Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Education
January 2003
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB1
Unit 1 Foundation Physics

Monday 13 January 2003 Morning Session

In addition to this paper you will require:
- 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 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			
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 **Figure 1** shows part of an electrical circuit where five wires form a junction. The electric currents are shown on the figure.

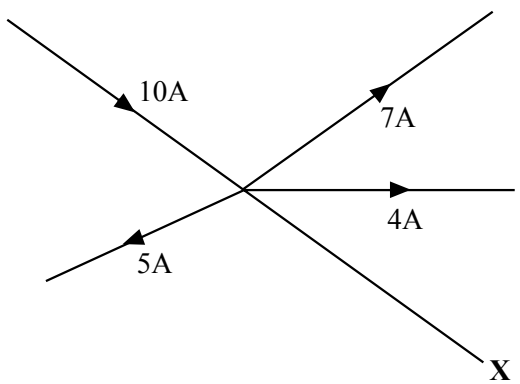


Figure 1

State the size of the current in wire **X**. Draw an arrow on the diagram to indicate the direction of the current.

Current .....

(2 marks)

2 **Figure 2** shows a simple pendulum swinging from side to side. Positions **A** and **C** show the extremes of the motion; position **B** is the equilibrium position.

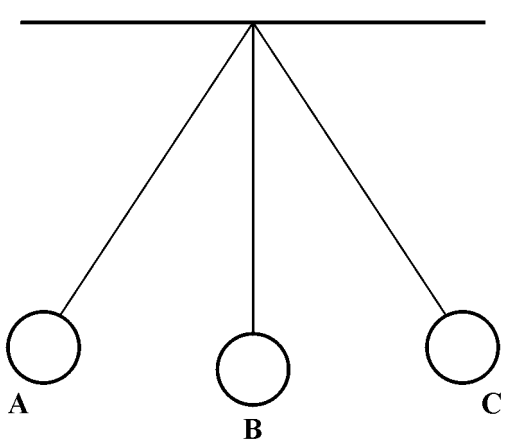


Figure 2

(a) Mark and label on the diagram the amplitude of the motion.

(1 mark)

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		
ν_e	1		
$\overline{\nu}_e$	−1		
μ^-		1	
μ^+		−1	
ν_μ		1	
$\overline{\nu}_\mu$		−1	
τ^-			1
τ^+			−1
ν_τ			1
$\overline{\nu}_\tau$			−1

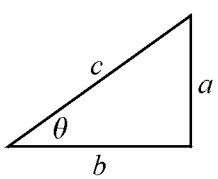
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

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

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

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



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

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

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

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

(b) The motion of the pendulum is damped by air resistance.

(i) Draw a sketch graph on the axes below to show how you expect the displacement of the pendulum to vary with time.

(1 mark)

(ii) Describe how you would investigate the variation of the amplitude of oscillation with time.

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(3 marks)

TURN OVER FOR THE NEXT QUESTION

3 In the circuit shown in **Figure 3** cell **X** has an emf of 12 V and a negligible internal resistance. The resistances of R_A and R_B are 10 Ω and 15 Ω respectively.

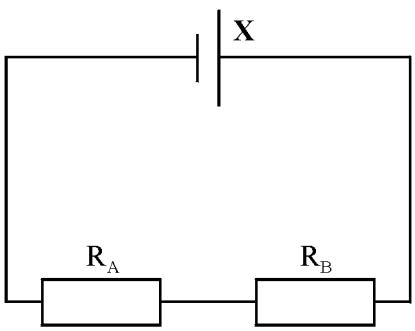

Figure 3

(a) Calculate the potential difference across R_B.

Potential difference .....

(2 marks)

(b) Cell **X** is replaced by cell **Y** that has an emf of 12 V and an internal resistance of 7.5 Ω. Calculate the terminal potential difference across cell **Y**.

Potential difference .....

(3 marks)

4 **Figure 4** shows a student standing on a plank that pivots on a log. The student intends to cross the stream.

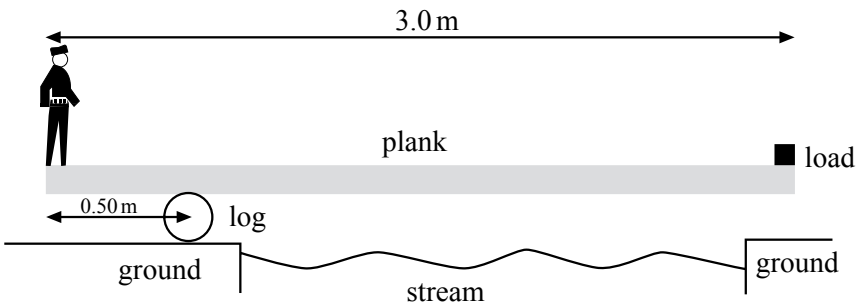

Figure 4

(a) The plank has a mass of 25 kg and is 3.0 m long with a uniform cross-section. The log pivot is 0.50 m from the end of the plank. The student has a mass of 65 kg and stands at the end of the plank. A load is placed on the far end in order to balance the plank horizontally.

Draw on **Figure 4** the forces that act on the plank. *(3 marks)*

(b) By taking moments about the log pivot, calculate the load, in N, needed on the right-hand end of the plank in order to balance the plank horizontally.

Gravitational field strength, $g = 9.8\,\text{N kg}^{-1}$

Load .....

(3 marks)

(c) Explain why the load will eventually touch the ground as the student walks towards the log.

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(2 marks)

5 A bungee rope of unstretched length 50 m is designed to allow a 70 kg man to come to rest 85 m below the platform from which he jumps.

(a) Calculate the energy stored in the rope when the man has come to rest.
Ignore the weight of the rope.

Gravitational field strength, $g = 9.8\,\text{N kg}^{-1}$

Energy stored .....
(2 marks)

(b) Calculate the gravitational potential energy lost by the man when he has come to rest.

Gravitational potential energy .....
(3 marks)

25

SECTION B

Answer **all** questions in this section.

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

Total for this question: *8 marks*

6 **Figure 5** shows a speed-time graph for a car that halts at traffic lights and then moves away.

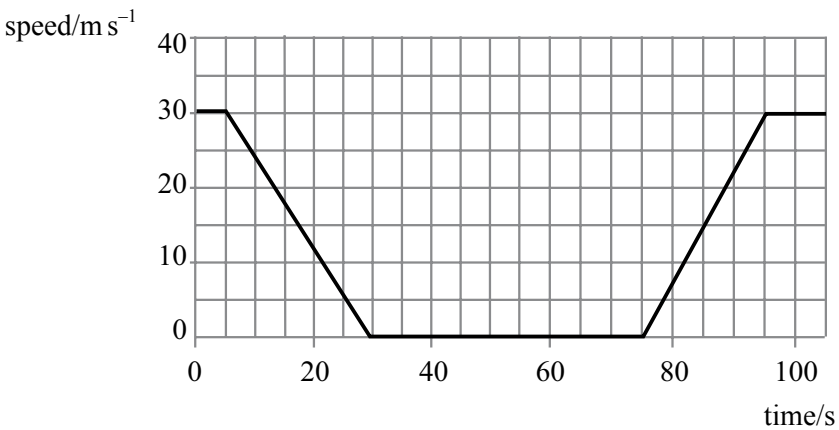

Figure 5

(a) Use the graph to show that the car travels about 380 m whilst decelerating.

(2 marks)

(b) Use the graph to calculate the acceleration of the car for the time interval from 75 s to 95 s.

Acceleration .....

(2 marks)

(c) Calculate the total distance travelled by the car in the time interval 5 s to 95 s.

Distance travelled .....
(1 mark)

(d) A second car travels the same route without being halted at the traffic lights. The speed of this car is a constant 30 m s^{-1}.

Calculate the difference in journey time between the first and second cars.

Journey time difference .....
(3 marks)

8

TURN OVER FOR THE NEXT QUESTION

Total for this question: *15 marks*

7 (a) A raindrop falls at a constant vertical speed of $1.6\,m\,s^{-1}$ in still air. The wind now blows horizontally at $1.4\,m\,s^{-1}$.

(i) Draw a scale diagram and use it to find the angle the path of the raindrop now makes with the vertical.

(2 marks)

(ii) Use your scale diagram or a calculation to determine the resultant speed of the raindrop when the wind is blowing.

Speed of raindrop .....

(1 mark)

(b) The mass of the raindrop is 4.5×10^{-8} kg. Calculate its kinetic energy.

Kinetic energy .....

(3 marks)

(c) Calculate the work done by the raindrop as it falls through a vertical distance of 5.0 m in still air.

Gravitational field strength, $g = 9.8\,\text{N kg}^{-1}$

Work done .....

(3 marks)

(d) Explain why a raindrop falling vertically through still air eventually reaches a constant speed.

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

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(6 marks)

15

Total for this question: ***7 marks***

8 A 250 MW generating station is to supply the energy needs of a large but isolated community. The choice is between a coal-fired station and a nuclear station; the projected lifetimes of both stations are about 25 years. Discuss and compare the relative costs and the environmental impacts of both types of station.

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

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(7 marks)

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Total for this question: *9 marks*

9 A fairground ride ends with the car moving up a ramp at a slope of 20° to the horizontal as shown in **Figure 6**.

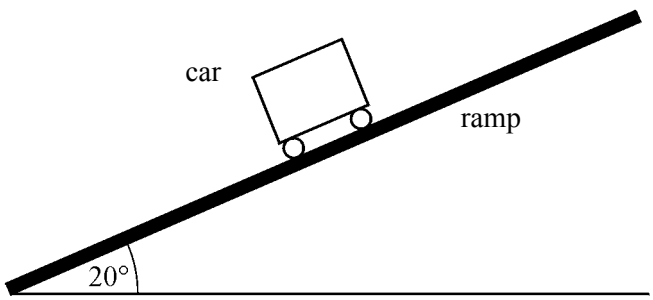

Figure 6

(a) The car carrying its maximum load of passengers has a total weight of 6.8 kN.
Show that the component of the weight acting parallel to the ramp is about 2.3 kN.

(2 marks)

(b) The mass of the fully loaded car is 690 kg. Show that the force in part (a) will decelerate the car at about 3.3 m s^{-2}.

(2 marks)

(c) The car enters the ramp at 22 m s^{-1}. Calculate the minimum length that the ramp must be in order for the car to stop before it reaches the end. Neglect the length of the car.

Minimum length .....

(2 marks)

(d) The ride owner decides to use a shorter ramp and to install brakes on the car. The additional decelerating force provided by these brakes is 4600 N. Calculate the new stopping time.

Stopping time .....

(3 marks)

9

TURN OVER FOR THE NEXT QUESTION

Total for this question: ***11 marks***

10 **Figure 7** shows a graph of electrical resistance against temperature for a thermistor.

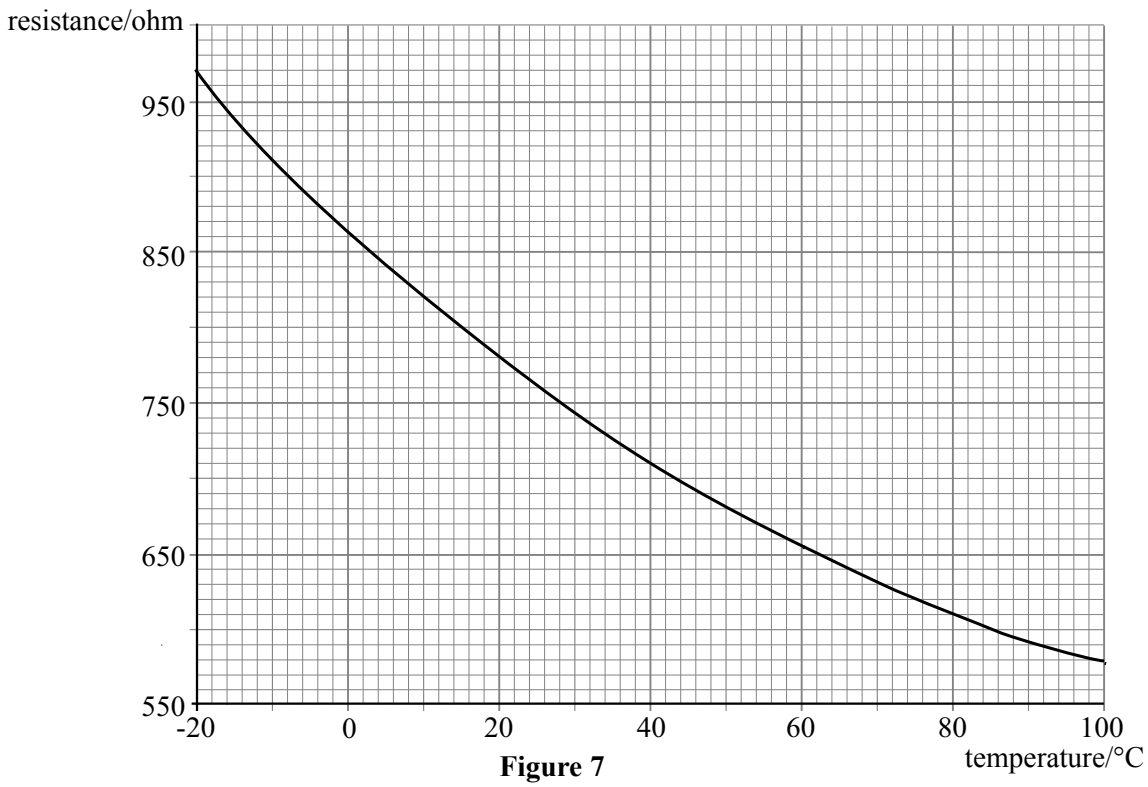

Figure 7

(a) (i) Explain in terms of the motion of charge carriers how electrical resistance arises.

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(1 mark)

(ii) State **two** reasons why a change in the temperature of a thermistor will change its resistance.

Reason 1 .....

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Reason 2 .....

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(2 marks)

(iii) Explain clearly how the reasons you gave in part (a) (ii) lead to the variation of resistance with temperature shown in **Figure 7**.

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(2 marks)

(b) The thermistor is connected in series with a 10 V power supply of negligible internal resistance and a resistor of constant value 480 Ω. The current in the circuit must not exceed 9.0 mA. Calculate the highest temperature at which the circuit can be used.

Highest temperature .....

(4 marks)

(c) A student intends to monitor weather conditions by placing the thermistor circuit outside the laboratory and transmitting the signals to a computer inside. State **two** advantages that this method of remote sensing by computer has over the manual collection of data by the student.

Advantage 1 .....

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Advantage 2 .....

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(2 marks)

11

END OF QUESTIONS