Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
January 2004
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) PHB1
Unit 1 Foundation Physics

Monday 12 January 2004 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			
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 **24** marks in this section.

1 Complete the following table.

Quantity	Vector or Scalar	S.I. Unit
Displacement	Vector	m
Velocity		
Weight		
Energy		

(3 marks)

2 In a test to find a suitable metal wire to use for a fuse, the following graph of current, I, against time, t, was obtained. The circuit, which was connected to a constant source of emf, was switched on at $t = 0$ s.

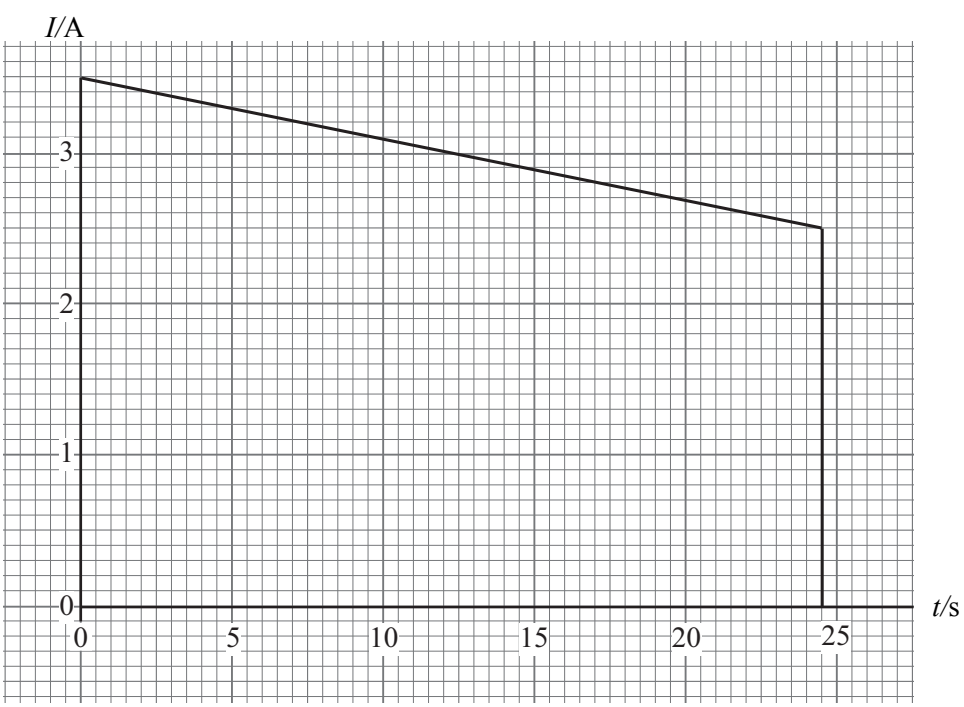


Figure 1

(a) Calculate the total charge that flowed during this test.

Total charge.....

(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, $F = k\Delta l$

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

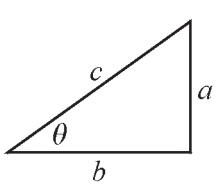
Geometrical and Trigonometrical Relationships

circumference of circle $= 2\pi r$

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

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

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



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

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

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

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

(b) Explain why the current decreased during the test before the fuse melted.

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(2 marks)

3 **Figure 2** shows a laboratory experiment to test the loading of a uniform horizontal beam of weight W. The length of the beam is 1.50 m. The load, M, has a weight of 100 N and its centre of mass is 0.40 m from the pivot. The beam is held in a horizontal position by the tension, T, in the stretched spring.

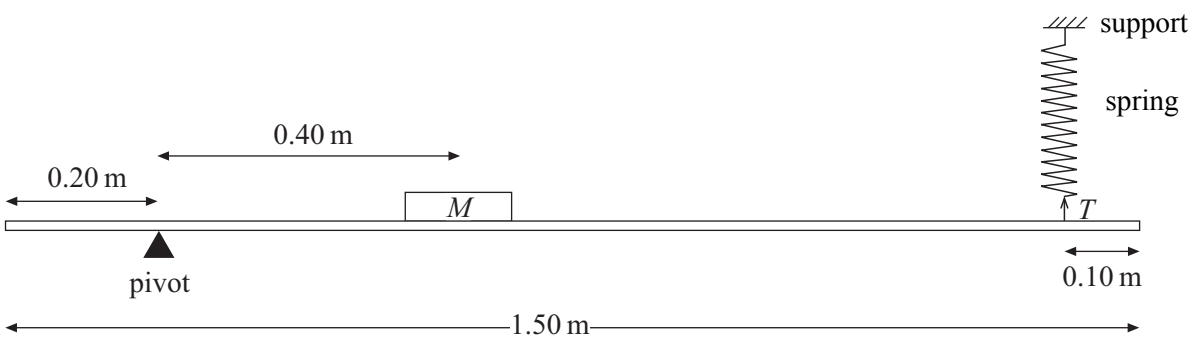

Figure 2

(a) Add clearly labelled arrows to **Figure 2** so that it shows all of the forces acting on the beam.

(2 marks)

(b) The tension, $T = 36$ N. Calculate the moment of T about the pivot.

Moment.....

(2 marks)

(c) Calculate the weight, W, of the beam.

Weight W.....

(3 marks)

4 **Figure 3** shows the characteristic for an electronic component.

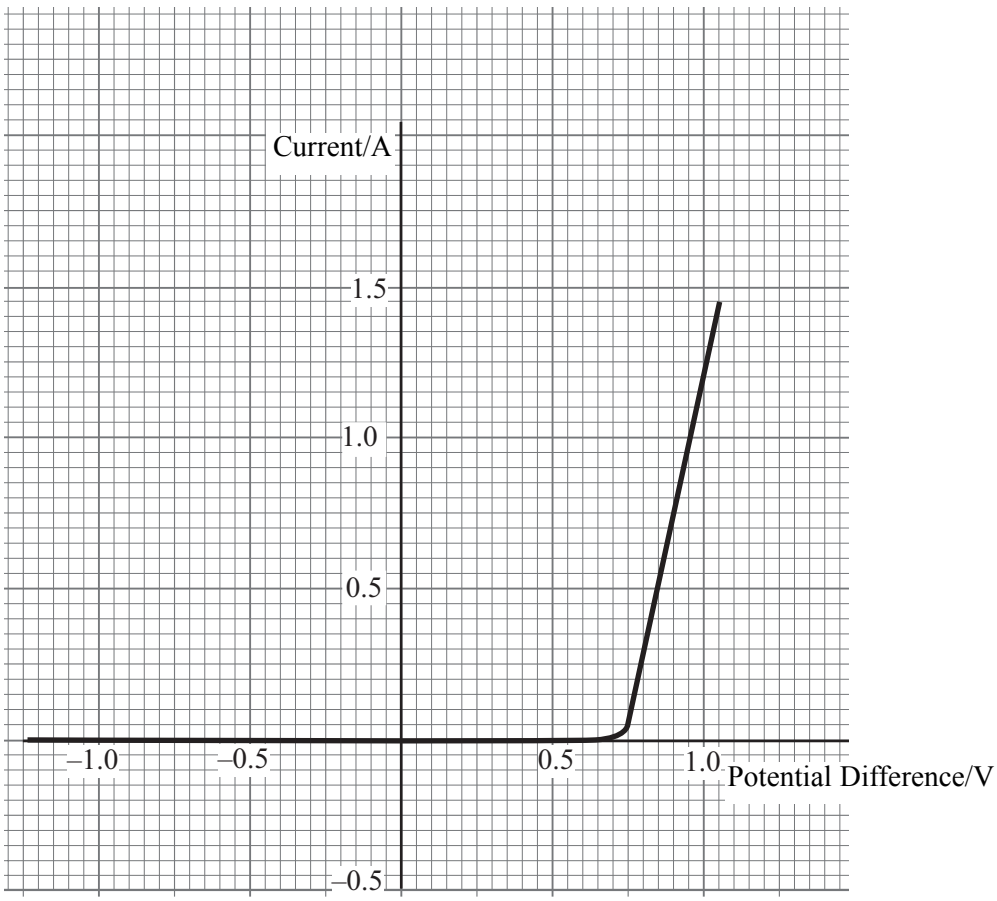

Figure 3

(a) Name the component .....

(1 mark)

(b) Calculate the resistance of this component when the current is +0.90 A.

Resistance.....

(2 marks)

(c) State **one** practical use for this component.

.....

(1 mark)

5 **Figure 4** shows a child coming down a slide in a playground. The vertical height of the slide is 3.0 m. The angle between the main slope of the slide and its vertical support is 50°.

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

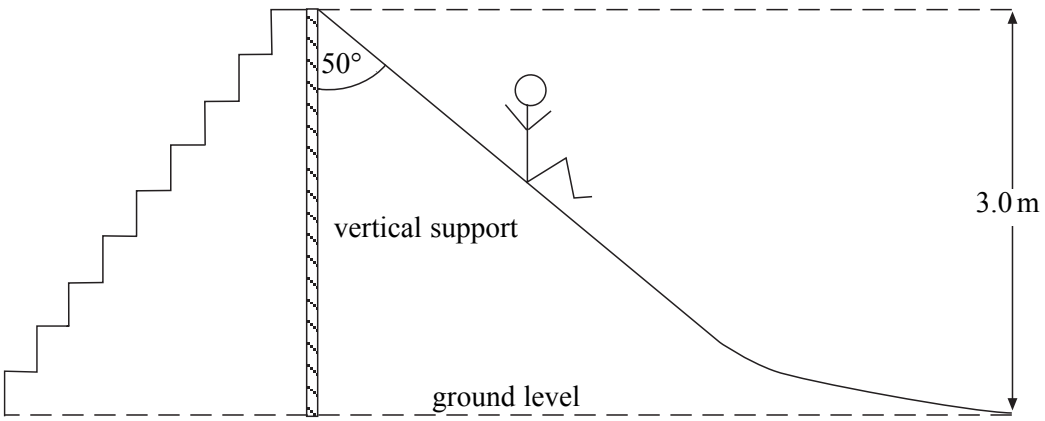

Figure 4

(a) The child has a mass of 41 kg. Calculate the gain in gravitational potential energy as the child climbed to the top of the slide.

Gravitational potential energy gained.....
(2 marks)

(b) Assume that the slide is frictionless.

(i) Use your answer to part (a) to calculate the speed of the child when reaching the bottom of the slide.

Speed.....
(2 marks)

(ii) Calculate the resultant force acting on the child when in the position shown in **Figure 4**.

Resultant force.....
(2 marks)

24

SECTION B

Answer **all** questions in this section

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

Total for this question: *8 marks*

6 The graph in **Figure 5** shows how the vertical component, v, of the velocity of a rocket varies with time, t, from its take-off on level ground to the **highest point of its trajectory**.

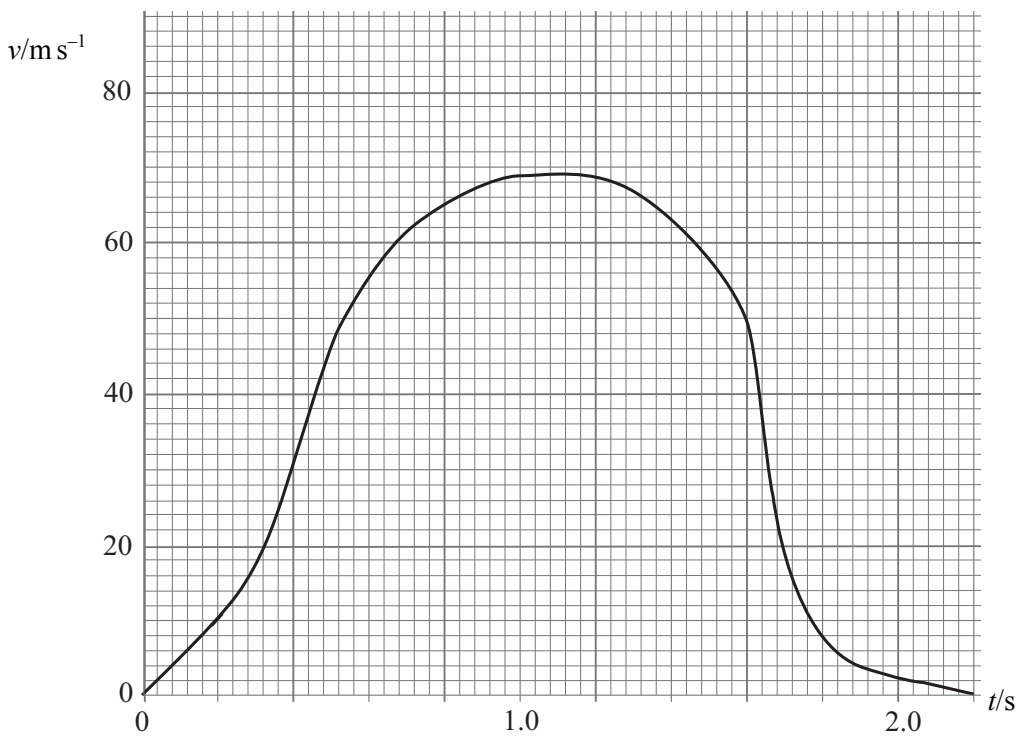

Figure 5

(a) Take readings from the graph to calculate the average vertical acceleration of the rocket from time $t = 0$ to time $t = 0.60$ s.

Average acceleration.....

(3 marks)

(b) Use the graph to estimate the maximum height reached by the rocket.

Maximum height.....
(3 marks)

(c) Assume that air resistance is negligible. Calculate the time taken for the rocket to fall from its maximum height back to the ground.

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

Time to fall to the ground.....
(2 marks)

8

TURN OVER FOR THE NEXT QUESTION

Total for this question: *10 marks*

7 The heating circuit of a hairdryer is shown in **Figure 6**. It consists of two heating elements, R_1 and R_2, connected in parallel. Each element is controlled by its own switch.

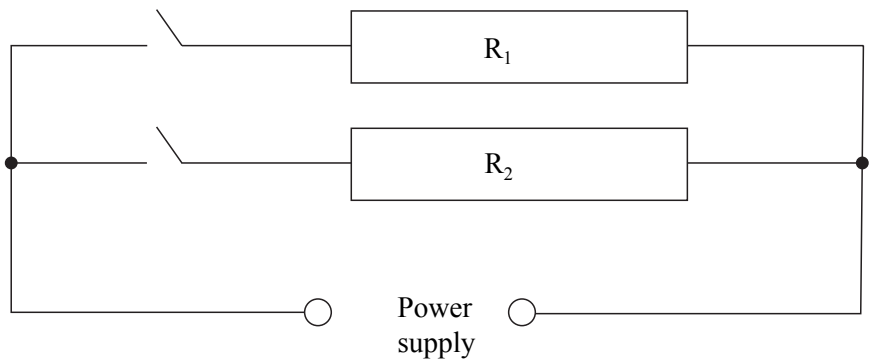

Figure 6

The elements are made from the same resistance wire. This wire has a resistivity of $1.1 \times 10^{-6}\,\Omega\,m$ at its working temperature. The cross-sectional area of the wire is $1.7 \times 10^{-8}\,m^2$ and the length of the wire used to make R_1 is 3.0 m.

(a) Show that the resistance of R_1 is about 190 Ω.

(3 marks)

(b) Calculate the power output from the heating circuit with only R_1 switched on when it is connected to a 240 V supply.

Power output.....

(2 marks)

(c) With both elements switched on, the total power output is three times that of R_1 on its own.

(i) Calculate the length of wire used to make the coil R_2.

Length.....
(3 marks)

(ii) Calculate the total current with both elements switched on.

Total current.....
(2 marks)

10

TURN OVER FOR THE NEXT QUESTION

Total for this question: *15 marks*

8 **Figure 7** shows a water-skier of mass 70 kg being pulled in a straight line at a constant speed of 6.0 m s^{-1}. The tension in the towrope is 1200 N.

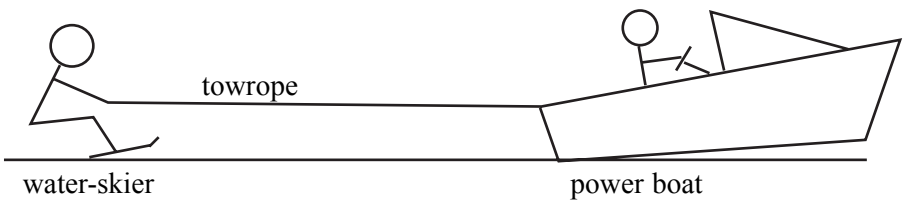

Figure 7

(a) State the magnitude of the total resistive force acting on the skier.

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(1 mark)

(b) When the tension is 1200 N the towrope has been stretched by 0.40 m. Calculate

(i) the energy stored in the towrope;

Energy.....
(2 marks)

(ii) the stiffness of the towrope in N m^{-1}.

Stiffness.....N m^{-1}
(2 marks)

(c) The skier is now accelerated uniformly to 12.0 m s^{-1} in 5.0 s by the power boat.

(i) Assuming that the resistive forces acting on the skier remain constant, calculate the increase in tension in the rope.

Increase in tension.....
(3 marks)

(ii) In practice the increase in tension will be greater than the answer to part (c)(i). Explain why this is so, and describe and explain what the skier should do to avoid falling over during the acceleration.

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

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(7 marks)

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Total for this question: *8 marks*

9 The circuit shown in **Figure 8** can be used as an electronic thermometer. The battery has negligible internal resistance.

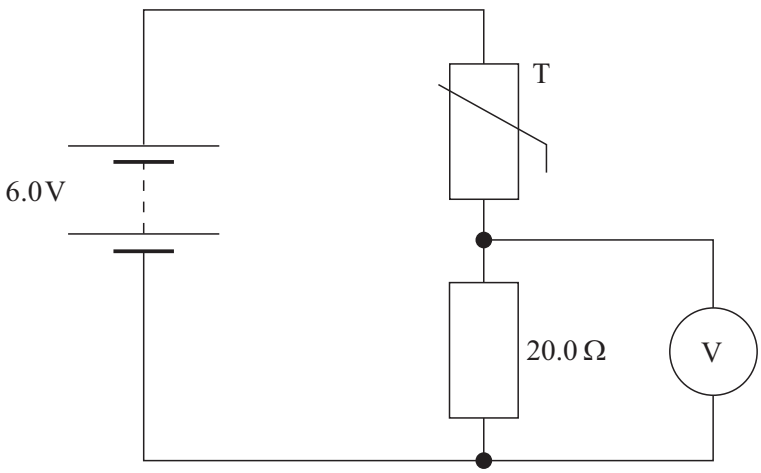

Figure 8

The reading on the digital voltmeter can be converted to give the temperature of the thermistor T which is used as a temperature sensor.

(a) Explain why the reading on the voltmeter increases as the temperature of the thermistor increases.

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(2 marks)

(b) When the thermistor is at 80.0 °C the voltmeter reading is 5.0 V. Show that the resistance of the thermistor at this temperature is 4.0 Ω.

(1 mark)

(c) When the thermistor is at 20.0 °C its resistance is 24.5 Ω. Calculate the reading on the voltmeter.

Voltmeter reading.....
(2 marks)

(d) The battery is replaced with another having the same emf but an internal resistance of 3.0 Ω.

(i) Calculate the new voltmeter reading when the thermistor temperature is 80.0 °C.

Voltmeter reading.....
(2 marks)

(ii) State and explain the effect, if any, on the measured temperature when the thermistor is at 20.0 °C.

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(1 mark)

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8

Total for this question: *10 marks*

10 Scientific measurements are now often made automatically by electronic data capture systems. These data may be collected in the form of an *analogue* signal which is subsequently converted into *digital* form for transmission and/or processing.

(a) With the aid of diagrams explain the terms *analogue* and *digital* in this context.

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(4 marks)

(b) State and explain the causes of **two** problems associated with the transmission of electrical signals along metal cables. You should go on to discuss how the problems may be overcome for both digital and analogue data.

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

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(6 marks)

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END OF QUESTIONS