Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
June 2002
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB1
Unit 1

Friday 31 May 2002 Afternoon Session

In addition to this paper you will require:
- a calculator;
- 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.
- Marks are awarded for units in addition to correct numerical answers, and for the use of appropriate numbers of significant figures.
- 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 the spaces provided.

Total for this section: *25 marks*

1 (a) State the difference between vector and scalar quantities.

.....

(1 mark)

(b) State **one** example of a vector quantity (other than force) and **one** example of a scalar quantity.

Vector quantity .....

(1 mark)

Scalar quantity .....

(1 mark)

(c) A 6.0 N force and a 4.0 N force act on a body of mass 7.0 kg at the same time. Calculate the maximum and minimum accelerations that can be experienced by the body.

Maximum acceleration.....Minimum acceleration.....

(3 marks)

2 A vehicle accelerates uniformly from a speed of $4.0\,\mathrm{m\,s^{-1}}$ to a speed of $12\,\mathrm{m\,s^{-1}}$ in 6.0 s.

(a) Calculate the vehicle's acceleration.

Acceleration.....

(2 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, $F = k\ l$

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

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

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 $\frac{f}{f} = \frac{v}{c}$ 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

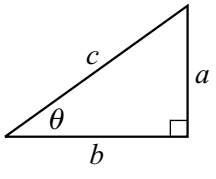
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\ r$

area of a circle $= \ r^2$

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

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



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

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

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

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

Turn over ►

NO QUESTIONS APPEAR ON THIS PAGE

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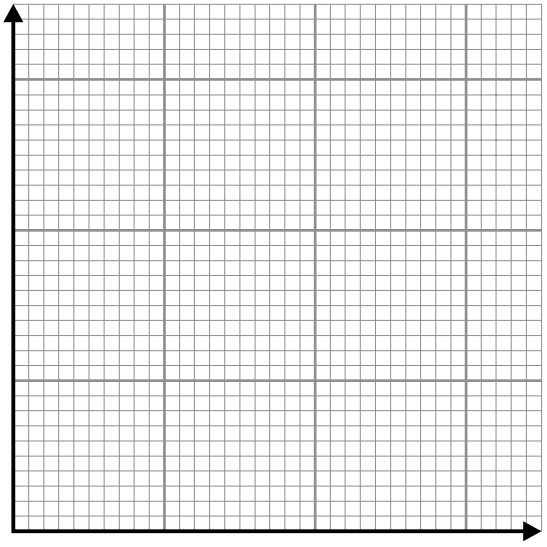
(b) On the axes below, draw a graph of speed against time for the vehicle covering the 6.0 s period in which it accelerates.



(2 marks)

(c) Calculate the distance travelled by the vehicle during its 6.0 s period of acceleration.

Distance.....

(2 marks)

3 A small hydroelectric power station uses water which falls through a height of 4.8 m.

(a) Calculate the change in potential energy of a 1.0 kg mass of water falling through a vertical height of 4.8 m.

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

Change in potential energy.....

(2 marks)

Turn over ►

(b) State **two** factors that affect the usefulness of hydroelectric power stations for electricity production.

.....

.....

.....

.....

(2 marks)

4 (a) **Figure 1** shows a graph of V against I for a filament lamp. Calculate the maximum resistance of the lamp over the range shown by the graph.

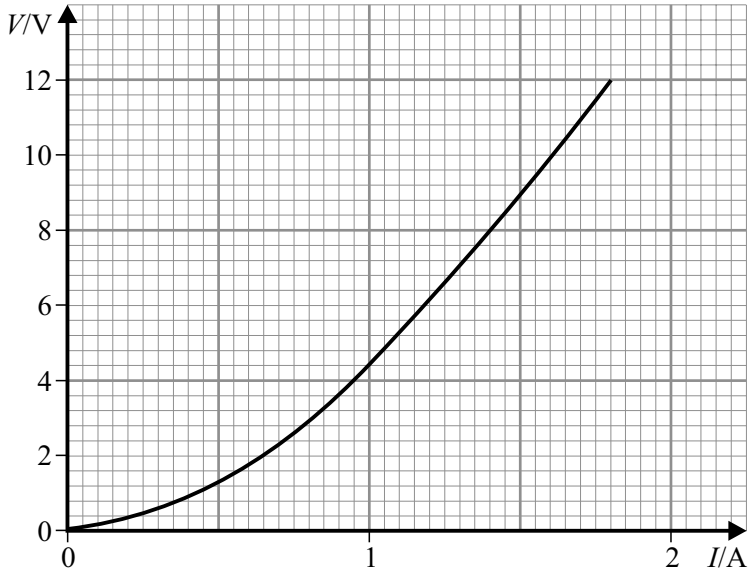
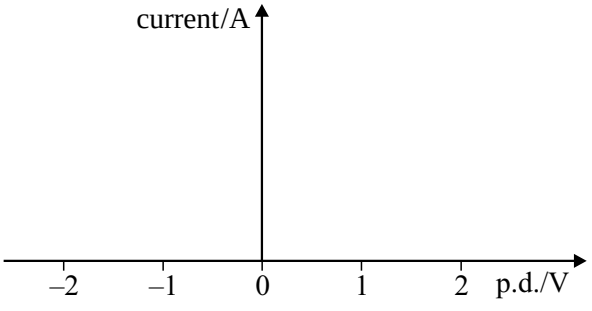


Figure 1

Resistance.....

(3 marks)

(b) Sketch, on the axes below, a graph of current against potential difference for a diode.



(2 marks)

5 (a) (i) Name an electrical component that could be used as a position sensor.

.....

(1 mark)

(ii) Name an electrical component that could be used as a temperature sensor.

.....

(1 mark)

(b) State **two** situations in which the measurement of a quantity would have to be done by remote sensing. For each example state a reason why remote sensing is essential.

First situation .....

Reason .....

.....

Second situation .....

Reason .....

.....

(2 marks)

25

TURN OVER FOR THE NEXT QUESTION

SECTION B

Answer **all** questions in the spaces provided.

6 **Total for this question: *14 marks***

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

.....

.....

.....

(2 marks)

(ii) State the principle of moments.

.....

.....

.....

(2 marks)

(b) **Figure 2** shows a trailer attached to the towbar of a stationary car. The weight of the trailer is 1800 N and is shown acting through its centre of gravity.

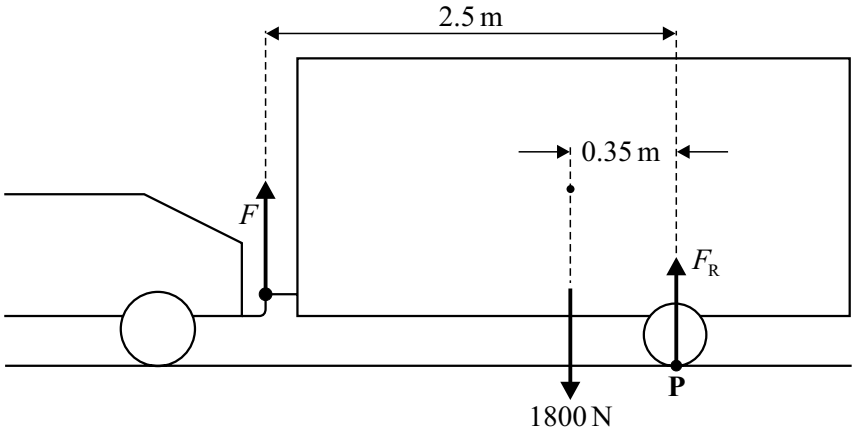


Figure 2

(i) Calculate the force, F, exerted by the towbar on the trailer.

F.....

(3 marks)

(ii) F_R is the normal reaction of the road on both of the trailer's wheels. Calculate F_R.

F_R.....

(2 marks)

(c) The moment exerted by the trailer on the towbar will be different when the car is moving quickly forward at a constant speed. Without performing any further calculations, state and explain how the moment will differ. You should consider the moments acting about the point **P** on **Figure 2**. Two of the 5 marks in this question are for the quality of your written communication.

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(5 marks)

14

7 **Total for this question: *12 marks***

A rugby ball is kicked towards the goal posts shown in **Figure 3** from a position directly in front of the posts. The ball passes over the cross-bar and between the posts.

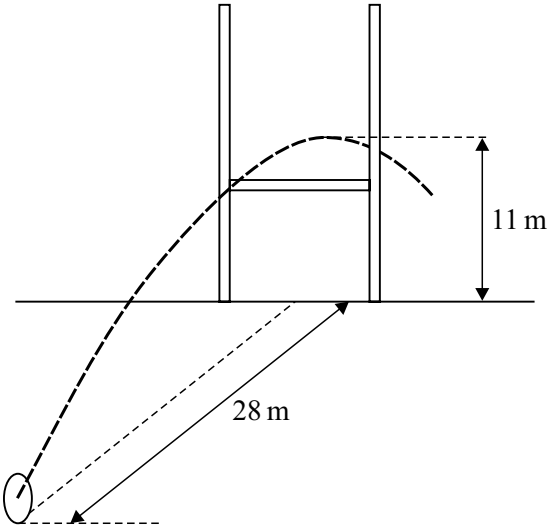

Figure 3

(a) The ball takes 1.5 s to reach a point vertically above the cross-bar of the posts.

(i) Calculate the ball's horizontal component of velocity, v_h. Ignore air resistance.

v_h .....

(2 marks)

(ii) The ball reaches its maximum height at the same time as it passes over the cross-bar. State the vertical component of velocity when the ball is at its maximum height.

.....

(1 mark)

(iii) The ball's maximum height is 11 m. Calculate, v_v, the vertical component of velocity of the ball immediately after it has been kicked. Ignore the effects of air resistance.

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

v_v.....

(3 marks)

(b) (i) Determine the magnitude of the initial velocity, v, of the ball immediately after it is kicked.

v.....

(3 marks)

(ii) Determine the angle above the horizontal at which the ball was kicked.

Angle.....

(1 mark)

(c) State and explain at what instant the ball will have its maximum kinetic energy.

.....

.....

.....

(2 marks)

12

8 **Total for this question: *8 marks***

In the circuit in **Figure 4**, R_1 can be varied between 0 and 2.0 kΩ. The resistance of the LDR, R_2, can vary from 200 Ω to 30 kΩ as the lighting conditions vary. The battery has no internal resistance.

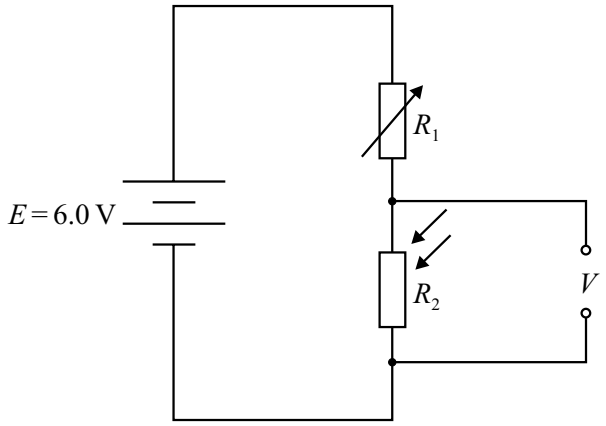

Figure 4

(a) Calculate the **minimum** possible value of the potential difference, *V*, across the LDR.

V.....

(3 marks)

(b) The circuit shown in **Figure 4** can be used to monitor the brightness of the light falling on to the LDR. The values of *V* are processed by a computer. Describe how *V* has to be changed to make it suitable for computer processing. Two of the 5 marks in this question are for the quality of your written communication.

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(5 marks)

8

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

A copper cable connecting a car's battery to its starter motor carries a current of 150 A. The maximum voltage drop across the cable should be 0.13 V.

(a) Show that the maximum permitted resistance of the cable should be approximately $9.0 \times 10^{-4}\,\Omega$.

(1 mark)

(b) The length of the cable is 0.24 m. Calculate the minimum cross-sectional area of the cable.

resistivity of copper = $1.6 \times 10^{-8}\,\Omega\,\text{m}$

Minimum cross-sectional area.....

(3 marks)

(c) Calculate the drift velocity of electrons in the cable when the current is 150 A.

the number of electrons per unit volume, *n*, for copper = $1.1 \times 10^{29}\ \text{m}^{-3}$

e, the charge of an electron = $-1.6 \times 10^{-19}\,\text{C}$

Drift velocity.....

(3 marks)

7

10 **Total for this question: *9 marks***

Figure 5 shows several 12 V, 21 W lamps connected in parallel. The circuit is protected by a fuse which melts if the current in the circuit exceeds 15 A.

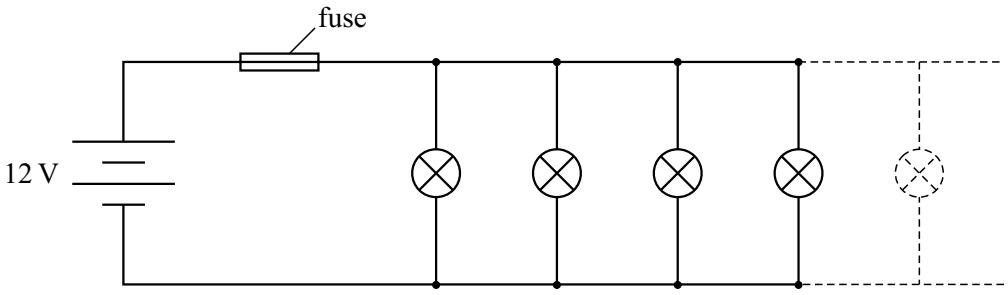

Figure 5

(a) Determine the maximum number, *n*, of lamps that can be used without melting the fuse.

n.....

(4 marks)

(b) Show that the working resistance of a single 12 V, 21 W lamp is 6.9 Ω.

(2 marks)

(c) Two of the 12 V, 21 W lamps are connected in parallel with a 12 V, 4.0 W lamp of resistance 36 Ω as shown in **Figure 6**.

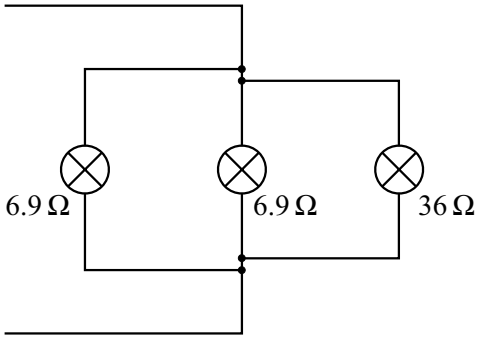

Figure 6

Calculate the resistance of the parallel combination of lamps, when they are working normally.

Resistance.....

(3 marks)

9

END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE