

IMAGING TEST

NAME.....

Take the velocity of light $c = 3 \times 10^8 \text{ ms}^{-1}$, and speed of sound as 340 ms^{-1}

1.(a) Which of the following is the best estimate for the wavelength of red light?

10^{-10} m , 10^{-7} m , 10^{-4} m , 10^{-2} m

(1)

(b) An x-ray beam has waves of wavelength $1 \times 10^{-9} \text{ m}$.

(i) Are these waves longitudinal or transverse?

(1)

(ii) What is the frequency of the waves?

(2)

(iii) What is the time duration of one wave?

(2)

(c) Why are x-rays particularly suitable in the detection of bone fractures?

(2)

(d) An x-ray photograph film is of size 400 mm by 300 mm and contains light sensitive grains of size 4mm across.

(i) How many pixels are there on the film?

(1)

(ii) What is the smallest size of feature that can be resolved on the film?

(1)

(iii) Each pixel on the film stores one bit of information. How many bits of information can be stored on the film?

(2)

2. A radio station transmits signals at a wavelength of 650 kHz. Calculate the wavelength of the signal.

(2)

3. An ultra-sound echo locator sends out pulses of waves of frequency 40 kHz lasting for 75 ms into a material in which the waves travel at 1600 m s^{-1} . An echo from a fault in the material is obtained 300 ms after being sent out.

(i) How many waves will be in each burst of signal?

(2)

(ii) What is the depth of the fault in the material?

(2)

(iii) What is the smallest limit of depth detection by this wave process?

(1)

4. A book contains 200,000 words. Each word has an average of 6 characters and each character needs 1 byte of memory storage.

(a) If stored in digital form, how much memory does the book require?

(1)

(b) How long would it take to transmit the book to a disc at a rate of 1 Mbit per second?

(2)

5. In image processing a sharp edge to a picture needs smoothing to make the edge less abrupt. Explain how this can be done.

(2)

6. A convex lens forms a clear image of a distant object on a screen 25 cm from the centre of the lens.

(i) Will the image be larger, smaller or the same size as the object?

(1)

(ii) What is the curvature of the waves going into the lens?

(1)

(iii) What curvature does the lens add to the incoming wave?

(2)

(iv) What is the focal length of the lens?

(1)

(v) What is the power of the lens?

(2)

(vi) The object is now brought closer to the lens. Which way must the lens be moved relative to the screen to bring the image back into focus?

(1)

7. A convex lens of power +10 D is placed 30 cm from an object of height 3 cm.

(i) Find the position of the image relative to the lens.

(3)

(ii) What is the magnification factor of the lens for this image position?

(2)

(iii) The object is now placed 10 cm from the lens. Where will the image of the object be formed?

(1)