OCR
RECOGNISING ACHIEVEMENT

Friday 11 January 2013 – Afternoon

AS GCE PHYSICS B (ADVANCING PHYSICS)

G491/01 Physics in Action

Duration: 1 hour

Candidate forename		Candidate surname	

Centre number					Candidate number				

INSTRUCTIONS TO CANDIDATES

* Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
* Use black ink. HB pencil may be used for graphs and diagrams only.
* Answer **all** the questions.
* Read each question carefully. Make sure you know what you have to do before starting your answer.
* Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
* Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

* The number of marks is given in brackets **[ ]** at the end of each question or part question.
* The total number of marks for this paper is **60**.
* You are advised to spend about 20 minutes on Section A and 40 minutes on Section B.
* The values of standard physical constants are given in the Data, Formulae and Relationships Booklet. Any additional data required are given in the appropriate question.
* Where you see this icon you will be awarded marks for the quality of written communication in your answer.
  This means, for example, you should:
  * ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
  * organise information clearly and coherently, using specialist vocabulary when appropriate.
* This document consists of **16** pages. Any blank pages are indicated.

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Turn over

Answer **all** the questions.

SECTION A

1 Here is a list of electrical units.

     A s   C s^{-1} J s^{-1} J C^{-1} A V^{-1}

Choose the correct unit from this list for

(a) electric charge   ....

(b) potential difference   ....

(c) conductance.   ....

[3]

2 Fig. 2.1 shows three wavefronts of the light from a very distant object incident on a lens.
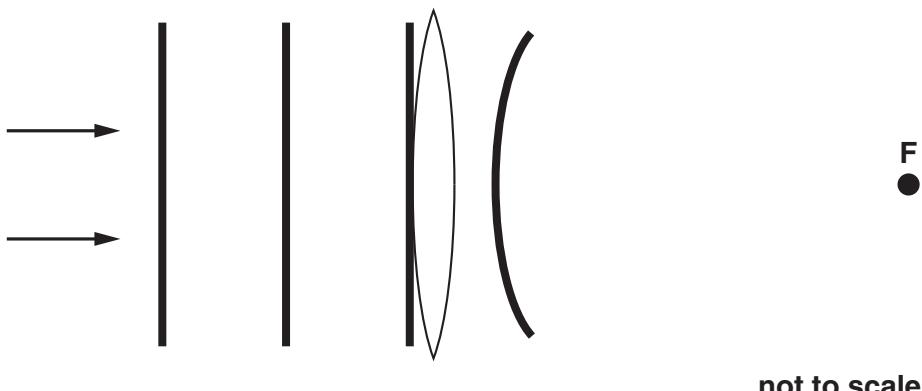

not to scale

Fig. 2.1

(a) State how the diagram shows that the object is very distant from the lens.

[1]

(b) On Fig. 2.1 one wavefront of the light between the lens, and **F**, the principal focus of the lens, has been drawn.

Add **three more** wavefronts to the diagram between the lens and **F**.   [2]

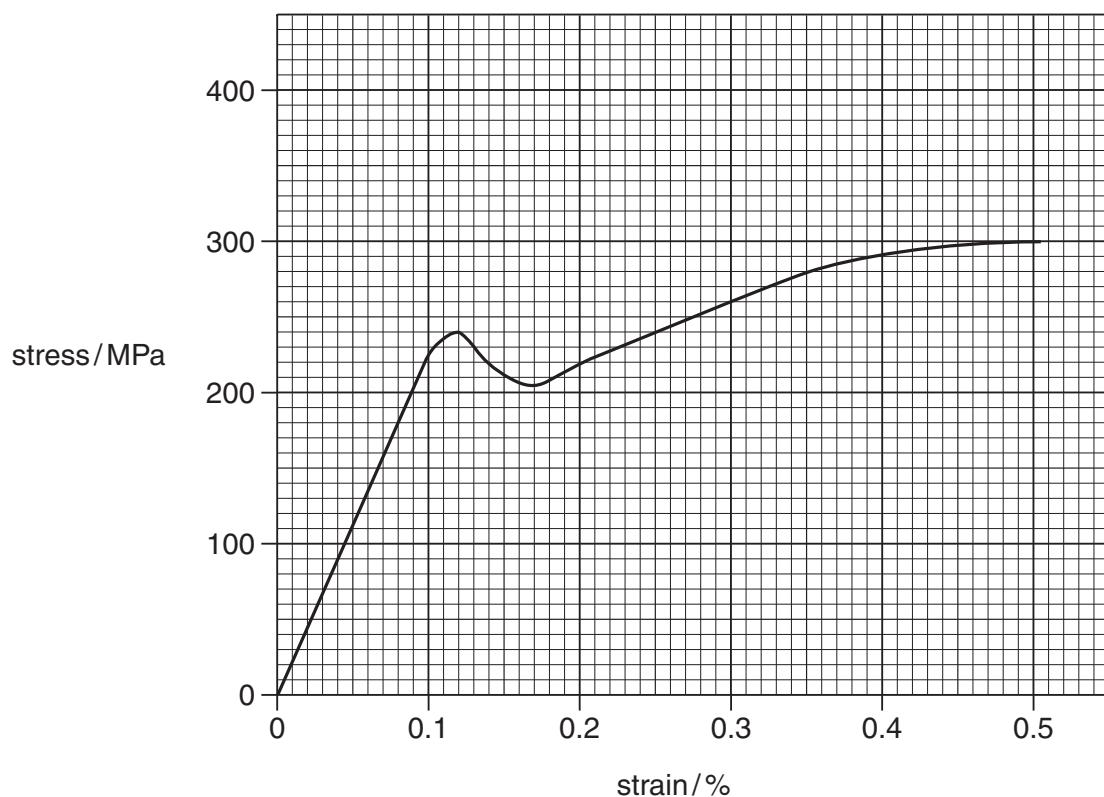**3** Fig. 3.1 shows part of the stress against strain graph for mild steel.

Fig. 3.1

(a) Write down the stress when the strain is 0.1%.

stress = ... MPa **[1]**

(b) Calculate the Young modulus for mild steel.

Make your method clear.

Young modulus = ... Pa **[2]**

Turn over

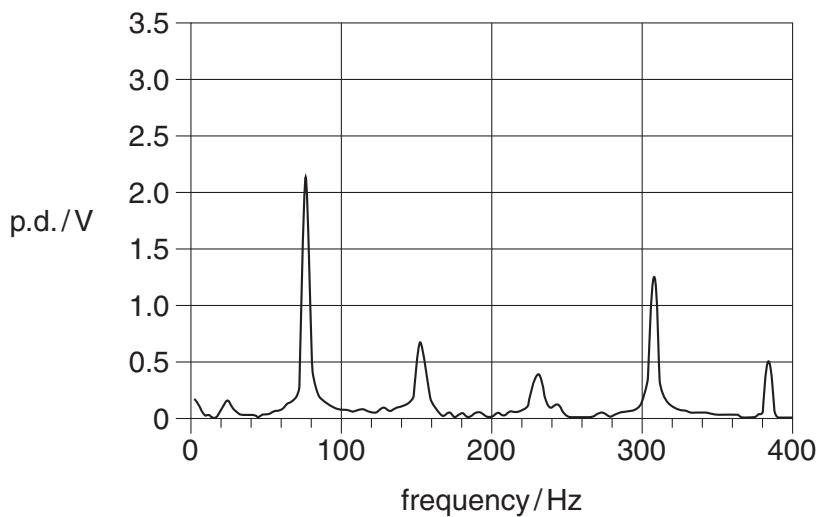**4** Fig. 4.1 shows the frequency spectrum of a sound.

Fig. 4.1

The sound consists of a lowest frequency f_1 with higher harmonics at nf_1 where n = 2, 3, 4 or 5.

(a) Use these data to estimate the lowest frequency f_1 as precisely as you can.

Show how your method improves precision and quote your final answer to a sensible number of significant figures.

lowest frequency f_1 = ... Hz **[2]**

(b) Describe the spectrum of the sound when the sound is quieter.

[2]

5 Fig. 5.1 shows an analogue voltage signal varying in time.

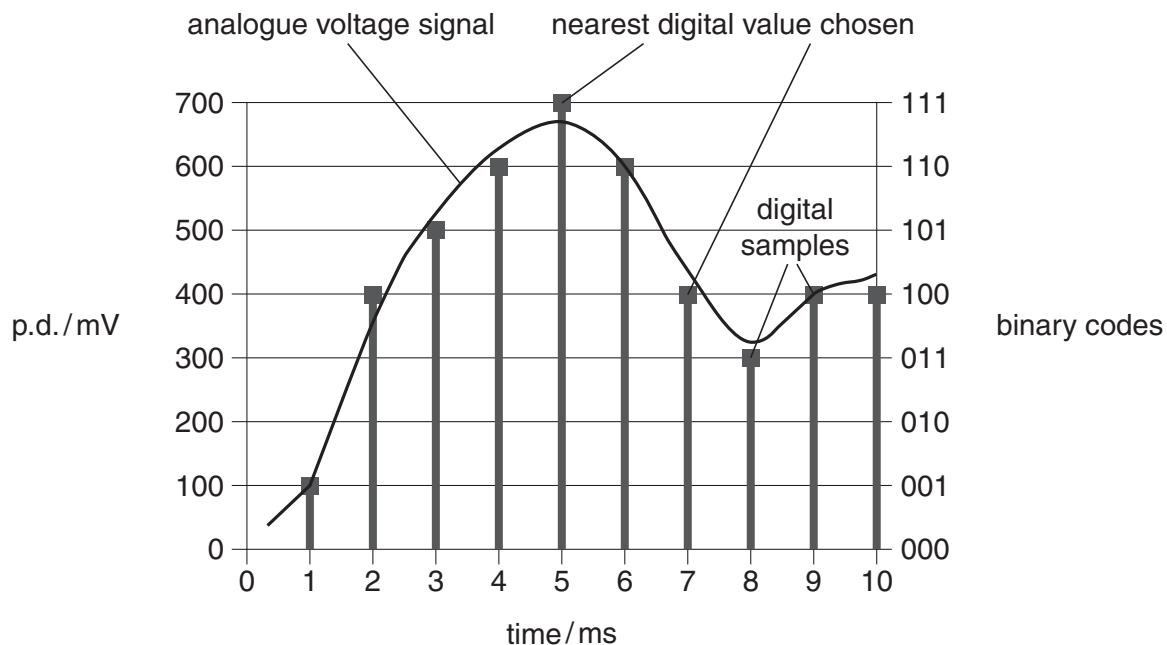It is sampled every 1.0 ms for conversion into a digital signal.

Fig. 5.1

(a) Use information from Fig. 5.1 to calculate the number of bits per second used for the binary coding.

number of bits per second = ... **[2]**

(b) Fig. 5.1 shows that the digital samples can differ from the original analogue signal.

State and explain how this error can be reduced.

[2]

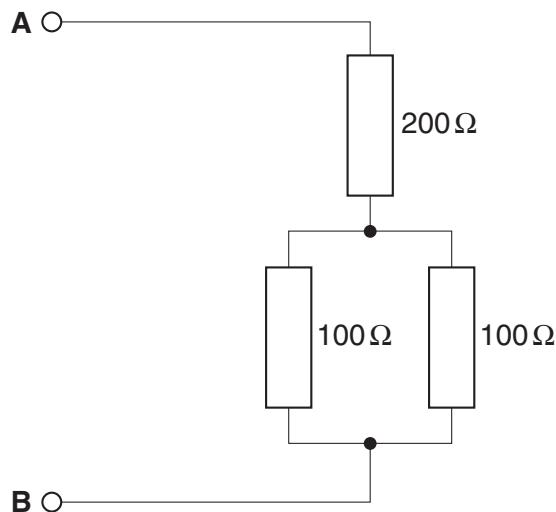**6** Three resistors are connected as shown in Fig. 6.1.

Fig. 6.1

(a) Here are four possible values for the total resistance between points **A** and **B**.

250 Ω   300 Ω   350 Ω   400 Ω

Put a (ring) around the correct answer. **[1]**

(b) A 12 V battery of negligible internal resistance is connected between **A** and **B**.

Calculate the current drawn from the battery.

current = ... A **[2]**

7 Fig. 7.1 shows part of an ultrasound image of a 20 week old foetus.

Fig. 7.1

Here are some data for the ultrasound pulses in soft tissue used to create this image.

wavelength of ultrasound	3×10^{-4} m
speed of ultrasound	$1500\,\text{m}\,\text{s}^{-1}$
pulse duration	$0.8\,\mu\text{s}$

(a) Calculate the frequency of the ultrasound used.

frequency = ... Hz **[2]**

(b) Calculate the number of oscillations in a pulse.

Make your method clear.

number of oscillations per pulse = ... **[2]**

Turn over

SECTION B

8 A laptop computer is connected to the internet by sending and receiving radio signals through a wireless hub.

The following specifications are given for the hub.

power rating	8 W
bit rate	300 Mbit s^{-1}
wave speed *c*	3 × 10^8 m s^{-1}

mains voltage	230 V
carrier wave frequency	5 GHz
maximum range of hub	60 m

(a) Calculate the current drawn by the hub from the mains supply.

current = ... A **[2]**

(b) Calculate the wavelength of the radio carrier waves used to communicate between the hub and laptop.

wavelength = ... m **[2]**

(c) (i) A 2 Gbyte file is downloaded from the internet through the hub.

Calculate the minimum time to complete the download.

time = ... s **[2]**

(ii) Suggest and explain a reason why the time could be significantly longer than the value you have calculated.

[2]

(d) Explain why the laptop will fail to communicate reliably with the hub beyond a certain distance. You should consider ideas about **signal strength** and **noise**.

Organise your explanation clearly and coherently using ideas about signal strength and noise.

You may wish to use labelled diagrams to illustrate your answer.

[3]

[Total: 11]

Turn over

9 This question is about the materials from which cutting tools such as drill bits are made.

(a) (i) Metals have a polycrystalline structure.

Explain the term *polycrystalline* as applied to the structure of a metal.

You may wish to use labelled diagrams in your answer.

[2]

(ii) Drill bits can be made from steel alloy. Fig. 9.1 shows the microstructures of pure iron metal and a steel alloy.
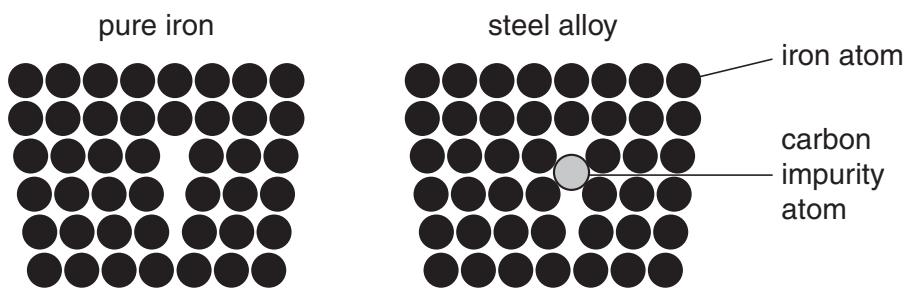

pure iron   steel alloy   iron atom

carbon impurity atom

Fig. 9.1

Steel alloy containing carbon is less ductile than pure iron.

State the meaning of the term *ductile* and describe how Fig. 9.1 can be used to help explain why steel is less ductile than iron.

[3]

(b) (i) Diamond is much harder than steel. This gives a diamond-coated steel drill bit an advantage over a steel one.

1   State what is meant by *hardness*.

2   Explain the advantage.

[2]

(ii) The atoms in steel have metallic bonding and in diamond the atoms have covalent bonding.

Describe these types of bonding. Use your description to explain the difference in hardness between steel and diamond.

You may wish to use labelled diagrams in your answer.

Use appropriate technical terms in your answer.

[4]

[Total: 11]

Turn over

10 This question is about the touch-sensitive screen of a mobile phone such as the one shown below.

flexible plastic coating
top conductive film
insulating spacer dots
bottom resistive film
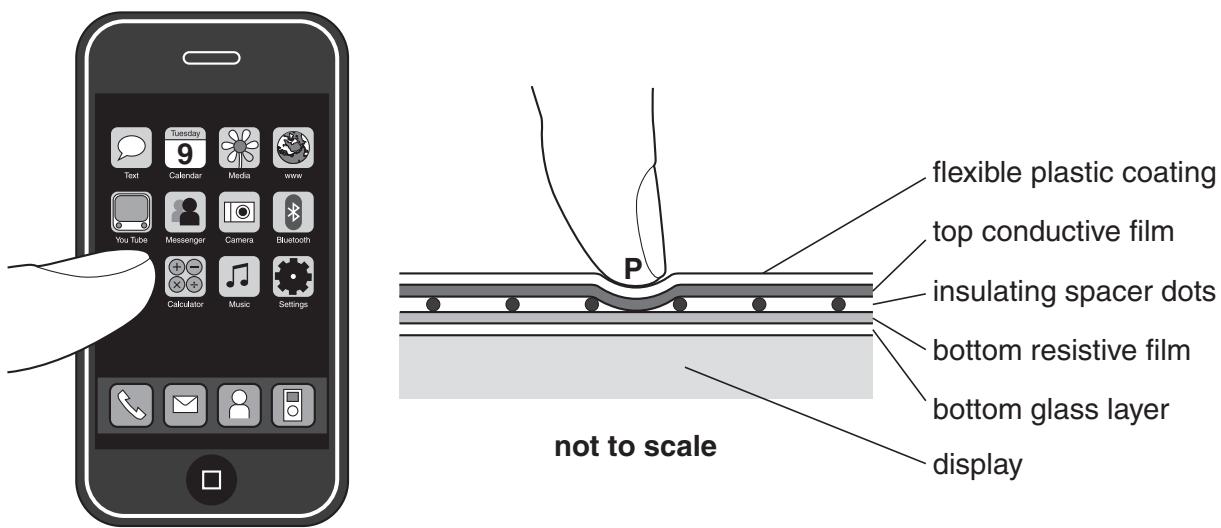bottom glass layer
display

not to scale

Fig. 10.1

The screen consists of several layers as shown in Fig. 10.1. A finger pressed on the screen at point **P** causes two separate conducting films (the top conductive film and the bottom resistive film) to touch and make an electrical contact.

(a) (i) State why the plastic coating and the top conductive film need to be flexible.

[1]

(ii) State why the spacer dots between the conducting films are made from an insulator.

[1]

(b) The two conducting films are made from a semiconducting material.

   (i) State what you understand by the term *semiconductor*.

....

[1]

   (ii) The top conductive film has a much higher conductivity than the lower resistive film.

   State and explain how the conductivity of a semiconducting material can be varied in the manufacturing process.

....

[2]

   (iii) Here are some data for the lower resistive film.

length *L*	60 mm
cross-sectional area *A*	$2.5 \times 10^{-6} \, \text{m}^2$
resistivity *ρ*	$0.17 \, \Omega \, \text{m}$

Calculate the resistance of this length of film.

resistance = ... Ω **[2]**

(c) Fig. 10.2a shows the circuit connections to measure the x-position on the touch-sensitive screen. Fig. 10.2b shows the equivalent potential divider circuit using conventional circuit symbols. Point **P** represents the point of contact between the films.
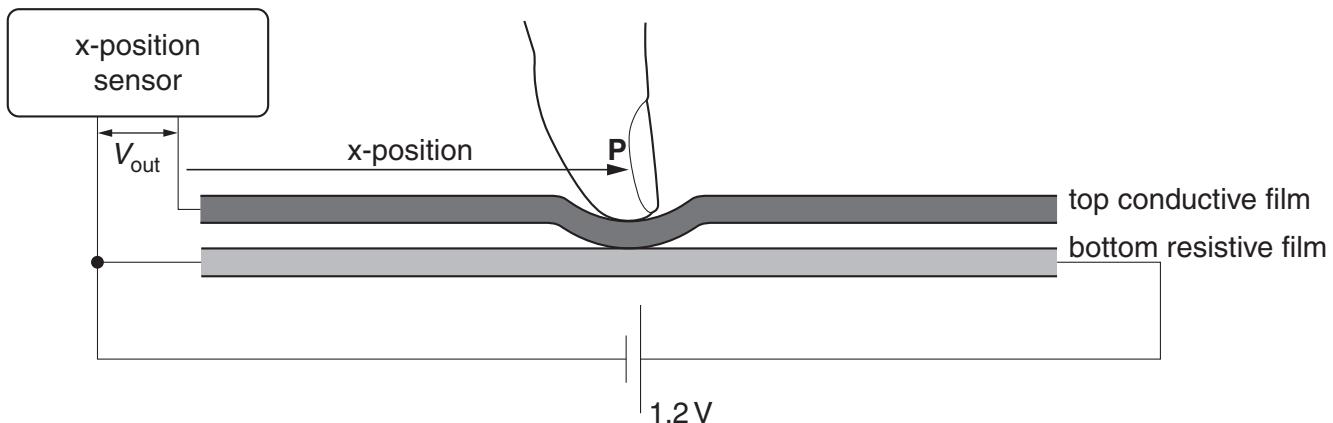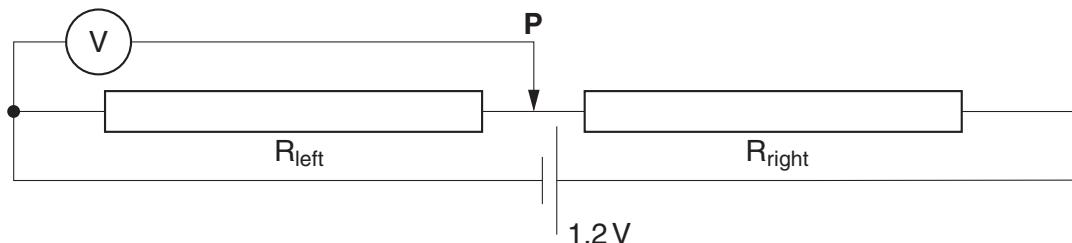

Fig. 10.2a

Fig. 10.2b

(i) Explain how the voltage output V_{out} across the sensor varies with the x-position of the contact point **P** on the screen.

[2]

(ii) The length of the resistive film is 60 mm and the p.d. across it is 1.2 V.

1 Show that the sensitivity of the touch-screen film is 20 mV mm^{-1}.

2 The voltage resolution of the x-position sensor is 5.0 mV.

Calculate the position resolution of this system.

position resolution = ... mm **[2]**

(iii) Calculate the number of bits needed to code for the x-position voltage.

Make your method clear.

number of bits = ... **[3]**

[Total: 14]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE