New Specification

Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Physics

Assessment Unit AS 1

Module 1: Forces, Energy and Electricity

[AY111]

AY111

TUESDAY 16 JUNE, AFTERNOON

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 **5**.
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	
Total Marks	

If you need the values of physical constants to answer any questions in this paper, they may be found in the Data and Formulae Sheet.

Answer **all seven** questions.

Examiner Only	
Marks	Remark

1 (a) Physical quantities may be classified as **vectors** or **scalars**.

(i) Explain what is meant by a **scalar** quantity.

_____ [1]

(ii) There are six physical quantities listed below. Indicate which of the physical quantities are **vectors** by placing a tick (✓) in the box corresponding to the quantity.

Kinetic energy ☐

Displacement ☐

Voltage ☐

Mass ☐

Force ☐

Power ☐ [2]

(b) Two tugs are used to rescue a ship which has lost engine power and is close to some rocks. The tugs just manage to hold the ship stationary against a current producing a force on the ship.

The force that tug A exerts on the ship is 200 kN to the North. Tug B exerts a force of 140 kN to the West.

Find, by scale drawing or calculations, the magnitude F and direction θ of the resultant of these two forces on the ship.

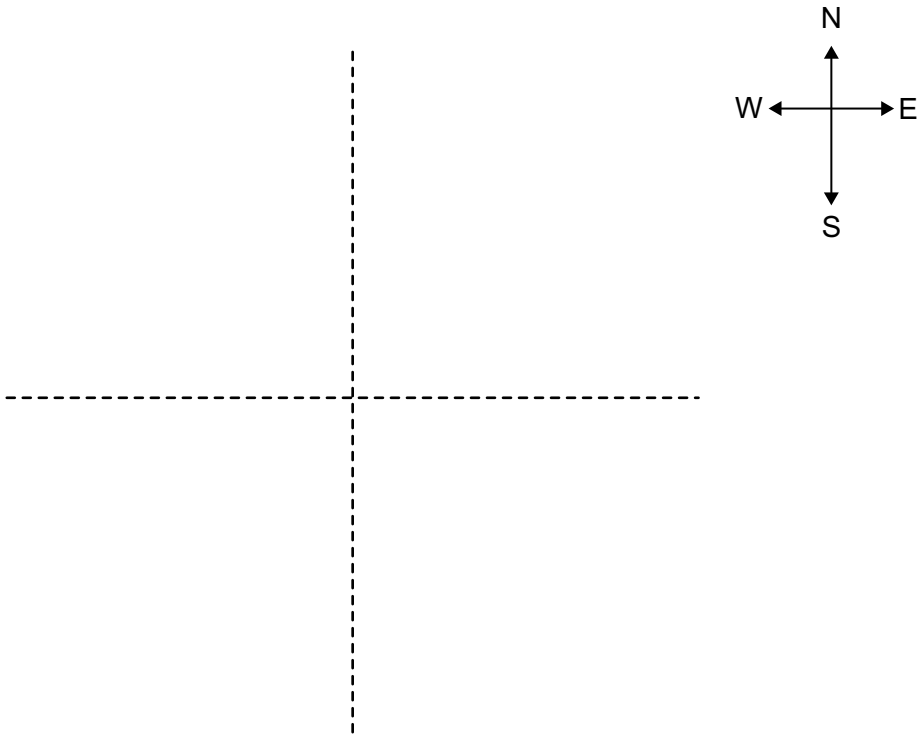

Fig. 1.1

Force F = _____ kN

Direction = _____° relative to E–W line. [4]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

2 **(a)** **(i)** State how to calculate the moment of a force about a point.

_____

_____

_____ [2]

(ii) Name the SI unit of the moment of a force.

_____ [1]

(iii) State the principle of moments.

_____

_____

_____ [2]

(b) **Fig. 2.1** shows a stationary wheelbarrow being supported by a gardener who applies a vertical force of 50 N at the end of the handles. The weight of the wheelbarrow and contents is 175 N. The force applied to the handles acts at a horizontal distance of 1.40 m from the point of contact of the wheel with the ground.

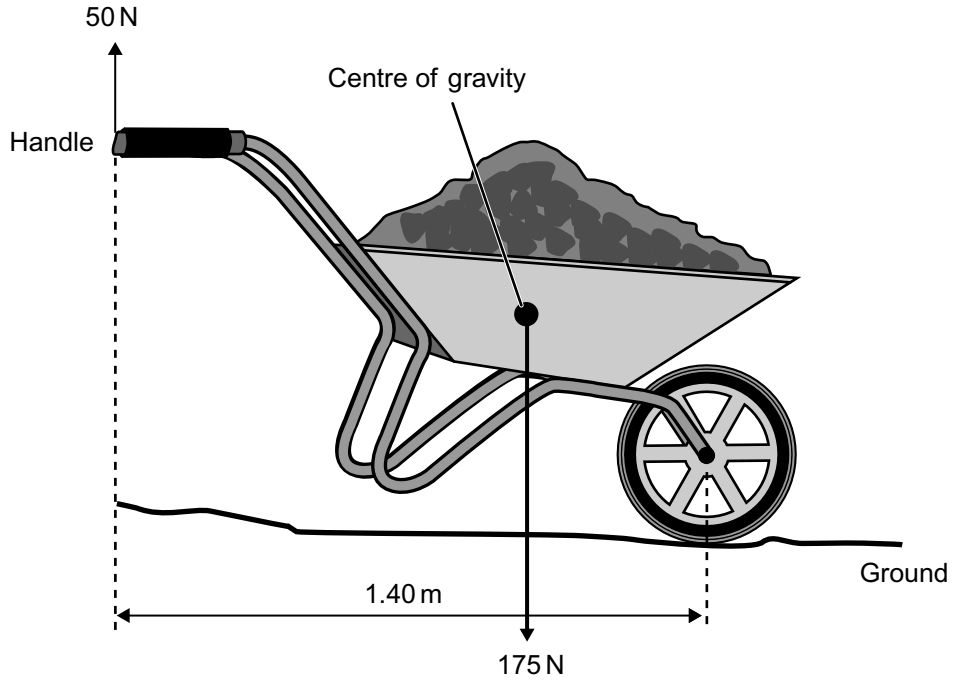

Fig. 2.1

(i) Another force acts on the wheelbarrow at the wheel. State the magnitude and direction of this force.

Magnitude = _____N

Direction _____ [2]

(ii) Calculate the horizontal distance from the centre of gravity to the end of the handle.

Distance = _____m [3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

3 A rugby ball is kicked over the crossbar between the goal-posts from a position 25 m directly in front of the posts as shown in **Fig. 3.1**.

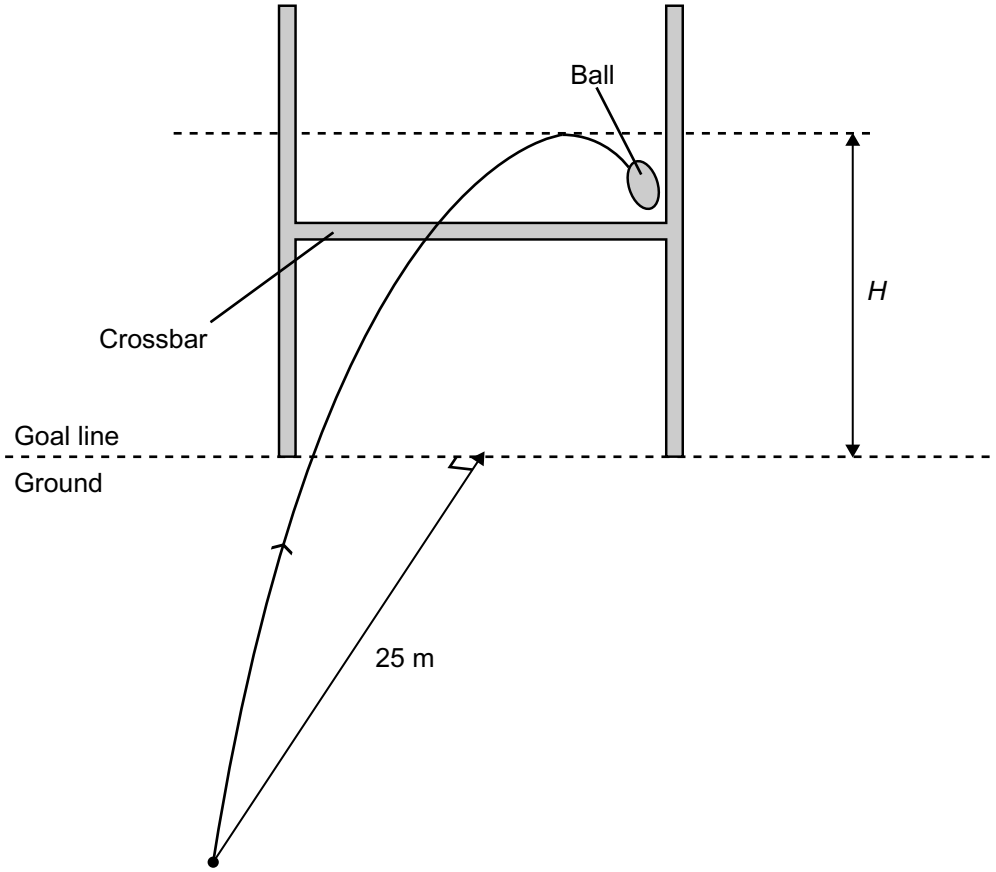

Fig. 3.1

The ball reaches maximum height *H* above the ground at a position vertically above the crossbar. It takes 1.4 seconds to reach this maximum height. Assume air resistance is negligible.

(a) (i) Calculate the horizontal component of velocity at the instant the ball leaves the kicker's foot.

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

(ii) Calculate the vertical component of velocity at the instant the ball is kicked.

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

(b) (i) Use your answers to part **(a)** to find the magnitude of the initial velocity after the ball is kicked.

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

(ii) Find the angle above the horizontal at which the ball is kicked.

Angle = _____ ° [2]

(iii) Find the maximum height *H* reached by the ball.

H = _____ m [3]

Examiner Only

Marks	Remark

Examiner Only	
Marks	Remark

4 **(a)** **(i)** Draw and label an experimental arrangement which could be used to measure the Young modulus of the material of a long wire.

[2]

(ii) List the measurements you would make, and state the instruments you would use to take the readings.

_____

_____

_____

_____ [3]

(iii) Explain how you would determine the Young modulus from your series of experimental results.

_____

_____

_____

_____

_____

_____

_____ [4]

(b) Three identical light springs each have an unstretched length of 120 mm and a spring constant k of 300 N m^{-1}. In the calculations that follow, all extensions are within the limit of proportionality of the springs.

(i) The springs are first joined in parallel, with a light rod attached to their lower ends. The upper ends are attached to a firm support, as shown in **Fig. 4.1**.

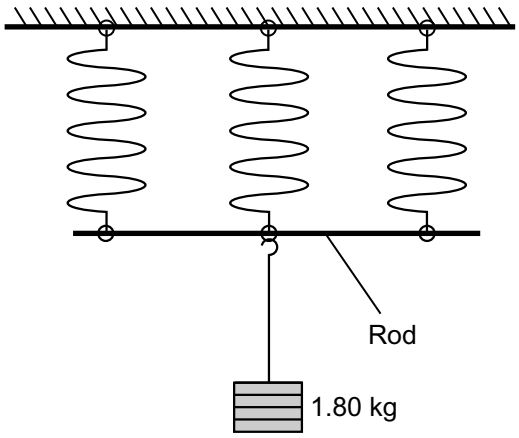

Fig. 4.1

A mass of 1.80 kg is attached to the rod. Calculate the distance h the rod moves down.

h = _____ mm [3]

Examiner Only

Marks	Remark

Examiner Only	
Marks	Remark

(ii) The springs are now disconnected from the rod and joined end-to-end, as shown in **Fig. 4.2**.

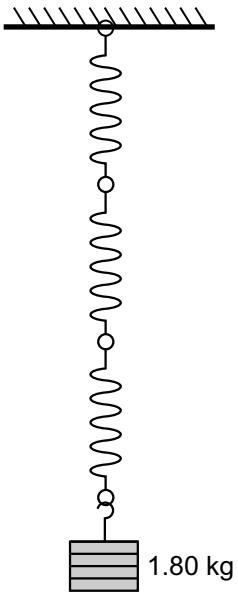

Fig. 4.2

A mass of 1.80 kg is attached to the lower end of the spring combination. Calculate the distance *H* the lower end of the bottom spring moves down.

H = _____ mm [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

5 **(a)** Terms often used in describing an electrical power source, such as a battery, are **terminal potential difference** and **electromotive force (e.m.f.)**. Write a short explanation of these terms and when it is appropriate to use them.

_____

_____

_____

_____ [2]

(b) **(i)** What is meant by the internal resistance of an electrical power source?

_____

_____ [1]

(ii) Describe an experiment to determine the internal resistance of a battery.
Include a circuit diagram.
Show how a value of the internal resistance can be obtained from the series of experimental results.
Show also how the e.m.f. of the battery can be obtained.

Circuit diagram

[2]

Description of experiment:

_____

_____

_____

_____ [2]

Analysis of results to determine internal resistance:

_____

_____

_____

_____

_____

_____ [3]

Determination of e.m.f.:

_____ [1]

Quality of written communication [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

6 **Fig. 6.1** shows a heating element as used in the rear window of a car. It consists of six strips of resistive material, joined by strips of copper of negligible resistance. The voltage applied to the heater is 14.2 V when the engine is running. The total current delivered to the heater by the battery is 8.4 A.

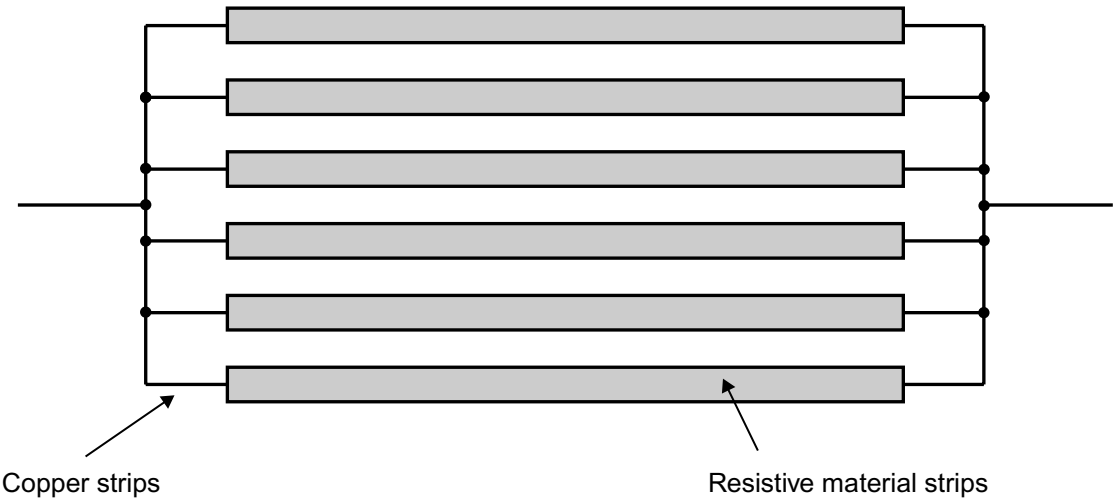

Fig. 6.1

(a) **(i)** Calculate the total resistance of the element.

Resistance = _____ Ω [2]

(ii) Calculate the power delivered by the battery to the heating element.

Power = _____ W [2]

(b) (i) Calculate the resistance of one of the strips of resistive material.

Resistance = _____ Ω [1]

(ii) Each strip is 1.05 m long and has a rectangular cross-section of 2.0 mm by 0.15 mm. Calculate the resistivity of the material from which the strip is made. State the appropriate unit.

Resistivity = _____

Unit = _____ [4]

(c) The heating element has six strips connected **in parallel**. Suggest **two** reasons why this arrangement is preferable to connecting the same strips **in series**.

1. _____

_____

2. _____

_____ [3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

7 A battery of e.m.f. 12 V and negligible internal resistance is connected to a resistor network, as shown in the circuit diagram in **Fig. 7.1**.

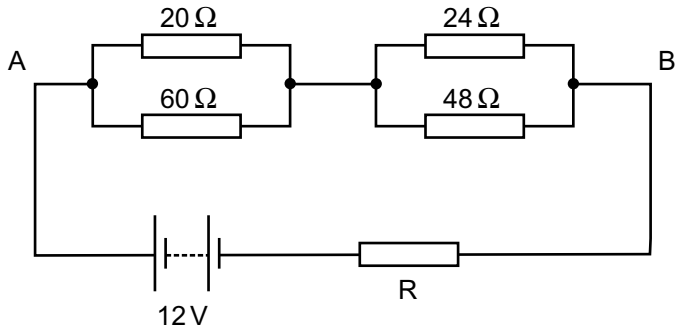

Fig. 7.1

(a) Show clearly that the resistance of the single equivalent resistor that could replace the four resistors between the points A and B is 31 Ω.

[3]

(b) The current delivered by the battery is 300 mA. Calculate the **total** circuit resistance.

Total resistance = _____ Ω [2]

(c) Hence find the value of the resistance of the resistor R.

Resistance of R = _____ Ω [1]

(d) Find the current in the 48 Ω resistor.

Current = _____ mA [2]

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 $= 1.60 \times 10^{-19}$ 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	$\lambda = \frac{h}{p}$