

Answer **all** the questions.

Section A

- 1 Here is a list of units:

A Pa V W S

- (a) From the list write down the unit for:

pressure conductance [2]

- (b) From the list write down the unit that is equivalent to:

Js^{-1} JC^{-1} [2]

- 2 An analogue signal contains frequencies in the range 200 to 4000 Hz.

- (a) State the bandwidth of the analogue signal. Hz [1]

- (b) The signal is to be digitised. State the lowest suitable sampling frequency.

..... Hz [1]

- (c) The signal has noise associated with it at a voltage variation given by

$$V_{\text{noise}} = V_{\text{total}} / 128.$$

Show that 7 bits per sample is sufficient to code all of the information when digitising this signal.

[1]

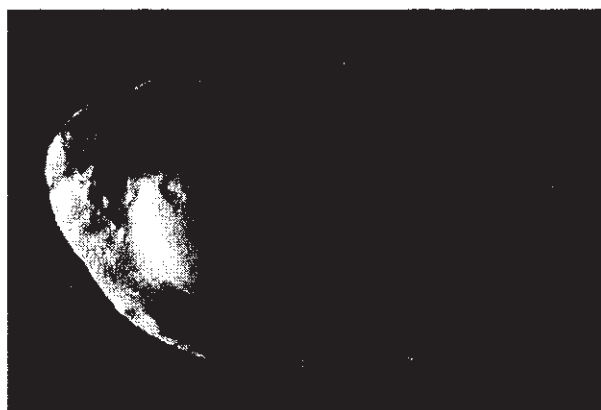
- (d) Use your answers to (b) and (c) to calculate the rate of transfer of digital information needed for this signal.

rate of transfer = bits $^{-1}$ [1]



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- 3 Fig. 3.1 shows two images of one of Saturn's moons. The left hand image is the original photograph taken and the right hand one is a processed image.



original image



processed image

Fig. 3.1

- (a) State one improvement in the processed image compared with the original image.

[1]

- (b) The two columns below list some **processes** that can be used to improve images and **explanations** of how they are done.

processes

explanations

noise removal

'alter pixel value range

sharpening

median filter

contrast adjust

edge detection

Draw a straight line from each **process** box to the box containing the **explanation** of how it is done.

[2]



- 4 A battery has an emf ε of 3.0V and an internal resistance r of $0.38\ \Omega$.

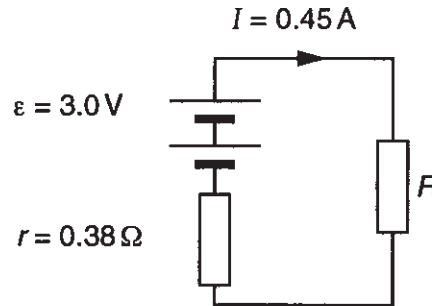


Fig. 4.1

- (a) Here are five suggested statements about electro-motive force (emf).

Draw rings around **A**, **B**, **C**, **D** or **E** to indicate which **two** statements are correct.

- A** It is the maximum current the battery can produce.
- B** It is the maximum p.d. the battery can produce when the current delivered is negligible.
- C** It is the maximum power the battery can deliver.
- D** It is the force per unit charge acting on electrons that pass through the battery.
- E** It is the energy transferred per unit charge by the battery to the electrons in the circuit.

[2]

- (b) The battery delivers a current I of 0.45A into a resistor R as shown in Fig. 4.1.

- (i) Show that the p.d. across the resistor R is about 2.8V.

[2]

- (ii) Calculate the resistance of the resistor R .

resistance = Ω [1]



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- 5 Fig. 5.1 shows plane wavefronts of light from a distant star passing through a thin converging lens to form an image of the star.

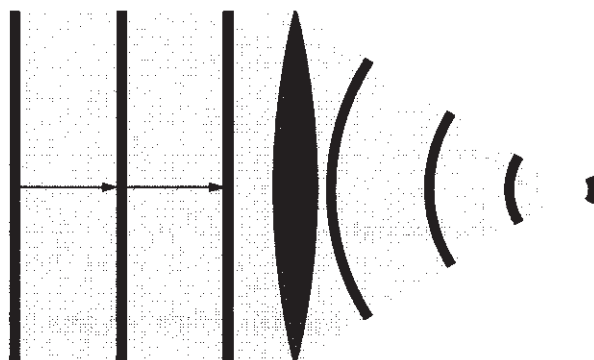


Fig. 5.1

- (a) Label Fig. 5.1 with the letter **X** at the point where the image of the star is formed. [1]
- (b) State what the lens does to the curvature of the wavefronts.

[1]

- 6 The refractive index of diamond is 2.4.

Calculate the speed of light in diamond.

$$c = 3.0 \times 10^8 \text{ ms}^{-1}$$

speed of light in diamond = ms^{-1} [2]



- 7 The following measurements of a uniform metal wire are taken so that its resistivity ρ can be calculated.

resistance $R = 118.3 \pm 0.1 \Omega$

length $L = 2.500 \pm 0.002 \text{ m}$

diameter $D = 0.25 \pm 0.01 \text{ mm}$

The equation used to calculate the resistivity is: $\rho = \frac{\pi D^2 R}{4 L}$

- (a) State which measurement has the greatest effect on the uncertainty in the calculated value of ρ .

measurement [1]

- (b) Give a reason for your choice in (a).

[1]

[Total Section A: 22]



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