Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009

Centre Number

71	

Candidate Number

Physics

Assessment Unit AS 1

assessing

Module 1: Forces and Electricity

[ASY11]

ASY11

TUESDAY 16 JUNE, AFTERNOON

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Answer **all seven** questions.
Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.
Quality of written communication will be assessed in question **5(a)**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Your attention is drawn to the Data and Formula Sheet which is inside this question paper.
You may use an electronic calculator.
You will need a ruler and protractor.

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 on the Data and Formulae Sheet.

Examiner Only	
Marks	Remark

Answer **all seven** questions

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

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

____ [1]

(ii) 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.

Kinetic energy	☐	Mass	☐
Displacement	☐	Force	☐
Momentum	☐	Power	☐

[2]

(b) State the two conditions for a body to be in equilibrium under the action of a number of coplanar forces.

1. ____

____

2. ____

____ [2]

(c) Two tugs are used to rescue a small 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 of 250 kN on the ship as shown in **Fig. 1.1**.

Tug A develops a force of 200 kN in the direction shown on **Fig. 1.1**.

Find, by scale diagram or calculation, the magnitude and direction θ of the force F developed by tug B if the three forces acting on the ship are in equilibrium.

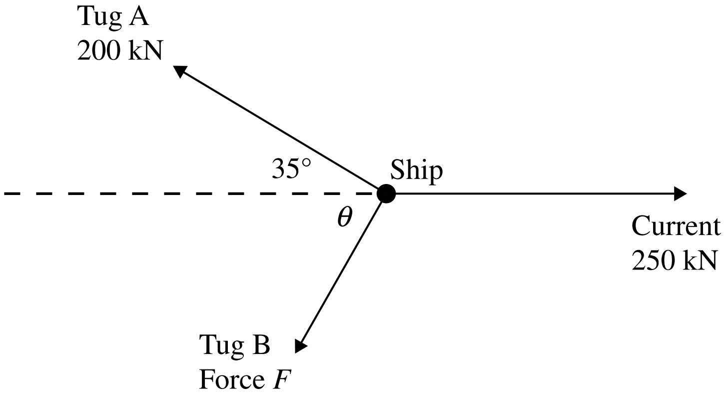

Fig. 1.1

F = ___________ kN

θ = ___________ ° [5]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

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

____

____

____ [1]

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

____ [1]

(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.

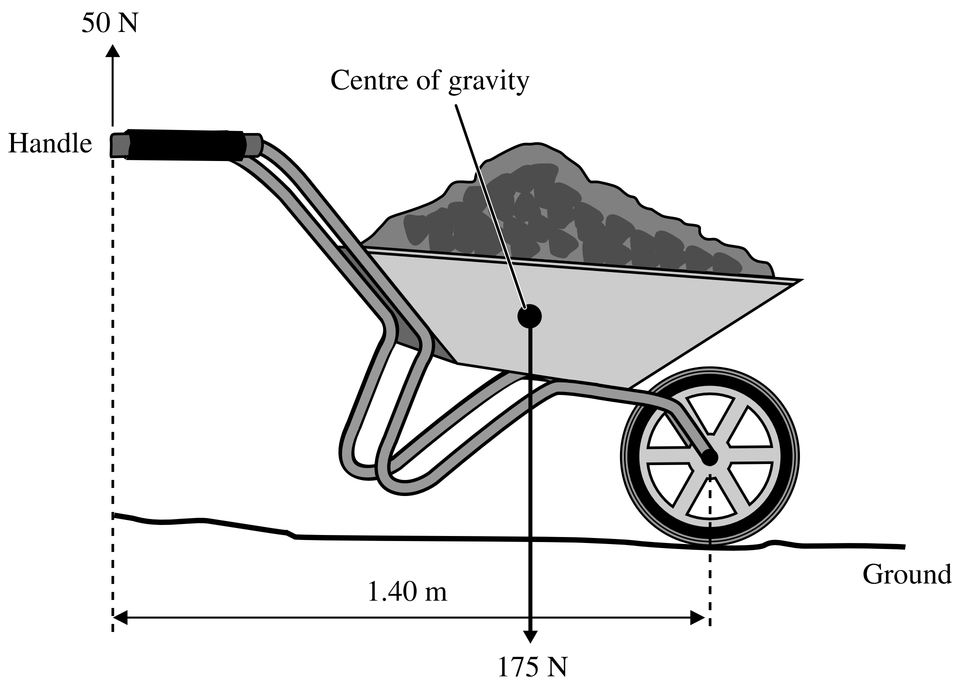

Fig. 2.1

Examiner Only	
Marks	Remark

(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

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**.

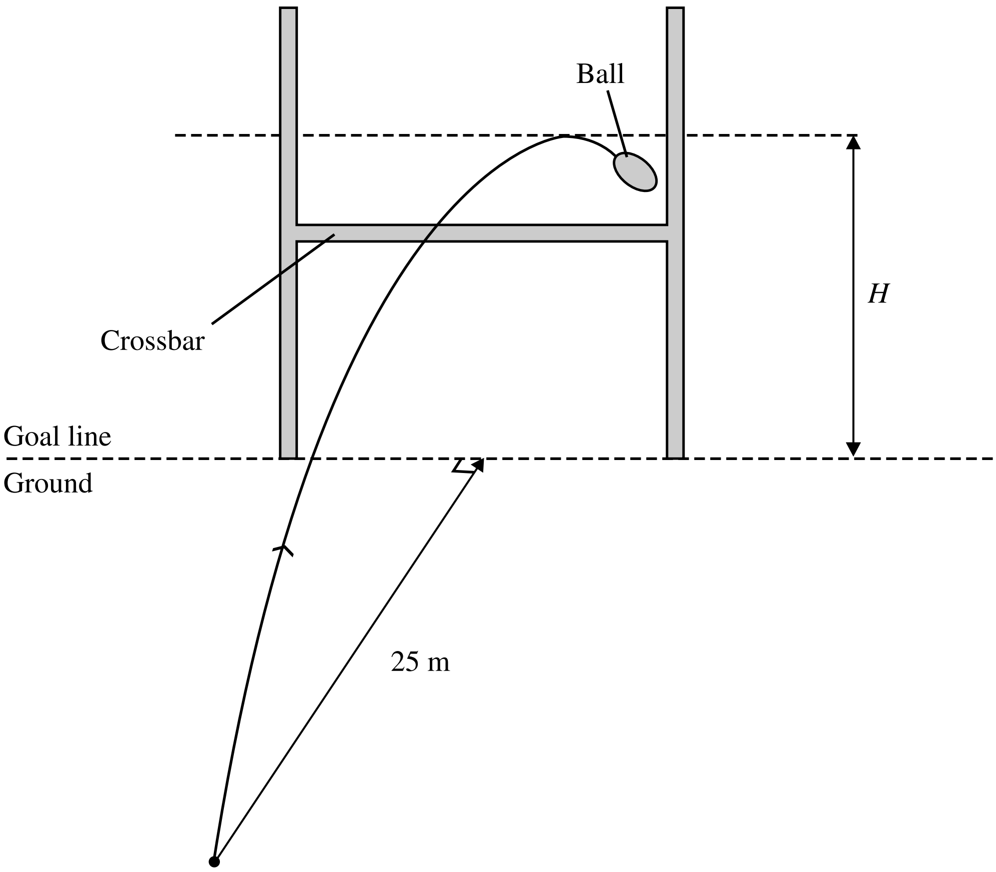

Fig. 3.1

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 = ___________ $m\,s^{-1}$ [3]

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

Examiner Only	
Marks	Remark

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 [2]

4 **(a)** **(i)** Define the **momentum** of a body.

____ [1]

(ii) Define the **impulse** of a force.

____ [1]

(b) An oxygen molecule of mass 5.31×10^{-26} kg has speed of $480\,\text{m}\,\text{s}^{-1}$.

(i) Calculate the magnitude of the momentum of the molecule and give an appropriate SI unit.

Magnitude _______________

SI unit _______________ [2]

(ii) The molecule strikes a wall normally and rebounds with the same speed, also normally to the wall. Use the impulse–momentum relation to calculate the magnitude of the impulse the wall gives to the molecule.

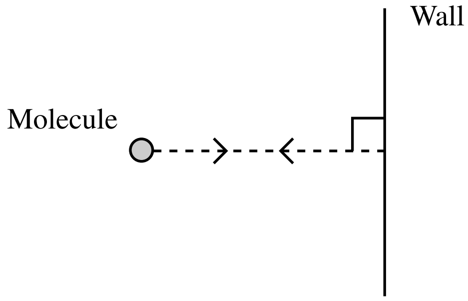

Fig. 4.1

Impulse = ___________SI units [2]

Examiner Only
Marks | Remark

Examiner Only	
Marks	Remark

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

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]

Quality of written communication [1]

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

____

____ [1]

(ii) Obtain the relationship between the electromotive force E, the terminal potential difference V and the internal resistance r when a power source is used to provide a current I to an external resistor of resistance R.

$E - V =$ ______________ [2]

(iii) State the necessary condition for an electrical power source to supply maximum power to an external load resistance.

____ [1]

Examiner Only	
Marks	Remark

6 **(a)** 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. 6.1**.

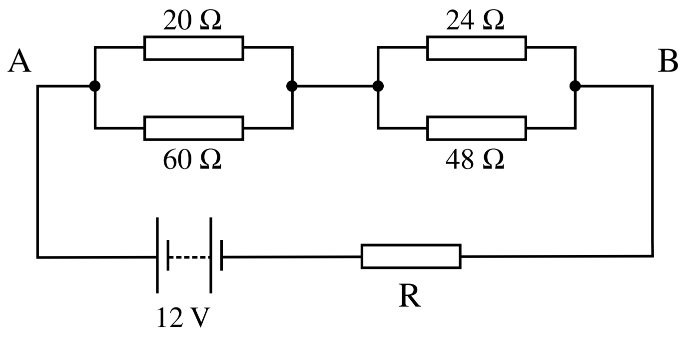

Fig. 6.1

(i) 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]

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

Total resistance = ___________ Ω [2]

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

Resistance of R = ___________ Ω [1]

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

Current = ___________ mA [2]

(b) A 0–200 μA microammeter is to be modified to measure currents up to 1.00 mA by the addition of a shunt. The microammeter has internal resistance 600 Ω.

(i) Draw a labelled circuit diagram of the arrangement, showing how the shunt is attached to the microammeter.

[1]

(ii) Calculate the resistance of the shunt needed.

Shunt resistance = ___________ Ω [3]

Examiner Only	
Marks	Remark

7 A potential divider circuit is shown in **Fig. 7.1**. R_x is a fixed resistor of resistance R_x and R_y is a variable resistor of resistance R_y. The combined resistance of R_x and R_y is 500 Ω and the supply voltage is 25.0 V. The output voltage V_o is obtained between the terminals A and B.

Examiner Only	
Marks	Remark

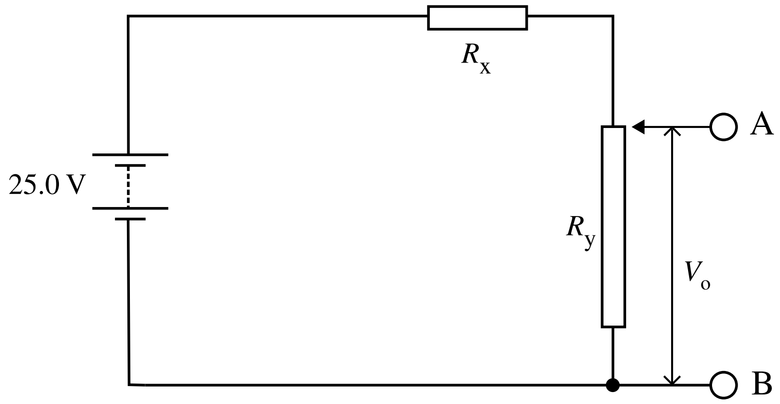

Fig. 7.1

(a) The maximum value of V_o is 15.0 V when the sliding contact A is at the position shown.
Calculate the resistance of R_x and the resistance of R_y.

R_x = ______________ Ω

R_y = ______________ Ω [3]

(b) The position of the sliding contact A is adjusted so that the output is 5.0 V. A load of resistance 300 Ω is then connected to the terminals AB.
Calculate the new value of V_o.

Examiner Only	
Marks	Remark

V_o = ____________ V [4]

THIS IS THE END OF THE QUESTION PAPER

GCE Physics (Advanced Subsidiary and Advanced)

Data and Formulae Sheet

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$
permeability of a vacuum	$\mu_0 = 4\pi \times 10^{-7}\ \text{H m}^{-1}$
permittivity of a vacuum	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$ $\left(\dfrac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\ \text{F}^{-1}\ \text{m}\right)$
elementary charge	$e = 1.60 \times 10^{-19}\ \text{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$
unified atomic mass unit	$1\ \text{u} = 1.66 \times 10^{-27}\ \text{kg}$
mass of electron	$m_e = 9.11 \times 10^{-31}\ \text{kg}$
mass of proton	$m_p = 1.67 \times 10^{-27}\ \text{kg}$
molar gas constant	$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23}\ \text{mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^{2}\ \text{kg}^{-2}$
acceleration of free fall on the Earth's surface	$g = 9.81\ \text{m s}^{-2}$
electron volt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$

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USEFUL FORMULAE

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

Mechanics

Momentum-impulse relation	$mv - mu = Ft$ for a constant force
Power	$P = Fv$
Conservation of energy	$\frac{1}{2}mv^2 - \frac{1}{2}mu^2 = Fs$ for a constant force

Simple harmonic motion

Displacement	$x = x_0 \cos \omega t$ or $x = x_0 \sin \omega t$
Velocity	$v = \pm\omega\sqrt{x_0{}^2 - x^2}$
Simple pendulum	$T = 2\pi\sqrt{l/g}$
Loaded helical spring	$T = 2\pi\sqrt{m/k}$

Medical physics

Sound intensity level/dB	$= 10 \lg_{10}(I/I_0)$
Sound intensity difference/dB	$= 10 \lg_{10}(I_2/I_1)$
Resolving power	$\sin \theta = \lambda/D$

Waves

Two-slit interference	$\lambda = ay/d$
Diffraction grating	$d \sin \theta = n\lambda$

Light

Lens formula	$1/u + 1/v = 1/f$

Stress and Strain

Hooke's law	$F = kx$
Strain energy	$E = \langle F \rangle x$ $(= \frac{1}{2}Fx = \frac{1}{2}kx^2$ if Hooke's law is obeyed)

Electricity

Potential divider	$V_{out} = R_1 V_{in}/(R_1 + R_2)$

Thermal physics

Average kinetic energy of a molecule	$\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$
Kinetic theory	$pV = \frac{1}{3}Nm\langle c^2\rangle$

Capacitors

Capacitors in series	$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
Capacitors in parallel	$C = C_1 + C_2 + C_3$
Time constant	$\tau = RC$

Electromagnetism

Magnetic flux density due to current in

(i) long straight solenoid	$B = \frac{\mu_0 NI}{l}$
(ii) long straight conductor	$B = \frac{\mu_0 I}{2\pi a}$

Alternating currents

A.c. generator	$E = E_0 \sin \omega t$ $= BAN\omega \sin \omega t$

Particles and photons

Radioactive decay	$A = \lambda N$ $A = A_0 e^{-\lambda t}$
Half life	$t_{\frac{1}{2}} = 0.693/\lambda$
Photoelectric effect	$\frac{1}{2}mv^2_{max} = hf - hf_0$
de Broglie equation	$\lambda = h/p$

Particle Physics

Nuclear radius	$r = r_0 A^{\frac{1}{3}}$