OCR
Oxford Cambridge and RSA

A Level Physics A
H556/02 Exploring physics

Practice paper – Set 1
Time allowed: 2 hours 15 minutes

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

You may use:
- a scientific 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.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **100**.
- 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 **28** pages.

SECTION A

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

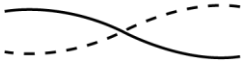
Write your answer to each question in the box provided.

Answer **all** the questions.

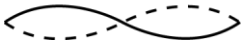
1 A student blows across the open end of an empty bottle.

Which diagram shows a possible stationary wave pattern for this bottle?

A 

B 

C 

D 

Your answer ☐

[1]

2 Violet light is incident on the surface of a metal. Photoelectrons are emitted from the surface of the metal. The frequency of the radiation incident on this metal is increased but the intensity of the radiation is kept constant.

Which statement is correct?

A The value of the Planck constant increases.

B The work function of the metal increases.

C The number of photoelectrons emitted per second increases.

D The maximum kinetic energy of photoelectrons increases.

Your answer ☐

[1]

3 A battery of electromotive force (e.m.f.) 6.0 V is connected across a resistor of resistance 12 Ω. The potential difference across the resistor is 4.5 V.

What is the internal resistance of the battery?

A 3 Ω

B 4 Ω

C 9 Ω

D 16 Ω

Your answer ☐

[1]

4 A student is given two identical filament lamps. Each lamp is labelled as '12 V, 24 W'. The student connects the two lamps in series across a 12 V supply of negligible internal resistance.

Which of the following statements is/are true when the lamps are in **series**?

1 The resistance of each lamp is 6.0 Ω.
2 The current in the circuit is greater than 1.0 A.
3 The potential difference across each lamp is 6.0 V.

A 1, 2 and 3

B Only 2 and 3

C Only 1 and 2

D Only 2

Your answer ☐

[1]

5 What is the de Broglie wavelength in nm of a proton travelling at 1.5×10^4 m s^{-1}?

A 2.6×10^{-2} nm

B 2.6 nm

C 49 nm

D 4.9×10^4 nm

Your answer ☐

[1]

6 A wire **X** has length L and radius r. Another wire **Y** made of the same material as **X** has length $2L$ and radius $3r$. The wires are connected in **parallel** to a battery.

What is the correct ratio of

$$\frac{\text{power dissipated in } \mathbf{Y}}{\text{power dissipated in } \mathbf{X}} \; ?$$

A 0.22

B 1.0

C 4.5

D 6.0

Your answer ☐

[1]

7 A student records the following data during an experiment to determine the internal resistance of a battery.

e.m.f. = (4.5 ± 0.2) V
terminal p.d. = (3.0 ± 0.1) V
current = (2.0 ± 0.1) A

What is the percentage uncertainty in the value for the internal resistance of the battery?

A 5.0 %

B 6.1 %

C 13 %

D 25 %

Your answer ☐

[1]

8 A capacitor consists of two parallel plates separated by air. The capacitor is connected across a d.c. supply. The charged capacitor is then disconnected and the separation between the plates is doubled.

Which statement is correct about the charge stored by the capacitor?

A The charge is the same.

B The charge doubles.

C The charge halves.

D The charge quarters.

Your answer ☐

[1]

9 Four capacitors of capacitance 10 μF, 20 μF, 30 μF and 40 μF are connected in **series** to a battery.

Which capacitor has the **largest** potential difference across it?

A 10 μF capacitor

B 20 μF capacitor

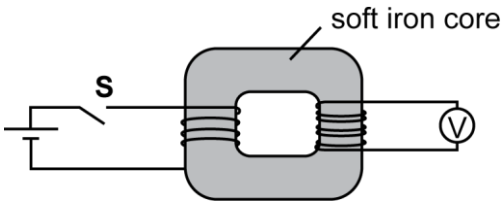
C 30 μF capacitor

D 40 μF capacitor

Your answer ☐

[1]

10 The diagram below shows a transformer.



The primary coil is connected to a switch **S** and a cell. The secondary coil is connected to a voltmeter. The switch is then **closed**.

Which statement is correct?

The voltmeter reading….

A does not change.

B increases and then stays constant.

C increases and then decreases to zero.

D increases and then changes direction.

Your answer ☐

[1]

11 A charged particle travelling with speed v describes a circular path of radius R in a plane perpendicular to a uniform magnetic field. The orbital period of this particle is T.
The same particle now travels with speed $2v$ in a circular path in the same plane as before.

What is the orbital period of the particle now?

A $0.25T$

B $0.5T$

C T

D $2T$

Your answer ☐

[1]

12 Which is the correct decay of a quark?

A $u \rightarrow d + {}^{0}_{-1}e + \overline{\nu_e}$

B $u \rightarrow d + {}^{0}_{-1}e + \nu_e$

C $d \rightarrow u + {}^{0}_{-1}e + \nu_e$

D $d \rightarrow u + {}^{0}_{-1}e + \overline{\nu_e}$

Your answer ☐

[1]

13 What is the correct SI unit for acoustic impedance?

A kg s

B kg m^{-2} s^{-1}

C kg m^{-3} s^{-1}

D kg m^{-2} s^{-2}

Your answer ☐

[1]

14 Which is **not** a component used in a gamma camera?

A X-ray tube

B collimator

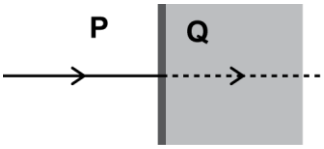
C computer

D photomultiplier tubes

Your answer ☐

[1]

15 The diagram below shows a beam of ultrasound incident at the boundary between two materials.
The acoustic impedance of material **P** is 1.5 times the acoustic impedance of material **Q**.



What is the percentage of the ultrasound intensity **transmitted** at the boundary?

A 20 %

B 30 %

C 80 %

D 96 %

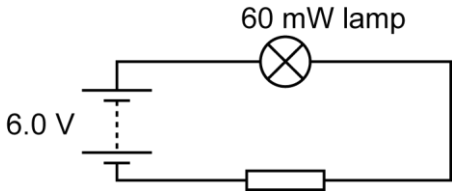
Your answer ☐

[1]

SECTION B

Answer **all** the questions.

16 A battery is connected in series with a lamp and a resistor as shown.



The battery has e.m.f. 6.0 V and negligible internal resistance. The potential difference across the lamp is 2.4 V and it dissipates 60 mW. The resistor has cross-sectional area of 2.0 mm^2. The number density of charge carriers (free electrons) within the resistor is 1.4×10^{25} m^{-3}.

(a) Calculate the resistance *R* of the resistor.

R = ... Ω **[3]**

(b) Calculate the mean drift velocity *v* of the free electrons within the resistor.

v = ... $m\ s^{-1}$ **[3]**

(c) The number density of the free electrons in the connecting wires is greater than that of the resistor. The connecting wires have the same diameter as the resistor. State and explain whether the mean drift velocity of the free electrons would be smaller, the same, or larger than your value in **(b)**.

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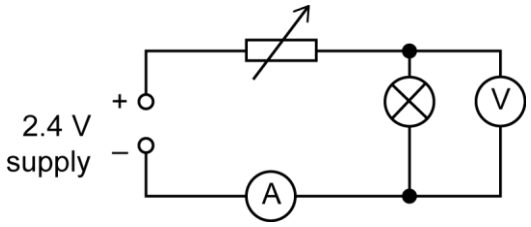
..... **[2]**

(d) A student connects the circuit shown to plot the I-V characteristic of the filament lamp.



The current in the lamp is I and the potential difference across it is V. The supply has e.m.f. 2.4 V and negligible internal resistance. The maximum resistance of the variable resistor is about 60 Ω.

(i) Explain why this circuit will provide data for large V values but not for small V values.

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..... **[2]**

(ii) Complete Fig. 16 to design a circuit so that data may be obtained for V from zero to 2.4 V for the lamp.

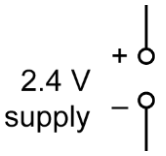

Fig. 16

[2]

17 (a)* Students are given a glass block and a ray box to determine the refractive index of glass. The students measure the angle of incidence *i* and the angle of refraction *r*. The table shows the results collected by the students.

i / ° ± 0.5°	10	20	30	40	50	60	70	80
r / ° ± 0.5°	6	13	20	25	31	35	39	41

The refractive index of air is 1.00.

Describe, with the help of a labelled diagram, how the students may have conducted the experiments in the laboratory.

Discuss how you could use the data from the table to graphically determine a value for the refractive index of glass.

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(b) Fig.17 shows a ray of light at the boundary between glass and water.

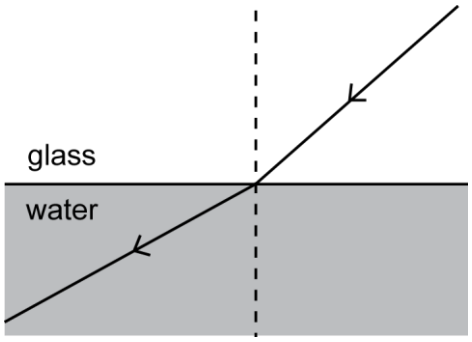

Fig. 17 (not to scale)

Use Fig. 17 to describe and explain how the wavelength of the light changes as light travels from glass to water.

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..... **[3]**

18 **(a)** State the meaning of *coherence*.

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..... **[1]**

(b) Fig. 18 shows a loudspeaker placed in front of two narrow slits in a metal plate.

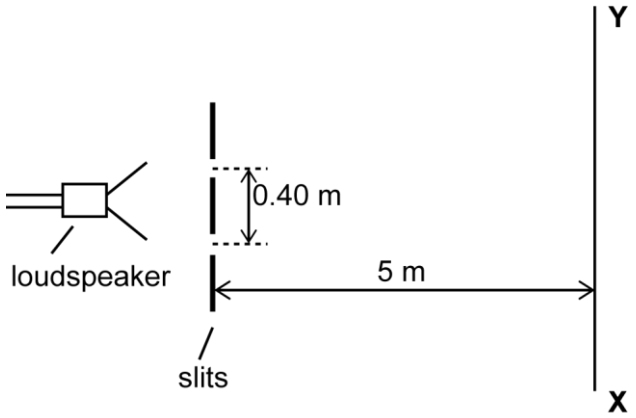

Fig. 18

The loudspeaker emits sound waves of frequency 2.8 kHz. The separation between the centres of the narrow slits is 0.40 m.

A microphone, moved along the line **XY** at a distance of 5.0 m from the slits, detects regions of low and high intensity sound.

The separation between adjacent regions of low and high intensity sound is 0.75 m.

(i) Explain how you can use an oscilloscope set to a time-base of 0.1 ms div^{-1} to check that the frequency of sound is 2.8 kHz.

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..... **[3]**

(ii) Explain how the arrangement shown in Fig. 18 produces an interference pattern along the line **XY**.

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..... **[4]**

(iii) Calculate the wavelength of sound.

wavelength = ... m **[3]**

(iv) Calculate the speed of sound.

speed = ... m s^{-1} **[1]**

(v) State and explain the effect, if any, on the position and the intensity of the maxima when the amplitude of the transmitted waves is halved.

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..... **[3]**

19 Fig. 19 shows a photocell.

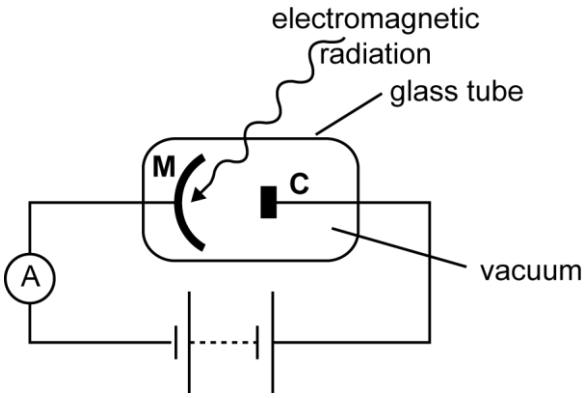

Fig. 19

When the metal **M** is exposed to electromagnetic radiation, photoelectrons are ejected from the surface of the metal. These photoelectrons are collected at the electrode **C** and the sensitive ammeter indicates the presence of a tiny current.
The work function of the metal **M** is 2.3 eV.
The incident electromagnetic radiation has wavelength 5.1×10^{-7} m.
The ammeter reading is 0.24 μA.

(a) Calculate the number of photoelectrons reaching **C** in a time of 5.0 s.

number = ... **[3]**

(b) Calculate the maximum kinetic energy of the ejected photoelectrons.

maximum kinetic energy = ... J **[3]**

(c) The wavelength of the incident radiation is kept constant but the intensity of the radiation is doubled.

State and explain the effect, if any, on the current in the photocell.

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..... **[2]**

20 (a) State what is meant by the *decay constant* of an isotope.

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..... **[1]**

(b) A radioactive substance has 2000 nuclei. The decay constant of the isotope of the substance is 0.10 s^{-1}.

Use the equation $\frac{\Delta N}{\Delta t} = -\lambda N$ and Δt = 1.0 s to estimate the number of nuclei left after time t = 2.0 s.

number of nuclei left = ... **[2]**

(c)* A group of students are investigating the decay of protactinium.
A fresh sample of protactinium is prepared. The activity of the sample was measured at intervals of 1.0 minutes for 6.0 minutes.
The table shows the activity corrected for background radiation.

time t / min	0	1.0	2.0	3.0	4.0	5.0	6.0
activity A / Bq	943	523	287	161	79	61	20

Fig. 20 shows the variation of ln(A) with time t.

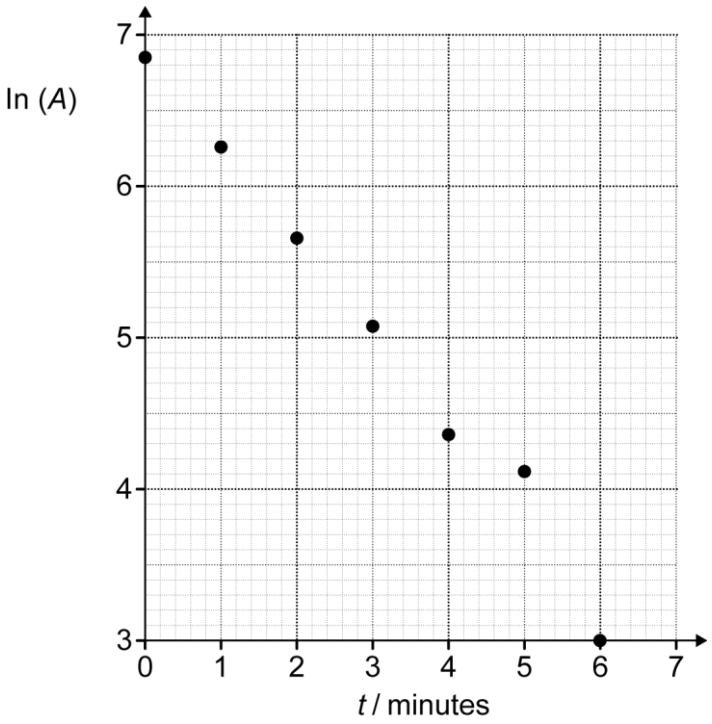

Fig. 20

Explain how the graph in Fig. 20 can be used to determine the half-life of protactinium.
Determine the half-life of protactinium. Include an uncertainty in your value.

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..... **[6]**

21 **(a)** A positively charged particle is travelling in a uniform field.
Fig. 21.1 shows the particle travelling at right angles to the direction of the field.

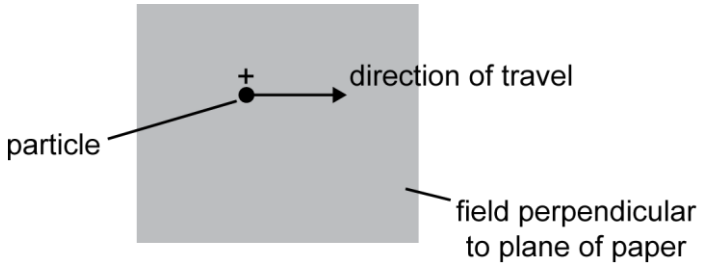

Fig. 21.1

Describe the motion of the particle in terms of the force it experiences when the field is

(i) a magnetic field

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..... **[2]**

(ii) an electric field.

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..... **[2]**

(b) Fig. 21.2 shows a uniformly charged sphere of radius *R*.

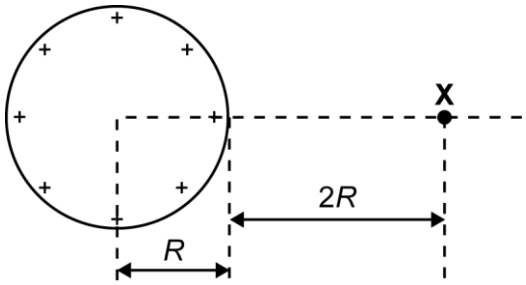

Fig. 21.2

The electric potential at point **X** is +1800 V. Point **X** is at a distance of 2*R* from the **surface** of the sphere.

(i) Calculate the electric potential *V* at the surface of the sphere.

V = ... V **[2]**

(ii) The radius of the sphere is 4.0 cm.

Calculate

1 the surface charge *Q* on the sphere

Q = ... C **[2]**

2 the electric field strength *E* at the surface of the sphere.

E = ... N C^{-1} **[2]**

(c) Fig. 21.3 shows two particles with the same charge but of opposite sign.

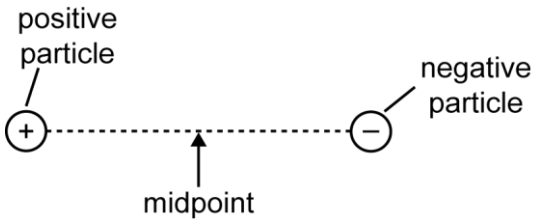

Fig. 21.3

State and explain the magnitude of the electric potential at the midpoint between the particles.

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..... **[2]**

22 **(a)** State what is meant by *induced nuclear fission*.

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..... **[1]**

(b) Explain the role of the moderator and the control rods in a nuclear reactor.

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..... **[4]**

(c) A possible fission reaction is

$$^{1}_{0}\mathrm{n} + {}^{235}_{92}\mathrm{U} \rightarrow {}^{236}_{92}\mathrm{U} \rightarrow {}^{98}_{38}\mathrm{Sr} + {}^{136}_{54}\mathrm{Xe} + k\,{}^{1}_{0}\mathrm{n}$$

where k is the number of neutrons released in the reaction. The $^{236}_{92}\mathrm{U}$ nucleus is very unstable.

(i) State the number k of neutrons released in this reaction.

k = ... **[1]**

(ii) State the binding energy of the released neutrons.

..... **[1]**

(iii) A nuclear reactor uses uranium-235 as fuel. The output power from the reactor is 1.0 GW. The mass of the $^{236}_{92}U$ nucleus is 236.053 u. The total mass of the fission products is 235.840 u.

Calculate the number of fission reactions per second.

number of reactions per second = ... s^{-1} **[4]**

23 **(a)** Describe the X-ray attenuation mechanisms of *simple scatter* and *pair production*.

simple scatter .....

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pair production .....

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[2]

(b) Calculate the maximum wavelength of the X-rays for the pair production process.

maximum wavelength = ... m **[3]**

(c) An X-ray image of a patient's arm is required.
Fig. 23.1 shows a parallel beam of X-rays is incident on a cross-section of the patient's arm.

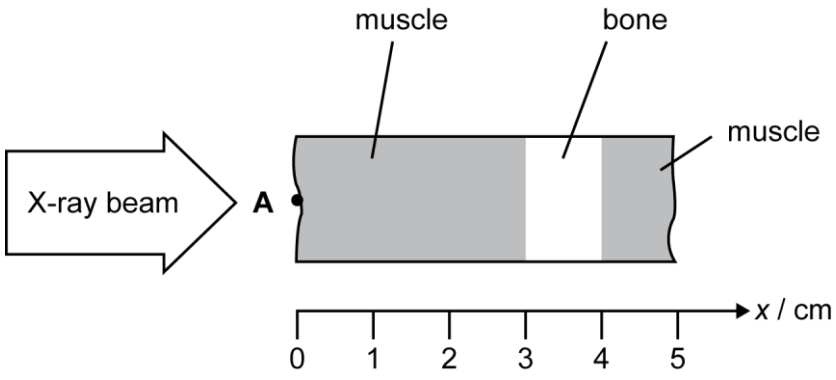

Fig. 23.1

Fig. 23.2 shows the variation of the intensity of the X-rays with distance *x* from the point **A**.

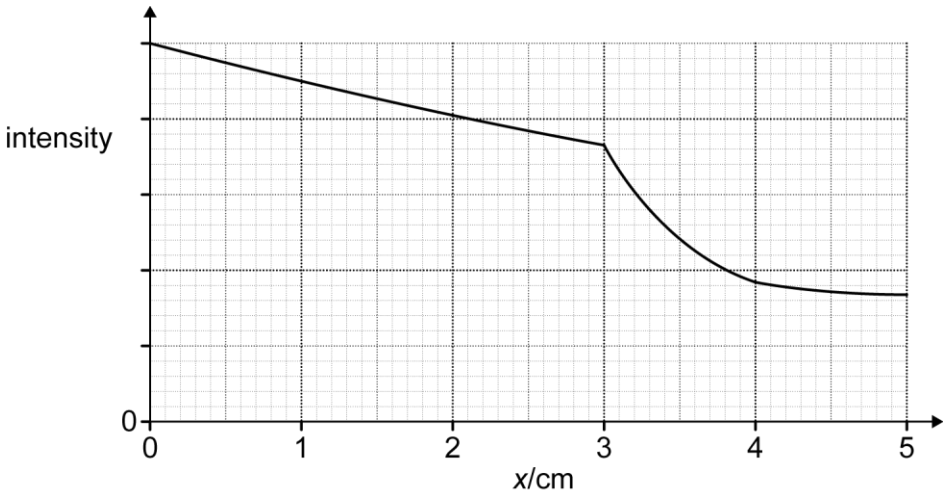

Fig. 23.2

Explain the shape of the graph shown in Fig. 23.2.

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END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).