Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2011

Physics

Assessment Unit AS 1

Module 1: Forces, Energy and Electricity

[AY111]

AY111

TUESDAY 21 JUNE, MORNING

TIME

1 hour 30 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 75.
Quality of written communication will be assessed in question **2**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question.
Your attention is drawn to the Data and Formulae Sheet which is inside this question paper.
You may use an electronic calculator.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
Total Marks	

Examiner Only	
Marks	Remark

1 "To calculate the density of a material, the mass of a sample is divided by the volume of the sample. If the sample of the material is a cube, the volume is calculated by multiplying the lengths of the three sides of the cube together."

(a) Give **two** base quantities and **two** derived quantities named in the paragraph above. State the S.I. unit of each quantity that you have chosen.

Base Quantities	S.I. Unit

Derived Quantities	S.I. Unit

[4]

(b) Determine the base unit of energy.

Base unit = _____ [2]

Where appropriate in this question you should answer in continuous prose. You will be assessed on the quality of your written communication.

Examiner Only	
Marks	Remark

2 A pupil describes a simple experiment to measure the acceleration of free fall, g. Her method is as follows:

1. Drop a ball bearing from a measured height of 2 m and measure the time it takes to hit the ground using a stopclock.

2. Use the equation $s = \frac{1}{2} g t^2$ to calculate a value for g where $s = 2$ m and t is the time recorded from the stopclock.

State what measurement has the largest source of uncertainty in this pupil's experiment and suggest methods by which the uncertainty could be reduced. Describe how the pupil could further improve the experiment and how the results could be used to obtain a more accurate value for g.

_____

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_____

_____ [6]

Quality of written communication [2]

Examiner Only	
Marks	Remark

3 When a long jumper completes a jump, his centre of mass is 1.0 m above ground level at take off and 0.4 m above ground level on landing.

(a) Sketch the path of the centre of mass of the long jumper from take off to landing on **Fig. 3.1**.

Fig. 3.1

[2]

(b) The long jumper has studied some physics and has read that in order to make the horizontal distance of his jump as long as possible he should jump at an angle of 45° to the horizontal.

The athlete takes off at a speed of 9.3 m s^{-1} at an angle of 45° to the horizontal.

(i) Calculate the initial **vertical** velocity of the athlete.

Vertical velocity = _____ $m\,s^{-1}$ [1]

(ii) Show that the **vertical** component of the velocity of the athlete on landing has magnitude 7.4 m s^{-1}

[3]

(iii) Calculate the time spent in the air by the athlete during the jump.

Time = _____ s [2]

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(Questions continue overleaf)

Examiner Only	
Marks	Remark

4 The moment of a force about a point is defined as the magnitude of the force multiplied by the **perpendicular distance** from the line of action of the force to the point. **Fig. 4.1** shows a force F acting to create a moment around the point P.

Fig. 4.1

(a) (i) State the directional sense of the moment caused by the force F.

_____ [1]

(ii) Show clearly on **Fig. 4.1** what is meant by the **perpendicular distance** from the line of action of the force to point P. Label the distance d. [1]

Examiner Only	
Marks	Remark

(b) A monkey of mass 24 kg hangs from a branch of a tree at a point 3.5 m from where the branch connects to the trunk of the tree. The branch has a mass of 180 kg and its centre of gravity is 1.3 m from the tree. **Fig. 4.2** shows a diagram representing the tree trunk and the branch.

(i) Complete the diagram by drawing arrows at the appropriate positions on **Fig. 4.2** to represent the weight of the branch and the monkey. Label the arrows with the magnitude of the forces. [2]

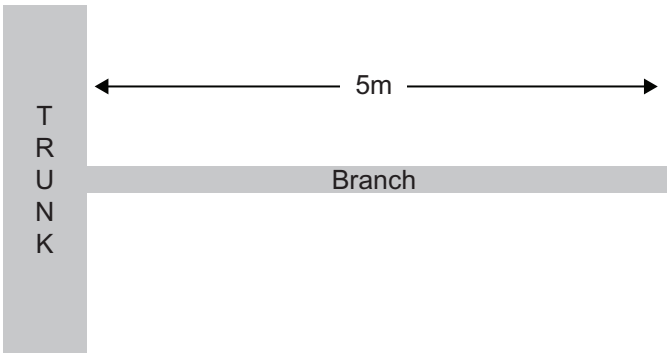

Fig. 4.2

(ii) The branch will snap off the tree if the moment about the trunk exceeds 4020 N m. A second monkey of mass 29 kg starts to walk from the trunk along the same branch. Assuming that the branch does not bend before it snaps, calculate the distance along the branch the monkey will reach before the branch snaps off.

Distance from trunk = _____ m [3]

(iii) If the branch had started to bend downwards as the monkey walked along it, explain why it would have been able to walk further along the branch before it snapped.

_____

_____ [1]

Examiner Only	
Marks	Remark

5 When a ball is dropped from a height, h_1, it rebounds to a height, h_2.

(a) (i) Show that the energy efficiency of the bounce of the ball can be calculated using **Equation 5.1**

$$\text{Energy efficiency} = \frac{h_2}{h_1} \qquad \textbf{Equation 5.1}$$

[2]

For a basketball to be used in an official competition the basketball must be **inflated to an air pressure such that, when it is dropped onto the playing floor from a height of 1800 mm, it will rebound to a height of between 960 mm and 1160 mm.**

(ii) Calculate the maximum energy efficiency of the bounce of a ball that is suitable to be used in official competitions.

Efficiency = _____ [2]

(b) Calculate the speed at which a ball leaves the ground, if it rebounds to a height of 960 mm. Assume no energy losses between the ball leaving the ground and reaching its rebound height.

Examiner Only

Marks	Remark

Speed = _____ $m\,s^{-1}$ [2]

Examiner Only	
Marks	Remark

6 **(a)** State Hooke's law.

_____

_____

_____ [2]

(b) A spring that obeys Hooke's law has a **length** of 8 cm when a load of 2 N is attached to it and a length of 14 cm when a load of 6 N is attached. The spring reaches its limit of proportionality when a load of 8 N is attached.

(i) On the grid of **Fig. 6.1** draw a graph of force against **length** for the spring up to and beyond the limit of proportionality.

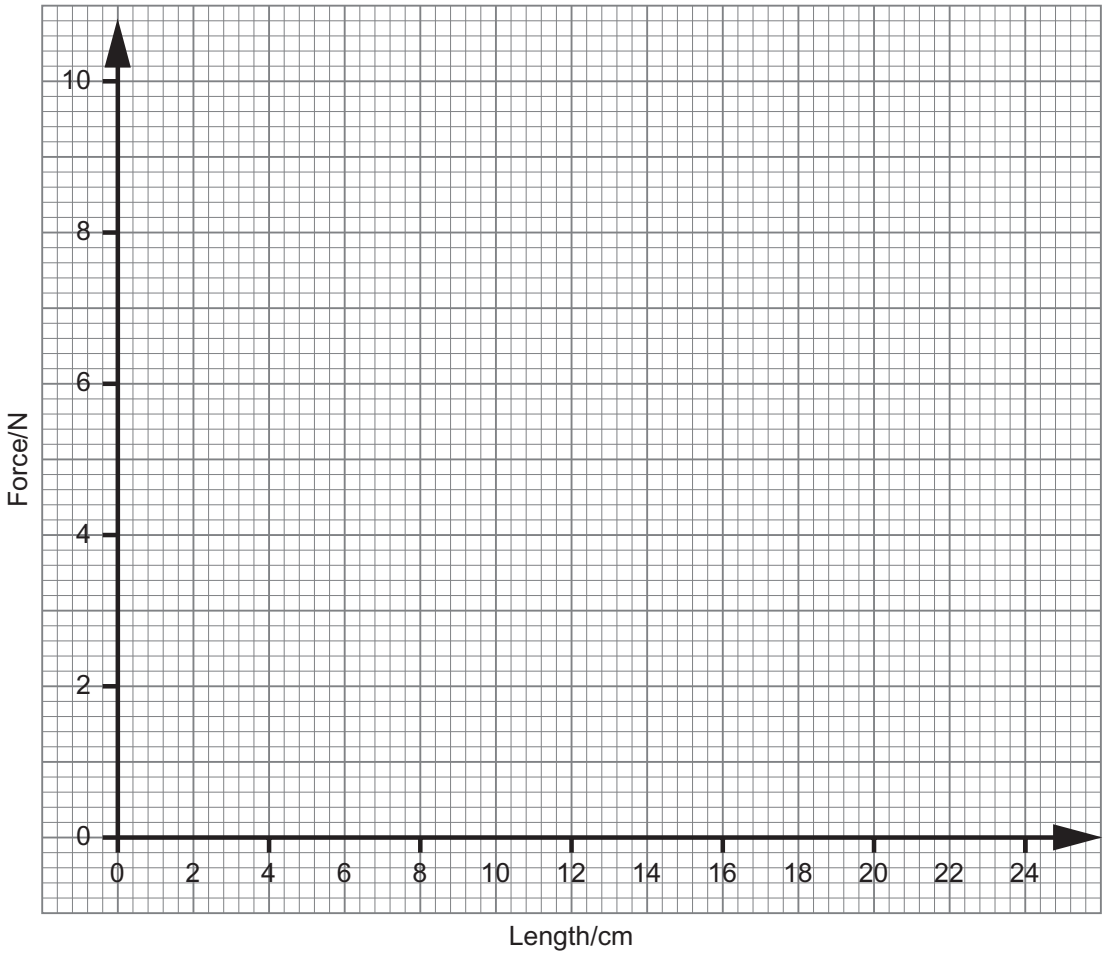

Fig. 6.1

[3]

(ii) Calculate the spring constant of the spring and state the units of the spring constant.

Spring constant = _____

Units = _____ [3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

7 **(a)** State **one** similarity and **one** difference between potential difference and electromotive force (emf).

Similarity

_____

_____

Difference

_____

_____ [2]

(b) A camera battery has a capacity of 1400 mA h. This means that it may deliver a current of 1400 mA for 1 hour or 700 mA for 2 hours etc.

(i) Show that the total charge that flows is 5.04 kC

[2]

(ii) This charge transfers 14.6 kJ of electrical energy. Calculate the emf of the battery.

emf of battery = _____ V [2]

Examiner Only	
Marks	Remark

8 **(a)** **(i)** State Ohm's Law.

_____

_____

_____ [2]

Fig. 8.1 shows the variation in the current through three electrical conductors, A, B and C, as the potential difference (P.D.) across them is altered.

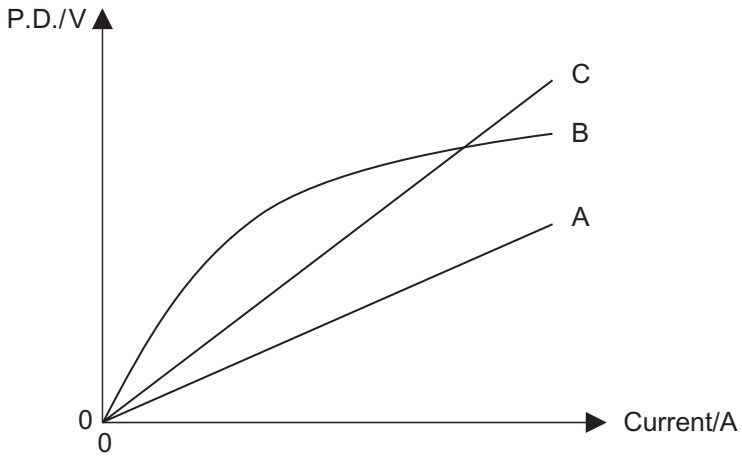

Fig. 8.1

(ii) Which graph illustrates Ohm's Law for the greatest resistance, A, B or C?

Graph _____ [1]

(b) **(i)** Compare the value of resistance of conductors B and C over the full range shown.

_____

_____

_____

_____ [3]

(ii) Suggest what component of a circuit conductor B might be and explain why you chose the component that you did.

_____

_____ [2]

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Examiner Only	
Marks	Remark

9 Manganin is an alloy of copper, manganese and nickel. An experiment was carried out to determine the resistivity of manganin. The sample of wire had a diameter of 0.40 mm.

(a) Show that the resistance of the wire is given by **Equation 9.1** if all quantities are expressed in S.I. units.

$$R = \frac{\rho l}{1.26 \times 10^{-7}} \qquad \textbf{Equation 9.1}$$

[2]

(b) The circuit shown in **Fig. 9.1** was set up to measure the variation in the current through the wire as the length was varied from 0.40 m up to 1.20 m. The variable resistor was used to keep the potential difference across the wire **constant at 2.0 V**. The results are shown in **Table 9.1**.

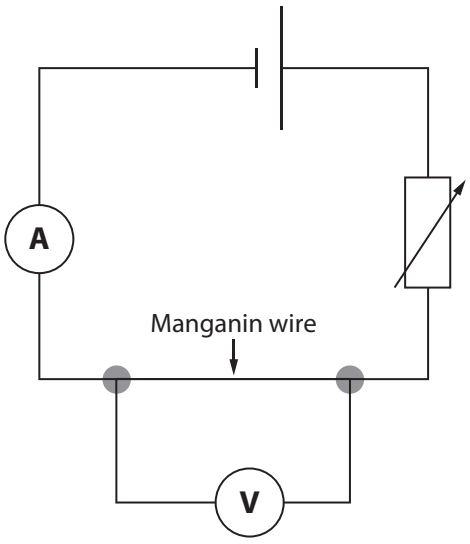

Fig. 9.1

Table 9.1

Length/m	Current/A	Resistance/Ω
0.40	1.31	
0.60	0.87	
0.80	0.65	
1.00	0.52	
1.20	0.44	

(i) Calculate the resistance of the wire at each length and insert the values into the last column of **Table 9.1**. [1]

(ii) On the axes of **Fig. 9.2** plot a graph of resistance against length for the manganin wire. [3]

(iii) Use your graph to calculate a value for the resistivity of manganin.

Resistivity = _____

Unit = _____ [3]

Examiner Only	
Marks	Remark

Fig. 9.2

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

10 **(a)** Show that the combined resistance of two equal resistors, R, in parallel is $\frac{R}{2}$.

[2]

(b) The total resistance of the network of resistors in **Fig. 10.1** is 22 kΩ.

(i) Calculate the resistance of the unknown resistor R.

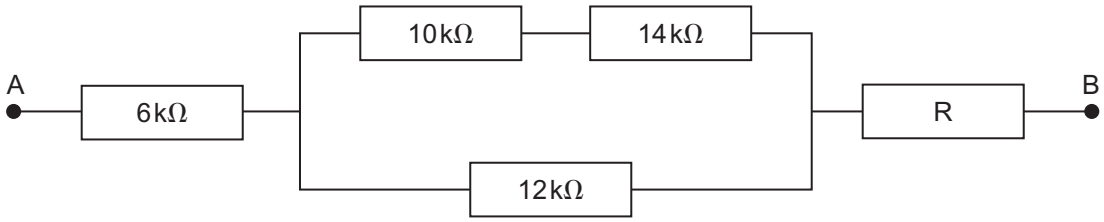

Fig. 10.1

R = _____ kΩ [3]

(ii) The current flowing through the 12 kΩ resistor is 0.12 mA. Calculate the potential difference between the points A and B in the circuit.

Potential difference = _____ V [3]

THIS IS THE END OF THE QUESTION PAPER

GCE Physics

Data and Formulae Sheet

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall on the Earth's surface	$g = 9.81$ m s^{-2}
electron volt	1 eV = 1.60×10^{-19} J

Useful formulae

The following equations may be useful in answering some of the questions in the examination:

Mechanics

Conservation of energy	$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$ for a constant force
Hooke's Law	$F = kx$ (spring constant k)

Sound

Sound intensity level/dB	$= 10 \lg_{10} \frac{I}{I_0}$

Waves

Two-source interference	$\lambda = \frac{ay}{d}$

Light

Lens formula	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$
Magnification	$m = \frac{v}{u}$

Electricity

Terminal potential difference	$V = E - Ir$ (E.m.f. E; Internal Resistance r)
Potential divider	$V_{out} = \frac{R_1 V_{in}}{R_1 + R_2}$

Particles and photons

de Broglie equation	$\lambda = \frac{h}{p}$