

(a) Calculate the critical angle for the glass.

(3)

Refractive index of glass (n) = 1.52

Use the equation $\sin C = \frac{1}{n}$

critical angle for the glass = ... °

(b) Optical fibres used in cables can be covered in cladding.

The cladding has a lower refractive index than the optical fibre.

Figure 7a shows light passing through an optical fibre without cladding.

Figure 7b shows light passing through an optical fibre with cladding.

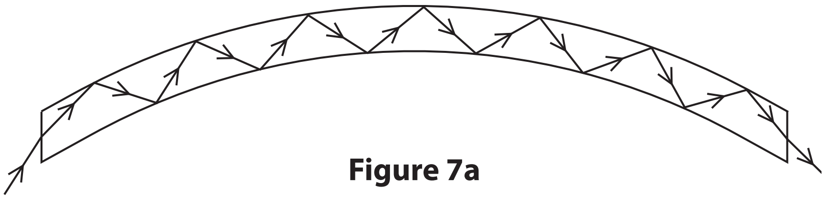

Figure 7a

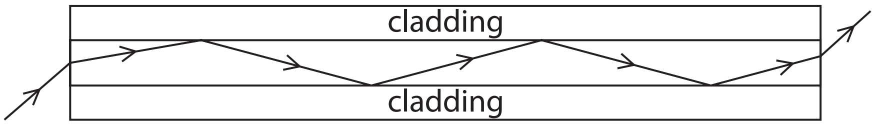

Figure 7b

Explain **one** advantage of transmitting light through an optical fibre with cladding.

(2)

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(Total for Question 4 = 5 marks)

5 Musical notes are sound waves.

Plucking strings or forcing air through pipes can produce sound waves.

Compare the types of wave formed on strings and formed in pipes when musical notes are produced.

You may use diagrams to support your answer.

(6)

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(Total for Question 5 = 6 marks)

TOTAL FOR SECTION C = 30 MARKS

TOTAL FOR EXAM = 90 MARKS

Formulae sheet

Wave speed	$v = f\lambda$
Speed of a transverse wave on a string	$v = \sqrt{\dfrac{T}{\mu}}$
Refractive index	$n = \dfrac{c}{v} = \dfrac{\sin i}{\sin r}$
Critical angle	$\sin C = \dfrac{1}{n}$
Inverse square law in relation to the intensity of a wave	$I = \dfrac{k}{r^2}$

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