Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

General Certificate of Education
January 2007
Advanced Subsidiary Examination

PHYSICS (SPECIFICATION B) PHB1
Unit 1   Foundation Physics

AQA
ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Friday 12 January 2007   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.
- Four of these marks will be awarded for using good English, organising information clearly and using specialist vocabulary where appropriate.
- The marks for questions are shown in brackets.
- Questions 6(d) and 9(c) should be answered in continuous prose. In these questions you may 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 about 30 minutes on **Section A** and about 1 hour on **Section B**.
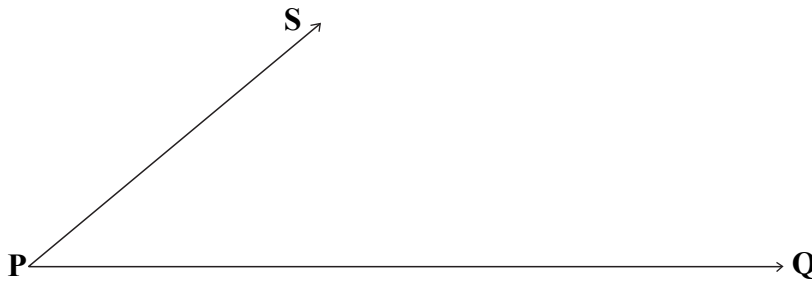
PHB1

SECTION A

Answer **all** questions in this section.

There are 25 marks in this section.

1   (a)   **Figure 1** shows the vector diagram for two forces acting on an object at point **P**. The diagram is drawn to scale with 1 cm representing 1 N.

Figure 1

Complete the vector diagram to determine the magnitude of the resultant force and the angle between the resultant force and the force represented by **PQ**.

magnitude .... angle ....
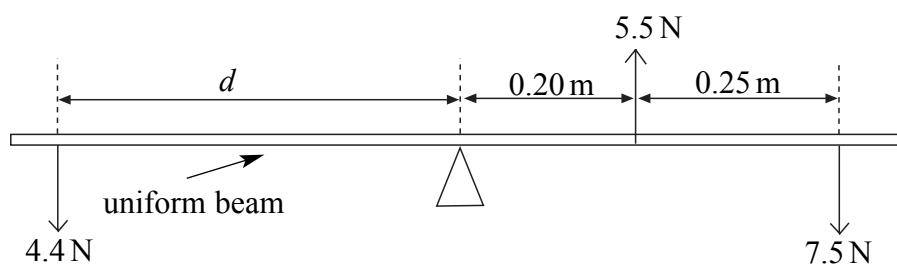*(3 marks)*

(b)   **Calculate** the magnitude of the resultant force when the same two forces act at **P** at right angles to each other.
You must not use a scale diagram for this part.

resultant force ....
(2 marks)

2   **Figure 2** shows a system of forces acting on a uniform beam that is pivoted at its centre.

Figure 2

Detach this perforated page at the start of the examination.

Foundation Physics Mechanics Formulae

$$\text{moment of force} = Fd$$

$$v = u + at$$

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

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

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

$$\text{for a spring, } F = k\Delta l$$

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

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

Foundation Physics Electricity Formulae

$$I = nAvq$$

$$\text{terminal p.d.} = E - Ir$$

$$\text{in series circuit, } R = R_1 + R_2 + R_3 + \ldots$$

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

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

Waves and Nuclear Physics Formulae

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

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

$$\text{diffraction grating} \quad n\lambda = d\sin\theta$$

$$\text{Doppler shift} \quad \frac{\Delta f}{f} = \frac{v}{c} \text{ for } v \ll c$$

$$\text{Hubble law} \quad v = Hd$$

$$\text{radioactive decay} \quad A = \lambda N$$

Properties of Quarks

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

Lepton Numbers

Particle	Lepton number L		
	L_e	L_μ	L_τ
e^-	1		
e^+	-1		
v_e	1		
$\overline{v}_e$	-1		
μ^-		1	
μ^+		-1	
v_μ		1	
$\overline{v}_\mu$		-1	
τ^-			1
τ^+			-1
v_τ			1
$\overline{v}_\tau$			-1

Geometrical and Trigonometrical Relationships

$$\text{circumference of circle} = 2\pi r$$

$$\text{area of a circle} = \pi r^2$$

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

$$\text{volume of sphere} = \tfrac{4}{3}\pi r^3$$
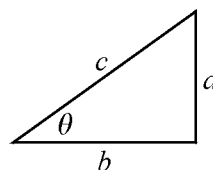
$$\sin\theta = \frac{a}{c}$$

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

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

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

Turn over ▶

There are no questions printed on this page

(a) Calculate the distance d for which the beam will be in equilibrium.

distance d ....
(3 marks)

(b) The beam has a weight of 9.5 N. Calculate the magnitude of the force acting on the pivot.

magnitude of force ....
(2 marks)

3 A metal wire has an area of cross-section $1.8 \times 10^{-6}\,\text{m}^2$. The charge carriers are electrons which move with a drift speed of $9.0 \times 10^{-5}\,\text{m s}^{-1}$ when the current in the wire is 2.5 A.

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

Calculate
(a) the density of charge carriers (the number per m^3) in the wire,

density of charge carriers......................................
(2 marks)

(b) the number of electrons that pass each point in the wire in 1.5 ms when the current is 2.5 A.

number of electrons......................................
(2 marks)

Turn over ▶

4 **Figure 3** shows a network of resistors connected to a supply of negligible internal resistance.

Figure 3
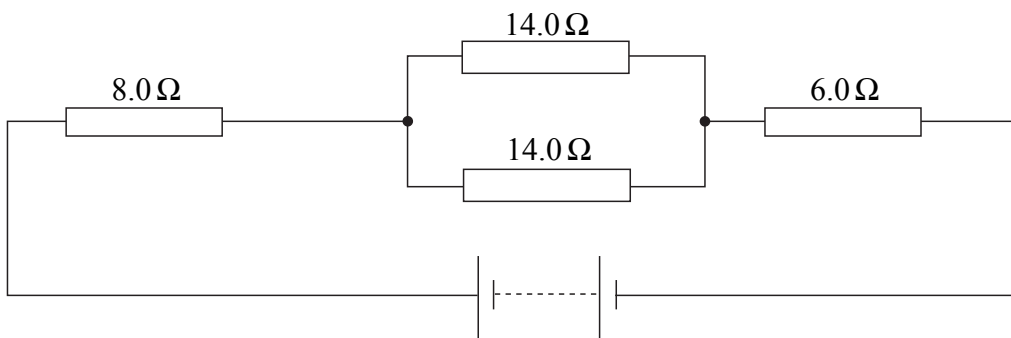
(a) Calculate the total resistance of the network of resistors.

total resistance ....
(2 marks)

(b) The current in the $8.0\,\Omega$ resistor is $0.35\,A$.

Calculate
(i) the current in each of the $14.0\,\Omega$ resistors,

current ....

(ii) the emf of the supply.

emf ....
(3 marks)

5 **Figure 4** shows a circuit that is to be used as a sensor to monitor light intensity.

Figure 4
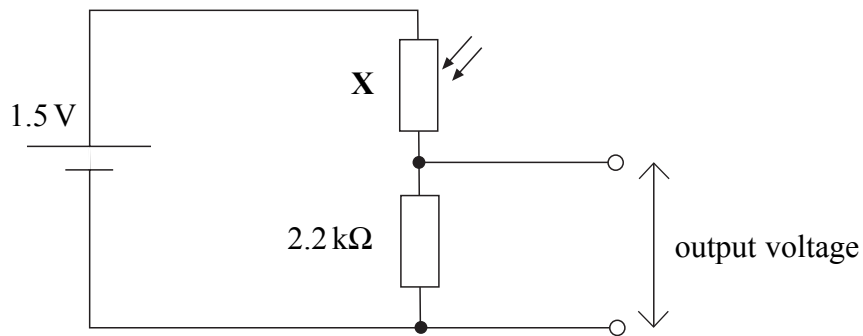
(a) State the full name of the component labelled **X**.

....

(1 mark)

(b) Calculate the output voltage when the resistance of **X** is 1.8 kΩ.

output voltage ....

(2 marks)

(c) (i) State and explain how the resistance of component **X** changes when the light intensity falls.

....

....

....

(ii) State how the output voltage of the sensor will change when the light intensity falls.

....

(3 marks)

25

Turn over ▶

SECTION B

Answer **all** questions in this section.

There are 50 marks in this section.

6   **Figure 5** shows a skateboarder of mass 54 kg about to descend a curved ramp in a skate park.

Figure 5
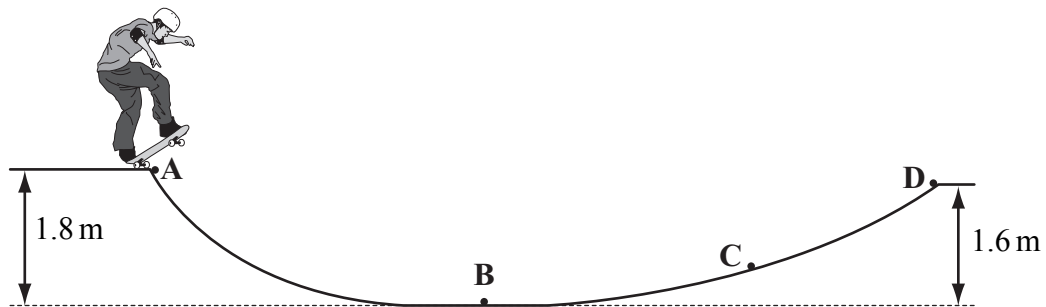
The skateboarder can be assumed to be a rigid body during the motion.
acceleration due to gravity $g = 9.8 \, \text{m s}^{-2}$

(a)   At which of the points **A**, **B**, **C** or **D** is the magnitude of the acceleration greatest along the track?

....
(1 mark)

(b)   The skateboarder is initially at rest. Assuming that there is no frictional force acting, calculate
   (i)   the kinetic energy the skateboarder would have at **B**,

kinetic energy ....

   (ii)   the speed of the skateboarder at **B**.

speed at **B** ....
(4 marks)

(c) The skateboarder has just enough energy to reach **D** because of friction. The total length of the track between **A** and **D** is 8.0 m.

Calculate
  (i) the energy lost due to friction as the skateboarder moves from **A** to **D**,

energy lost ....

  (ii) the magnitude of the overall frictional force assuming it to be constant.

frictional force ....
(4 marks)

(d) State and explain where on the track the skateboarder will have zero acceleration along the track **when there are frictional forces acting**.

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

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(5 marks)

7 A driver of a car has to carry out an emergency stop when driving at $20\,\mathrm{m\,s^{-1}}$. The graph in **Figure 6** shows how the speed of the car varies with time from the instant that the driver notices the need to stop the car.

Figure 6
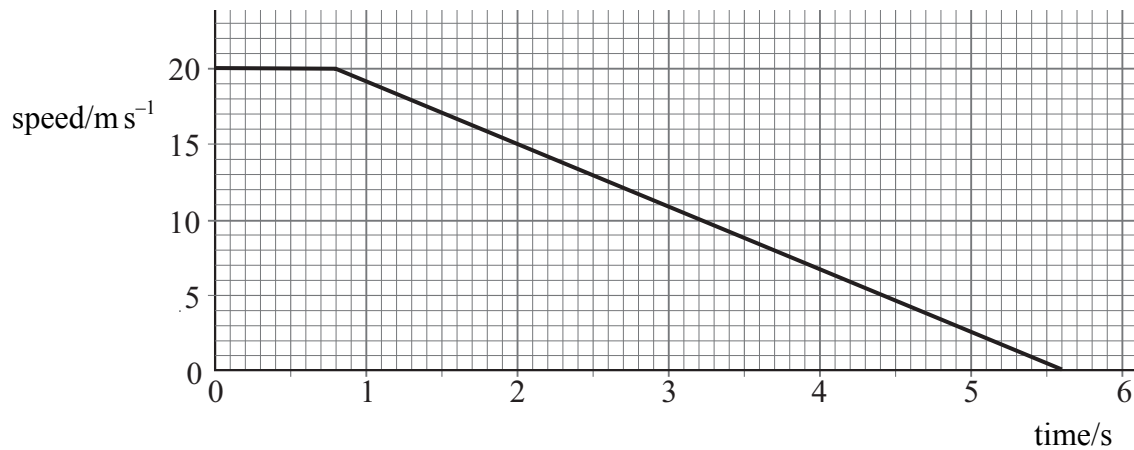
(a) (i) Calculate the deceleration of the car in $\mathrm{m\,s^{-2}}$, when the brakes are applied.

deceleration .... $\mathrm{m\,s^{-2}}$

(ii) The car has a total mass of $950\,\mathrm{kg}$. Calculate the decelerating force acting on the car during braking.

decelerating force ....
(4 marks)

(b)   The driver has to perform this emergency stop when a lorry pulls out unexpectedly from a side road 60 m ahead and stops in the path of the car.

(i)   How far does the car travel before the driver applies the brakes in the emergency?

distance travelled ....

(ii)   Do further calculations to determine whether the car stops before colliding with the lorry. State your conclusion clearly.

Conclusion ....
(4 marks)

(c)   The driver needs the same time to apply the brakes and has the same deceleration when travelling at $10\,\mathrm{m\,s^{-1}}$.

(i)   Show on **Figure 6** how the speed of this car would vary with time from the instant that an emergency rises.

(ii)   Calculate the speed in $\mathrm{km\,h^{-1}}$ that corresponds to a speed of $10\,\mathrm{m\,s^{-1}}$.

speed .... $\mathrm{km\,h^{-1}}$
(3 marks)

11

8 **Figure 7** shows how the resistance *R* of three electrical components varies with temperature *θ* in °C.

Figure 7
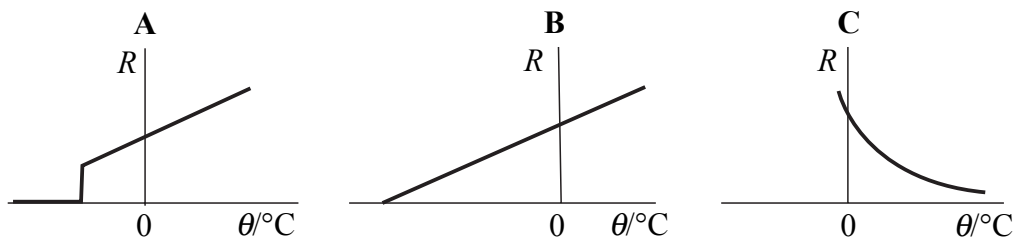
(a) Indicate below which one of **A**, **B** or **C** shows the correct graph for

a wire-wound resistor, ...

a thermistor, ...

a superconductor. ....

(2 marks)

(b) An experiment is performed at room temperature to find out how the resistance of a wire-wound resistor varies with potential difference over the full range from $0 - 6\,V$. The resistance is calculated using readings of potential difference and current.

(i) Complete the diagram below to show the circuit that includes a potential divider to control the potential difference and the correct positions for an ammeter and voltmeter.

6 V

wire-wound resistor
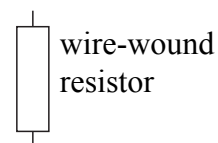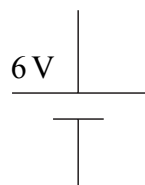
(ii) **Figure 8** shows how the current in the wire-wound resistor varies with potential difference.

Figure 8
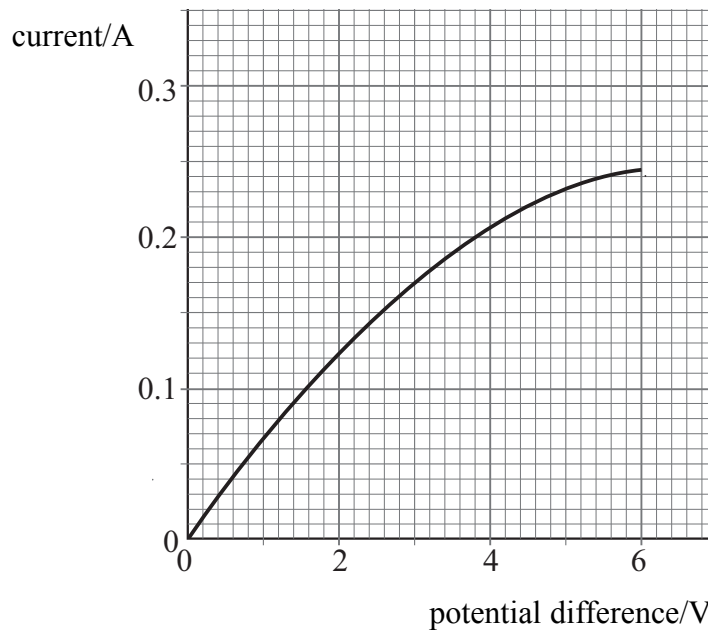
Calculate the resistance of the wire-wound resistor when the potential difference is 3.0 V.

resistance ....

(iii) Explain why the graph has the shape shown in **Figure 8**.

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(6 marks)

Question 8 continues on the next page

Turn over ▶

(c) The metal wire used to manufacture the wire-wound resistor has a resistance per metre of 26 Ω and a diameter of 0.23 mm. Calculate the resistivity of the material from which the wire is made.

resistivity ....

(4 marks)

12

9 Pilot studies have been conducted for the building of a tidal barrage across the river Severn. A barrage (a huge dam) enables electricity to be generated as the tide comes in. The seawater can then be trapped behind the barrage and then more electricity can be generated when the tide goes out and the trapped water is released.

A Severn barrage could have large turbines driving 200 generators which could provide 8000 MW of power for 12 hours each day. This would provide the same electrical energy as 3 nuclear power stations. At current rates the barrage would provide about 6% of the total energy needs for England and Wales.

(a) A generator produces an output at 11 kV. Calculate the output current produced by the generator.

output current ....

(3 marks)

(b) Calculate the total electrical energy used each day in England and Wales suggested by data in the above paragraph. Give your answer in J.

energy per day ....

(3 marks)

(c) Capital costs and maintenance costs are two factors that need to be considered when deciding whether building one tidal barrage across the river Severn is better than building 3 nuclear power stations.

Write a short account comparing the advantages of using one system in preference to the other. **Do not consider the capital and maintenance costs**.

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

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(7 marks)

13

END OF QUESTIONS

There are no questions printed on this page