Rewarding Learning

**ADVANCED SUBSIDIARY (AS)**
**General Certificate of Education**
**2016**

Centre Number

Candidate Number

# Physics

Assessment Unit AS 1
*assessing*
Module 1: Forces, Energy and Electricity

*AY111*

**[AY111]**

**MONDAY 20 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.
**You must answer the questions in the spaces provided.**
**Do not write outside the boxed area on each page or on blank pages.**
Complete in blue or black ink only. **Do not write with a gel pen.**
Answer **all eleven** questions.

**INFORMATION FOR CANDIDATES**

The total mark for this paper is 75.
Quality of written communication will be assessed in Question **7**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each part of the question.
Your attention is drawn to the Data and Formulae Sheet which is inside this question paper.
You may use an electronic calculator.

9867.11**R**

**1 (a)** Read the following paragraph, which is an excerpt from a recipe in a cookery book. A number of physical quantities are mentioned. Identify them in **Table 1.1** below and state the **S.I. unit** in which each is measured.

"In order to bake the perfect sponge cake, it is necessary to find a balance between the mass of dry ingredients and volume of wet ingredients used, as well as the oven temperature and time of cooking. A cake which is too dry may prove difficult to decorate."

**Table 1.1**

| Quantity | S.I. unit |
|---|---|
| | |
| | |
| | |
| | |

[4]

**(b)** Express the unit of power, the watt, in S.I. base units.

S.I. base units ___________________ [2]

**2** A student has carried out an experiment to measure the value of g, the acceleration of free fall, in the school laboratory. The time taken, t, for a small metal sphere to fall freely from rest through a measured distance, s, has been recorded as shown in **Table 2.1**.

**Table 2.1**

| s/m | t/s |
|---|---|
| 0.432 | 0.30 |
| 0.981 | 0.44 |

**(a)** Use all the data to calculate a value for g.

g = ________________ $m\ s^{-2}$ [3]

**(b)** What apparatus was required to obtain the data in **Table 2.1**?

______________________________________________

______________________________________________ [1]

**(c)** Suggest a possible source of error associated with this experiment, which may lead to calculated values for g which are not equal to the accepted value.

______________________________________________

______________________________________________ [1]

**3** A golfer wishes to pitch a golf ball directly into the hole, which is at a horizontal distance of 18 metres from the ball and at the same vertical height as the ball. In order to achieve this, he projects the ball at an angle of 50° to the horizontal, with velocity v, as shown in **Fig. 3.1**.

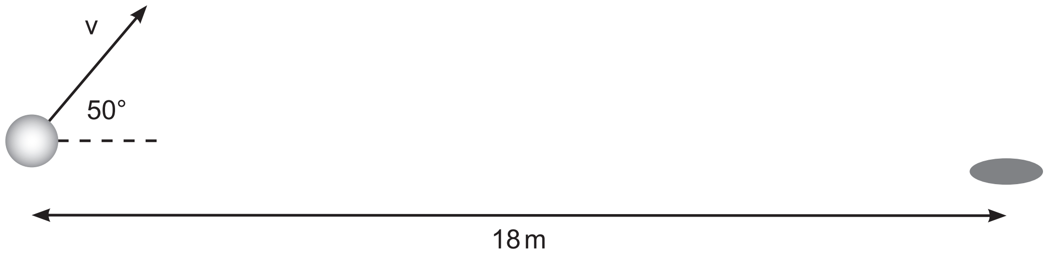


**Fig. 3.1**

**(a) (i)** Assuming that the flight of the ball is unaffected by air resistance, write **two equations** for the total time taken, T, for the ball to reach the hole, one each for the vertical and horizontal components of velocity.

$T_{vertical}$ = ____________________ $T_{horizontal}$ = ____________________ [3]

**(ii)** Hence, show that the initial velocity, v, of the ball is 13.4 m $s^{-1}$.

[2]

**(b)** Calculate the time spent in the air by the golf ball.

Time = ____________________ s [1]

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

_______________________________________________

_______________________________________________

_______________________________________________ [2]

**(b)** A woman of mass 59 kg steps into a stationary lift in order to travel from the tenth floor of an office building to the ground floor. The lift accelerates downwards at 2.5 m $s^{-2}$ until it reaches a steady velocity. It travels at this velocity for a certain time, before decelerating at 2.2 m $s^{-2}$ and coming to rest on the ground floor. The woman feels a reaction force from the floor at all times.

**(i)** Calculate the size of the reaction force as the woman stands in the lift while it is stationary.

Reaction = __________________ N [1]

**(ii)** Calculate the **maximum** reaction force she will experience.

Maximum reaction = __________________ N

During which stage of the journey will this occur?

_______________________________________________ [3]

**(c)** Describe and explain the circumstance which might lead to the woman experiencing the sensation of 'weightlessness' while standing on the floor of the moving lift.

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________ [2]

**5** Young gymnasts are practising on a **uniform** wooden beam of weight 124 N and length 180 cm. In order to raise it above the floor, the beam is resting on two metal supports, A and B, each of which is at 20 cm from the end of the beam, as in **Fig. 5.1**.

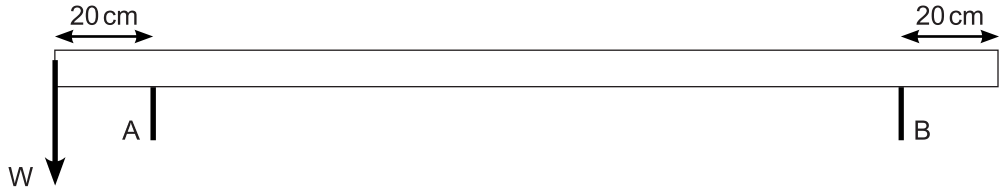


**Fig. 5.1**

**(a) (i)** Calculate the **maximum** weight of gymnast, W, who can stand at the left-hand end of the beam, without the beam beginning to tip up.

Maximum weight = ___________________ N [3]

**(ii)** What upward force is provided by the support at A, when this gymnast is standing in this position?

Force = ___________________ N [1]

**(b)** The coach requires that the same wooden beam is used by heavier gymnasts. She decides to reposition the supports, but is unsure whether they should be moved closer together or further apart. State in which direction the supports should be moved. Explain your answer making reference to the principle of moments.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________ [3]

6 (a) During training for the Olympic Games, a javelin thrower had the following data recorded by his coach.

**Table 6.1**

| | |
|---|---|
| Release velocity/m $s^{-1}$ | 22.11 |
| Height of release/m | 2.02 |
| Angle of release/° | 43.4 |
| Max height/m | 13.78 |
| Time of flight/s | 3.22 |
| Distance/m | 51.71 |

The javelin follows a path from point of release A to where it strikes the ground at B, as shown in **Fig. 6.1** below.

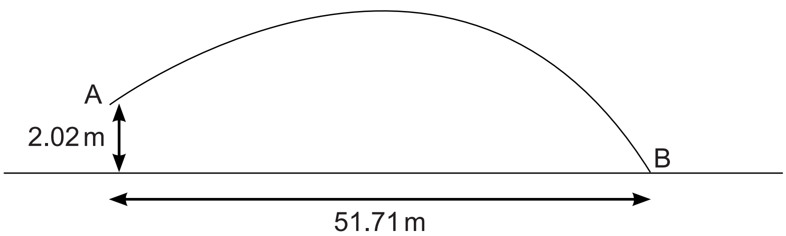


**Fig. 6.1**

(i) The mass of the javelin is 0.800 kg. Use this information and data from **Table 6.1** to calculate the kinetic energy of the javelin as it leaves the thrower's hand.

Kinetic energy = ____________________ J [2]

**(ii)** Over the duration of its flight, air resistance leads to an overall loss in **total** energy of 8%. Use this information and data from **Table 6.1** to calculate the kinetic energy of the javelin as it strikes the ground.

Kinetic energy = ___________________ J [3]

**(b)** Following another throw, the javelin fell and had a kinetic energy of 245 J as it hit the ground. The tip of the javelin entered the soil and travelled 6.5 cm before coming to a complete stop. Calculate the average resistive force acting on the javelin as it moved through the soil.

Average force = ___________________ N [2]

**Where appropriate in this question you should answer in continuous prose. You will be assessed on the quality of your written communication in parts (b) and (c).**

**7** Describe an experiment to measure the Young modulus of copper wire. Include:

**(a)** a labelled diagram of the arrangement of apparatus;

[2]

**(b)** an outline of the procedure, listing the measurements to be taken and the instruments required to take them;

______________________________________________

______________________________________________

______________________________________________

______________________________________________ [4]

**(c)** an explanation of how the Young modulus of copper may be determined from the results.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

____________________________________________________________________ [3]

Quality of written communication [2]

**8** **(a)** Define:

**(i)** electrical current

_______________________________________________

_______________________________________________ [1]

**(ii)** potential difference between two points

_______________________________________________

_______________________________________________ [2]

**(b)** A steady current of 25 mA flows through a component for 2 minutes. The potential difference across the component is constant at 6.0 V for this time. Calculate:

**(i)** the total charge passing through the component in this time.

Charge = ____________________ C [2]

(ii) the heat energy dissipated by the component in this time.

Energy = ____________________ J [1]

**9** **(a)** State Ohm's Law.

______________________________________________________________________

______________________________________________________________________

_________________________________________________________________ [2]

**(b)** An arrangement of four **identical** resistors is shown in **Fig. 9.1**.

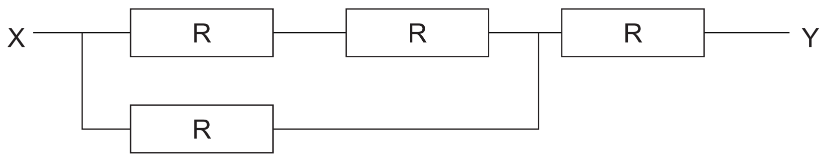


**Fig. 9.1**

The potential difference between points X and Y is 6.0 volts. The current entering at X is 2.0 mA.

**(i)** What is the **total** resistance between points X and Y?

Total resistance = ____________________ Ω [1]

**(ii)** Calculate the resistance of one of the resistors.

Resistance = ________________ Ω [3]

**10 (a)** Derive an equation for the resistivity of a sample of wire, in terms of resistance R, diameter d and length l of the wire.

[2]

**(b)** A student carried out an investigation into how the resistance of a metal wire varied with length of wire. She plotted values of length in metres against resistance in ohms and obtained the graph shown in **Fig. 10.1** below.

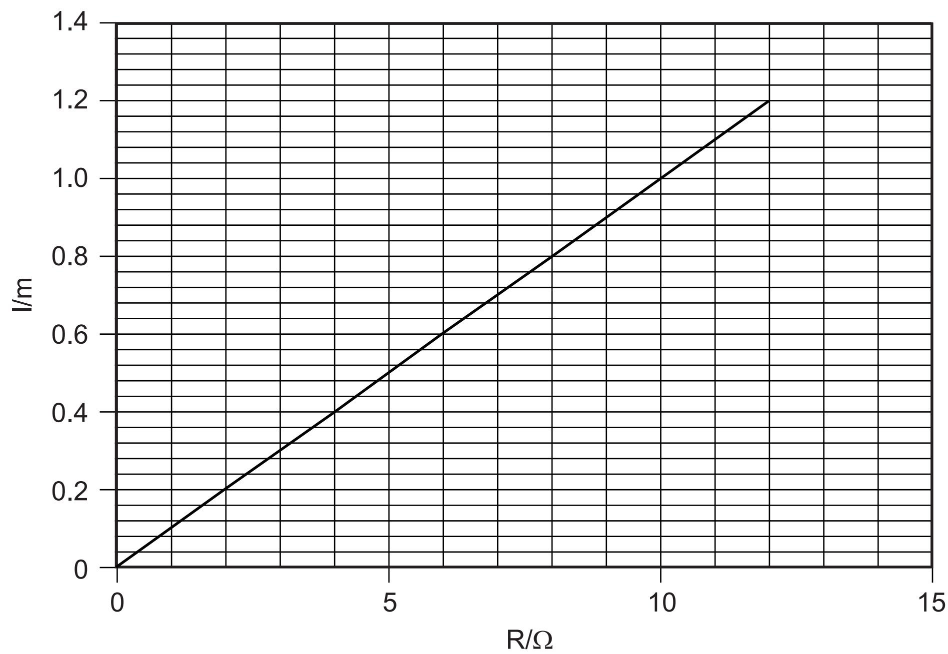


**Fig. 10.1**

**(i)** The student cannot recall whether the metal wire is a sample of aluminium (resistivity $2.82 \times 10^{-8}\ \Omega\ \text{m}$) or nichrome (resistivity $1.00 \times 10^{-6}\ \Omega\ \text{m}$). Use the equation you stated in **(a)** and data from **Fig. 10.1** to carry out calculations to decide which of these two materials was used in the experiment, and explain your decision.

Material ____________________

Explanation

________________________________________________________________________

________________________________________________________________________ [3]

**(ii)** State how the student may have ensured the investigation was carried out in as safe a manner as possible.

________________________________________________________________________

________________________________________________________________________ [1]

**11** Since the discovery in 1986 of the first high-temperature superconductors, there has been great interest in them. Their superconducting state can be maintained using liquid nitrogen (boiling point 77 K).

**(a)** Explain what is meant by the phenomenon of superconductivity.

______________________________________________________________________

______________________________________________________________________

____________________________________________________________________ [2]

**(b)** On **Fig. 11.1**, sketch a graph of resistance, R, against temperature, T, for a superconductor with transition temperature of 92 K, over the range of temperatures 0 to 200 K. Label the transition temperature $T_s$.


**Fig. 11.1**

[3]

**(c)** State and briefly describe an application of superconductors.

______________________________________________________________________

______________________________________________________________________

____________________________________________________________________ [2]

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| For Examiner's use only | | |
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| **Question Number** | **Marks** | **Remark** |
| 1 | | |
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| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| **Total Marks** | | |

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