Rewarding Learning

Centre Number

71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2014

Physics

Assessment Unit AS 1

assessing

Module 1: Forces, Energy and Electricity

[AY111]

AY111

WEDNESDAY 15 JANUARY, 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 eleven** 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 **10**.
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	
11	
Total Marks	

Examiner Only	
Marks	Remark

1 **(a)** Complete **Table 1.1** to show six of the fundamental quantities and their SI base units.

Table 1.1

Quantity	SI base unit
mass	kilogram
	metre
time	
current	
	kelvin
	mole

[2]

(b) The joule is an SI derived unit. Express the joule in SI base units.

Base units = _____ [2]

(c) Two forces of 3.0 N and 7.0 N act on a body M. The forces are at right angles to each other as shown in **Fig. 1.1** (not to scale).

Fig. 1.1

On **Fig. 1.1** sketch the resultant of the two forces.

By calculation or by the use of a scale drawing, determine the magnitude and direction, to the horizontal, of the resultant force on the body M.

Magnitude = _____ N

Direction = _____ ° to the horizontal [2]

Examiner Only

Marks	Remark

Examiner Only	
Marks	Remark

2 **(a)** One method to determine the acceleration of free fall, *g*, in the laboratory uses an accurate timer and a small sphere.

(i) Name any other apparatus needed to determine *g*.

_____ [1]

(ii) Outline the method and state the measurements required to measure *g* accurately.

_____

_____

_____ [2]

(iii) Explain how these measurements may be used to find the value of *g*.

_____

_____

_____ [2]

(b) A parachutist jumps from an aeroplane and free falls before deploying his parachute. **Fig. 2.1** illustrates how his downward velocity varies with time **during free fall**.

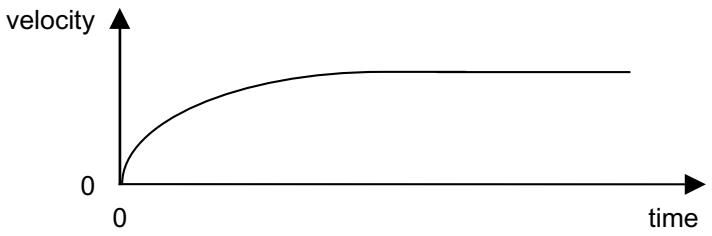


Fig. 2.1

Describe and explain the motion experienced by the parachutist during free fall.

_____

_____

_____

_____ [2]

3 When a golf ball is struck it follows a parabolic path. On one shot, the ball leaves the golf club at an angle of 49° to the horizontal and a speed of 34 $m\,s^{-1}$. Assume that the influence of air resistance and ball spin is negligible.

Examiner Only	
Marks	Remark

(a) Calculate the time taken by the ball to reach its maximum height.

Time taken = _____ s [3]

(b) Calculate the horizontal distance between the point where the ball was struck and where it hits the ground. Assume the ground to be level.

Distance = _____ m [3]

Examiner Only	
Marks	Remark

4 **(a)** State Newton's Second Law of Motion.

_____

_____ [2]

(b) A driver reacts to a hazard when at a speed of 18 $m\,s^{-1}$ (about 40 miles per hour). His reaction time is such that he travels 12 m before the brakes are applied. Under ideal conditions the car then travels a further 24 m before coming to rest.

(i) Calculate the average braking force exerted while the car travels the 24 m before coming to rest if the car and passengers have a total mass of 880 kg.

Braking force = _____ N [3]

(ii) Under wet conditions the braking force is reduced **by** 40%. Find the total stopping distance, in the wet, from when the hazard is seen.

Stopping distance = _____ m [3]

Examiner Only	
Marks	Remark

5 When a house is extended a steel beam may be inserted between two adjacent walls. The beam is used to support two upstairs walls as shown in **Fig. 5.1**.

The upstairs walls exert loads of 2000 N and 800 N. The weight of the uniform steel beam is 8000 N and its length is 6.0 m.

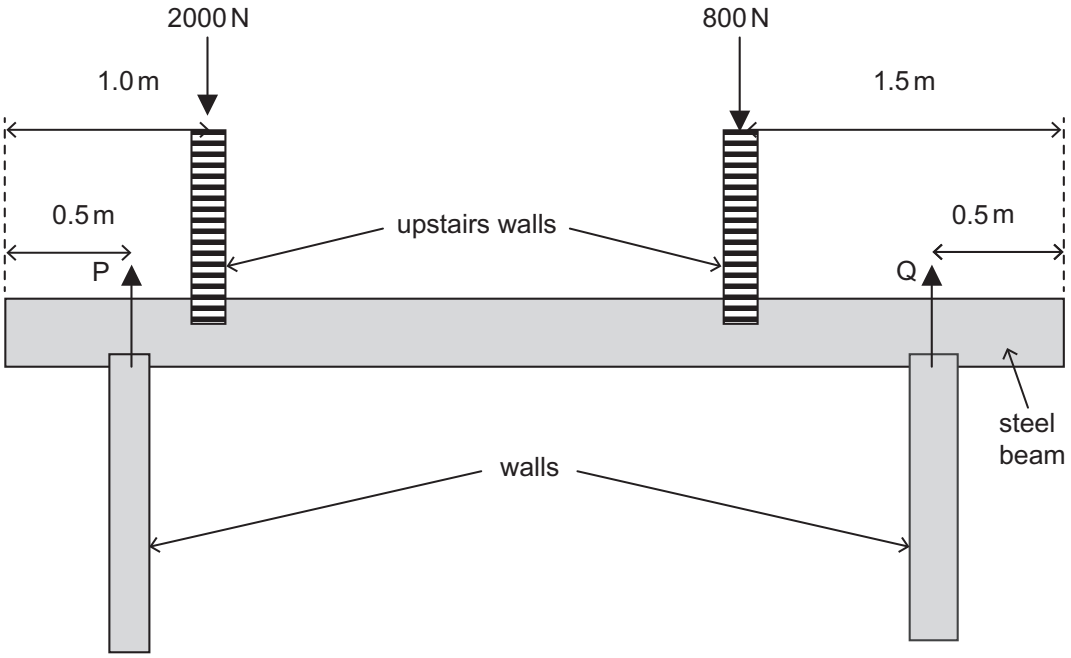


Fig. 5.1

(i) Calculate the total upward force provided by the two walls.

Total force = _____ N [1]

(ii) Calculate the magnitude of each of the upward forces, P and Q as shown in **Fig. 5.1**, exerted on the steel beam.

P = _____ N

Q = _____ N [3]

Examiner Only	
Marks	Remark

6 **(a)** State the Principle of Conservation of Energy.

_____

_____

_____ [1]

(b) An aircraft of mass 45 000 kg approaches an airport at an altitude of 8000 m with a velocity of 140 m s^{-1}. During the descent the velocity is reduced to 80 m s^{-1} and the altitude to 700 m. Depending on conditions this will take 15 minutes.

(i) Calculate the loss in kinetic energy during this descent (you may assume that the mass change due to fuel usage is negligible).

Loss in kinetic energy = _____ MJ [2]

(ii) Calculate the loss in potential energy during this descent.

Loss in potential energy = _____ MJ [2]

(iii) The total energy loss is dissipated as heat and sound. Calculate the energy dissipated per second, in kW, into the atmosphere during this descent.

Energy dissipated per second = _____ kW [2]

Examiner Only	
Marks	Remark

7 **(a)** State Hooke's Law.

_____

_____ [2]

(b) A student performs an experiment to investigate the extension of a thin metal wire and to find the Young modulus of the wire. She plots a graph of the applied force and the extension produced. The graph is shown in **Fig. 7.1**.

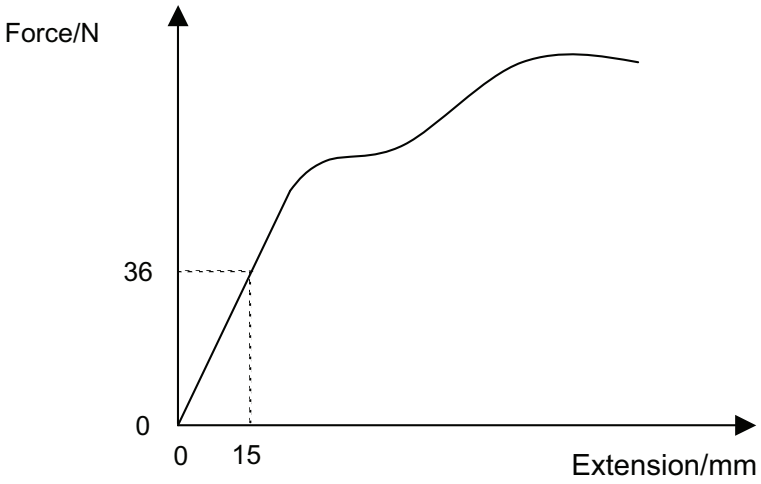


Fig. 7.1

(i) On the graph identify the limit of proportionality as a point labelled **A**, and the elastic limit as a point labelled **B**. [2]

(ii) The wire has diameter 0.23 mm and its unstretched length is 2.0 m. Determine the Young modulus of the material from which the wire is made.

Young modulus = _____ Pa [3]

8 **(a)** Define the electromotive force (e.m.f.) of a battery.

Examiner Only

Marks	Remark

_____

_____ [2]

(b) A car battery has internal resistance 27.0 mΩ and e.m.f. 12.6 V. When the headlights and sidelights of the car are switched on the current drawn from the battery is 11.2 A.

(i) Calculate the charge which flows round the circuit in 42 minutes.

Charge = _____ C [2]

(ii) Find the terminal potential difference across the battery when these lights are turned on. Express your answer to three significant figures.

Potential difference = _____ V [2]

(iii) Calculate the power delivered to the lights under these conditions.

Power = _____ W [2]

(iv) The sidelights together use a total of 28 W. Calculate the power of each of the two headlights.

Power = _____ W [1]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

9 A student is provided with a reel of resistance wire and is asked to determine the resistivity of the material of the wire.

(a) Outline the procedures the student should implement to obtain **reliable** data from which the value for the resistivity of the material can be obtained.

[3]

(b) The student has access to apparatus found generally in school physics laboratories. Identify the measurement that contributes the greatest uncertainty in the value for resistivity. Explain your choice.

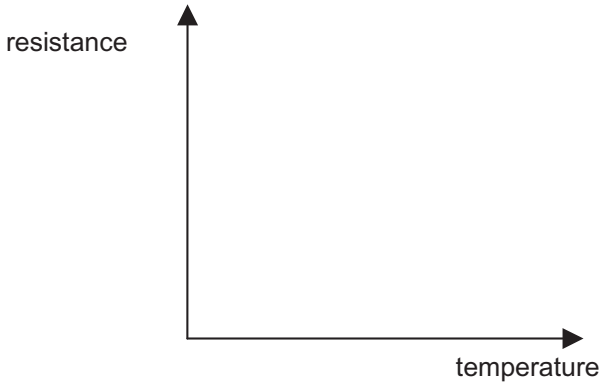
[2]

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

10 (a) A thermistor is made from a semiconducting material which has a negative temperature coefficient.

Sketch a graph to show the variation with temperature of the resistance of a negative temperature coefficient (ntc) thermistor.



[1]

(b) Explain why there is a change in resistance of the filament of a light bulb as its temperature increases.

_____

_____

_____ [2]

(c) Some electronic components exhibit a lower resistance when initially turned on. To protect them an ntc thermistor may be placed in series with the component. Explain how a thermistor can protect the component when the circuit is switched on.

_____

_____

_____

_____ [2]

Quality of written communication [2]

Examiner Only	
Marks	Remark

11 (a) In the circuit shown in **Fig. 11.1** a **four** cell battery is connected to a 16.4 Ω resistance through a switch, s. **Table 11.1** provides the meter readings with the switch open and closed.

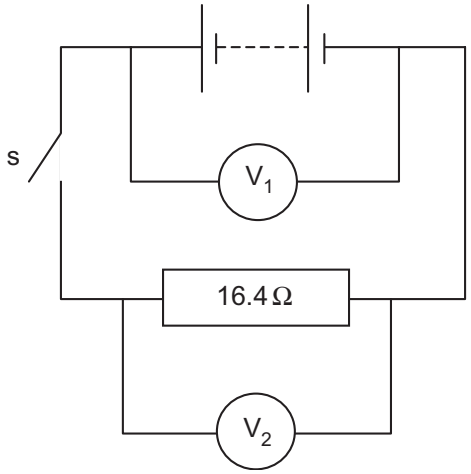


Fig. 11.1

Table 11.1

s	V_1	V_2
open	6.52 V	0.00 V
closed	5.33 V	5.33 V

(i) Determine the average internal resistance **of a cell**.

Average internal resistance = _____ Ω [4]

(ii) If this circuit was set up in reality, it is unlikely that the voltmeters would read exactly the same value with the switch closed. Which reading would be higher and why?

_____

_____

_____ [1]

Examiner Only	
Marks	Remark

(b) A potential divider is used to reduce an 18 V supply to 5 V for an electronic circuit. Two resistors, R_1 and R_2, are needed.

Fig. 11.2 shows the arrangement so that the 5 V is developed across the resistor R_2.

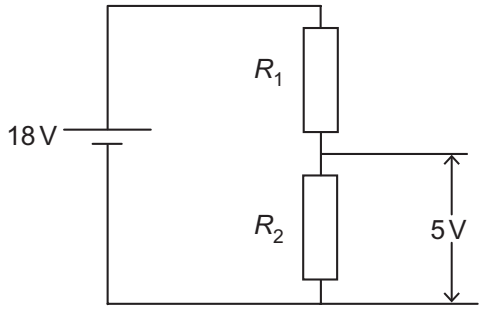


Fig. 11.2

(i) Resistor R_2 has resistance 120 Ω. Calculate the resistance of resistor R_1.

R_1 = _____ Ω [1]

(ii) The electronic circuit provides a load of 480 Ω in parallel with the resistor R_2.

1. Find the combined resistance of this load and R_2.

Combined resistance = _____ Ω [1]

2. Hence find the actual voltage across the load.

Voltage = _____ V [2]

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GCE (AS) 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 $= 1.60 \times 10^{-19}$ 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	$\lambda = \frac{h}{p}$