Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2013

Centre Number

71	

Candidate Number

Physics

Assessment Unit AS 1

assessing

Module 1: Forces, Energy and Electricity

[AY111]

THURSDAY 13 JUNE, AFTERNOON

AY111

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	
8	
9	
Total Marks	

1 The physical quantity **power** may be defined as:

the rate of doing work or the rate of energy transfer.

(a) Use the definition to explain whether power is a vector or scalar quantity.

____

____ [1]

(b) A particle P is acted on by two perpendicular forces as shown in **Fig. 1.1**.

Fig. 1.1 is not drawn to scale.

(i) On **Fig. 1.1** draw the resultant of these two forces. [1]

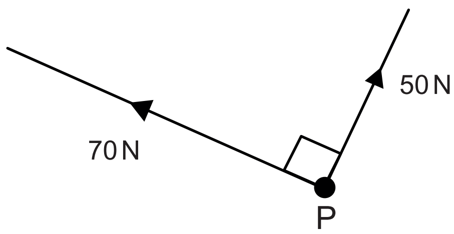

Fig. 1.1

(ii) Determine, by calculation or scale drawing, the magnitude of the resultant vector acting on particle P.

Magnitude = ______________ N [2]

Examiner Only	
Marks	Remark

(iii) Determine the direction, relative to the 70 N vector, in which the resultant vector acts.

Direction = ____________ ° [2]

(c) A displacement vector D has magnitude and direction 64 km, 38° east of north as shown in **Fig. 1.2**. Find the components of vector D in the east and north directions.

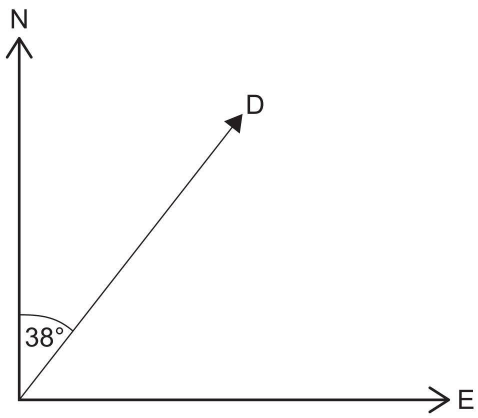

Fig. 1.2

East = ____________ km

North = ____________ km [2]

Examiner Only	
Marks	Remark

2 **Figs. 2.1** and **2.2** represent the data for the **projectile motion** of a ball thrown from a high point above the ground on Planet X. **Fig. 2.1** is a graph of the variation of the ball's **vertical** displacement with time. **Fig. 2.2** is a graph of the variation of the same ball's **vertical** velocity with time.

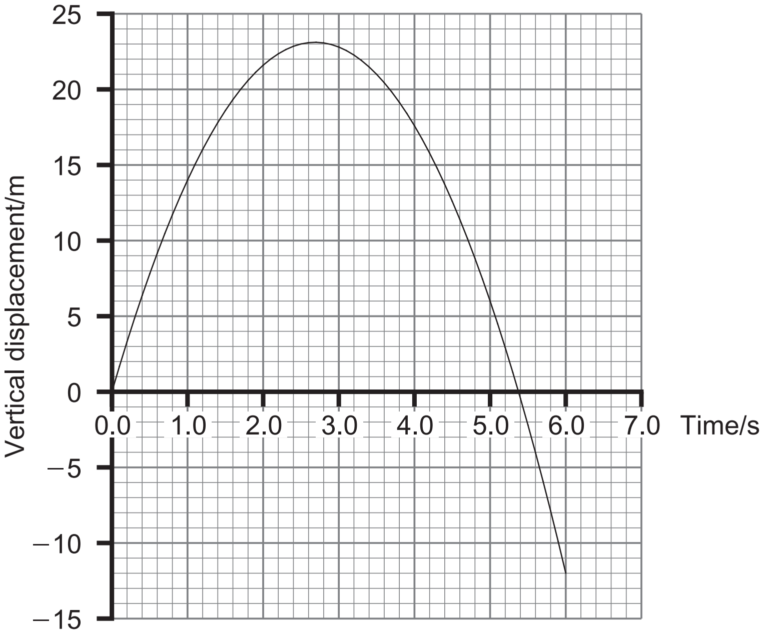

Fig. 2.1

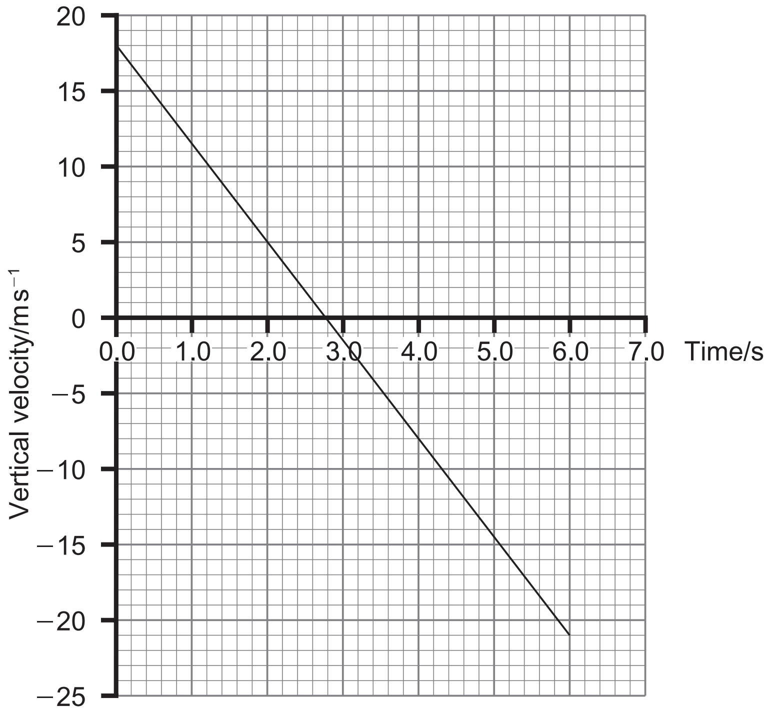

Fig. 2.2

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(a) **(i)** Calculate the acceleration due to gravity on Planet X.

Acceleration = _____________ $m\,s^{-2}$ [3]

(ii) Show that the vertical displacement of the ball after the 6 s monitoring period determined from the velocity–time graph is consistent, to ±30%, with the value obtained from the vertical displacement–time graph.

[5]

(b) This part of the question considers the horizontal component of the ball's projectile motion.

The ball had a horizontal component of velocity of 0.4 $m s^{-1}$ at the instant the six second monitoring period began.

(i) Complete the displacement–time graph of **Fig. 2.3** to show how the horizontal displacement of the ball varies with time up to six seconds. Add appropriate values to the vertical axis.

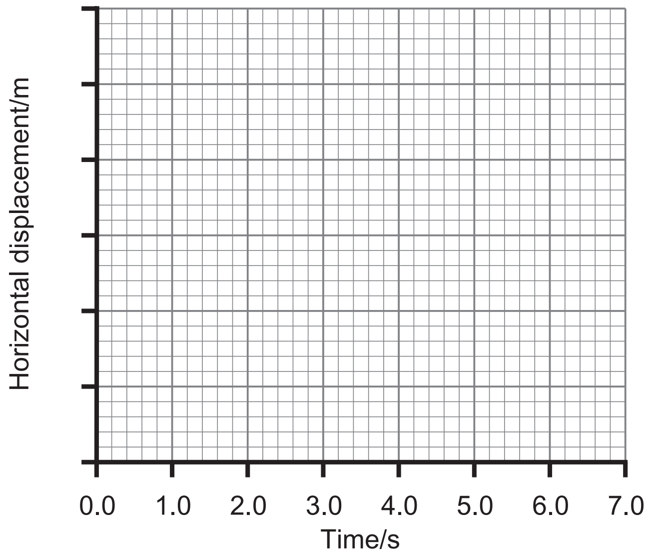

Fig. 2.3 [2]

(ii) Complete **Fig. 2.4** by sketching the best-fit line to show the variation in the horizontal velocity with time. Add appropriate values to the vertical axis.

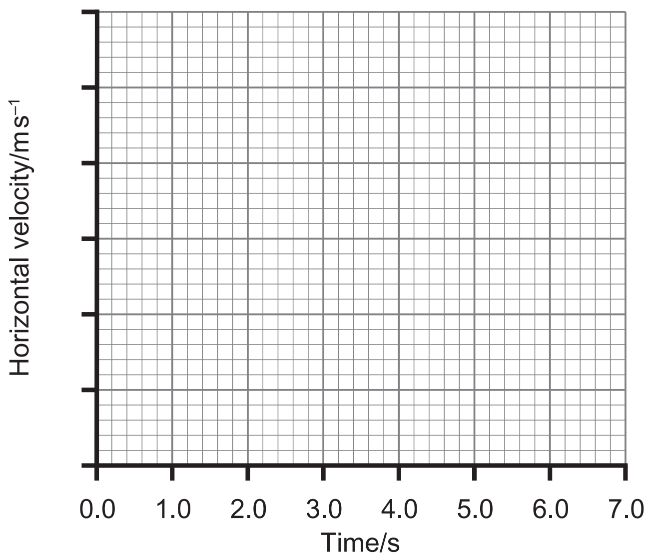

Fig. 2.4 [1]

Examiner Only	
Marks	Remark

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(Questions continue overleaf)

3 (a) (i) Define the term **work**.

____

____ [1]

A rope exerts a force of 240 N on a box of mass 6 kg to move it at a **steady speed** along the ground. The rope acts at an angle of 28° to the vertical in moving the box a distance of 36 m from Position 1 to Position 2 as shown in **Fig. 3.1**.

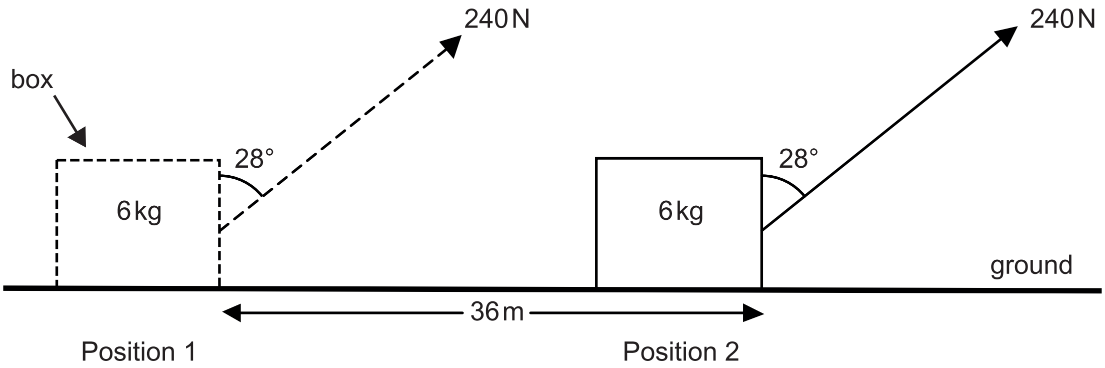

Fig. 3.1

(ii) Calculate the value of the frictional force between the box and the ground.

Frictional force = ______________ N [2]

(iii) Calculate the work done in moving the box from Position 1 to Position 2.

Work = ______________ J [1]

Examiner Only	
Marks	Remark

(b) A skier of mass 78 kg is **stationary** at the top of a 34 m long slope. **Fig. 3.2** illustrates the situation.

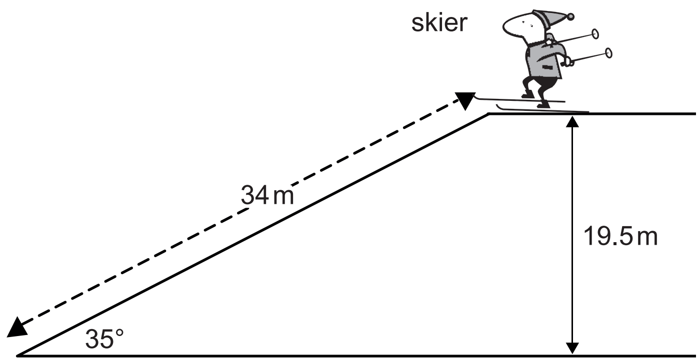

Fig. 3.2

Calculate the velocity attained by the skier during the 34 m descent down the slope if 10% of the skier's energy is used up in overcoming friction.

Velocity = ______________ m s^{-1} [3]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

4 (a) Define the moment of a force about a point.

____

____ [1]

(b) **Fig. 4.1** represents the main features of a bicycle pedal. The force F exerted by the rider acts **vertically** down onto the footpad and a moment is exerted on the axle via the crank.

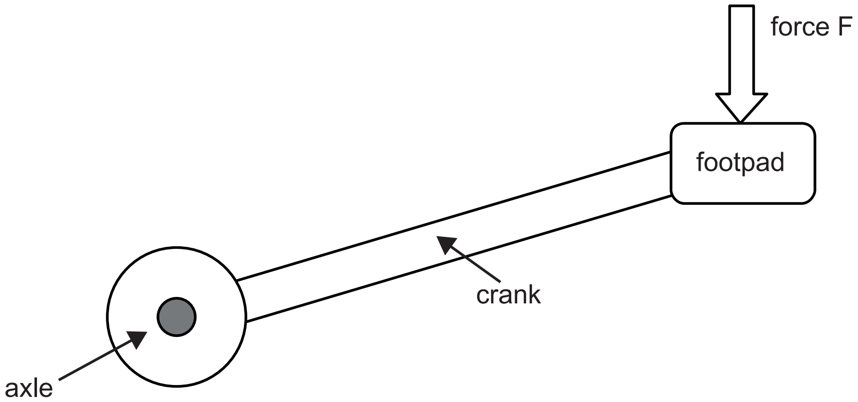

Fig. 4.1

(i) By drawing any suitable construction lines on **Fig. 4.1**, carefully indicate the distance that should be measured in order to calculate the moment of the force about the axle. Label this distance **x**. [2]

The graph in **Fig. 4.2** shows how the moment produced varies for one complete rotation of the pedal.

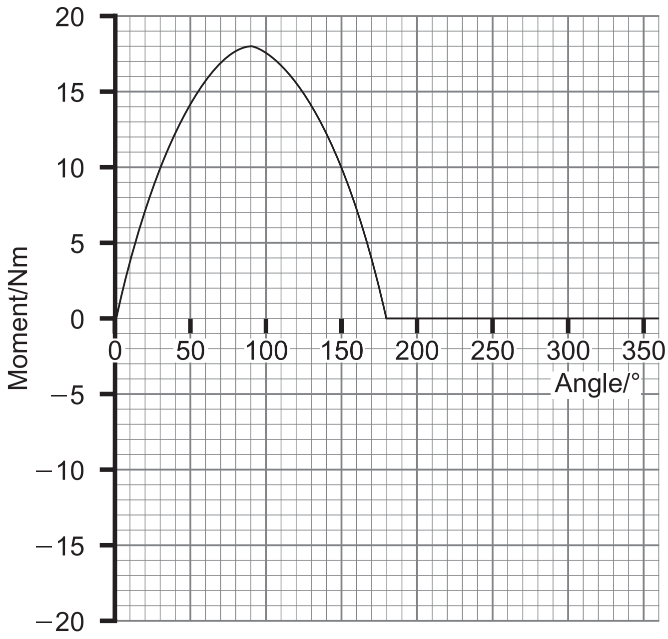

Fig. 4.2

(ii) Identify the position of the crank for angle 0° and explain why the moment varies as shown in **Fig. 4.2** as the angle increases from 0° to 360°.

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____

____

____ [4]

(iii) If the actual length of the crank is 22 cm (see **Fig. 4.1**), calculate the size of force F if it remains constant during the first half of the rotation, from 0° to 180°.

Force F = ______________ N [3]

Examiner Only	
Marks	Remark

Where possible 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 Describe an experiment to determine the Young modulus of copper. Assume the copper is in the form of a thin wire and that you have access to equipment typically found in school physics laboratories.

(a) (i) Diagram of apparatus

(ii) Procedure (include measurements to be taken and recorded):

(iii) Safety precaution: ____________________

____

____________________ [6]

(b) Analysis of results to determine the Young modulus.

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____________________ [2]

Quality of written communication [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

6 To make a mug of coffee 400 g of water was boiled using an electric kettle. This required 4.11×10^{21} electrons to flow past a point in the electric wires. The kettle is connected to a standard 230 V supply (mains) and is switched on for 126 s.

(i) Show that the average current flowing during the time the kettle is switched on is 5.22 A.

[2]

(ii) Determine the power rating of the kettle.

Power = _____________ kW [3]

(iii) Determine the electrical energy transferred during the 126 s of the heating by the kettle.

Energy transferred = _____________ J [3]

7 Determining the internal resistance *r* of a cell requires a circuit to be set up that enables quantities to be measured that when analysed allow the internal resistance to be obtained.

(i) Complete the circuit diagram, in **Fig. 7.1**, which will enable you to take readings from which you can determine the value of *r*.

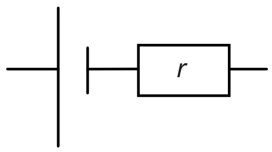

Fig. 7.1 [2]

(ii) On **Fig. 7.2** indicate the quantities to be used to plot a graph from which *r* can be determined. Label the axes, on the lines provided, and sketch the shape of graph expected.

Fig. 7.2 [2]

(iii) Explain how the value of the internal resistance of the cell is obtained from your graph.

____

____

____ [2]

Examiner Only	
Marks	Remark

8 Resistor R_m, in the circuit shown in **Fig. 8.1**, is a length of manganin wire and the current flowing from the cell is 425 mA.

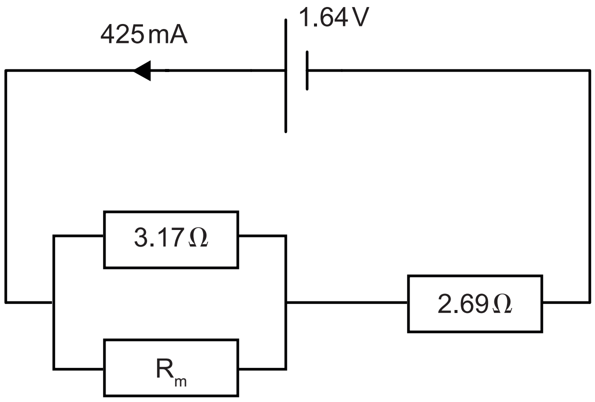

Fig. 8.1

(i) Show that the voltage across R_m is 0.50 V.

[2]

(ii) Determine the resistance of R_m.

R_m = ______________ Ω [3]

Examiner Only	
Marks	Remark

(iii) The manganin wire used to form R_m is 2.35 m long and 0.846 mm in diameter. Determine the resistivity of manganin.

Examiner Only	
Marks	Remark

Resistivity = ______________ Ω m [3]

Examiner Only	
Marks	Remark

9 **Fig. 9.1** is the circuit diagram for a potential divider that incorporates a thermistor and a variable resistor initially fixed at 3180 Ω.

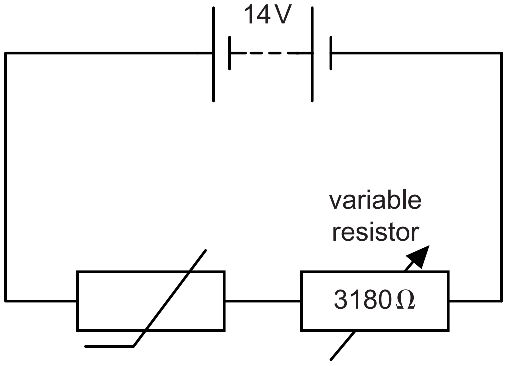

Fig. 9.1

(a) The thermistor's resistance at 20 °C is 2860 Ω and at 100 °C is 199 Ω. Explain why the resistance of the thermistor varies with temperature in the manner that it does.

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____

____

____ [2]

(b) This potential divider circuit is to be used to control the temperature in an incubator. A heater will switch on when the potential difference (p.d.) across the thermistor is 6.0 V.

(i) Show that the thermistor resistance that produces a p.d. of 6.0 V across the thermistor is 2400 Ω (to 2 sig. figs).

[2]

(ii) The heater element is part of a heating circuit that has to be placed in parallel with the thermistor. If the heating element has a resistance of 1600 Ω, calculate the new resistance to which the variable resistor must be adjusted if the heater's switch-on voltage is to remain at 6.0 V.

Resistance = _____________ Ω [3]

Examiner Only	
Marks	Remark

THIS IS THE END OF THE QUESTION PAPER

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	$\lambda = \frac{h}{p}$

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