UNIVERSITI SAINS MALAYSIA

KSCP Semester Examination
Academic Session 2004/2005

Mei 2005

ZCT 104E/3 - Physics IV (Modern Physics)
[Fizik IV (Fizik Moden)]

Duration 3 hours
[Masa 3 jam]

Please check that the examination paper consists of **TWELVE** pages of printed material before you begin the examination

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **DUA BELAS** muka surat yang bercetak sebelum anda memulakan peperiksaan ini]*

Instruction: **Answer all 25 objective questions in Part A**
Answer all 3 Structured Questions in Part B [75 marks]

Please answer the objective questions from Part A in the objective answer sheet provided
Please submit the objective answer sheet and the answers to the structured questions separately

Students are allowed to answer all questions in Bahasa Malaysia or in English

[Arahan: ***Jawab kesemua 25 soalan objektif daripada Bahagian A***
Jawab kesemua 3 Soalan Struktur daripada Bahagian B (75 markah)]

[Sila jawab soalan-soalan objektif daripada bahagian A dalam kertas jawapan objektif yang dibekalkan Jawab kesemua soalan struktur daripada Bahagian B Hantar kertas jawapan objektif dan jawapan kepada soalan struktur berasingan]

[Pelajar dibenarkan untuk menjawab samada dalam bahasa Malaysia atau bahasa Inggeris]

Data

speed of light in free space, $c = 3\ 00 \times 10^{8}$ m s ^{1}
permeability of free space, $\mu_0 = 4\pi \times 10^{-7}$ H m ^{1}
permittivity of free space, $\varepsilon_0 = 8\ 85 \times 10^{-12}$ F m ^{1}
elementary charge, $e = 1\ 60 \times 10^{19}$ C
Planck constant, $h = 6\ 63 \times 10^{-34}$ J s
unified atomic mass constant, $u = 1\ 66 \times 10^{27}$ kg
rest mass of electron, $m_e = 9\ 11 \times 10^{31}$ kg
rest mass of proton, $m_p = 1\ 67 \times 10^{27}$ kg
molar gas constant, = 8 31 J K^{-1} mol ^{1}
Avogadro constant, $N_A = 6\ 02 \times 10^{23}$ mol^{-1}
gravitational constant, $G = 6\ 67 \times 10^{-11}$ N m^2 kg ^{2}
acceleration of free fall, $g = 9\ 81$ m s ^{2}

Part A: Objective 25 marks
Instruction: Answer all 25 objective questions in this Part.
[Bahagian A Objektif]
[Arahan Jawab kesemua 25 soalan objektif dalam Bahagian ini]

1 A massive particle has a speed of 0 95*c* Can its energy and speed be increased by more than 500%?
[Laju suatu zarah yang berjisim ialah 0 95c Bolehkah tenaga dan lajunya bertambah sebanyak 500%?]

A. The energy can but not the speed
B. The speed can but not the energy
C. Both the energy and speed can be increased by this amount
D. Both the energy and speed cannot be increased by this amount
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

2 Consider a photon travelling in vacuum Can its energy and speed be increased by more than 500%?
[Pertimbangkan suatu foton yang bergerak di dalam vakuum Bolehkah tenaga dan lajunya bertambah sebanyak 500%?]
A. The energy can but not the speed
B. The speed can but not the energy
C. Both the energy and speed can be increased by this amount
D. Both the energy and speed cannot be increased by this amount
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

3 Constancy of the speed of light in all inertial reference systems implies that
[Kemantapan laju cahaya dalam semua rangka rujukan inersia mengimplikasikan]

A $x^2+y^2+z^2+c^2t^2=x'^2+y'^2+z'^2+c^2t'^2$

B $x^2+y^2+z^2-c^2t^2=x'^2+y'^2+z'^2-c^2t'^2$

C. $x+y+z-ct=x'+y'+z'-ct'$

D. $x+y+z+ct=x'+y'+z'+ct'$

E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

4 If a neutron spontaneously decays into a proton, an electron and a neutrino (which is massless), the decay products are observed to have a total kinetic energy of E_k If the proton mass is M_P and the electron mass is m_e how large is the neutron mass?
[Jika suatu neutron mereput kepada satu proton, satu elektron dan satu neutrino (yang tak berjisim) secara spontan, jumlah tenaga kinetik hasil reputannya dicerap sebagai E_k Jika jisim proton ialah M_P dan jisim elektron ialah m_e apakah jisim neutron?]

A $\left(M_P+m_e\right)-\frac{E_k}{c^2}$ B $\frac{E_k}{c^2}-\left(M_P+m_e\right)$ **C.** $M_P+m_e+\frac{E_k}{c^2}$

D. $\sqrt{\left(M_P+m_e\right)^2+\left(\frac{E_k}{c^2}\right)^2}$ **E.** Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

5 The following pairs of energies represent the rest energy and total energy of three different particles particle 1 E, $2E$, particle 2 E, $3E$, particle 3 $2E$, $4E$ Rank the particles according to their speed
[Pasangan tenaga berikut mewakili tenaga rehat dan jumlah tenaga bagi tiga zarah yang berbeza zarah 1 E, 2E, zarah 2 E, 3E, zarah 3 2E, 4E Aturkan zarah-zarah tersebut mengikut laju mereka]

A. $v_3>v_2=v_1$ **B.** $v_2>v_3=v_1$ **C.** $v_1>v_2=v_3$

D. $v_3>v_2>v_1$ **E.** Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

6 Observer A sees a pendulum oscillating back and forth in a relativistic train and measures its period to be T_A Observer B moves together with the train and measures the period of the pendulum to be T_B These two results will be such that
[Tempoh suatu bandul yang mengayun berulang-alik di dalam suatu keretapi kerelatifan diukur sebagai T_A oleh pemerhati A Manakala pemerhati B yang gerak bersama dengan keretapi tersebut mengukur tempoh bandul tersebut sebagai T_B Keputusan pengukuran tempoh-tempoh tersebut adalah]

A. $T_A>T_B$ **B.** $T_A=T_B$ **C.** $T_A<T_B$

D. T_A could be greater or smaller than T_B depending on the direction of the motion

E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C D]*

7 Which of the following statements are (is) correct? *[Pilih kenyataan(-kenyataan) yang benar daripada yang berikut]*

I An ideal blackbody absorbs all of the light that is incident on it *[Jasad hitam yang ideal menyerap kesemua cahaya yang jatuh ke atasnya]*

II The distribution of energy in the blackbody radiation does not depends upon the material from which the blackbody is constructed *[Taburan tenaga dalam pancaran jasad hitam tidak bergantung kepada jenis bahan yang membentuk jasad hitam itu]*

III The correct expression for the energy of a photon is $E = h\lambda$ *[Ekspresi yang betul bagi tenaga suatu foton ialah $E = h\lambda$]*

IV For a blackbody, the total intensity of energy radiated over all wavelengths increases as the forth power of the temperature *[Bagi satu jasad hitam, keamatan tenaga yang dipancarkan bila sumbangan kesemua jarak gelombang dijumlahkan bertambah mengikut kuasa empat suhunya]*

A. I,II,III **B. I,II** **C. II, III, IV** **D. I,II,IV**
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C. D]*

8. Which of the following statements are (is) correct?
[Pilih kenyataan(-kenyataan) yang benar daripada yang berikut]

I In the Compton Effect, there is a zero wavelength shift for forward scattering ($\theta = 0°$)
[Dalam kesan Compton, anjakan jarak gelombang sifar berlaku dalam serakan ke depan ($\theta = 0°$)]

II In the Compton Effect, no energy or momentum is transferred to the electron in the forward scattering
[Dalam kesan Compton, tiada tenaga atau momentum dipindahkan kepada elektron dalam serakan ke depan]

III In the Compton Effect, conservation of momentum and energy must be simultaneously satisfied
[Dalam kesan Compton, keabadian tenaga dan momentum mesti dipatuhi secara serentak]

IV In the Compton Effect, energy and momentum are transferred to the scattered electron when θ is non zero
[Dalam kesan Compton, tenaga dan momentum dipindahkan kepada elektron terserakkan jika sudut θ bukan sifar *]*

A. I,II,III **B. I,II** **C. II, III, IV** **D. I,II,IV**
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C. D]*

9. Which of the following statements are (is) correct?
[Pilih kenyataan(-kenyataan) yang benar daripada yang berikut]

I	A photon is a particle with positive charge *[Foton adalah zarah yang bercas positif]*
II	A photon's mass is not necessarily zero *[Jisim foton tidak semestinya sifar]*
III	Photon always move with a speed of c irrespective of the medium through which it is moving *[Tidak kisah medium apa yang dilaluinya, foton sentiasa bergerak dengan laju c]*
IV	The number of photons per unit cross sectional area in a beam of light is proportional to the intensity of the light beam *[Nombor foton per unit keratan rentas dalam satu alur cahaya adalah berkadaran dengan keamatan alur cahaya itu]*

A. I,II,III **B. IV** **C. II, III, IV** **D. I,II,IV**
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

10. In photoelectric effect, which one of the following is the correct expression for the cut-off frequency of the metal in terms of its work function, W_0?
[Dalam kesan fotoelektrik, kenyataan yang mana satukah adalah ekspresi yang betul yang menyatakan frekuensi penggal sesuatu logam dalam sebutan fungsi kerjanya?]
A. W_0 / h **B.** W_0 / c **C.** h / W_0 **D.** $(h/c)W_0$
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

11. In Compton effect, an incident X-ray photon of wavelength λ is scattered by an electron, the scattered photon having a wavelength of λ'. Suppose that the incident photon is scattered by a proton instead of an electron For a given scattering angle θ, the change $\lambda' - \lambda$ in the wavelength of the photon scattered by the proton
[Dalam kesan Compton, suatu foton sinar-X tuju dengan jarak gelombang λ diserakkan oleh suatu elektron manakala jarak gelombang bagi foton terserak ialah λ' Katakan foton tuju diserakkan oleh suatu proton yang manggantikan elektron Untuk suatu sudut serakan θ yang diberikan, perubahan $\lambda' - \lambda$ dalam jarak gelombang foton terserak oleh proton adalah]

A. is greater than that scattered by the electron
B. is less than that scattered by the electron
C. is same as that scattered by the electron
D. cannot be determined
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

12 In an electron-positron pair production by an energetic photon in the vicinity of a nucleus, the frequency of the photon λ must be
[Dalam penghasilan pasangan elektron-positron oleh suatu foton bertenaga tinggi di persekitaran suatu nucleus, frekuensi foton λ semestinya]

A. $\lambda \leq h/2m_e c$ **B.** $\lambda \geq h/2m_e c$ **C.** $\lambda \leq h/m_e c$ **D.** $\lambda \geq h/m_e c$
E. $\lambda \leq h/2m_e$

13. In an important experiment in 1927 a beam of electrons was scattered off a crystal of nickel The intensity of the scattered beam varied with the angles of scattering, and analysis of these results lead to confirmation of
[Dalam suatu eksperimen yang dilakukan dalam tahun 1927, suatu alur elektron diserakkan oleh suatu hablur nikel Keamatan alur yang terserak berubah-ubah mengikut sudut ia diserakkan, dan analisis keputusan itu membawa kepada pengesahan]

A. the particle nature of light
B. the Bohr model of atom
C. the wave nature of electrons
D. the Rutherford model of the nucleus
E. the quantisation of energy levels

14. Consider a particle in a box of width L and infinite height Let the particle be in a state $n = 11$ What is the first value of x ($0 \leq x \leq L$), where the probability of finding the particle is highest?
[Pertimbangkan suatu zarah dalam kotak dengan lebarL dan ketinggian infinit Biar ia berada dalam keadaan $n = 11$ Apakah nilai x ($0 \leq x \leq L$) yang pertama di mana keberangkalian menjumpai zarah terserbut adalah paling tinggi?]

A. $L/22$ **B.** $L/11$ **C.** L **D.** $L/10$
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

15. Protons are being accelerated in a particle accelerator When the speed of the proton is doubled, their de Broglie wavelength will
[Proton sedang dipecutkan oleh pemecut zarah Bila laju proton digandakan dua kali, jarak gelombang de Broglie mereka akan]

A. increase by a factor of 2
B. decrease by a factor of 2
C. increase by a factor of $\sqrt{2}$
D. decrease by a factor of $\sqrt{2}$
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

16. If the minimum uncertainty in an object's position is decreased by half, what can we say about the uncertainty in its momentum?
[Jika ketidakpastian minimum bagi kedudukan suatu objek dikurangkan separuh, apa yang boleh dikatakan ke atas ketidakpastian dalam momentumnya?]

A. The uncertainty in momentum is at most half of what it was before the change
B. The uncertainty in momentum is at least twice what it was before the change
C. The uncertainty in momentum does not change
D. The minimum uncertainty in momentum is precisely half of what it was before the change
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

17 To which of the following values of *n* does the longest wavelength in the Balmer series correspond?
[Nilai n yang manakah bersepadanan dengan jarak gelombang paling panjang dalam siri Balmer?]

A. 3 **B.** 5 **C.** 1 **D.** infiniti
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

18 In order for an atom to emit light, it
[Untuk memancarkan cahaya, sesuatu atom kena]

A. must be in the gaseous state *[berada dalam keadaan gas]*
B. must be stimulated by external radiation *[dirangsang oleh pancaran luar]*
C. must be in the ground state *[berada dalam keadaan bumi]*
D. must be in an excited state *[berada dalam keadaan teruja]*
E. must be fluorescent *[berpendarfluor]*

19 Which of the following statements are (is) correct?
[Pilih kenyataan(-kenyataan) yang benar daripada yang berikut]
A. Einstein proposed the model of the atomic structure that provides the best explanation of the observation that each atom in the periodic table has a unique sets of spectral lines
[Einstein menyarankan model struktur atom yang membekalkan penjelasan paling baik ke atas pencerapan bahawa setiap atom di dalam jadual berkala mempunyai satu set garisan spektrum yang unik.]
B. According to one of the assumptions of the Bohr model, the electron in a hydrogen atom moves in an elliptical orbit about the nucleus
[Menurut salah satu anggapan model Bohr, elektron di dalam atom hidrogen berkisar di dalam orbit elips yang mengelilingi nucleus]

C. Bohr's model of an atom includes idea from both classical and quantum physics
[Model atom Bohr mengandungi idea-idea daripada kedua-dua bidang fizik klasik dan fizik kuantum]

D. The plum-pudding model of atom by Thomson was verified by Rutherford's alpha scattering experiment
[Model atom 'plum-pudding' oleh Thomson telah diverifikasikan oleh eksperimen penyerakan alfa Rutherford]

E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

20 Consider an electron, a proton and an alpha particle each trapped separately in identical infinite square wells Which particle corresponds to the highest ground-state energy?
[Pertimbangkan suatu elektron, suatu proton dan suatu zarah alfa yang masing-masing diperangkapkan secara berasingan di dalam telaga segiempat infinit yang identikal Zarah yang manakan bersepadanan dengan paras tenaga bumi yang paling tinggi?]

A. the electron **B.** the proton **C.** the alpha particle
D. The ground state energy is the same in all three cases
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

21 Consider the three particles in Question 20 again Which particle has the longest wavelength when the system is in the ground state?
[Pertimbangkan semula zarah-zarah dalam Soalan 20 Zarah yang manakan mempunyai jarak gelombang yang paling panjang bila sistem berada dalam keadaan bumi?]

A. the electron **B.** the proton **C.** the alpha particle
D. All three particles have the same wavelength
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

22 Which of the following statements are (is) correct?
[Pilih kenyataan(-kenyataan) yang benar daripada yang berikut]

A. The kinetic energy of the electron in the first Bohr orbit of hydrogen is -13 6 eV
[Tenaga kinetik elektron dalam orbit Bohr pertama ialah -13 6 eV]

B. The electron in a doubly ionised lithium atom experiences a weaker attractive force than the single electron in a hydrogen atom
[Elektron dalam atom lithium yang dua kali terionkan mengalami daya tarikan yang lebih lemah berbanding dengan elektron tunggal dalam atom hidrogen]

C. In a hydrogen atom, the difference in the energy between adjacent orbit radii increases with the increasing value of n
[Dalam atom hidrogen, perbezaan tenaga di antara dua radius orbit yang berjiranan bertambah bila nilai n bertambah]

D. The Bohr model correctly predicts the energy for the ground state of the hydrogen atom
[Model Bohr meramal dengan tepatnya tenaga keadaan bumi atom hidrogen]

E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

23 Hydrogen atoms can emit four lines with visible colours from red to violet These four visible lines emitted by hydrogen atoms are produced by electrons
[Atom hidrogen boleh memancarkan empat garis warna nampak daripada merah ke ungu Empat garis nampak yang dipancarkan oleh atom hidrogen ini adalah dihasilkan oleh elektron]

A. that starts in the $n = 2$ level
B. that end up in the $n = 2$ level
C. that end up in the ground state
D. that start in the ground state
E. Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

24 An electron in the hydrogen atom is in the $n = 4$ energy level When this electron makes a transition to a lower level, the wavelength of the photon emitted is in
[Suatu elektron dalam atom hidrogen berada dalam paras n = 4 Bila elektron tersebut melakukan peralihan kepada paras tenaga yang lebih rendah, jarak gelombang foton yang terpancarkan berada dalam]

I. the Lyman series **II.** the Blamer series
III. the Paschen series **IV.** the Pfund series

A. I **B. II** **C. III** **D. I,II,III**
E. I, II, III, IV

25 What is the longest radiation wavelength that can be used to ionized the ground-state hydrogen atom?
[Apakah jarak gelombang pancaran yang paling panjang yang boleh digunakan untuk mengiokan atom hidrogen pada keadaan bumi?]

A. $hc/(13\ 6\ \text{eV})$ **B.** $2hc/(13\ 6\ \text{eV})$ **C.** $13\ 6\ hc$
D. $(13\ 6\ \text{eV})/hc$ **E.** Non of A, B, C, D *[Jawapan tiada dalam A, B, C, D]*

Part B: Structured Questions [75 marks]
Instruction: Answer ALL questions in this Part.
[Bahagian B Soalan Struktur 75 markah]
[Arahan Jawab KESEMUA soalan dalam Bahagian ini]

1 **(a)** Based on the physics constants data sheet provided (first page), calculate the ratio of the mass of proton to that of the electron
[Berdasarkan lampiran data (dalam m/s pertama) pemalar-pemalar fizik yang dibekalkan, hitungkan nisbah antara jisim proton kepada jisim elektron]

[5 marks]

(b) Calculate the kinetic energy of the electrons in a beam, in units of electron rest energy $m_e c^2$, such that the relativistic mass of the electrons in the beam is as large as that of the proton
[Hitungkan tenaga kinetik bagi elektron-elektron dalam satu alur elektron, dalam unit tenaga rehat elektron $m_e c^2$, sedemikian rupa supaya jisim kerelatifan elektron dalam alur tersebut bersamaan dengan jisim proton)

[5 marks]

(c) What is the electric potential (in unit of Volt) that is required to accelerate the electron in (b) (from rest) ?
[Apakah beza keupayaan elektrik (dalam unit Volt) yang diperlukan untuk memecutkan elektron dalam (b) di atas (daripada keadaan rehat)?]

[5 marks]

(d) If a 'moving clock' runs slower, what will the age difference between two twins if one stays on the Earth while the second makes a round trip to a point in space ten light years from Earth at a speed of 0 95c?
[Jika masa bagi 'jam yang bergerak' mengalir lebih perlahan, apakah perbezaaan umur di antara dua orang anak kembar jika salah satu daripada mereka tinggal di Bumi manakala yang seorang lagi menjalani satu penggembaraan dengan laju 0 95c ke satu tempat sejauh 10 tahun-cahaya daripada Bumi dan kembali ke Bumi selepas penjelajahan tersebut?]

[10 marks]

2 **(a)** A 60-W bulb is at an efficiency of 6 20% What is the number of photons per second given off by the bulb assuming the wavelength of light to be 580 nm?
[Suatu lampu 60 W beroperasi dengan kecekapan 6 20% Apakah nombor foton yang dipancarkan per saat? Anggap jarak gelombang cahaya yang dipancarkan ialah 580 nm]

[6 marks]

(b) A large number of 30 0 pm photons are scattered twice by stationary electrons Find the **RANGE** of wavelength of the scattered photon in pm
*[Sejumlah besar foton yang berjarak gelombang 30 0 pm diserakkan dua kali oleh elektron-elektron rehat Hitungkan **julat** bagi jarak gelombang foton yang terserakkan dalam unit pm]*

[10 marks]

(c) The work functions of several metals are listed below
[Fungsi kerja beberapa logam adalah seperti berikut]

Metal	ϕ (in eV)
W	4 5
Ag	4 8
Cs	1 8
Cs on W	1 36

(i) Which metals yield photoelectrons when bombarded with light of wavelength 500 nm? *[Logam apakah yang menghasilkan fotoelektron bila ditembak dengan cahaya berjarak gelombang 500 nm?]*

(ii) For those surfaces where photoemission occurs with the above light source, calculate the stopping potential in volts
[Bagi permukaan logam yang mana pemancaran foton berlaku dengan menggunakan punca cahaya tersebut, hitungkan keupayaan penghenti dalam unit Volt]

(iii) For the metal tungsten calculate the threshold wavelength which would just start producing photoelectrons
[Bagi logam tungsten hitungkan jarak gelombang penggal yang mana penghasilan fotoelektron mula berlaku]

[3 + 4 + 2 = 9 marks]

3. (a) Find the frequency of revolution of electron in $n = 1$ and $n = 2$ Bohr orbits What is the frequency of the photon emitted when an electron in the $n = 2$ orbit drops to $n = 1$ orbit?
[Hitungkan frekuensi kisaran bagi elektron dalam orbit-orbit Bohr n = 1 dan n = 2 Apakah frekuensi foton yang dipancarkan bila suatu elektron dalam orbit n=2 jatuh ke orbit n = 1?]

[(3 + 2 + 2)+ 3 marks = 10 marks]

(b) Consider the case of 'particle in a box' (infinite square well) The lowest energy level of a particle confined to a 1-D region of space with fixed dimension L is E_0 If an identical particle is confined to a similar region with fixed distance $L/4$, what is the energy of the lowest energy level in the latter case? Express your answer in terms of E_0.

[Pertimbangkan kes 'zarah di dalam kotak' (telaga segiempat infinit) Tenaga paling rendah bagi satu zarah terkongkong di dalam satu ruang 1-D dengan dimensi L yang tetap ialah E_0 Jika suatu zarah yang identical dikongkongkan di dalam satu ruang yang serupa tapi dengan jarak tetap L/4, apakah tenaga bagi paras tenaga yang terendah dalam kes ini? Nyatakan jawapan anda dalam sebutan E_0]

[5 marks]

(c) Estimate the kinetic energy (in MeV) should electrons have if they are to be

diffracted from crystal with interatomic distance of the order of a few A

[Anggarkan tenaga kinetik (dalam unit eV) yang harus diperolehi oleh elektron-elektron jika mereka hendak dibelaukan oleh hablur yang berjarak antara-atom dalam tertib beberapa A *]*

[5 marks]

(d) What is the frequency of the de Broglie waves associated with a body of rest mass m_0 moving with velocity v?

[Apakah frekuensi bagi gelombang de Broglie yang dikaitkan dengan jasad yang jisim rehatnya m_0 dan bergerak dengan laju v?]

[5 marks]

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