Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

Leave blank

General Certificate of Education
June 2006
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) **PHB1**
Unit 1 Foundation Physics

Friday 9 June 2006 9.00 am to 10.30 am

For this paper you must have:
- a calculator
- a pencil and ruler

Time allowed: 1 hour 30 minutes

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A** and **Section B**.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.
- Show all your working.
- A *Formulae Sheet* is provided on page 3. Detach this perforated page at the start of the examination.

Information
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers. Questions 7(d) and 10(c)(ii) should be answered in continuous prose. Quality of Written Communication will be assessed in these answers.

Advice
- You are advised to spend about 30 minutes on **Section A** and about 1 hour on **Section B**.

For Examiner's Use			
Number	Mark	Number	Mark
A		6	
		7	
		8	
		9	
		10	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

SECTION A

Answer **all** questions in this section.

There are **25** marks in this section.

1 In the S.I. system, four of the base units are the metre (m), the second (s), the kilogramme (kg) and the ampere (A). Other units can be defined in terms of these base units. For example the unit for speed is $m\,s^{-1}$.

Complete the following table.

quantity	unit name	S. I. base units
force	newton	$kg\,m\,s^{-2}$
work		$kg\,m^2\,s^{-2}$
electric charge		

(3 marks)

Detach this perforated page at the start of the examination.

Foundation Physics Mechanics Formulae

moment of force $= Fd$

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

$s = \frac{1}{2}(u + v)t$

for a spring, $F = k\Delta l$

energy stored in a spring $= \frac{1}{2}F\Delta l = \frac{1}{2}k(\Delta l)^2$

$T = \frac{1}{f}$

Foundation Physics Electricity Formulae

$I = nAvq$

terminal p.d. $= E - Ir$

in series circuit, $R = R_1 + R_2 + R_3 + ...$

in parallel circuit, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$

output voltage across $R_1 = \left(\frac{R_1}{R_1 + R_2}\right) \times$ input voltage

Waves and Nuclear Physics Formulae

fringe spacing $= \frac{\lambda D}{d}$

single slit diffraction minimum $\sin\theta = \frac{\lambda}{b}$

diffraction grating $n\lambda = d\sin\theta$

Doppler shift $\frac{\Delta f}{f} = \frac{v}{c}$ for $v << c$

Hubble law $v = Hd$

radioactive decay $A = \lambda N$

Properties of Quarks

Type of quark	Charge	Baryon number
up u	$+\frac{2}{3}e$	$+\frac{1}{3}$
down d	$-\frac{1}{3}e$	$+\frac{1}{3}$
$\overline{\text{u}}$	$-\frac{2}{3}e$	$-\frac{1}{3}$
$\overline{\text{d}}$	$+\frac{1}{3}e$	$-\frac{1}{3}$

Lepton Numbers

Particle	Lepton number L		
	L_e	L_μ	L_τ
e^-	1		
e^+	−1		
υ_e	1		
$\overline{\upsilon}_e$	−1		
μ^-		1	
μ^+		−1	
υ_μ		1	
$\overline{\upsilon}_\mu$		−1	
τ^-			1
τ^+			−1
υ_τ			1
$\overline{\upsilon}_\tau$			−1

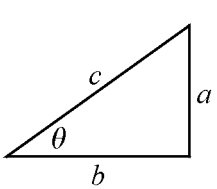
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

area of a circle $= \pi r^2$

surface area of sphere $= 4\pi r^2$

volume of sphere $= \frac{4}{3}\pi r^3$



$\sin\theta = \frac{a}{c}$

$\cos\theta = \frac{b}{c}$

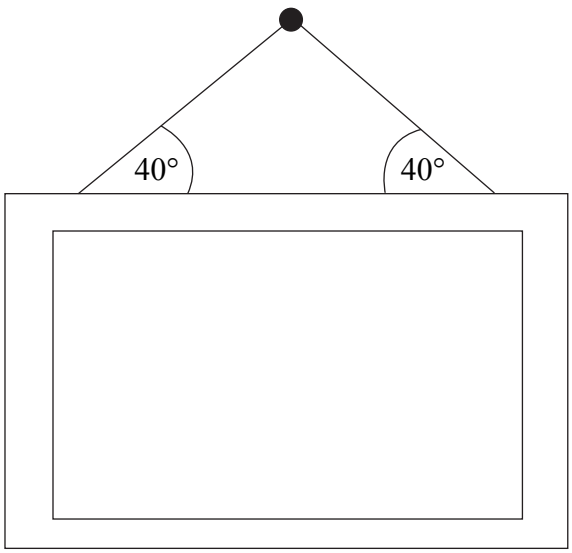
$\tan\theta = \frac{a}{b}$

$c^2 = a^2 + b^2$

There are no questions printed on this page

2 **Figure 1** shows a heavy mirror hanging symmetrically from a nail fixed to a wall. It is supported by a strong cord attached at two points on its top edge.

Figure 1



(a) Draw and clearly label **three** arrows on **Figure 1** to show the forces acting **on** the mirror in the vertical plane. *(3 marks)*

(b) The tension in the cord is 39 N and the angle that each end of the cord makes with the horizontal is 40°. Calculate the vertical component of the tension in the cord and hence the weight of the mirror.

vertical component of the tension .....

weight of the mirror .....

(3 marks)

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

.....

.....

.....

.....

(2 marks)

(b) State the Principle of Moments.

.....

.....

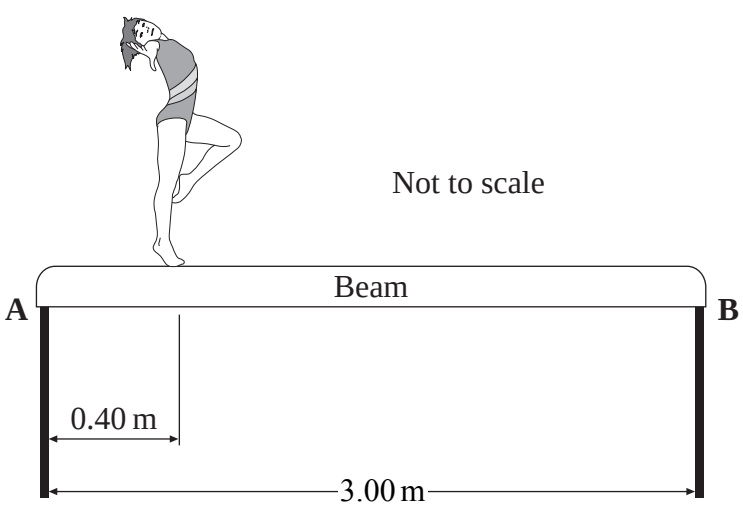
.....

.....

(2 marks)

(c) A gymnast balances on a uniform horizontal beam as shown in **Figure 2.**
The distance between the vertical supports **A** and **B** is 3.00 m and the gymnast is 0.40 m from **A**. The weight of the beam is 400 N and the gymnast weighs 540 N.

Figure 2



By taking moments about **B** calculate the reaction acting on the beam at **A**.

reaction .....

(3 marks)

4 (a) (i) What is a *superconductor*?

.....

.....

.....

(ii) With the aid of a sketch graph, explain the term *transition temperature*.

.....

.....

.....

(3 marks)

(b) Explain why superconductors are very useful for applications which require very large electric currents and name **two** such applications.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

5 The graph in **Figure 3** shows the output signal from a motor car's external temperature sensor on a cold day as the car is driven into a shower of rain.
This signal, which is directly proportional to the temperature in °C, is digitally sampled and then converted to a temperature which is displayed on the instrument panel. **Figure 4** shows a partial table of binary data and displayed temperatures corresponding to points on this graph.

Complete the table in **Figure 4**. *(3 marks)*

Figure 3

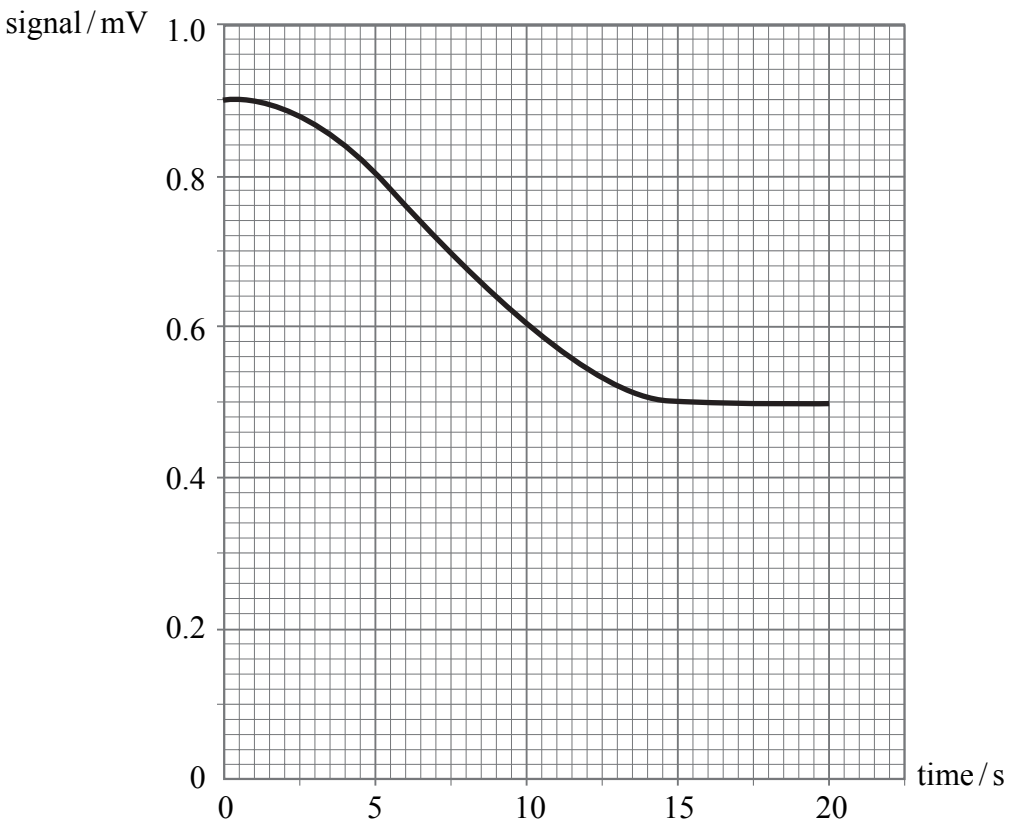


Figure 4

time / s	binary	temperature/°C
0.0	1001	4.5
5.0		
10.0		
15.0		
20.0	0101	2.5

Turn over for the next question

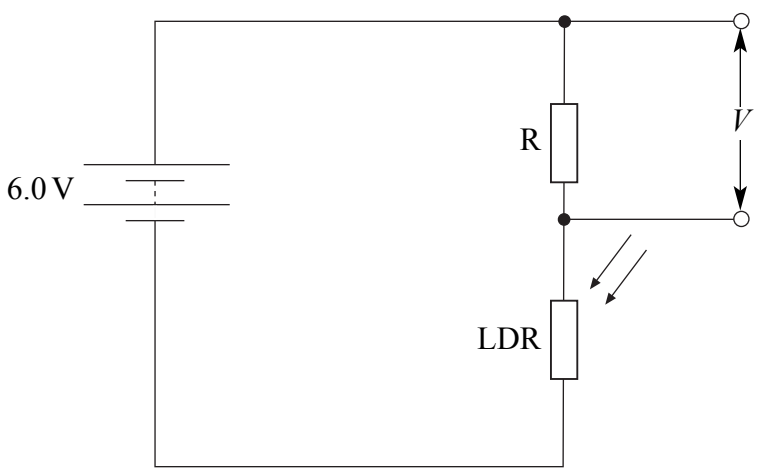
SECTION B

Answer **all** questions in this section.

There are **50** marks in this section.

6 **Figure 5** shows a simple light sensing circuit. When the output voltage V falls below 2.0 V, this acts as a signal which switches on a safety lamp. The LDR has a resistance of 1.25 kΩ when it is fully illuminated and 105 kΩ when it is in the dark. The battery has an emf of 6.0 V and negligible internal resistance.

Figure 5



(a) (i) Show that the safety light will come on when it is dark if resistor R has the value 50 kΩ.

(ii) Calculate V when the LDR is fully illuminated and the value of R is 50 kΩ.

V = ...

(5 marks)

(b) Draw a diagram for a circuit, using the same LDR and battery, which would produce an output signal which *increases* to 3.0 V when the LDR is in the dark.

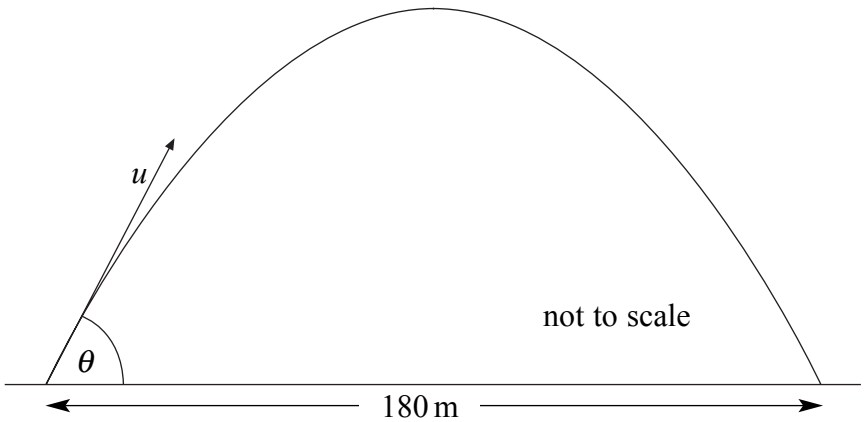
(2 marks)

7

Turn over for the next question

7 **Figure 6** shows the predicted path of a golf ball, hit without spin on a windless day. Air resistance has been neglected.

Figure 6



(a) The ball is predicted to travel 180 m horizontally in 7.2 s. It has an initial velocity u, as shown in **Figure 6**.
Calculate the horizontal component of u.

horizontal component .....
(1 mark)

(b) The ball is predicted to reach its maximum height after 3.6 s.
Calculate the vertical component of u.

acceleration due to gravity, $g = 9.8\ \text{m s}^{-2}$

vertical component .....
(2 marks)

(c) Find, by calculation or by scale drawing, the initial velocity u.

initial speed .....

angle θ.....

(3 marks)

(d) In practice the path of the golf ball would be different from that shown in **Figure 6** because of air resistance. Describe and explain the effects of air resistance on the flight of the ball. You may wish to draw a diagram to illustrate your explanation.

Two of the 6 marks are available for the quality of your written communication.

.....

.....

.....

.....

.....

.....

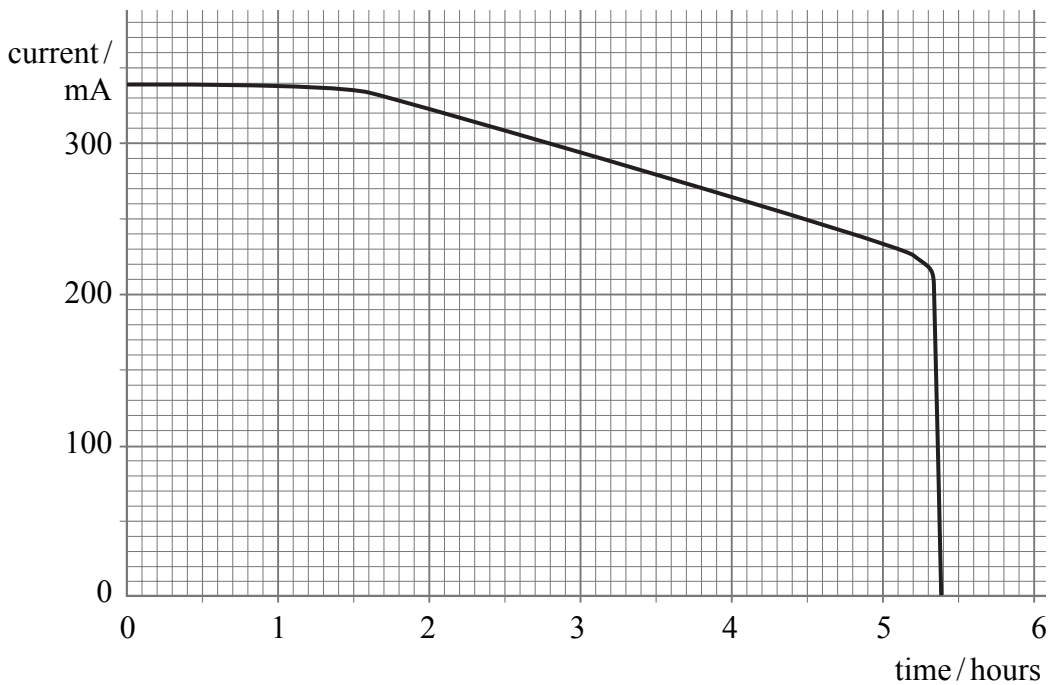
.....

.....

(6 marks)

8 A student used a simple series circuit to test and compare different types of electrical cell. The circuit consisted of the cell being tested, an ammeter and a resistor. The graph in **Figure 7** shows the results for one cell which was left on test until it failed completely.

Figure 7



(a) The emf of the cell at the start of the test was 1.6 V.
Calculate the total resistance in the circuit.

resistance .....

(3 marks)

(b) Use the graph in **Figure 7** to estimate the total flow of charge in the circuit during the test.

charge flow .....

(4 marks)

(c) The average emf provided by the cell during the test was 1.4 V.
Calculate the total work done by the cell.

work done .....

(2 marks)

9

9 A radio-controlled model car has a mass of 0.65 kg.

(a) The car accelerates uniformly from rest to 3.5 m s^{-1} in 1.5 s.
Calculate:

(i) the acceleration of the car,

acceleration .....

(ii) the resultant force acting on the car during this acceleration.

resultant force .....
(4 marks)

(b) After 1.5 s the motor is switched off and the car decelerates uniformly until it stops.
The deceleration is 0.60 m s^{-2}.

(i) Calculate the resistive force acting on the car.

resistive force .....

(ii) Assuming that the resistive force was constant throughout the motion, calculate the thrust from the motor when the car was accelerating.

thrust .....
(2 marks)

(c) Calculate the **total** distance travelled by the car.

total distance travelled .....

(2 marks)

8

Turn over for the next question

10 Overhead power supply cables are often constructed from a number of parallel strands of aluminium and steel. Aluminium is used because it is a very good electrical conductor and the steel strands provide tensile strength.

(a) Calculate the resistance of a 200 m long strand of aluminium of diameter 3.0 mm.

resistivity of aluminium = $2.8 \times 10^{-8}\ \Omega\,\text{m}$

resistance .....

(3 marks)

(b) The average tension in a single 200 m strand of steel due to the weight of the cable when it is hanging between two towers is 3500 N. The strand acts like a very long spring which has been extended by 27 cm. Calculate the energy stored in the steel strand.

energy stored .....

(2 marks)

(c) A 10 km length of power cable is used to deliver electricity to a small industrial town. The total resistance of the cable is 0.65 Ω and the transmission voltage is 400 000 V. At peak times it carries a current of 100 A.

(i) Calculate the power loss due to heating in the cable when the current is 100 A.

power loss .....

(2 marks)

(ii) Show that if the same power was supplied at 40 000 V then the power loss would be greater. Go on to describe how, and explain why, alternating current is used for the distribution of mains electricity.

Two of the 7 marks are available for the quality of your written communication.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(7 marks)

END OF QUESTIONS

There are no questions printed on this page