OCR
Oxford Cambridge and RSA

AS Level Physics A
H156/02 Depth in physics
Practice Question Paper

Date – Morning/Afternoon
Time allowed: 1 hour 30 minutes

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

You may use:
- a scientific calculator

First name	
Last name	

Centre number						Candidate number				

INSTRUCTIONS
- Use black ink. HB pencil may be used for graphs and diagrams only.
- 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.
- Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION
- The total mark for this paper is **70**.
- 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 **14** pages.

PRACTICE

Answer **all** the questions.

1 **(a)** **(i)** Define the moment of a force about a point.

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(ii) State the principle of moments as a condition for equilibrium.

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(b) **Fig. 1** shows the top of a crane which has an arm **AC** of mass 1800 kg. The centre of mass of the arm is at **D**.

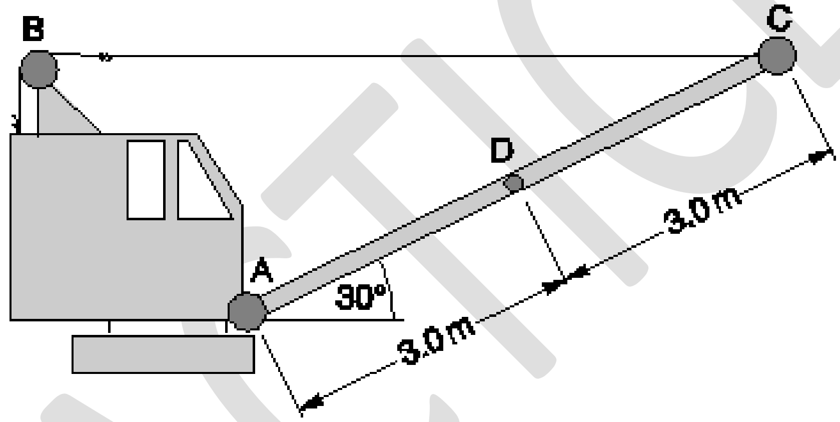

Fig. 1

The arm can rotate about the pivot at **A**. It is supported by a horizontal cable **BC**. The dimensions are as shown on the diagram.

(i) The arm is in equilibrium. Draw and label three arrows on **Fig. 1** to represent the three forces acting on the arm. **[3]**

(ii) Calculate the tension in the cable **BC**.

tension = ………………………kN **[3]**

PRACTICE

(c) The arm is rotated about **A** by shortening the cable **BC**. The cable is no longer horizontal. Explain whether the tension in the cable has increased or decreased.

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PRACTICE

2 A student carries out an experiment to measure *g*, the acceleration due to gravity, by measuring the time *t* for a steel ball to fall a distance *s*.
The method is shown in **Fig. 2.1**

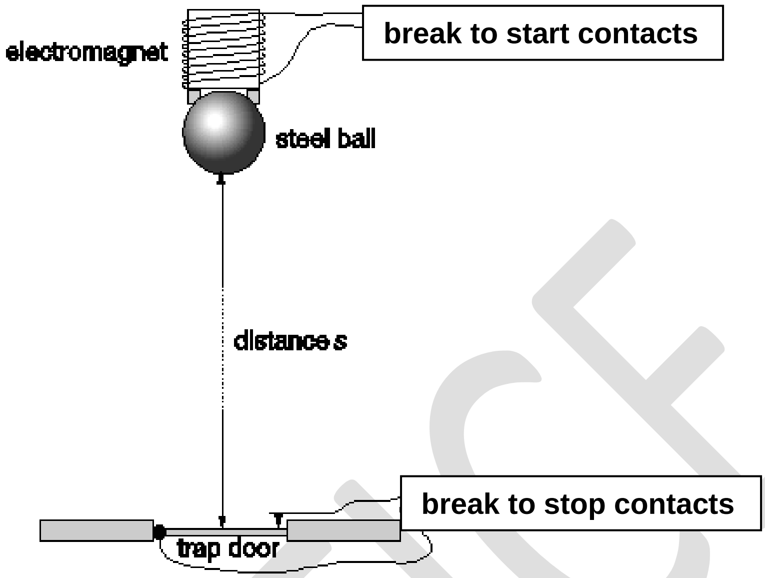

Fig 2.1

The break-to-start and break-to-stop contacts are connected to an electronic timer. As the steel ball is released from the electromagnet, the electronic timer starts. The ball falls a distance *s* before it hits a hinged metal 'trap door'. The trap door opens, breaks the circuit and stops the timer.

The student records the following data for a range of distances *s*, averaging the time *t* at each distance over several drops. He intends to plot a graph of *s* against t^2 so adds a third column to his table of results.

s/m	mean *t*/s	t^2/s^2
0.40	0.31	0.10
0.60	0.38	0.14
0.80	0.42	0.18
1.00	0.47	
1.20	0.51	
1.40	0.55	0.30

(a) **(i)** Complete the table. Add the final two points to the graph of **Fig. 2.2**. Draw a straight line of best fit on **Fig. 2.2**. **[3]**

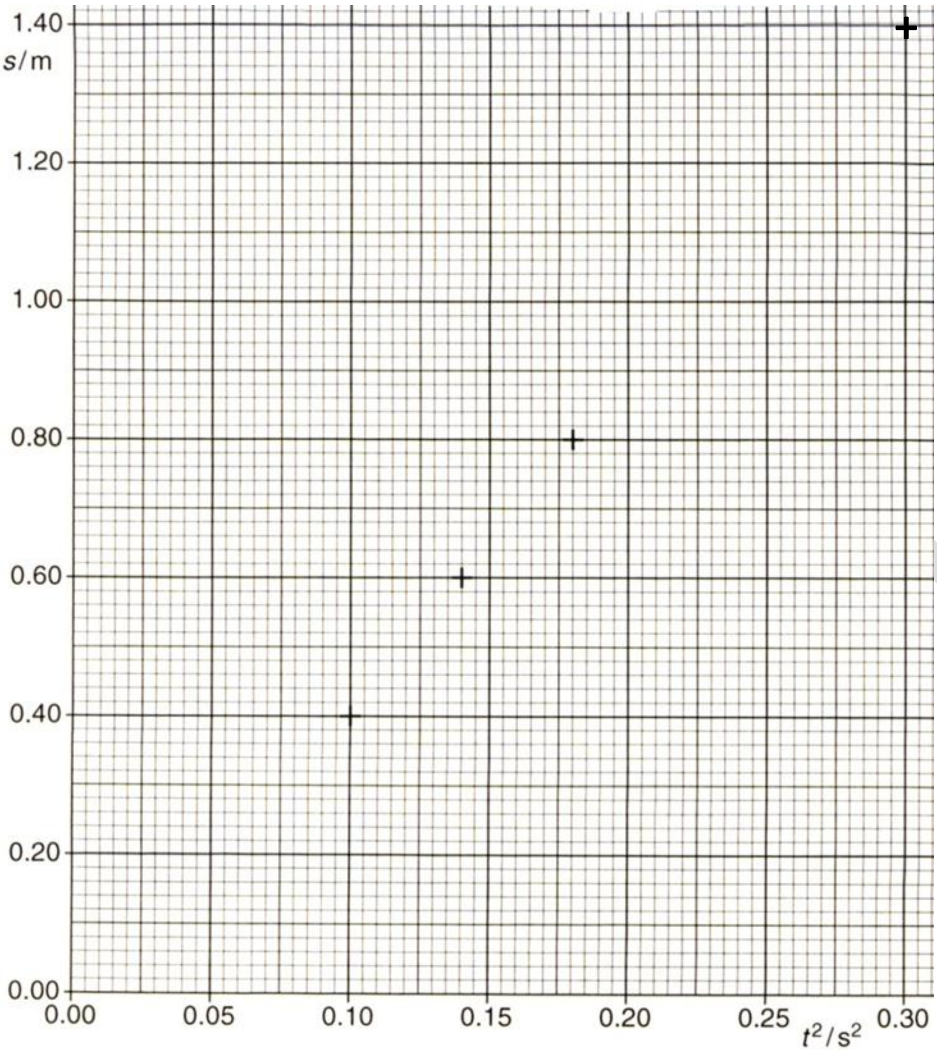

Fig 2.2

(ii) Determine the gradient of the line. Show clearly your working.

gradient = ……………………… m s^{-2} **[2]**

PRACTICE

(b) The student expected the line to go through the origin and have a gradient of $g/2$. The timing device he used measures to within 0.01 s and the distance s was measured to within 0.01 m.

(i) The fact that the line of best fit does not pass through the origin is unlikely to have been caused by random errors in his measurements. Justify this statement.

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.... **[2]**

(ii) Explain how a systematic error in each of the measured quantities could contribute to the line not passing through the origin and what effect, if any, each would have on the gradient of the line.

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(iii) Suggest one source of possible systematic error in the experiment.

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PRACTICE

3 **Fig. 3** shows a swimmer of mass 65 kg, weight 640 N, being lifted vertically upwards from the sea by a cable of negligible mass compared to the swimmer.

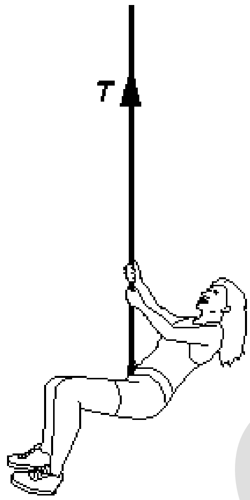

Fig. 3

The tension **T** in the cable from the time that she leaves the water at $t = 0$ until $t = 1.5$ s is 670 N.
At $t = 1.5$ s **T** reduces to and remains constant at 640 N.

(a) **(i)** Use Newton's laws to describe qualitatively the motion of the swimmer for the first 4.0 s of her ascent.

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(ii) Show that at $t = 4.0$ s her height h above the water is more than 2 m and that she is rising at about 0.7 m s^{-1}.

speed = ……………………… m s^{-1}

h = ………. ………………. m **[4]**

PRACTICE

(b) The cable is attached to a winch rotated by an electric motor in a rescue helicopter. The electric supply to the motor has an e.m.f. of 28 V. The circuit has a total resistance of 0.11 Ω. When the swimmer is rising at 0.70 m s^{-1} the motor draws a current of 30 A from the supply.

Under these conditions calculate:

(i) the power lost in the electrical circuit

power lost = ………………………… W **[2]**

(ii) the efficiency of the motor

efficiency = ………………………… **[4]**

PRACTICE

4 **Fig. 4.1** shows part of the $I - V$ characteristic of a silicon diode.

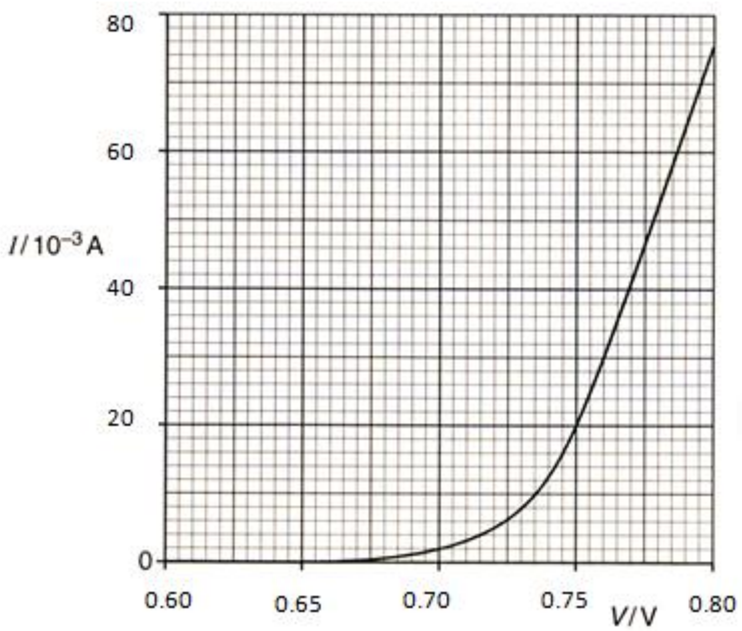

Fig. 4.1

(a) The graph has three distinct regions, from 0.60 V to 0.65 V, 0.65 V to 0.75 V and above 0.75 V.

State and justify how the resistance of the diode increases, remains the same or decreases in each of these regions.

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PRACTICE

(b)* In order to determine the *I-V* characteristic shown in **Fig. 4.1**, one student connects to the left hand incomplete circuit shown in **Fig. 4.2(a)** and another student connects to the right hand incomplete circuit **Fig. 4.2(b),** adding components between terminals **A** and **B**.

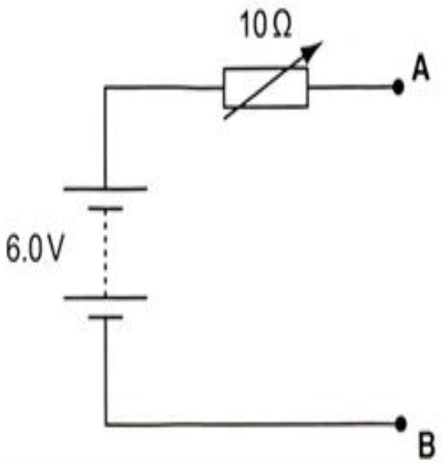

Fig. 4.2(a)

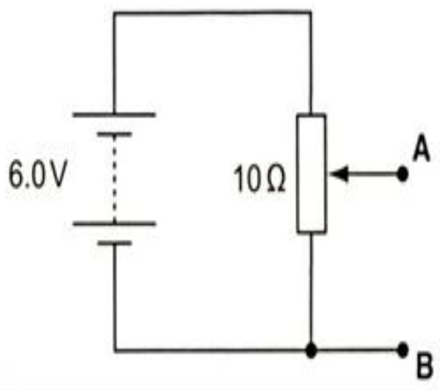

Fig. 4.2(b)

Only one of the circuits is suitable to carry out the task.
Draw an LED with a 100 Ω resistor in series and suitable meters to complete the correct circuit on Fig. 4.2.

Explain why only one of the circuits is suitable to carry out the task and why the 100 Ω resistor has been included.

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.... **[6]**

PRACTICE

5 In an experiment to measure the wavelength of yellow light from a sodium lamp, a beam of light from a lamp passes through a pair of narrow slits $\mathbf{S_1}$ and $\mathbf{S_2}$.This produces a pattern of regularly spaced bright and dark lines, called fringes, on a screen as shown in **Fig. 5.1**.

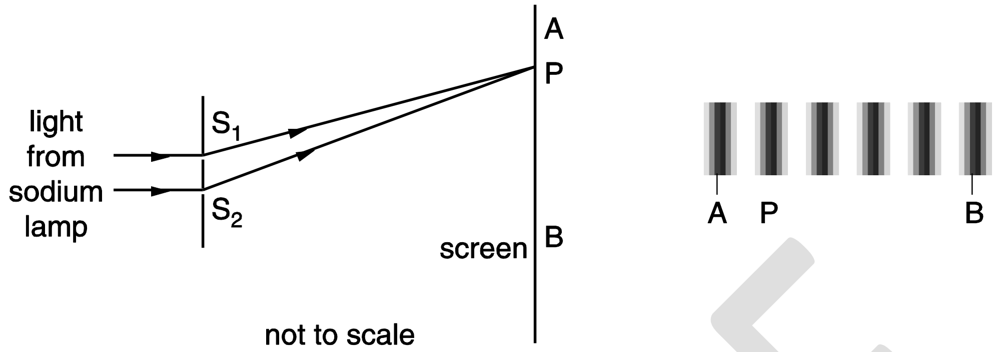

Fig 5.1

(a) A student makes the following measurements:

distance $\mathbf{S_1S_2}$ = 0.8 mm
distance **AB** on screen = 6.0 mm
distance from slits to screen = 1.6 m

Calculate the wavelength, in nanometre, of the sodium light.

wavelength = ... nm **[3]**

PRACTICE

(b)* **Fig. 5.2** shows a microscope slide, blackened with graphite paint, with the two slits $\mathbf{S_1}$ and $\mathbf{S_2}$ scratched through the paint, very close together, to form the double slit.

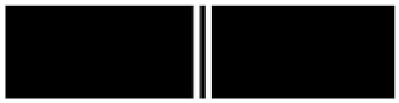

Fig. 5.2

Describe how you could reduce the uncertainty in calculating the value of the wavelength of the light used when carrying out the experiment in part **(a)**.

In your answer, include how to achieve the conditions necessary to produce a visible interference pattern on the screen and how you would make the measurements to calculate the wavelength, identifying the measurement which will give the greatest uncertainty.

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(c) To reduce the uncertainty in the calculated value of the wavelength, one student suggests making a different slide with a greater slit separation.
Discuss whether you think this change will reduce the uncertainty.

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PRACTICE

6 This question is about a photoelectric cell, which is an electronic device that detects photons. **Fig. 6** shows a cross-section through a simple photocell.

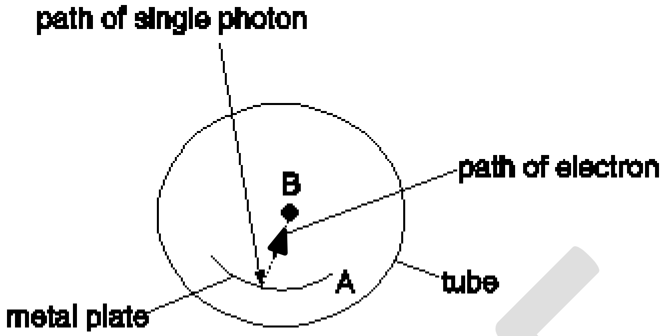

Fig. 6

A metal plate **A** is coated with potassium in an evacuated transparent tube. A photon of high enough energy, incident on the plate, can cause an electron to be released from the surface towards the collector rod **B**.

(a) Potassium has a work function of 3.5×10^{-19} J. Show that the longest wavelength of light that the photocell can detect is about 570 nm.

[3]

(b) There is a potential difference of 12 V between plate **A** and rod **B** so that released electrons are accelerated towards and collected by rod **B**. **B** is 5.0 mm from **A.**
Light of wavelength 570 nm is incident on plate **A**.

(i) Calculate the speed v of electrons arriving at rod **B**.

v = ……………………… m s^{-1} **[4]**

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PRACTICE

(ii) Estimate the response time of the photocell, that is the time it takes for electrons to travel from **A** to **B**.

response time = ……………………… s **[2]**

(c) The photocell is connected to a 12 V supply and a sensitive ammeter which can detect a current of 1.0×10^{-9} A. Only 5.0% of the photons of average energy 4.0×10^{-19} J incident on the plate **A** cause electrons to be released. Calculate the minimum light energy that plate **A** must absorb per second for the photocell circuit to detect a current.

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END OF QUESTION PAPER

PRACTICE

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