PP

Praneel Physics

A Level Physics A

H556/02 Exploring physics

Practice Paper – Set A

Time allowed: 2 hours 15 minutes

You must have:
- the Data, Formula and Relationship Booklet

You may use:
- a scientific or graphical calculator
- a ruler (cm/mm)

First name

Last name

Centre number

Candidate number

INSTRUCTIONS

- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer all the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION

- The total mark for this paper is **90**.
- The marks for each question are shown in brackets [ ].
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **22** pages.

SECTION A

You should spend a maximum of 30 minutes on this section.

Write your answer to each question in the box.

Answer **all** the questions.

1. Which of the following is a **base** SI unit?

A volt

B ohm

C ampere

D coulomb

Answer ☐ **[1]**

2. A charge of $4.0 \cdot 10^{-3}\,\mathrm{C}$ passes through a component. The energy transferred to the component is $0.12\,\mathrm{J}$. What is the potential difference across the component?

A $0.033\,\mathrm{V}$

B $0.48\,\mathrm{V}$

C $30\,\mathrm{V}$

D $480\,\mathrm{V}$

Answer ☐ **[1]**

3. Two coherent waves of equal amplitude a arrive at a point with a path difference of $\frac{\lambda}{2}$. What is the amplitude of the resultant wave at that point?

A 0

B a

C $\sqrt{2}\,a$

D $2a$

Answer ☐ **[1]**

4. An NTC thermistor is connected in series with a fixed resistor R across a $6.0\,\mathrm{V}$ supply. As the temperature of the thermistor **increases**, which of the following correctly describes the voltage across the fixed resistor?

A It increases because the thermistor resistance decreases.

B It decreases because the thermistor resistance decreases.

C It remains constant because the supply voltage is constant.

D It increases because the thermistor resistance increases.

Answer ☐ **[1]**

5. A closed-ended pipe of length $0.60\,\mathrm{m}$ supports stationary waves. The speed of sound is $340\,\mathrm{m/s}$. What is the frequency of the **third harmonic**?

A $142\,\mathrm{Hz}$

B $283\,\mathrm{Hz}$

C $425\,\mathrm{Hz}$

D $567\,\mathrm{Hz}$

Answer ☐ **[1]**

6. A capacitor of capacitance $220\,\mu\mathrm{F}$ is charged to $12\,\mathrm{V}$ and then discharged through a $10\,\mathrm{k}\Omega$ resistor. What is the charge remaining on the capacitor after one time constant?

A $2640\,\mu\mathrm{C}$

B $970\,\mu\mathrm{C}$

C $1620\,\mu\mathrm{C}$

D $4400\,\mu\mathrm{C}$

Answer ☐ **[1]**

7. A battery of EMF $9.0\,\mathrm{V}$ and internal resistance $1.0\,\Omega$ is connected to an external resistor of $8.0\,\Omega$. What is the terminal potential difference of the battery?

A $1.0\,\mathrm{V}$

B $8.0\,\mathrm{V}$

C $9.0\,\mathrm{V}$

D $9.0\,\mathrm{V}$

Answer ☐ **[1]**

8. A wire of resistivity ρ, length L and diameter d has resistance R. A second wire of the same material has length $2L$ and diameter $2d$. What is the resistance of the second wire?

A $R/2$

B R

C $2R$

D $4R$

Answer ☐ **[1]**

9. A coil of 500 turns has a uniform magnetic field passing through it. The flux through each turn changes from $2.0 \cdot 10^{-4}\,\mathrm{Wb}$ to $8.0 \cdot 10^{-4}\,\mathrm{Wb}$ in $0.20\,\mathrm{s}$. What is the magnitude of the induced EMF?

A $1.5\,\mathrm{mV}$

B $0.30\,\mathrm{V}$

C $1.50\,\mathrm{V}$

D $300\,\mathrm{V}$

Answer ☐ **[1]**

10. In a Young's double-slit experiment the slit separation is $0.50\,\mathrm{mm}$, the distance to the screen is $1.8\,\mathrm{m}$ and the wavelength of light is $600\,\mathrm{nm}$. What is the fringe spacing?

A $0.54\,\mathrm{mm}$

B $1.08\,\mathrm{mm}$

C $2.16\,\mathrm{mm}$

D $3.33\,\mathrm{mm}$

Answer ☐ **[1]**

11. Light travels from glass (refractive index 1.52) towards an air boundary. What is the critical angle for total internal reflection?

A $33°$

B $41°$

C $49°$

D $57°$

Answer ☐ **[1]**

12. A bar magnet falls through a solenoid connected to a galvanometer. Which statement about Lenz's law is **correct**?

A The induced current acts to increase the rate of change of flux.

B The induced EMF is proportional to the rate of change of flux linkage.

C The induced current creates a force that opposes the motion of the magnet.

D The magnitude of the induced EMF depends on the resistance of the solenoid.

Answer ☐ **[1]**

13. Uranium-238 undergoes alpha decay. Which of the following correctly gives the daughter nucleus?

A $^{238}_{93}\mathrm{Np}$

B $^{234}_{90}\mathrm{Th}$

C $^{236}_{92}\mathrm{U}$

D $^{234}_{92}\mathrm{U}$

Answer ☐ **[1]**

14. A step-up transformer has 500 turns on the primary coil and 4000 turns on the secondary. The primary voltage is $230\,\mathrm{V}$. What is the secondary voltage?

A $29\,\mathrm{V}$

B $230\,\mathrm{V}$

C $1840\,\mathrm{V}$

D $3680\,\mathrm{V}$

Answer ☐ **[1]**

15. A student measures the diameter of a wire as $(0.42 \pm 0.01)\,\mathrm{mm}$. What is the percentage uncertainty in the **cross-sectional area** of the wire?

A $1.2\,\%$

B $2.4\,\%$

C $4.8\,\%$

D $9.5\,\%$

Answer ☐ **[1]**

SECTION B

Answer **all** the questions.

16. This question is about Young's double-slit interference.

A student sets up the experiment shown in Fig. 16.1. A laser of wavelength $632\,\text{nm}$ illuminates a double slit with slit separation $a = 0.45\,\text{mm}$. A screen is placed a distance $D = 1.60\,\text{m}$ from the slits.

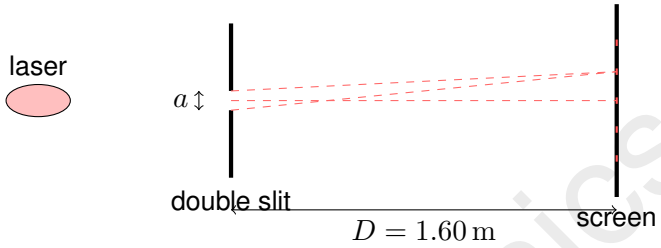


Fig. 16.1

(a) Calculate the fringe spacing x. **[2]**

fringe spacing $x =$ _____ mm

(b) The student increases the slit separation a while keeping all other variables constant.

State and explain the effect on the fringe spacing. **[2]**

(c) The student suggests replacing the laser with two separate lamps emitting the same colour of light.

Explain why no stable interference pattern would be observed. **[2]**

(d) The student replaces the double slit with a diffraction grating that has $300\,\text{lines}\,\text{mm}^{-1}$.

(i) Calculate the angle of the **second-order** maximum for light of wavelength $632\,\text{nm}$. **[2]**

angle = _____ degrees

(ii) State **two** ways in which the pattern produced by the diffraction grating differs from that produced by the double slit. **[2]**

17. A student determines the resistivity of a nichrome wire using an ammeter-voltmeter method. The apparatus is shown in Fig. 17.1.

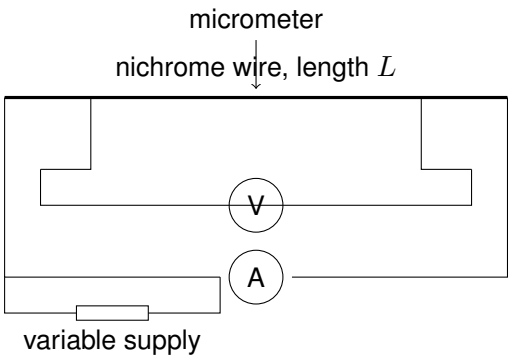


Fig. 17.1

(a) State **three** measurements the student needs to make and describe how each would be obtained. **[3]**

(b) Show that the resistivity ρ of the wire is given by

$$\rho = \frac{R\pi d^2}{4L}$$

where R is the resistance, d is the diameter and L is the length of the wire. **[2]**

(c) The student records the following values:

$$R = 14.2\,\Omega, \quad L = 0.850\,\mathrm{m}, \quad d = 0.38\,\mathrm{mm}$$

(i) Calculate the resistivity ρ of the wire. **[2]**

$\rho =$ _____ $\Omega\,\mathrm{m}$

(ii) The percentage uncertainties in the measurements are:

$$R : \pm 3\%, \quad L : \pm 1\%, \quad d : \pm 4\%$$

Calculate the percentage uncertainty in ρ. **[2]**

percentage uncertainty in $\rho =$ _____ %

(d) When a large current flows, the wire heats up significantly.

Explain the effect of heating on the resistance of the nichrome wire, in terms of the behaviour of electrons and ions. **[3]**

18. This question is about a battery with internal resistance.

A battery of EMF $\varepsilon = 6.0\,\mathrm{V}$ and internal resistance $r = 0.80\,\Omega$ is connected to a variable external resistor R.

(a) State Kirchhoff's second law. **[1]**

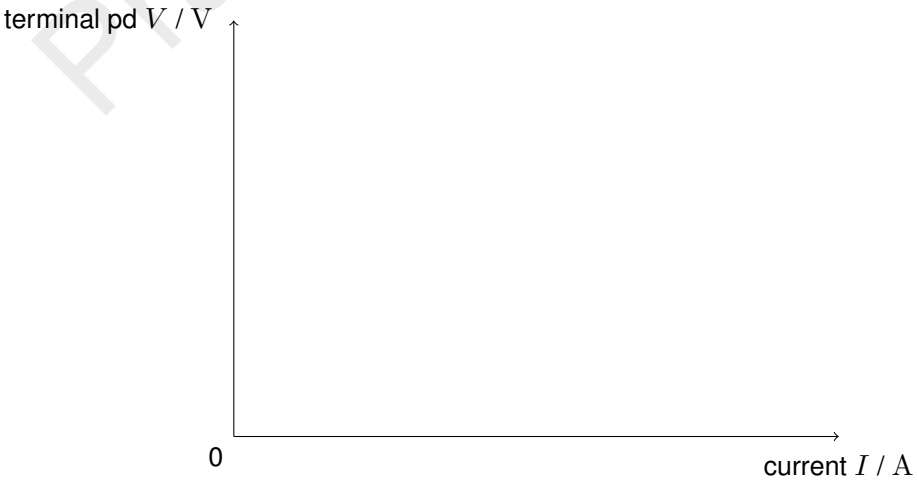
(b)(i) The external resistance is set to $R = 4.2\,\Omega$. Calculate the current in the circuit. **[2]**

current $I =$ _____ A

(b)(ii) Calculate the terminal potential difference (terminal pd) of the battery. **[2]**

terminal pd = _____ V

(c) On the axes below, sketch the variation of terminal pd V with current I as R is varied from a large value to a small value. Label the gradient and both intercepts. **[3]**



(d) Explain why the efficiency of the battery (ratio of power delivered to R to total power) is always less than 1. **[2]**

19*. A student determines the Planck constant h using LEDs (light-emitting diodes) of different colours.

Describe how the student could carry out this experiment to obtain an accurate value of h.

As part of your answer, describe how to:

- set up the circuit and vary the voltage across the LED,
- determine the threshold voltage V_0 for each LED,
- use a graph to obtain h,
- state what quantity the gradient of the graph represents and whether the line should pass through the origin.

[6]

20. A capacitor of capacitance $C = 470\,\mu\mathrm{F}$ is charged to a potential difference of $9.0\,\mathrm{V}$. It is then discharged through a resistor of resistance $R = 22\,\mathrm{k}\Omega$.

(a) Calculate the time constant τ for the discharge. **[2]**

time constant $\tau =$ _____ s

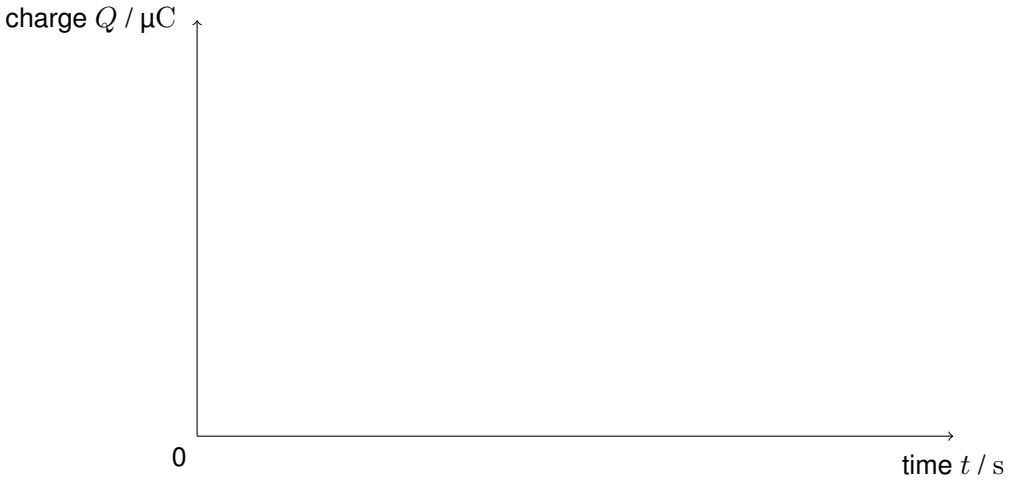
(b) Calculate the potential difference across the capacitor $15\,\mathrm{s}$ after the discharge begins. **[2]**

$V =$ _____ V

(c)(i) Explain how the student could produce a straight-line graph from the discharge data to verify the exponential decay. **[2]**

(c)(ii) State what quantity the gradient of this straight-line graph represents. **[1]**

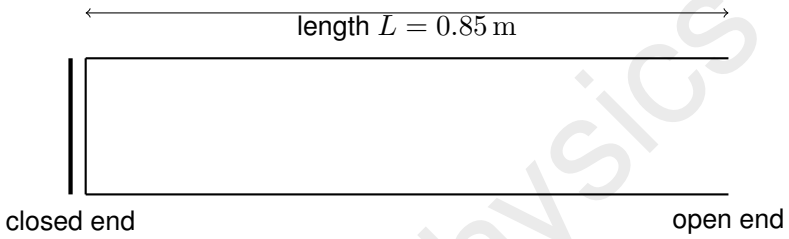
(d) On the axes below, sketch the variation of charge Q on the capacitor with time t during the discharge. Mark the initial charge Q_0 on the axis. **[3]**



21. A signal generator drives a loudspeaker at one end of a closed cylindrical tube of length $L = 0.85\,\mathrm{m}$. A microphone connected to an oscilloscope is moved inside the tube to detect nodes and antinodes. The speed of sound in air is $340\,\mathrm{m/s}$.

(a) Explain how a stationary wave is formed inside the tube. **[2]**

(b)(i) In the space below, draw a diagram showing the **fundamental** (first harmonic) mode of vibration inside the closed tube. Label the node(s) and antinode(s). **[2]**



(b)(ii) Calculate the fundamental frequency of vibration of the tube. **[2]**

fundamental frequency $f_1 =$ _____ Hz

(c) Calculate the frequency of the **third harmonic** (third mode of vibration) of the closed tube. **[2]**

frequency $=$ _____ Hz

(d) Explain why a closed-end pipe can only produce odd harmonics. **[2]**

22. Fig. 22.1 shows a bar magnet falling vertically through a solenoid. The solenoid has 200 turns and is connected to a cathode-ray oscilloscope (CRO).

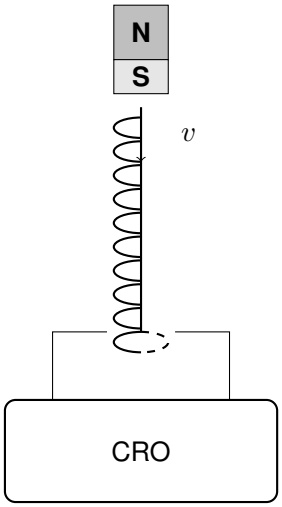


Fig. 22.1

(a) State Faraday's law of electromagnetic induction. [**1**]

(b) State Lenz's law. [**1**]

(c)(i) Describe the shape of the EMF–time trace that would be seen on the CRO as the magnet enters then exits the solenoid. [**2**]

(c)(ii) Explain why the peak magnitude of the EMF is greater when the magnet exits the solenoid than when it enters. [**2**]

(d)(i) The maximum magnetic flux through the solenoid is $3.8 \cdot 10^{-4}\,\mathrm{Wb}$. Calculate the maximum flux linkage. **[1]**

maximum flux linkage $=$ _____ Wb

(d)(ii) The time taken for the flux to change from zero to its maximum value is approximately $0.060\,\mathrm{s}$. Estimate the maximum induced EMF. **[2]**

maximum EMF $\approx$ _____ V

23*. Compare the use of **X-rays** and **ultrasound** in medical imaging.

As part of your answer, include:

- how X-rays are produced and detected,
- how ultrasound is produced and how reflection at tissue boundaries is used to form an image,
- the advantages and disadvantages of each technique, including reference to whether each is ionising, the resolution and contrast obtainable, and relative cost,
- one specific application for which X-rays are preferred and one for which ultrasound is preferred, with justification in each case.

[8]

END OF QUESTION PAPER