سلطنة عمان
وزارة التربية والتعليم

امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)
للعام الدراسي ١٤٤٠/١٤٣٩ هـ - ٢٠١٨ / ٢٠١٩ م
الدور الأول - الفصل الدراسي الثاني

تنبيه:
- المادة: الفيزياء.
- الأسئلة في (١٧) صفحة.
- زمن الإجابة: ثلاث ساعات.
- الإجابة في الورقة نفسها.

تعليمات مهمة:

- يجب الحضور إلى قاعة الامتحان قبل عشر دقائق على الأقل من بدء زمن الامتحان.
- يجب إحضار أصل ما يثبت الهوية وإبرازها للعاملين بالامتحانات.
- يجب الالتزام بالزي (الدشداشة البيضاء والمصر أو الكمة للذكور) والزي المدرسي للطالبات ، ويستثنى من ذلك الدارسون من غير العمانيين بشرط الالتزام بالذوق العام، ويمنع على جميع المتقدمات ارتداء النقاب داخل المركز وقاعات الامتحان.
- يحظر على الممتحنين اصطحاب الهواتف النقالة وأجهزة النداء الآلي وآلات التصوير والحواسيب الشخصية والساعات الرقمية الذكية والآلات الحاسبة ذات الصفة التخزينية والمجلات والصحف والكتب الدراسية والدفاتر والمذكرات والحقائب اليدوية والآلات الحادة أو الأسلحة أياً كان نوعها وأي شيء له علاقة بالامتحان.
- يجب على الممتحن الامتثال لإجراءات التفتيش داخل المركز طوال أيام الامتحان.
- يجب على الممتحن التأكد من استلام دفتر امتحانه، مغلفاً بغلاف بلاستيكي شفاف وغير ممزق ، وهو مسؤول عنه حتى يسلمه لمراقبي اللجنة بعد الانتهاء من الإجابة.
- يجب الالتزام بضوابط إدارة امتحانات دبلوم التعليم العام وما في مستواه وأية مخالفة لهذه الضوابط تعرضك للتدابير والإجراءات والعقوبات المنصوص عليها بالقرار الوزاري رقم ٥٨٨ / ٢٠١٥.
- يقوم المتقدم بالإجابة عن أسئلة الامتحان المقالية بقلم الحبر (الأزرق أو الأسود).
- يقوم المتقدم بالإجابة عن أسئلة الاختيار من متعدد بتظليل الشكل (▭) وفق النموذج الآتي:

س - عاصمة سلطنة عمان هي:

▭ القاهرة ▭ الدوحة

■ مسقط ▭ أبوظبي

ملاحظة: يتم تظليل الشكل (■) باستخدام القلم الرصاص وعند الخطأ، امسح بعناية لإجراء التغيير.

صحيح ■ **غير صحيح** ▭ ◉ ◒ ☒ ☑

مُسَوَّدَة، لا يتم تصحيحها

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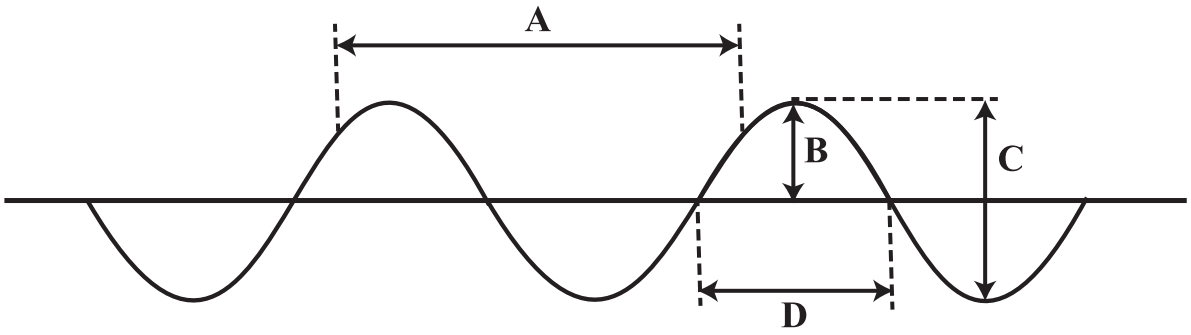
Question 1: Multiple Choice Items (14 marks)

There are 14 multiple-choice items worth one mark each.
Shade in the bubble (○) next to the **best** answer for each item.

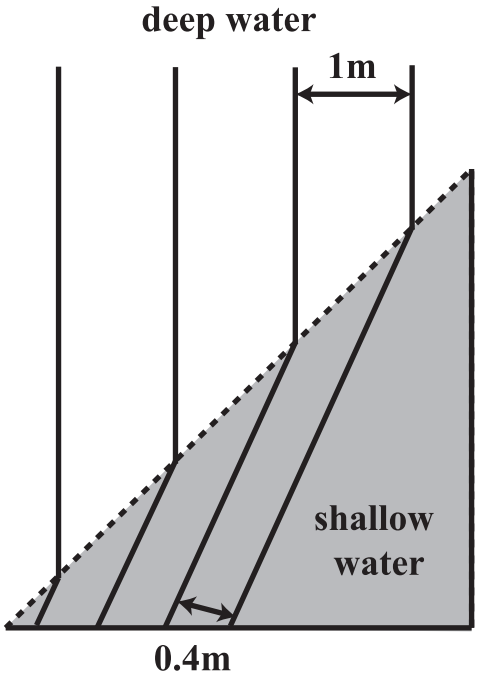
1) Which letter represents the amplitude of the wave shown in the figure below?



○ A ○ B

○ C ○ D

2) Wavefronts of speed (2 m/s) pass from deep water to shallow water as shown in the figure below. What is the speed of the waves in the shallow water?

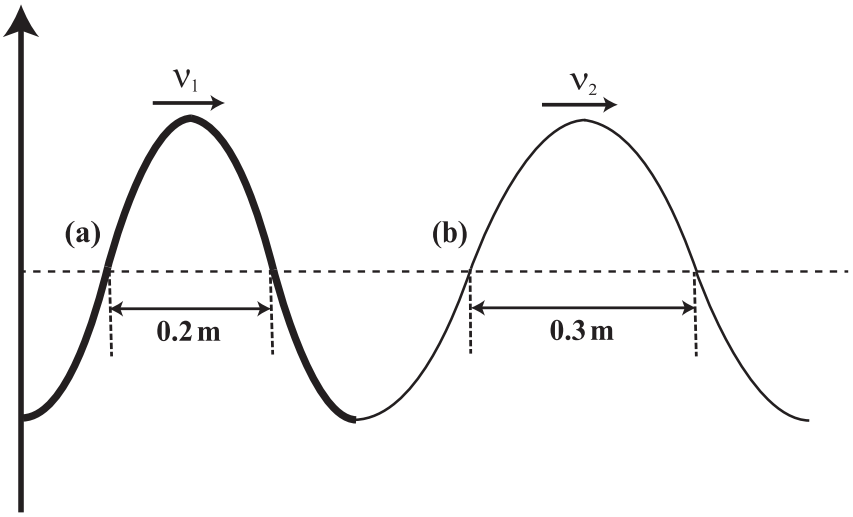


○ 0.2 m/s ○ 0.8 m/s

○ 2.0 m/s ○ 5.0 m/s

Question 1 continued

3) Two different strings (a) and (b) are joined together. If a pulse travels from string (a) to string (b) as shown in the figure below, what is the wave speed in string (b) in terms of the wave speed in string (a)?



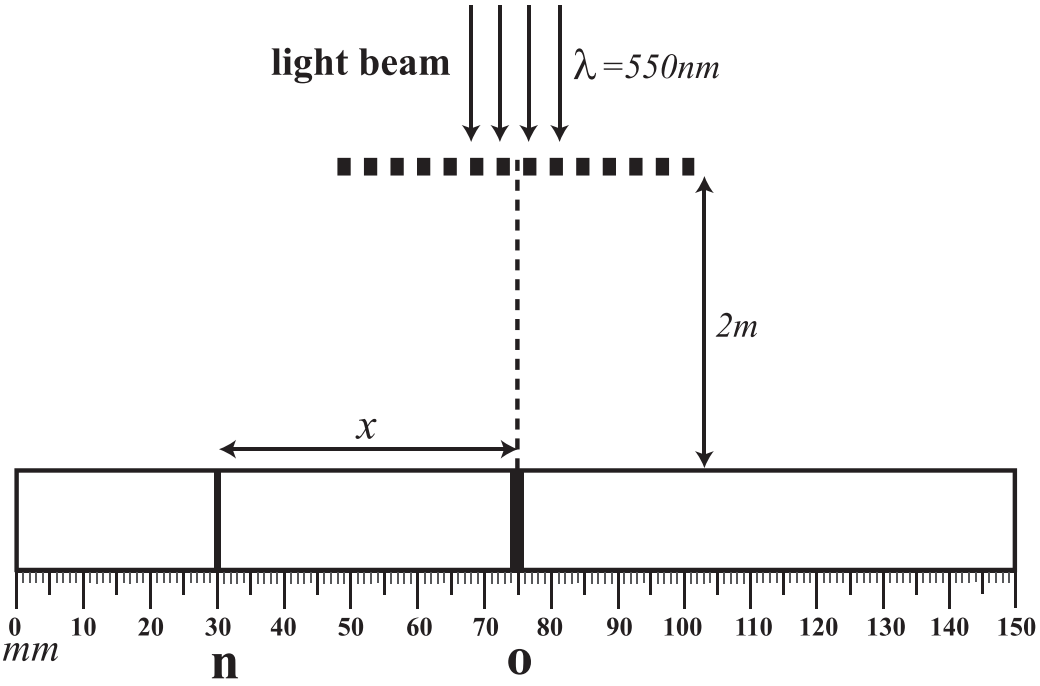
- ☐ $v_2 = \frac{2}{3} v_1$
- ☐ $v_2 = v_1$
- ☐ $v_2 = \frac{3}{2} v_1$
- ☐ $v_2 = 3 v_1$

4) Standing waves result from the superposition of two waves. Which of the following rows shows the correct information about the properties of these two waves?

	Amplitude	Frequency	Propagation's direction
☐	same	different	same
☐	different	different	opposite
☐	same	same	opposite
☐	different	same	same

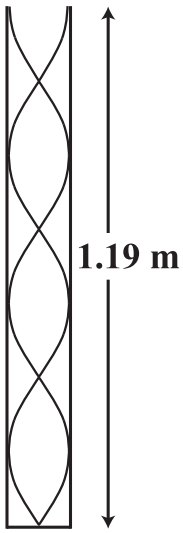
Question 1 continued

5) A diffraction grating with (20 *lines/mm*) is used to study the line spectrum of a light as shown in the figure below. What is the number of the (n^{th}) ordered diffraction maxima which is at distance (x) from the center (O)?



- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4

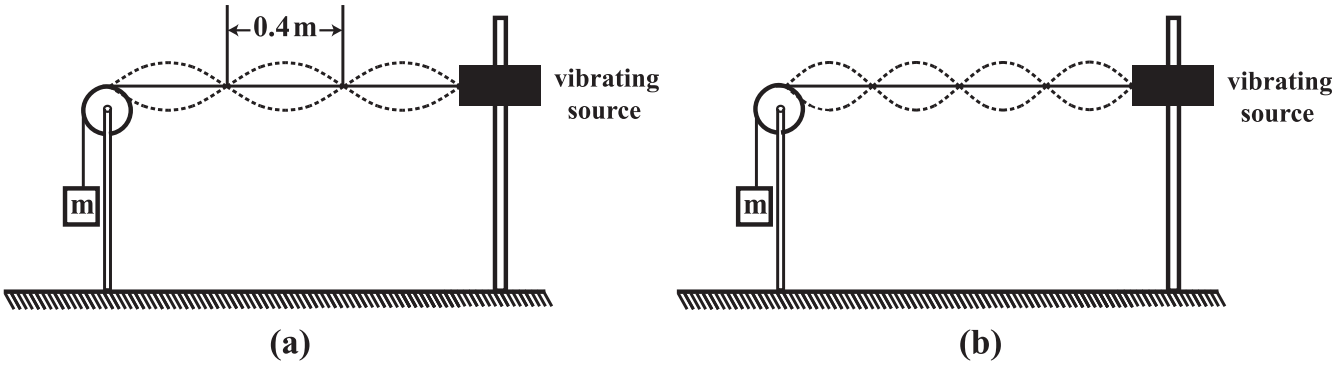
6) What is the frequency of the sound wave when resonance is formed in the tube shown in the figure opposite?



- ☐ 643 Hz
- ☐ 500 Hz
- ☐ 357 Hz
- ☐ 214 Hz

Question 1 continued

7) Two different standing wave patterns shown in figures (a) and (b) where formed by the same experimental setup with varied vibrating source.
If the frequency of the standing wave in figure (a) is (24 Hz), What will be the frequency and the wavelenght of the standing wave in figure (b).



	frequency (Hz)	wavelength (m)
☐	18	0.8
☐	32	0.8
☐	18	0.6
☐	32	0.6

8) Which principle was used by Einstein to derive the photoelectric equation?

- ☐ conservation of energy.
- ☐ conservation of mass.
- ☐ conservation of momentum.
- ☐ conservation of both energy and momentum.

9) An electron and a proton have the same de Broglie wavelength, what is the ratio of their kinetic energy $\left(\frac{KE_e}{KE_p}\right)$?

- ☐ 5.68×10^{-4}
- ☐ 1.83×10^{3}
- ☐ 0.42×10^{2}
- ☐ 2.38×10^{-2}

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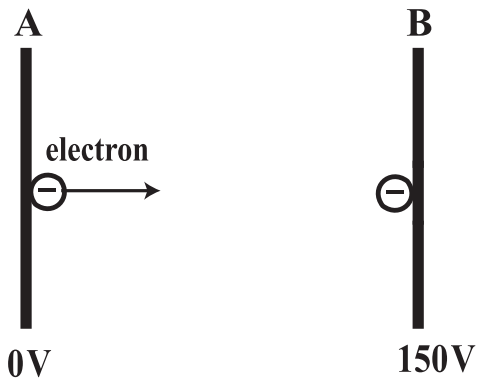
Question 1 continued

10) In the diagram shown below an electron is accelerated by two parallel plates (A) and (B). What is the de Broglie wavelength of the electron when it strikes plate (B)?



- ☐ 0.1 nm
- ☐ 0.83 nm
- ☐ 1.0 nm
- ☐ 8.3 nm

11) Which of the following statements explains the meaning of isotopes?

- ☐ Nuclei with the same proton number and nucleon number.
- ☐ Nuclei with a different proton number and nucleon number.
- ☐ Nuclei with the same proton number but a different neutron number.
- ☐ Nuclei with a different proton number but the same neutron number.

12) If (${}^{238}_{92}U$) nucleus undergoes successive (8) Alpha decays and (6) Beta decays, what is the resulting nucleus?

- ☐ ${}^{206}_{82}Pb$
- ☐ ${}^{207}_{82}Pb$
- ☐ ${}^{210}_{82}Pb$
- ☐ ${}^{214}_{82}Pb$

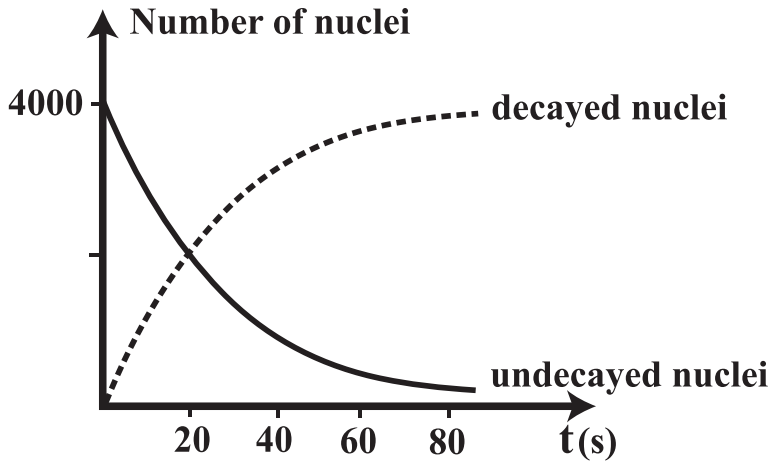
Question 1 continued

13) What is the value of energy released from the following decay equation?

$$^{1}_{0}n \longrightarrow {}^{1}_{1}p + {}^{0}_{-1}e + \text{energy}$$

- ☐ 0.271 MeV
- ☐ 0.511 MeV
- ☐ 0.783 MeV
- ☐ 1.293 MeV

14) What is the activity of the radioactive material shown in the figure below after (60 s)?

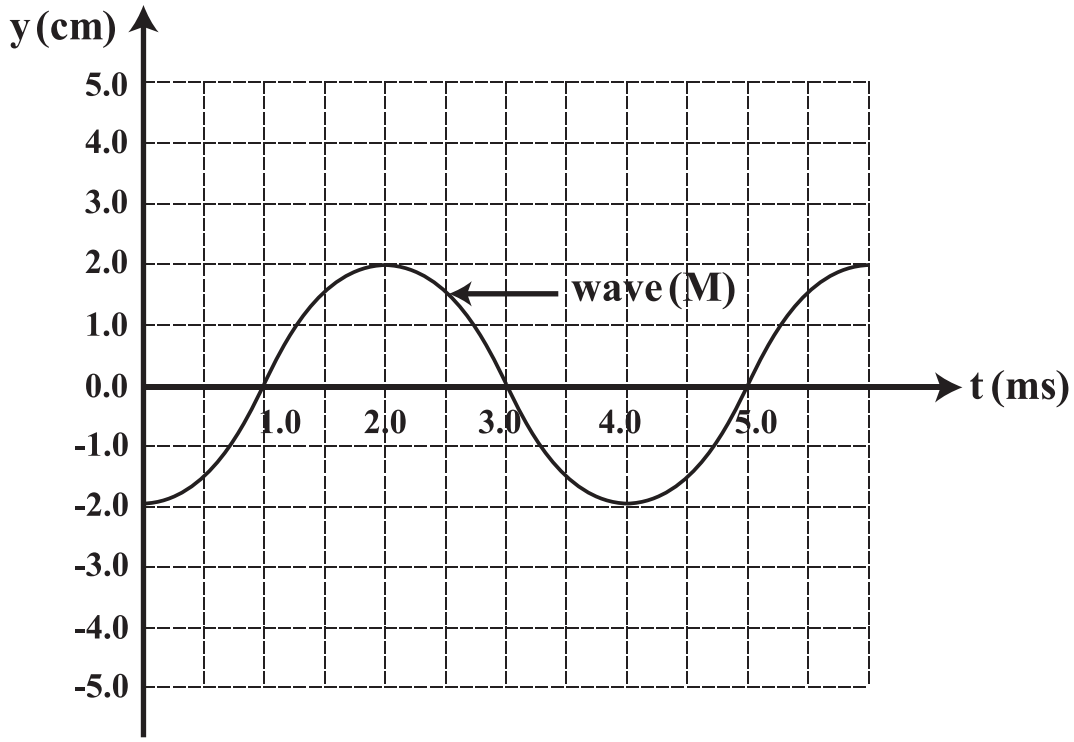


- ☐ 8.660 decays/s
- ☐ 17.325 decays/s
- ☐ 34.650 decays/s
- ☐ 46.199 decays/s

Question 2: Extended Questions (56 marks)

Write your answer for each of the following questions in the space provided.
Be sure to show all your work, including the correct units where applicable.

15) The graph below shows the variation of displacement (y) with time (t) of a wave (M) which has an intensity of (I).?



a. Write two characteristics of electromagnetic waves. (2 marks)

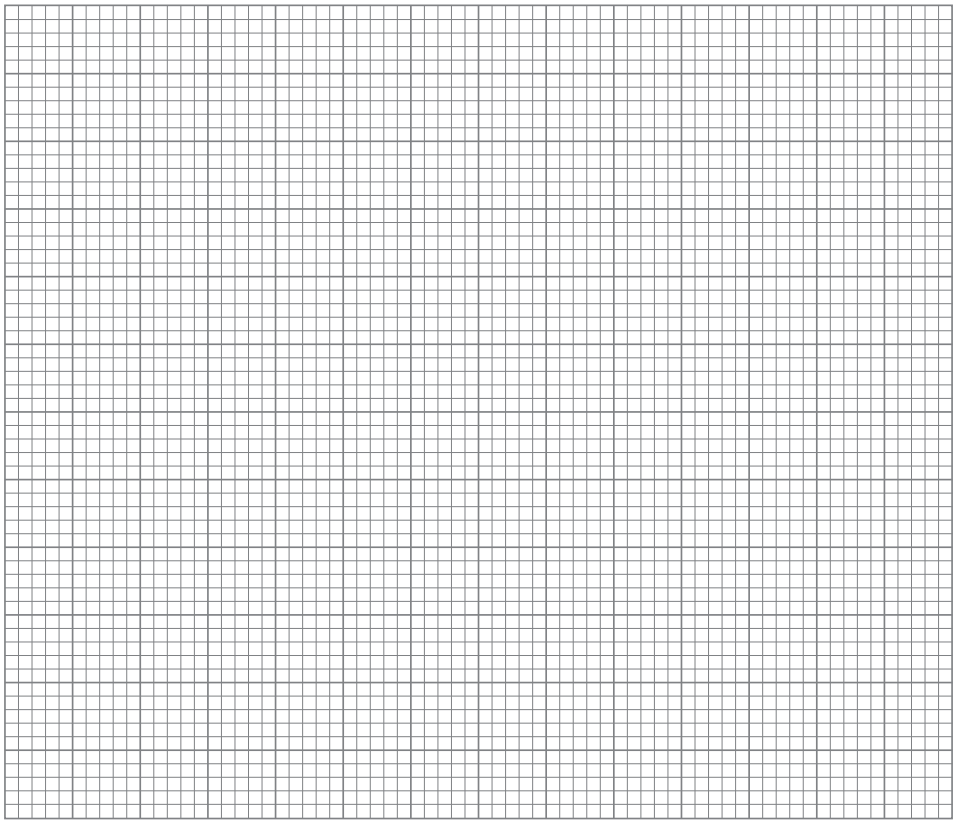
b. Determine the frequency of the wave (M). (2 marks)

Question 2 continued

c. A second wave (Z) with the same frequency as wave (M) has an intensity of (3 I) and the phase difference between the two waves is (90°).

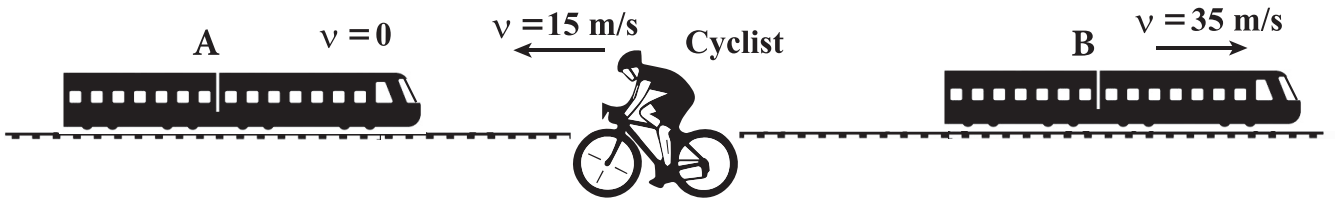
(i) Find the amplitude of wave (Z). (2 marks)

(ii) Sketch the variation of the displacement (y) with time (t) of wave (Z). (1 mark)



Question 2 continued

16) Two train whistles (A) and (B) each have a sound frequency of (392 Hz). Train (A) is stationary and train (B) is moving away from train (A) at a speed of (35 m/s). A cyclist is between them and moving towards train (A) with a speed of (15 m/s) as shown in the figure below.



a. Define the Doppler Effect. (2 marks)

b. Calculate the frequency of the whistle sound heard by the cyclist from train (A) only. (2 marks)

c. Calculate the sound wavelenght heard by the cyclist from train (B) only. (2 marks)

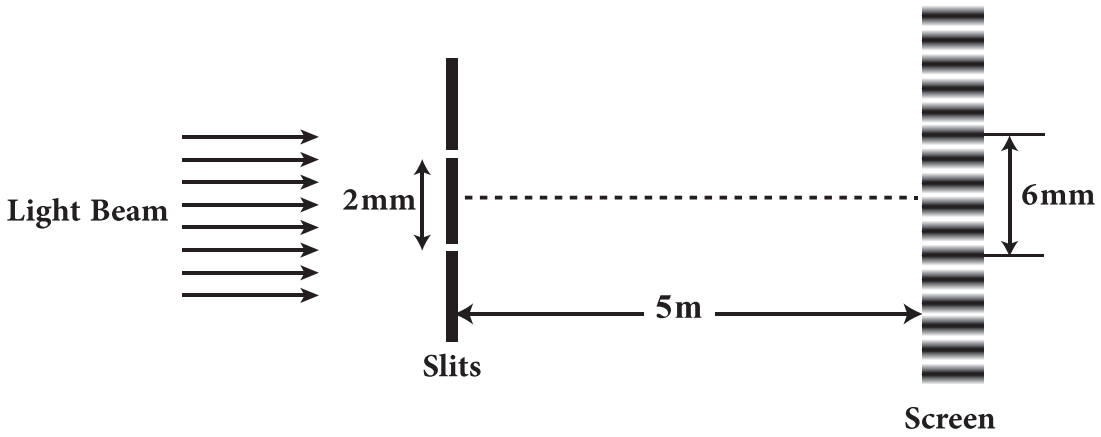
Question 2 continued

17) A string of (30 cm) length is adjusted to produce a fundamental mode at a frequency of (196 Hz).

a. What do we mean by a resonance effect? (2 marks)

b. Find the speed of the wave on the string. (2 marks)

18) Coherent monochromatic light of wavelength (λ) is incident on two narrow slits which are (2 mm) apart. The pattern observed on the screen is (5 m) away from the slits as shown in the figure below.

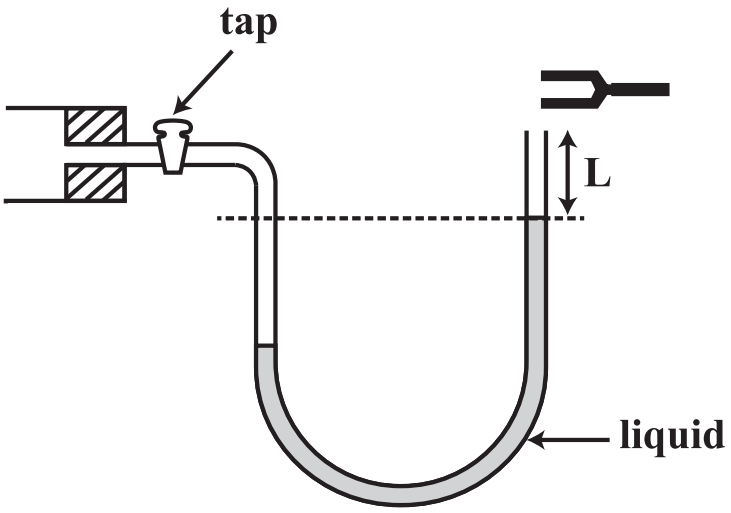


a. State two properties of light waves that happened in this case. (2 marks)

Question 2 continued

b. Determine the wavelength of the light. (4 marks)

19) A tuning fork of (460 Hz) causes resonance in the tube shown in the figure below when the length (L) of the air column above the water is (18.3 cm) and (55.8 cm) respectively.



a. State the principle of superposition. (1 mark)

Question 2 continued

b. Calculate the speed of the sound caused by the tuning fork in the air column. (3 marks)

c. Find the (n^{th}) harmonic mode. (3 marks)

20) The electron in a hydrogen atom makes a transition from an energy level at (-3.4 eV) to a level at (-1.5 eV).

a. What is the type of the line spectrum? (1 mark)

b. Find the frequency of the transition. (2 marks)

Question 2 continued

21) A student uses an experiment to investigate the photoelectric effects as shown in figure (A). The variation of the stopping voltage against the frequency is shown in figure (B).

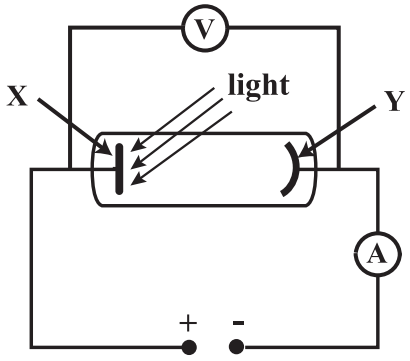


figure (A)

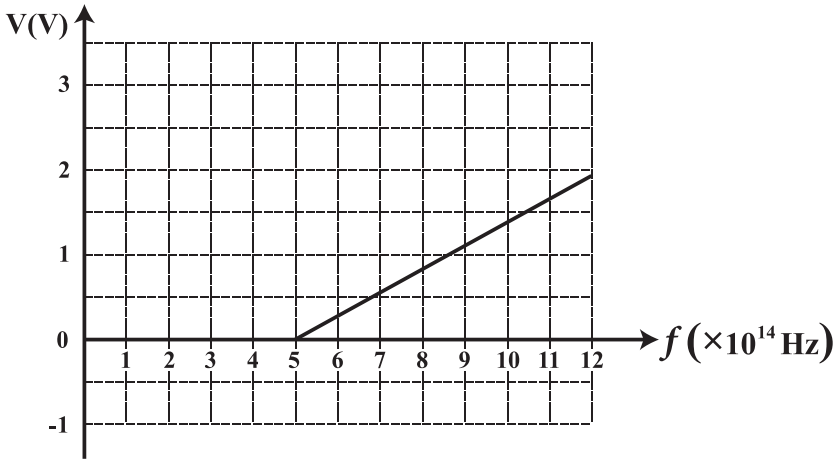


figure (B)

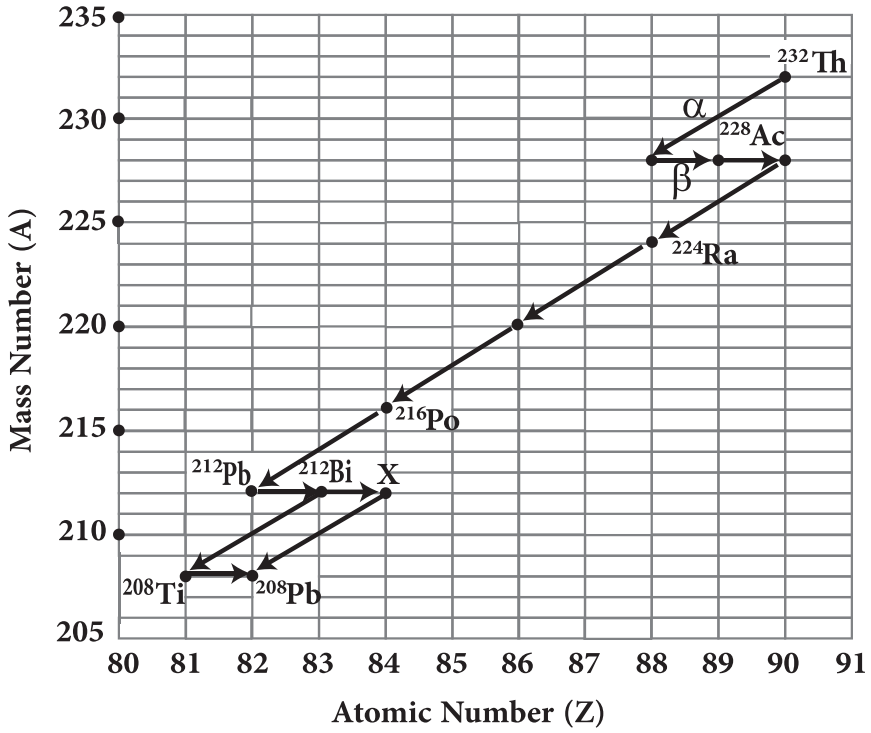
a. Name the parts in figure (A) which are labeled (X) and (Y). (2 marks)

b. What is the stopping potential for the photoelectrons ejected by light of $(11 \times 10^{14}$ Hz) frequency? (4 marks)

Question 2 continued

c. How many photons with a frequency of (7×10^{14} Hz) are required to emit electrons with a total kinetic energy of (165×10^{3} eV). (2 marks)

22) The graph below shows the decay series of ($^{232}_{90}Th$) nucleus.



a. Define the term "nucleon number". (1 mark)

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Question 2 continued

b. What is the number of neutrons in the atom of element (X)? (1 mark)

c. Write a nuclear equation to represent the decay of ($^{232}_{90}Th$) nucleus to ($^{228}_{89}Ac$) nucleus. (1 mark)

23) A sample of a radioactive element has a mass of (6.96 g). After 2 hours and 54 minutes its mass is reduced to (1.74 g).

a. What is meant by "the half-life of an element is 8 hours"? (2 marks)

b. Calculate the half-life of the element per minute. (3 marks)

Question 2 continued

24) The nuclear fusion between deuterium nucleus ($^{2}_{1}H$) and tritium nucleus ($^{3}_{1}H$) is represented in the following equation:

$$^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n + energy$$

Where the released energy is equal to (17.7 MeV). The binding energies per nucleon are given in the following table:

nuclei	Binding energy per nucleon (MeV)
$^{2}_{1}H$	1.12
$^{4}_{2}He$	7.07
$^{1}_{0}n$	–

a. State what is meant by nuclear fusion. (2 marks)

b. Calculate the mass defect in (kg) of helium ($^{4}_{2}He$) nucleus. (2 marks)

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Question 2 continued

c. Determine the binding energy per nucleon (in MeV) for tritium nucleus ($^{3}_{1}H$).

(3 marks)

[End of Examination]

FORMULA AND CONSTANTS

Waves

CONSTANTS				
$c = 3.0\times10^{8} m/s$ $v_{air} = 340\ m/s$ $n_{water} = 1.33$ $n_{air} = 1$	$v = \lambda f$	$f_o = \frac{f_s v}{(v \pm v_s)}$	$f_o = \frac{f_s (v \pm v_o)}{v}$	$f_o = \frac{f_s (v \pm v_o)}{(v \mp v_s)}$

Superposition

CONSTANTS				
$g = 9.8\ m/s^2$	$n\lambda = \frac{ax}{D}$	$(n+\frac{1}{2})\lambda = \frac{ax}{D}$	$f_n = \frac{nc}{2L}$	$f_n = \frac{(2n-1)c}{4L}$
	$sin\theta = \frac{n\lambda}{a}$	$dsin\theta = n\lambda$	$d = \frac{I}{n}$	

Quantum physics

CONSTANTS				
$e = 1.6\times10^{-19} C$ $m_{electron} = 9.11\times10^{-31} kg$ $m_{proton} = 1.67\times10^{-27} kg$ $h = 6.63\times10^{-34} J.s$	$\emptyset = hf_o$	$hf = \emptyset + \frac{1}{2} m v_{max}^2$	$\frac{1}{2} m v_{max}^2 = eV_o$	$\lambda = \frac{h}{P}$
	$E = h.f$	$\Delta E = hf = E_2 - E_1 = \frac{hc}{\lambda}$		

Particle and nuclear physics

CONSTANTS				
$m_p = 1.007276u$ $m_n = 1.008665u$ $m_e = 0.000549u$ $1MeV = 1.60\times10^{-13} J$ $1u = 931\ MeV$	$A = -\frac{dN}{dt} = N\lambda$	$N = N_o e^{-\lambda t}$	$\lambda = \frac{0.693}{t_{1/2}}$	$E = mc^2$
	$E_b = \Delta mc^2$	$E_n = \frac{E_b}{A}$		

مُسَوَّدَة

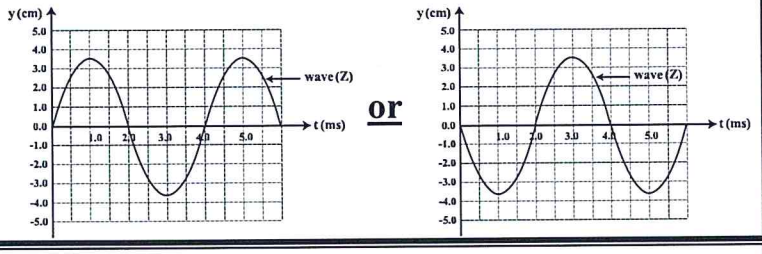
Physics 2018/2019 Bilingual Exam - 2nd Semester, 1st Session

Marking Guide

ANSWERS TO MULTIPLE CHOICE QUESTIONS :(14 marks)

Item	Answer	Mark	C.L	OB
1	B	1	K	1.1b
2	0.8 m/s	1	A	1.1c
3	$v_2 = \frac{3}{2}v_1$	1	R	1.3b
4	same | same | opposite	1	K	2.2b
5	2	1	A	2.5b
6	500 Hz	1	A	2.3b
7	32 | 0.6	1	R	2.2d
8	Conservation of Energy	1	K	3.2f
9	1.83×10^3	1	R	3.3b
10	0.1 nm	1	A	3.2h 3.3b
11	Nuclei with same proton number but different neutron number.	1	K	4.1d
12	$^{206}_{82}Pb$	1	A	4.1g 4.1h
13	0.783 Mev	1	A	4.3a
14	17.325 decays/s	1	R	4.2c 4.2f

ANSWERS TO EXTENDED QUESTIONS :(56 marks)

Item	Part	Answer	Mark	C.L	OB
15	a	▪ It is transvers waves. ▪ Consist of electric and magnetic fields. ▪ Show all properties common to wave motion. ▪ In vacuum it traveled with speed (3×10^8 m/s). (any two from the above, each is given one mark)	2	K	1.5b
	b	$T = 0.004s$ $f = \frac{1}{0.004} = 250Hz$	1 1	A	1.1b
	c-i	$\frac{I}{3I} = \frac{A_1^2}{A_2^2} = \frac{4}{A_2^2}$ $A_2^2 = \sqrt{12} = 3.5cm$	1 1	R	1.1f
	c-ii		1	R	1.1f
16	a	The change in frequency or wavelength of a wave in relation to an observer who is moving relative to the wave source.	2	K	1.4g
	b	$f_o = f_s\left(\frac{v+v_o}{v_o}\right)$ $f_o = 392\left(\frac{340+15}{340}\right)$ $= 409.3$ Hz	 1 1	A	1.4d

ANSWERS TO EXTENDED QUESTIONS :(56 marks)

Item	Part	Answer	Mark	C.L	OB
16	c	$f = f_s\left(\frac{v-v_o}{v+v_s}\right)$ $f = 392\left(\frac{340-15}{340+35}\right) = 339.73\ Hz$ $v = \lambda f \rightarrow \lambda = \frac{v}{f}$ $\therefore \lambda = \frac{340}{339.73} = 1.0m$	1 1	A	1.4b
17	a	It is the effect which occurs when a string is plucked and allowed to vibrate freely, there are certain frequencies at which it will vibrate at large amplitude.	2	K	2.3a
	b	$L = \frac{1}{2}\lambda \Rightarrow \lambda = 2\times 0.3 = 0.6m$ $v = \lambda f$ $= 0.6\times 196 = 117.6m/s$	1 1	A	2.2d

ANSWERS TO EXTENDED QUESTIONS :(56 marks)

Item	Part	Answer	Mark	C.L	OB
18	a	1- Interference. 2- Diffraction.	1 1	K	2.1a,b 2.4a
	b	From diagram: $n = 2\ dark\ fring$ $x = \frac{6\times10^{-3}}{2}$ $= 3 \times 10^{-3}m$ Equation of dark fringes: $\left(n+\frac{1}{2}\right)\lambda = \frac{ax}{D}$ $2.5\lambda = \frac{(2\times10^{-3})\times(3\times10^{-3})}{5}$ $\lambda = 4.8 \times 10^{-7}m$	 1 1 1 1	A	2.1i
	a	When two or more waves meet at point, the resultant displacement at that point is equal to the sum of the displacements of individual waves at that point.	1	K	2.2a
	b	$\lambda = 2(L_{n+1} - L_n)$ $= 2(55.8 \times 10^{-2} - 18.3 \times 10^{-2}) = 0.75\text{m}$ $c = f\lambda = 460 \times 0.75$ $= 345m/s$	 1 1 1	A	2.3c
	c	$f_n = \frac{(2n-1)c}{4L}$ $\text{n} = \left(\frac{(4\times460\times0.183)}{345} + 1\right) \times 0.5$ $= 0.988 \cong 1$	 2 1	R	2.3b

ANSWERS TO EXTENDED QUESTIONS :(56 marks)

Item	Part	Answer	Mark	C.L	OB
20	a	Absorption spectra	1	K	3.4b
	b	$\Delta E = E_2 - E_1$ $= (-1.5) - (-3.4) = 1.9eV$ $f = \frac{\Delta E}{h}$ $= \frac{1.9(1.6\times10^{-19})}{6.63\times10^{-34}} = 4.6\times10^{14}Hz$	1 1	A	3.4c
21	a	X: Emitter or Cathode Y: Collector or Anode	1 1	K	3.2g
	b	From the graph: $f_o = 5 \times 10^{14}Hz$ $\therefore \emptyset = hf_o$ $= 6.6 \times 10^{-34} \times 5 \times 10^{14}$ $= 3.3 \times 10^{-19}J = 2.06\ eV$ $E, = h.f$ $= 6.6 \times 10^{-34} \times 11 \times 10^{14}$ $= 7.26 \times 10^{-19}J = 4.54\ eV$ From equation: $V = E(eV) - \emptyset(eV)$ $V = 4.54 - 2.06 = 2.48V$	1 1 1	A	3.1c 3.2c 3.2h

ANSWERS TO EXTENDED QUESTIONS :(56 marks)

Item	Part	Answer	Mark	C.L	OB
21	c	Finding the kinetic energy of each electron: $KE = hf - \phi$ $= 6.6 \times 10^{-34} \times 7 \times 10^{14} - 3.3 \times 10^{-19} J$ $= 1.32 \times 10^{-19} J = 0.825 eV$ Finding the number of emitted electrons: $N = \frac{165 \times 10^3}{0.825} = 2 \times 10^5 electrons$ $Number\ of\ electrons\ =\ Number\ of\ photons$ $\therefore Number\ of\ photons = 2 \times 10^5$	1 1	R	3.2d 3.2f
22	a	The total number of protons and neutrons in the nucleus.	1	K	4.1c
	b	212 - 84 = 128 neutrons	1	A	4.1d
	c	$^{232}_{90}Th \rightarrow {}^{228}_{89}Ac + {}^{4}_{2}He + {}^{0}_{-1}e$	1	A	4.1f 4.1i
23	a	8 hours required for one-half of the original nucleus to decay.	2	K	4.2e
	b	$\frac{1.74}{6.96} = 0.25$ This means (0.25) of the original sample is remaining. So there are two half- lifes. $t_{1/2} = \frac{74min}{2} = 87min = 1hour\ and\ 27\ min$ **Another solution:** $6.96 \div 2 = 3.48\ t_{1/2}$ [1] $3.48 \div 2 = 1.74\ t_{1/2}$ [1] $2t_{1/2}$= 2h and 54min $\therefore t_{1/2}$ = 1h and 27min [1]	1 1+1	A	4.2e

ANSWERS TO EXTENDED QUESTIONS :(56 marks)

Item	Part	Answer	Mark	C.L	OB
24	a	Nuclear fusion occurs when two light nuclei combine to form a nucleus of greater mass.	2	K	4.3f
	b	From the equation: $E = m.c^2$ $E_b(binding\ energy) = \Delta m.c^2$ $E_n(binding\ energy\ per\ nucleon) = \frac{E_b}{A}$ $\therefore A.E_n = \Delta m.c^2$ $\Delta m = \frac{A.E_n}{c^2}$ $= \frac{4\times7.07\times10^6\times1.6\times10^{-19}}{(3\times10^8)^2}$ $= 5.03\times10^{-29}kg$	1 1	A	4.3a 4.3b
	c	$E(\text{energy released}) = \Sigma E_b(\text{after reaction}) - \Sigma E_b(\text{before reaction})$ $17.7 = (4\times7.07) - ([2\times1.12] + [3E_{n(\text{of Tririum})}])$ $E_{n(\text{of Tririum})} = \frac{8.34}{3}$ $= 2.78$ MeV	1 1 1	R	4.3a 4.3d

End Of Marking Guide