Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
January 2005
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB1
Unit 1 Foundation Physics

Wednesday 12 January 2005 Morning Session

In addition to this paper you will require:
- a calculator;
- a pencil and a 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** in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.
- All working must be shown, otherwise you may lose marks.
- 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.
- Mark allocations are shown in brackets.
- You are expected to use a calculator where appropriate.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

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			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

SECTION A

Answer **all** questions in this section.

There are **24** marks in this section.

1 A car accelerates uniformly from rest to a speed of 100 km h^{-1} in 5.8 s.

(a) Calculate the magnitude of the acceleration of the car in m s^{-2}.

Acceleration = ...m s^{-2}
(3 marks)

(b) Calculate the distance travelled by the car while accelerating.

Distance travelled =.....
(2 marks)

2 **Figure 1** shows a skier being pulled by rope up a hill of incline 12° at a steady speed. The total mass of the skier is 85 kg. Two of the forces acting on the skier are already shown.

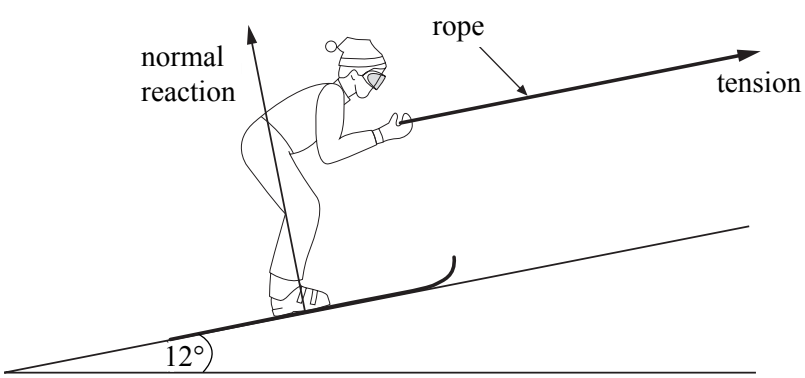


Figure 1

(a) Mark with arrows and label on **Figure 1** a further two forces that are acting on the skier.
(2 marks)

(b) Calculate the magnitude of the normal reaction on the skier.
gravitational field strength, g = 9.8 N kg^{-1}

Normal reaction = ...
(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

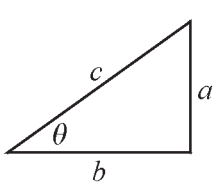
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

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

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

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



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

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

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

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

NO QUESTIONS APPEAR ON THIS PAGE

(c) Explain why the resultant force on the skier must be zero.

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(1 mark)

3 **Figure 2** shows the resistance against temperature characteristic for a thermistor.

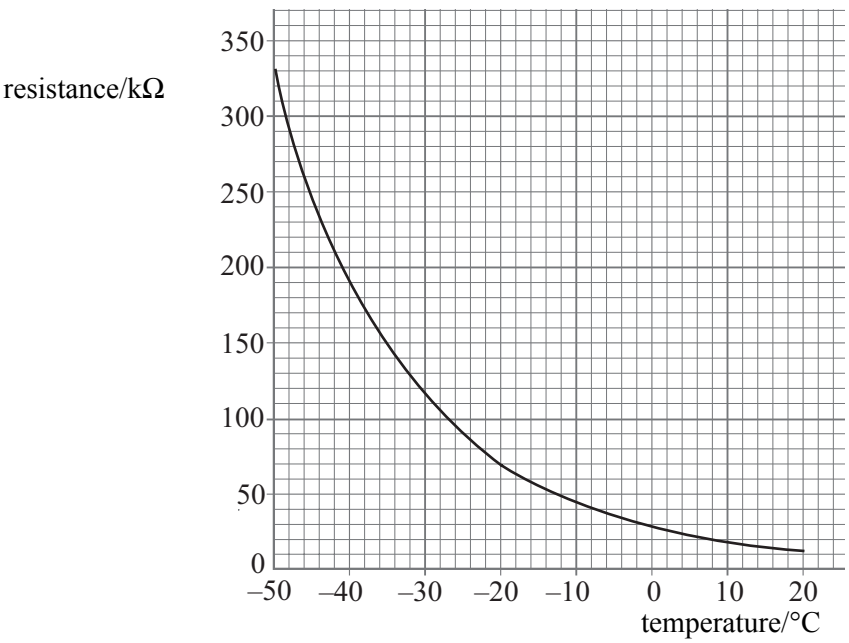

Figure 2

(a) Suggest the range of temperatures for which the resistance change of the thermistor is most sensitive to changes in temperature.

(1 mark)

Temperature range from .....°C to .....°C

(b) Explain, in terms of charge carriers, why the resistance of the thermistor falls as the temperature rises.

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(3 marks)

(c) **Figure 3** shows a circuit in which the thermistor is connected in series with a 100 kΩ fixed resistor and a 12 V battery of negligible internal resistance.

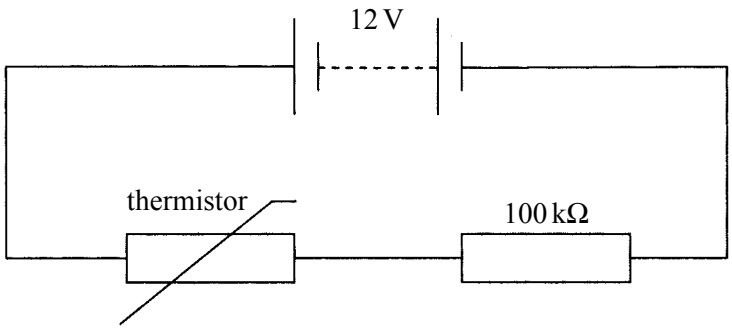

Figure 3

Calculate the potential difference across the thermistor at a temperature of –30°C.

Potential difference = ...

(4 marks)

4 **Figure 4** shows a spring loaded with a mass of 0.15 kg. When the mass is displaced vertically it oscillates up and down. **A** and **C** show the extreme positions of the mass and **B** is its equilibrium position.

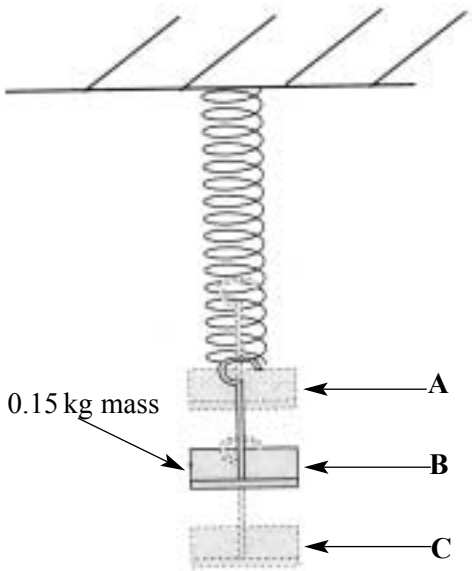

Figure 4

(a) The 0.15 kg mass extends the spring by 0.040 m. Calculate the elastic potential energy stored in the spring when it is extended by this amount.
gravitational field strength, $g = 9.8\ \text{N kg}^{-1}$

Elastic potential energy = ...
(2 marks)

(b) (i) Mark and label on the diagram the amplitude of the motion.
(1 mark)

(ii) Describe the energy changes that occur during one cycle when the mass is pulled down to position **C** and then released. You should consider the motion to be undamped during this cycle.

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(2 marks)

SECTION B

Answer **all** questions in this section.

There are **51** marks in this section.

Total for this question: *8 marks*

5 (a) State the principle of moments.

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(2 marks)

Figure 5 shows a child standing on a uniform plank, **AB**, which bridges a small stream. The plank has a weight of 178 N and is 5.0 m long. The reactions on the plank at each bank are 429 N and 149 N as shown in **Figure 5**. Each reaction acts vertically.

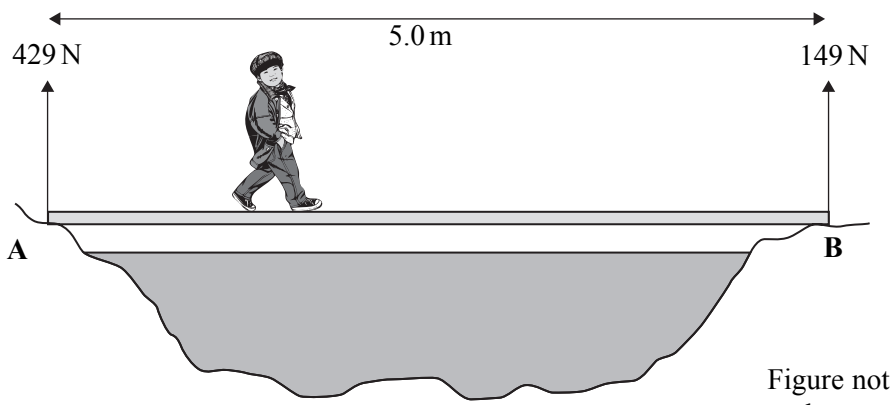

Figure not drawn to scale

Figure 5

(b) Calculate the weight of the child.

Weight of child = ...

(2 marks)

(c) By taking moments about **A**, calculate the distance of the child from **A**.

Distance from **A** = ...

(4 marks)

Total for this question: *15 marks*

6 (a) Define the term electromotive force (emf).

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(2 marks)

(b) **Figure 6** shows very high resistance voltmeter placed across an 8.00 Ω resistor connected to a cell of emf 1.56 V.

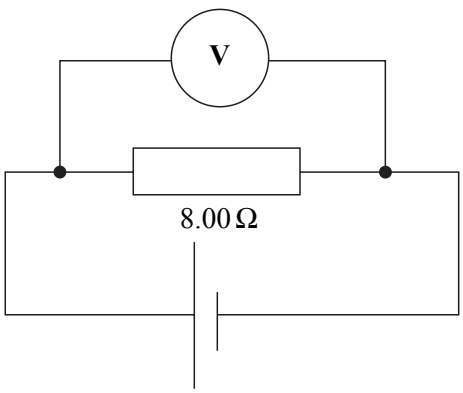

Figure 6

The very high resistance voltmeter registers 1.40 V. Show that the internal resistance of the cell must be about 0.9 Ω.

(3 marks)

(c) A voltmeter, having resistance 24.0 Ω, replaces the very high resistance voltmeter.

(i) Calculate the combined resistance of this voltmeter and the 8.00 Ω resistor connected in parallel.

Combined resistance = ...Ω

(2 marks)

(ii) Calculate the reading on this voltmeter.

Reading on voltmeter =..... V

(3 marks)

(iii) Explain why the reading on this voltmeter is different from the reading on the very high resistance voltmeter in part (b).

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(1 mark)

(d) Each lead connecting the resistor to the cell is made from a single strand of copper wire. Each lead is 0.30 m long and has a diameter of 2.0 mm. Show that the total potential difference across the two leads is negligible when the cell delivers a current of 0.20 A.

resistivity of copper, $\rho = 1.7 \times 10^{-8}\,\Omega\,\text{m}$

(4 marks)

15

Total for this question: *13 marks*

7 A small island is situated a long way from the mainland. The islanders require an electricity supply. It is suggested that wind turbine generators could be used together with oil powered generators.

(a) Explain why such a system of providing islanders with electrical power is seen as being a desirable proposition.

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

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(5 marks)

(b) Explain the role of the Sun in producing wave energy.

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(3 marks)

(c) **Figure 7** shows a graph of the relationship between the power generated in a wind turbine generator and the wind speed.

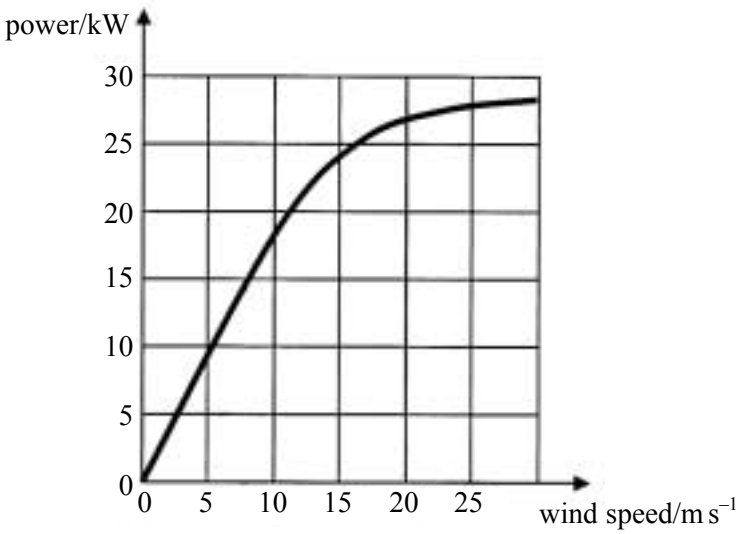

Figure 7

(i) An island has a mean wind speed of 7.5 m s^{-1}. Calculate the maximum energy in MJ that a single wind turbine generator could be expected to supply during the course of one year.

Maximum energy = ...MJ

(3 marks)

(ii) Suggest why this is the maximum amount of energy that could be expected.

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(2 marks)

Total for this question: *15 marks*

8 (a) A particular sensor system is used to sample data at regular intervals. The data are then transmitted along metal cables before storage by a computer for future analysis.

(i) Explain whether analogue or digital data are transmitted along the metal cable.

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(1 mark)

(ii) Explain the benefits of monitoring data with a high sampling rate.

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(1 mark)

(iii) Explain why signals need to be boosted when transmitted over long distances using metal cables.

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(3 marks)

(iv) The average current carried by the sensor system is 35 mA and the effective sensor resistance is 22 kΩ . Calculate the energy dissipated in the system in a 24 hour period.

Energy dissipated = ...

(3 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(b) In an attempt to increase the versatility of the sensor system its dimensions are reduced. Suggest an advantage and a drawback of this miniaturisation.

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(2 marks)

(c) State and explain the use of remote sampling of data in one named situation. You should make it clear why this situation is viewed as being *remote*. Name the actual sensor used and briefly describe the physical changes that occur when it is used.

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

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(5 marks)

15

END OF QUESTIONS