Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

For Examiner's Use

General Certificate of Education
January 2008
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Friday 11 January 2008 1.30 pm to 3.00 pm

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

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.
- Answer the questions in **Section A** and **Section B** in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- 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.
- Questions 7(a) and 10(b)(ii) should be answered in continuous prose. In these questions you will be marked on your ability to use good English, to organise information clearly and to use specialist vocabulary where appropriate.

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

For Examiner's Use			
Question	Mark	Question	Mark
A		6	
		7	
		8	
		9	
		10	
Total (Column 1) →			
Total (Column 2) →			
Quality of Written Communication			
TOTAL			
Examiner's Initials			

SECTION A

Answer **all** questions in this section.

There are 26 marks in this section.

1 (a) Explain why the resistance of a metallic conductor increases when its temperature is increased.

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(2 marks)

(b) A lamp filament of length 0.17 m is made from tungsten. The radius of the filament is 2.1×10^{-5} m and its resistance is 6.0 Ω.
Calculate the resistivity of tungsten.

resistivity .....

(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

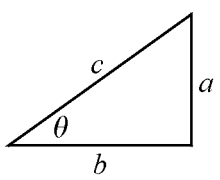
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

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

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

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



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

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

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

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

Turn over ▶

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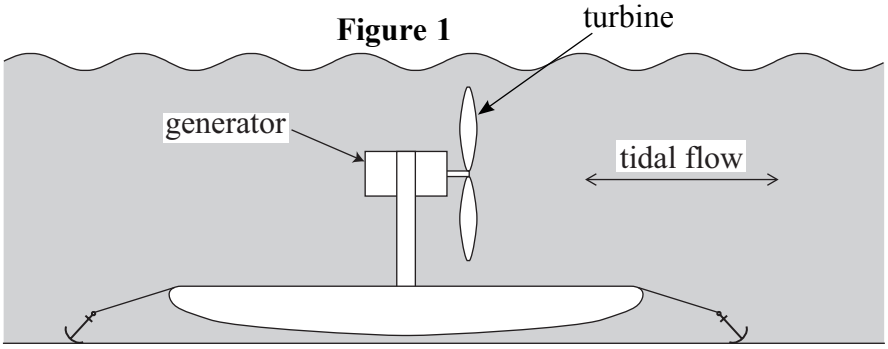
2 (a) **Figure 1** is a diagram of one type of tidal electricity generator. Whichever way the tide is flowing, it rotates the turbine and operates the generator.

Figure 1



(i) Identify the principal energy change involved in the system.

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(ii) Identify **one** way in which energy will be wasted by the system.

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(2 marks)

(b) State **two** advantages and **two** disadvantages of this system compared with electricity generation using fossil fuels.

First advantage

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Second advantage

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First disadvantage

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Second disadvantage

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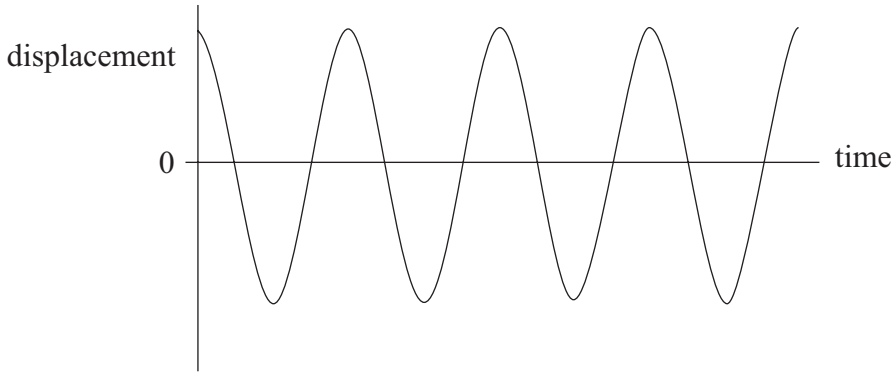
(4 marks)

Turn over ▶

3 **Figures 2** and **3** show the variation of displacement with time for an undamped mass-spring system.

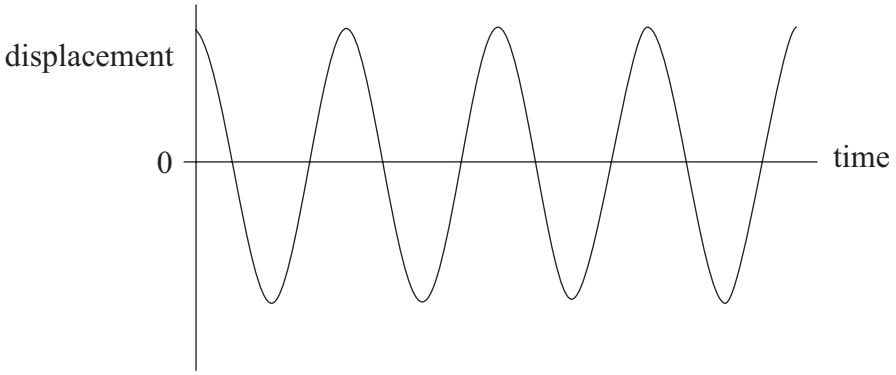
Figure 2



(a) In practice the oscillation will be slightly damped. Draw on **Figure 2** the variation of displacement with time for the system with a small amount of damping. *(2 marks)*

(b) (i) The mass is lowered into water and the system set to oscillate once more. Draw on **Figure 3** the variation of displacement with time for this system.

Figure 3



(ii) Explain why the amplitude of the oscillation changes in a damped system.

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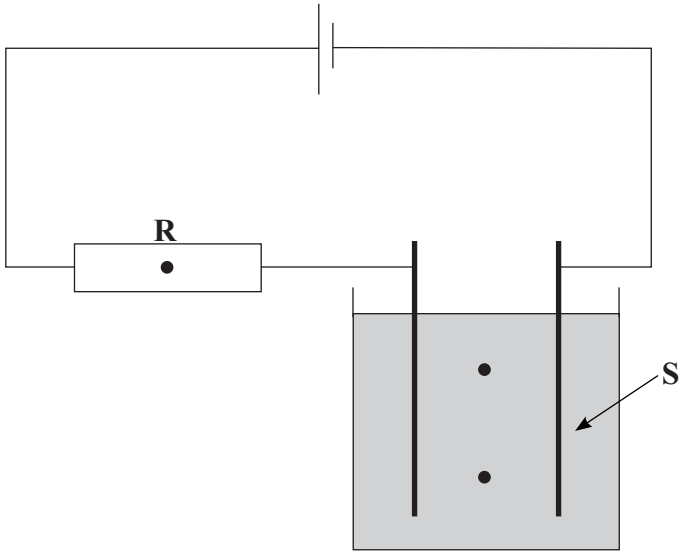
(3 marks)

4 **Figures 4** shows a circuit in which there is a current in a metallic resistor, **R**, and in a salt solution, **S**.

Figure 4



The dots in **R** and **S** indicate the charge carriers in those materials.

(i) Label on **Figure 4** the names and charges of each charge carrier.

(ii) Draw arrows on **Figure 4** to show the directions of drift of the charge carriers shown. *(5 marks)*

Turn over for the next question

There are no questions printed on this page

5 (a) (i) Describe what is meant by a superconductor.

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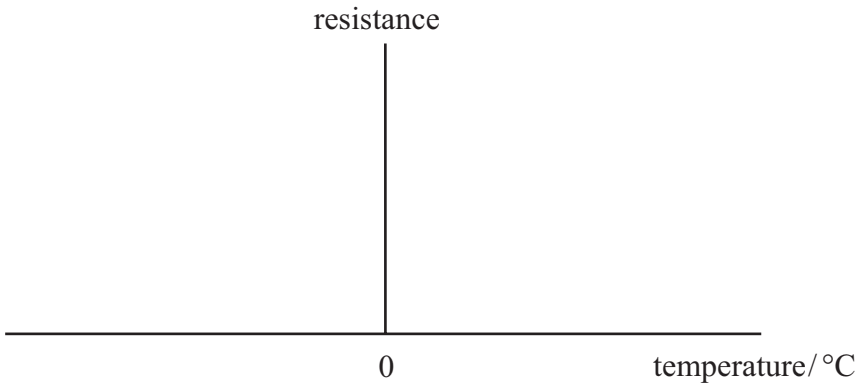
(ii) Sketch onto the axes below a graph of the variation of the resistance of a superconductor with temperature in °C.



(3 marks)

(b) (i) State a use for superconductors.

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(ii) State an advantage of the use of superconductors compared with the use of ordinary conductors.

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(2 marks)

26

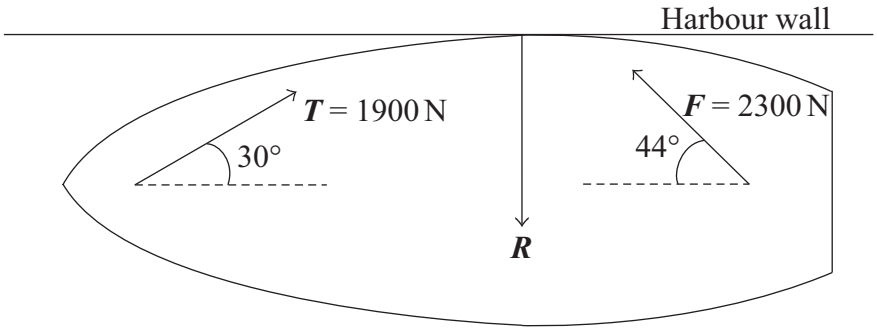
SECTION B

Answer **all** questions in this section.

There are 49 marks in this section.

6 The boat shown in **Figure 5** is kept in a steady position against a harbour wall by the tension, ***T***, in a single rope and by the thrust, ***F***, from its engine. The normal reaction of the harbour wall against the boat is labelled ***R***.

Figure 5



(a) In the space below, use a scale drawing to determine the magnitude of the force ***R***.

R = ...

(4 marks)

(b) The rope is removed. State and explain **two** effects that this would have on the initial movement of the boat. You should consider the resolution of forces and the principle of moments.

First effect

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Second effect

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(4 marks)

8

Turn over for the next question

7 (a) Describe an experiment from which you can obtain an accurate value of the acceleration of free fall.

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

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(6 marks)

(b) (i) Calculate the time taken for a stone to fall 86 m when dropped from a high cliff. Ignore air resistance.

acceleration of free fall, $g = 9.8\,m\,s^{-2}$

time .....

(ii) An identical stone is dropped from a moving aircraft, flying horizontally at a height of 86 m. State whether you would expect the time taken for this stone to fall 86 m to decrease, increase or remain the same compared with the stone dropped from the high cliff. Explain your answer. Ignore air resistance.

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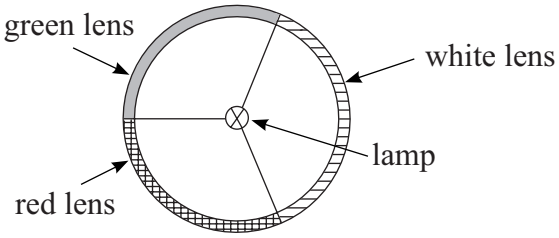
(4 marks)

10

Turn over for the next question

8 One design for a set of coloured warning lights has a single lamp illuminating three different coloured lenses. It is shown in **Figure 6**.

Figure 6

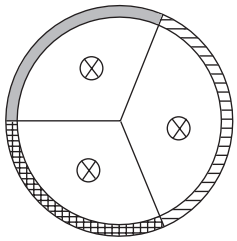


(a) (i) The lamp draws a current of 3.0 A from a 14 V supply that has no internal resistance.
Calculate the power of the lamp.

power of lamp .....

(ii) An alternative design has three separate 2.0 A lamps, one illuminating each of the lenses.
The lamps are connected in a parallel combination which is then connected to the same supply as in part (a)(i).
The arrangement is shown in **Figure 7**.

Figure 7



Calculate the resistance of each lamp.

resistance .....

(iii) Calculate the total resistance of the parallel combination of lamps.

(iv) State the advantage of the parallel combination compared with the single lamp.

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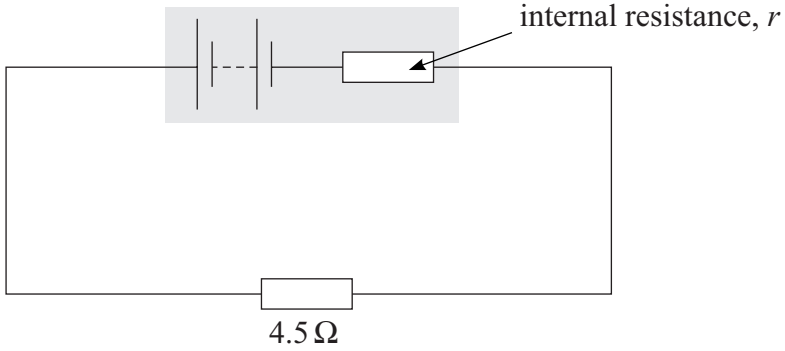
(6 marks)

(b) A 4.5 Ω resistor is placed in series with a battery of emf 14 V. The current through the resistor is 2.9 A.

Figure 8



(i) Calculate the internal resistance, *r*, of the battery.

internal resistance .....

(ii) Calculate the voltage lost across the internal resistance.

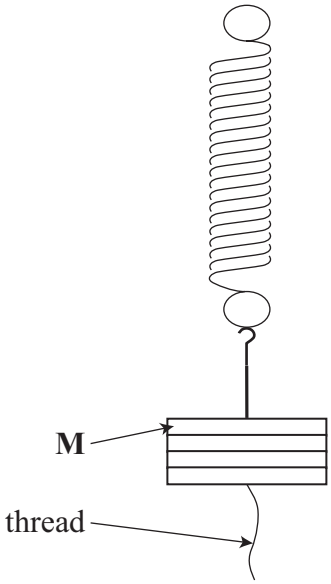
voltage lost .....

(3 marks)

9

9 **Figure 9** shows a mass, **M**, hanging from a spring that has a spring constant of $23\,\text{N}\,\text{m}^{-1}$. A light thread is attached to the bottom of the mass. The magnitude of the mass is 0.38 kg and it has a weight of 3.7 N.

Figure 9



(a) (i) The thread is pulled down vertically until the total extension of the spring is 0.21 m. Show that the total force stretching the spring is approximately 4.8 N.

(ii) Calculate the energy stored in the spring when it is extended by 0.21 m.

energy stored .....

(4 marks)

(b) The thread is released so that the mass oscillates.

(i) Draw on **Figure 9** arrows to indicate the forces acting on the mass at the instant the thread is released. Label the arrows with the magnitude of the forces.

(ii) Calculate the resultant force acting on the mass at the moment the thread is released.

resultant force .....

(iii) Calculate the acceleration of the mass at the instant it is released.

acceleration .....

(iv) State and explain how you would expect the acceleration of the mass to change during the first part of its upward movement.

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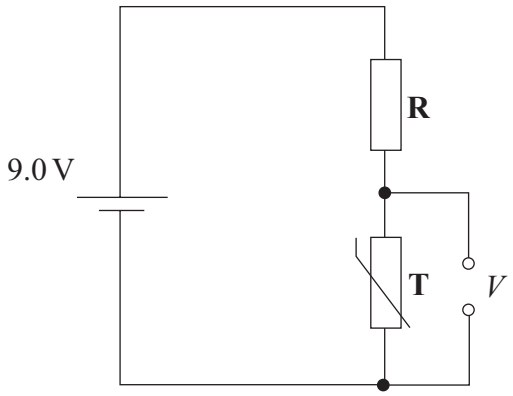
(7 marks)

11

10 **Figure 10** shows a thermistor, **T**, and a resistor, **R**, in a potential divider circuit. The emf of the battery is 9.0 V and its internal resistance should be ignored.

Figure 10



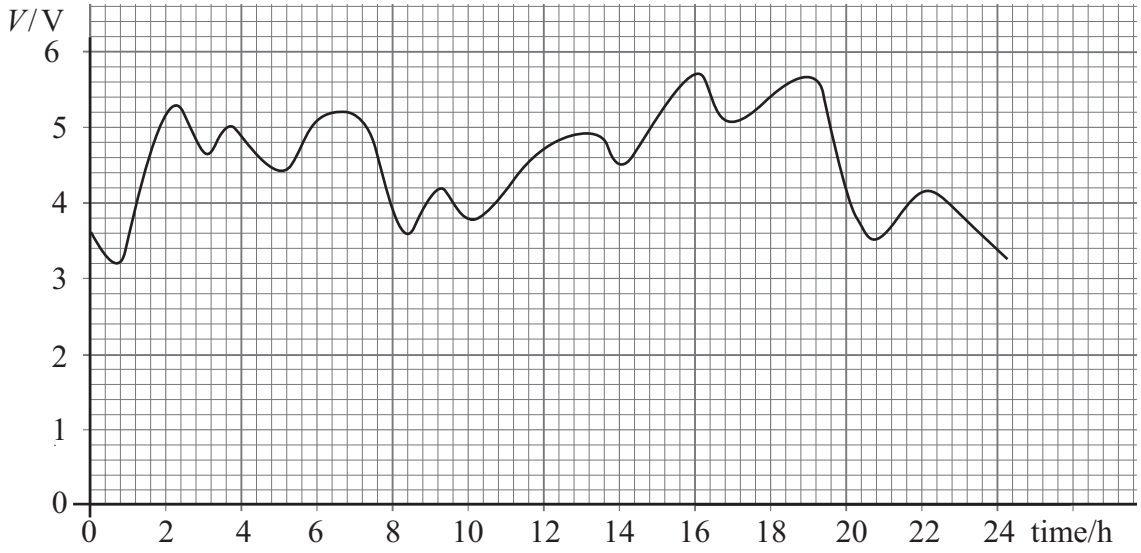
(a) Over the range of operating temperatures, the thermistor's resistance varies between 200 Ω and 600 Ω. **R** has a constant value of 400 Ω. Calculate the maximum value of the output voltage, *V*.

maximum voltage .....

(3 marks)

(b) (i) **Figure 11** shows the variation of the voltage, *V*, with time of a signal over a 24-hour period.

Figure 11



The signal is to be digitised to give a 4-bit binary code of zero (0000) when V is 3 V or more, but less than 3.25 V. Each subsequent binary unit represents another 0.25 V voltage interval. Fill in the table below to give the voltage V, and the corresponding binary code for times of 0, 6 and 12 hours.

time/h	V/V	binary code
0		
6		
12		

(3 marks)

(ii) A received signal is not a perfect representation of the original signal when transmitted digitally. Explain why this is the case and how a system can be designed to produce the best possible reproduction.

Two of the 5 marks are available for the quality of your written communication.

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(5 marks)

11

END OF QUESTIONS

There are no questions printed on this page