**Centre Number**

71

**Candidate Number**

*Rewarding Learning*

**ADVANCED SUBSIDIARY**
**General Certificate of Education**
**January 2011**

# Physics

## Assessment Unit AS 1

*assessing*

Module 1: Forces, Energy and Electricity

**[AY111]**

**WEDNESDAY 12 JANUARY, MORNING**

AY111

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 **9**.
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** | |

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**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 ten** questions.

**1** **(a)** **(i)** What is a **scalar** quantity?

_____

_____

**(ii)** What is a **vector** quantity?

_____

_____ [2]

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

Potential energy ☐

Frequency ☐

Velocity ☐

Charge ☐

Force ☐

Power ☐ [2]

| | Examiner Only | |
|---|---|---|
| | Marks | Remark |

6456

**2**

**(c)** **Fig. 1.1** shows a force of 12 N acting on a brick resting on a horizontal surface.
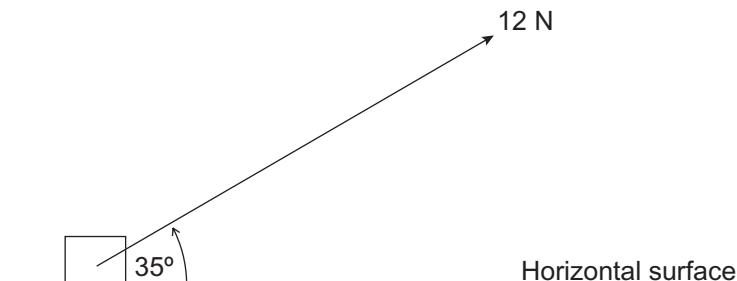
**Fig. 1.1**

**(i)** Find by calculation the horizontal and vertical components of this force.

Horizontal component = _____ N

Vertical component = _____ N            [2]

**(ii)** What is the resultant vertical force acting on the horizontal surface if the brick has mass 3.0 kg?

Force = _____ N            [2]

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**3**

**[Turn over**

**2** **(a)** A catapult is used to project a ball **vertically upwards** with an initial velocity of $5.0\,\text{m}\,\text{s}^{-1}$.

**(i)** Calculate the maximum height reached by the ball.

Maximum height = _____ m                    [2]

**(ii)** Calculate the total flight time (from launch until it returns to the starting point).

Flight time = _____ s                    [2]

**(b) Fig. 2.1** is a simplified sketch graph of velocity $v$ against time $t$ for a car travelling along a straight road between two sets of traffic lights.
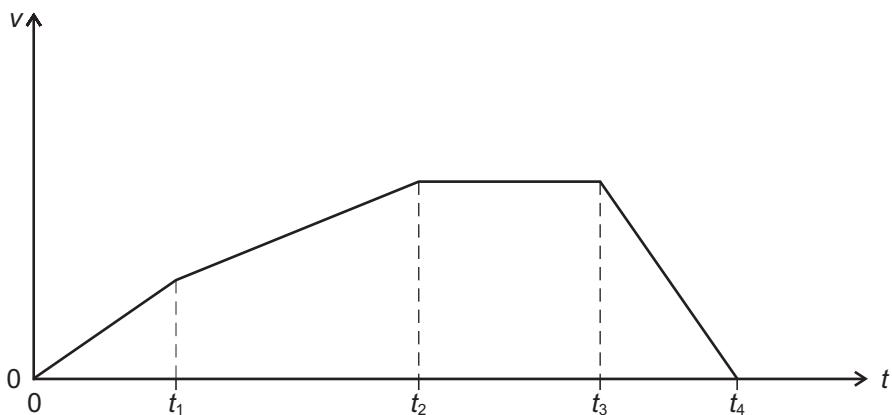
**Fig. 2.1**

**(i)** Describe in words how the **acceleration** of the car varies in the following time intervals from $t_1$ to $t_4$.

From $t_1$ to $t_2$: _____

From $t_2$ to $t_3$: _____

From $t_3$ to $t_4$: _____ [2]

**(ii)** State how the distance between the traffic lights could be deduced from **Fig. 2.1.**

_____

_____ [2]

**5**

**3** **(a)** State Newton's second law of motion.

_____

_____

_____ [2]

**(b)** A person, of mass 55.0 kg, stands on bathroom scales in a lift. The scales are calibrated to measure in newtons.

**(i)** The lift starts to ascend vertically upwards with constant acceleration of 1.5 m s$^{-2}$. Calculate the scale reading while the lift is accelerating upwards.

Reading = _____ N [2]

**(ii)** After this initial acceleration the lift continues to travel upwards at constant speed.

Determine the scale reading in this case.

Reading = _____ N [1]

**(iii)** The lift then starts to slow down with constant retardation of 1.0 m s$^{-2}$. Calculate the scale reading while the lift is slowing down.

Reading = _____ N [2]

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**6**

**4** **Fig. 4.1** shows a uniform plank, of weight 30 N and length 3 m, resting on two supports. The supports are 0.5 m and 2.0 m from the left hand end of the plank. A weight of 18 N is suspended from the left hand end of the plank.
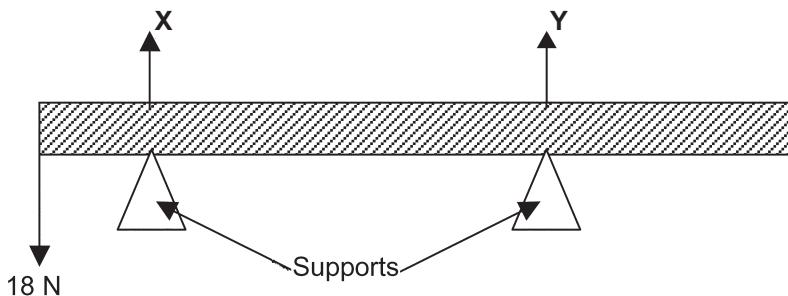
**Fig. 4.1**

**(a)** Find the reactions, **X** and **Y,** at the two supports.

**X** = _____ N        **Y** = _____ N        [3]

**(b)** By how much should the weight on the left hand end be increased so that the reaction **Y** becomes zero?

Increase in weight = _____ N        [2]

6456                                        7                                        **[Turn over**

**5** A small car has a mass of 800 kg and can accelerate from rest to a velocity of 27.8 m s$^{-1}$ in 13.5 seconds.

**(a) (i)** Calculate the kinetic energy of the car when moving at 27.8 m s$^{-1}$.

Kinetic energy = _____ J                [1]

**(ii)** Calculate the useful power output of the engine to produce this acceleration.

Power output = _____ W                [1]

**(iii)** The efficiency of the engine in converting chemical energy to useful kinetic energy is 29%. Calculate the chemical energy from the petrol needed to produce this amount of kinetic energy.

Chemical energy = _____ J                [2]

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**8**

**(b)** The car, travelling at $27.8\,\text{m s}^{-1}$, reaches the bottom of the slope as shown in **Fig 5.1.** The driver switches off the engine and allows the car to free wheel up the slope. Ignoring friction, calculate how far the car travels along the slope before coming to rest.
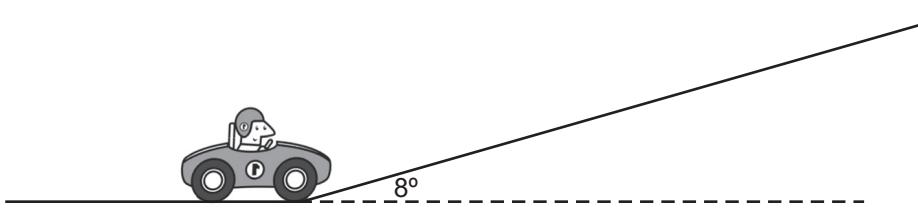
**Fig. 5.1**

Distance up the slope = _____ m    [3]

**[Turn over**

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

[3]

**(ii)** Apart from measuring the force on the wire, there are three other quantities to be measured when determining the Young modulus. In the table below list the other measurements you would make, and state the instruments you would use to make the measurements.

| Measurement | Instrument |
|---|---|
|  |  |
|  |  |
|  |  |

[3]

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**10**

**(b)** A stretching force of 5.5 N is applied to a copper wire of length 2.5 m, producing a strain of $7.8 \times 10^{-4}$. The Young Modulus of copper is $1.2 \times 10^{11}$ N m$^{-2}$.

**(i)** Calculate the extension produced in the wire.

Extension = _____ mm         [1]

**(ii)** Calculate the cross-sectional area of the wire.

Cross-sectional area = _____ mm$^2$      [3]

6456            **11**            **[Turn over**

**7** **(a)** Name one example of an ohmic conductor.

_____

On **Fig. 7.1**, sketch a graph to illustrate how the current through the conductor you have named varies with the potential difference across it. Assume the temperature of the conductor remains constant.
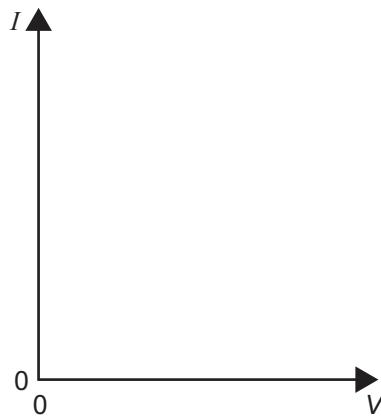
[2]

**Fig. 7.1**

**(b) (i)** Explain what is meant by superconductivity. On **Fig. 7.2** sketch a graph to illustrate this effect for a wire made of a superconducting material, both below and above the superconducting transition temperature. Label the transition temperature $T_s$.

_____

_____

[3]

**Fig. 7.2**

**12**

**(ii)** State one application of superconductivity.

_____

_____

_____ [1]

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**13**

**8** A current of 60 mA flows through a resistor of resistance 80 $\Omega$ for 12 minutes.

   **(a) (i)** Calculate the amount of charge which passes through the resistor in this time.

          Charge = _____ C                [1]

      **(ii)** Hence calculate the number of electrons which pass through the resistor in this time.

          Number of electrons = _____         [1]

   **(b) (i)** Calculate the potential difference across the resistor.

          Potential difference = _____ V      [1]

      **(ii)** Calculate the heat energy dissipated by the resistor in 12 minutes.

          Energy = _____ J             [2]

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**(Questions continue overleaf)**

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

**9** **(a)** Describe an experiment to determine the internal resistance of a battery. Include a circuit diagram.

Circuit diagram

[2]

Description of experiment:

_____

_____

_____

_____

_____

_____ [2]

**16**

| Examiner Only | |
|---|---|
| Marks | Remark |
| | |

**(b) (i)** Internal resistance can be obtained graphically. Label the axes of **Fig 9.1** to enable internal resistance to be determined. Sketch a graph of the results obtained from such an experiment.
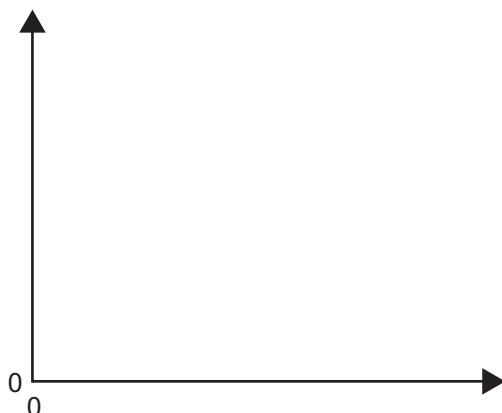
**Fig. 9.1**

**(ii)** How is the internal resistance obtained from your graph?

_____

_____ [3]

Quality of written communication                                    [2]

**(c)** A car battery has e.m.f 12.6 V and internal resistance 0.02 Ω. When the starter motor is connected to the battery, the battery delivers a current of 145 A. Calculate the terminal potential difference when the starter is connected.

Terminal potential difference = _____ V                    [2]

**10** **Fig. 10.1** depicts two fixed resistors and a variable resistor connected in series to an 18 V power supply of negligible internal resistance. The arrangement can be used to give a variable output voltage between C and D.
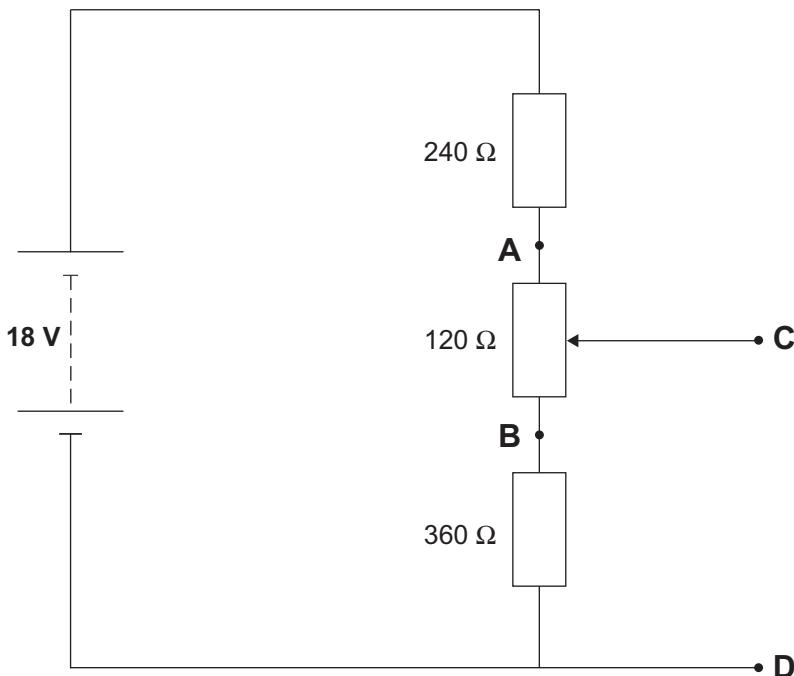
**Fig. 10.1**

(i) Calculate the current flowing round the circuit.

Current = _____ mA [2]

(ii) Hence calculate the potential difference across the 120 Ω variable resistor (the voltage between **A** and **B**).

Potential difference = _____ V [1]

**(iii)** Calculate the potential difference between the point **D** and the slider contact of the variable resistor (labelled **C**), when it is mid-way between **A** and **B**.

Potential difference = _____ V          [2]

**(iv)** A 210 Ω resistor is now placed across the output between **C** and **D**. Calculate the new potential difference between **C** and **D**.

Potential difference = _____ V          [3]

---

## THIS IS THE END OF THE QUESTION PAPER

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**19**

111604

## 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 e$V = 1.60 \times 10^{-19}$ J |

### Useful formulae

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

### Mechanics

Conservation of energy $\quad \frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs \quad$ for a constant force

Hooke's Law $\quad F = kx$ (spring constant $k$)

### Sound

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

### Waves

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

### Light

Lens formula $\quad \dfrac{1}{u} + \dfrac{1}{v} = \dfrac{1}{f}$

Magnification $\quad m = \dfrac{v}{u}$

### Electricity

Terminal potential difference $\quad V = E - Ir$ (E.m.f. $E$; Internal Resistance $r$)

Potential divider $\quad V_{out} = \dfrac{R_1 V_{in}}{R_1 + R_2}$

### Particles and photons

de Broglie equation $\quad \lambda = \dfrac{h}{p}$