سلطنة عمان
وزارة التربية والتعليم

امتحان دبلوم التعليم العام للمدارس الخاصة (ثنائية اللغة)
للعام الدراسي ١٤٣٦/١٤٣٥ هـ - ٢٠١٤ / ٢٠١٥ م
الدور الأول - الفصل الدراسي الثاني

تنبيه
- المادة: الفيزياء.
- الأسئلة في (١٣) صفحة.
- زمن الإجابة: ثلاث ساعات.
- الإجابة في الورقة نفسها.

تعليمات وضوابط التقدم للامتحـان:

- الحضور إلى اللجنة قبل عشر دقائق من بدء الامتحان للأهمية.
- إبراز البطاقة الشخصية لمراقب اللجنـة.
- يمنع كتابة رقم الجلوس أو الاسم أو أي بيانات أخرى تدل على شخصية الممتحن في دفتر الامتحان، وإلا ألغي امتحانه.
- يحظر على الممتحنين أن يصطحبوا معهم بمركز الامتحان كتبا دراسية أو كراسات أو مذكرات أو هواتف محمولة أو أجهزة النداء الآلي أو أي شيء له علاقة بالامتحان كما لا يجوز إدخال آلات حادة أو أسلحة من أي نوع كانت أو حقائب يدوية أو آلات حاسبة ذات صفة تخزينية.
- يجب أن يتقيد المتقدمون بالزي الرسمي (الدشداشة البيضاء والمصر أو الكمة للطلاب والدارسين والزي المدرسي للطالبات واللباس العماني للدارسات) ويمنع النقاب داخل المركز ولجان الامتحان.
- لا يسمح للمتقدم المتأخر عن موعد بداية الامتحان بالدخول إلا إذا كان التأخير بعذر قاهر يقبله رئيس المركز وفي حدود عشر دقائق فقط.
- يتم الالتزام بالإجراءات الواردة في دليل الطالب لأداء امتحان دبلوم التعليم العام.
- 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 - عاصمـة سلطنة عمـــان 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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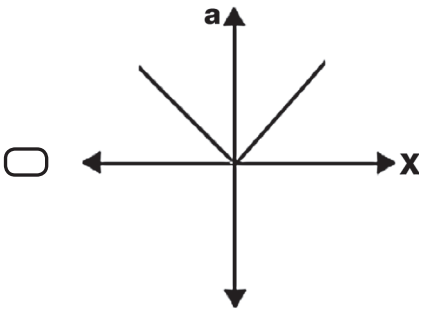
Multiple Choice Questions (28 marks)

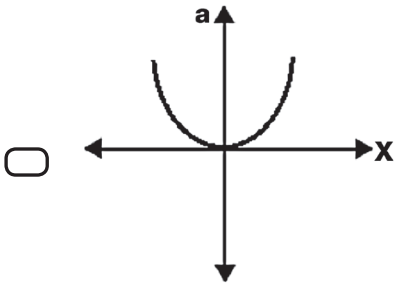
There are 14 multiple-choice items worth two marks each.
Shade in the **correct** answer for each of the following items .

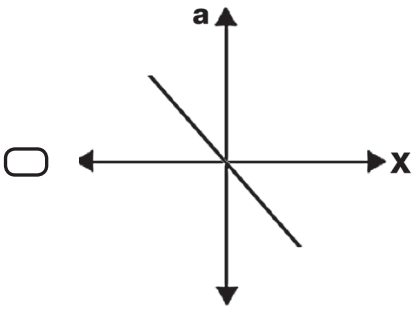
1) Which of the following will be at its maximum value when a simple pendulum in simple harmonic motion is at equilibrium position?

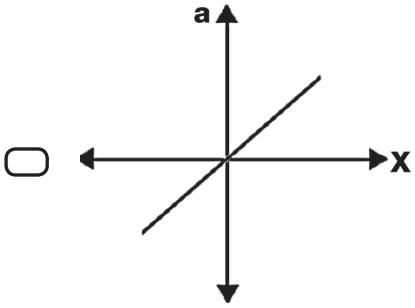
- ☐ Velocity.
- ☐ Amplitude.
- ☐ Acceleration.
- ☐ Displacement.

2) A particle performs a simple harmonic motion. Which of the following graphs of acceleration (a) versus displacement (x) is correct?

☐ 

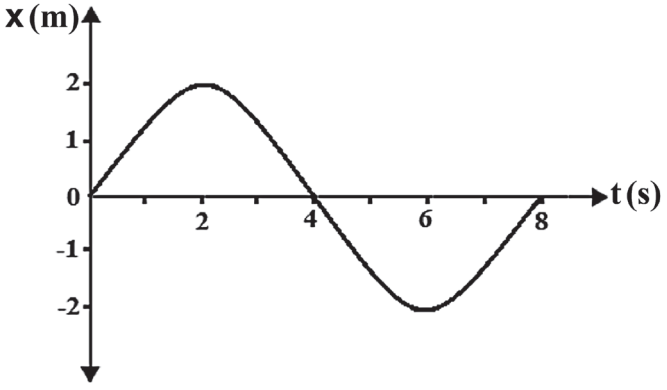
☐ 

☐ 

☐ 

3) A particle moving in (SHM) is represented by the graph below. Which of the following equations represents the velocity of the particle as a function of time?

- ☐ $v(t) = \frac{\pi}{2} \cos(\frac{\pi}{4} t)$
- ☐ $v(t) = \frac{\pi}{2} \sin(\frac{\pi}{4} t)$
- ☐ $v(t) = \frac{\pi}{2} \cos(\frac{\pi}{2} t)$
- ☐ $v(t) = \frac{\pi}{2} \sin(\frac{\pi}{2} t)$



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Multiple Choice continued

4) Which of the following correctly summarizes what happens to frequency (f) and wavelength (λ) when light waves propagate from air to glass?

	Frequency (f)	Wavelength (λ)
☐	Increases	Decreases
☐	Does not change	Increases
☐	Does not change	Decreases
☐	Increases	Does not change

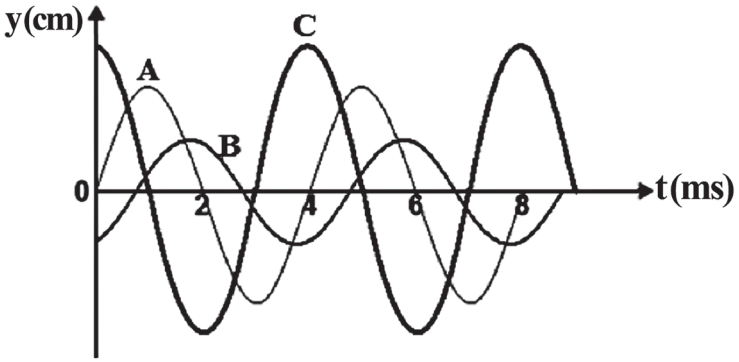
5) The figure below shows three different waves (A, B and C). What is the phase difference between wave (A) and wave (C)?

☐ $\frac{\pi}{4}$

☐ $\frac{\pi}{2}$

☐ $\frac{\pi}{8}$

☐ π



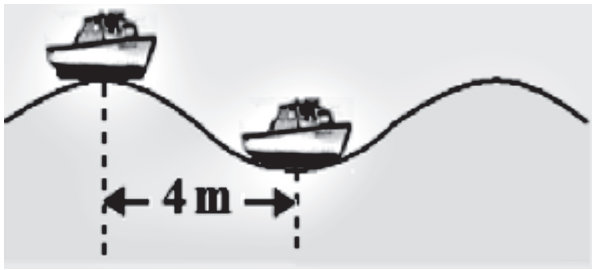
6) Two boats are anchored (4 m) apart as shown in the figure below. They bob up and down, returning to the same position every (3 s). What is the speed of the waves?

☐ 1.33 m/s

☐ 2.67m/s

☐ 12 m/s

☐ 24 m/s



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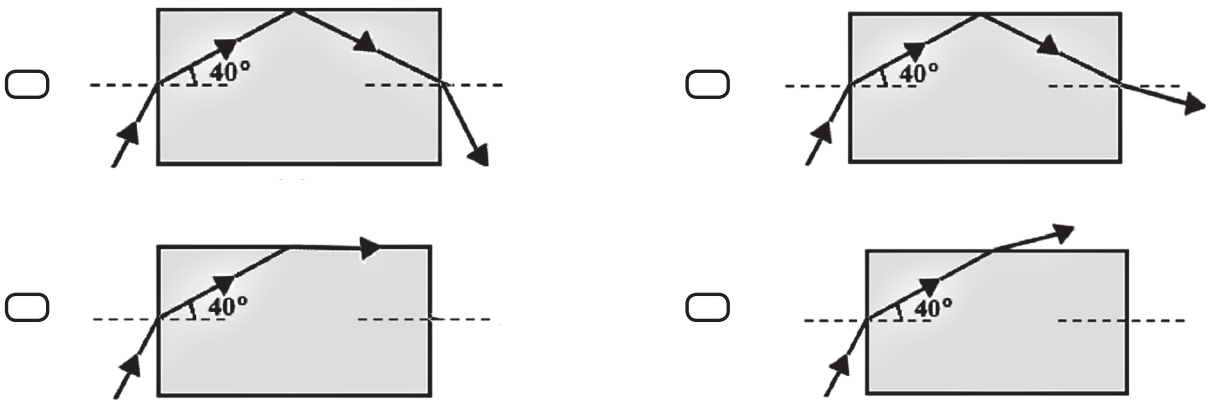
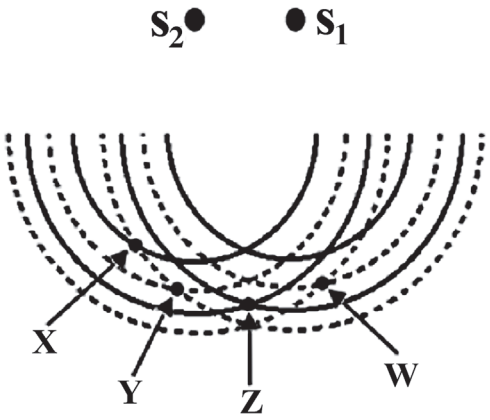
Multiple Choice continued

7) A ray of light is incident on one side of a rectangular glass block. If the angle of refraction in the glass is (40°), which of the following diagrams best represents the refracted ray? (The critical angle of glass is 42°).



8) **(S_1)** and **(S_2)** are sources of waves of equal amplitude and wavelength as shown in the figure below. Which point represents a destructive interference?

- Z
- Y
- X
- W



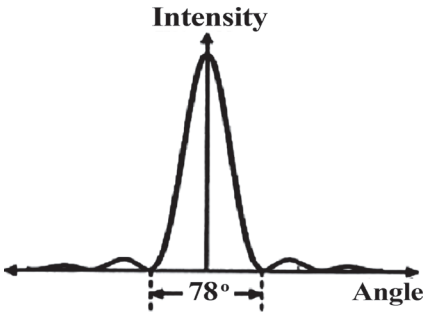
9) A rope is connected between a wave generator (f =50 Hz) and a wall. When the wave generator is operated, standing waves are formed with three antinodes.
If the speed of the waves equals (20 m/s), what is the length of the rope?

- 0.2 m
- 0.4 m
- 0.6 m
- 0.8 m

Multiple Choice continued

10) The graph below shows the intensity against the diffraction angle of a microwave of wavelength (λ) passing through a gap. What is the width of the gap?

- ☐ 0.63 λ
- ☐ 0.98 λ
- ☐ 1.02 λ
- ☐ 1.59 λ

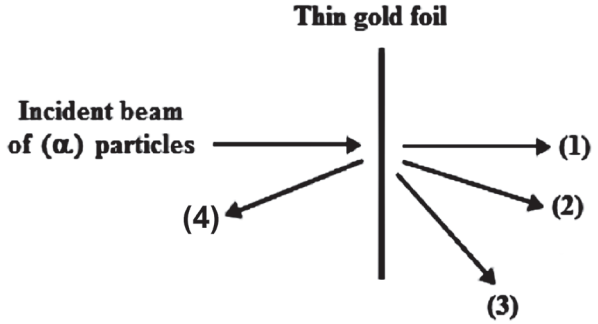


11) A police car's siren emits a sinusoidal wave with a frequency of (320 Hz) and a speed of (340 m/s). When the car moves at (40 m/s) towards a stationary listener, the Doppler effect phenomenon occurs. Which of the following statements describe what happens to the frequency and to the wavelength?

	Wavelength	frequency
☐	Decreases by (1.11m)	Decreases by (42.5Hz)
☐	Increases by (1.11m)	Increases by (42.5Hz)
☐	Increases by (0.125m)	Decreases by (37.6Hz)
☐	Decreases by (0.125m)	Increases by (37.6Hz)

12) In Rutherford's experiment, a narrow beam of α - particles was fired towards a thin piece of gold foil, as shown in the diagram below. What was the final direction of most of the α – particles?

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4



13) If the work function of a substance is (4.0 eV), how much must be the longest wavelength of light that causes photoelectric emission from this substance?

- ☐ 127 nm
- ☐ 311 nm
- ☐ 497 nm
- ☐ 796 nm

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Multiple Choice continued

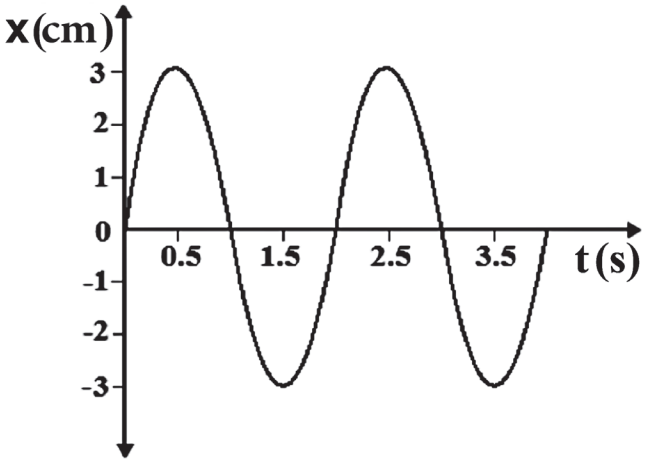
14) In a photoelectric effect, when the exciting wavelength is (λ), the fastest electron has a speed of (v). If the exciting wavelength is changed to ($3\lambda/4$), what will be the new speed of the fastest emitted electron?

- ☐ $\sqrt{\frac{3}{4}}v$
- ☐ $\sqrt{\frac{4}{3}}v$
- ☐ $\frac{3}{4}v$
- ☐ $\frac{4}{3}v$

Extended Questions (42 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) An object is undergoing simple harmonic motion. The graph below shows the position of the object as a function of time.



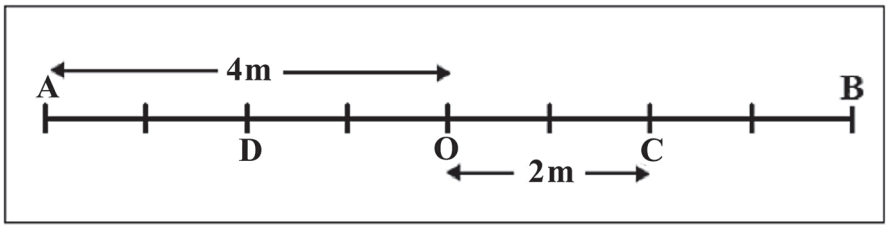
a. State two characteristics of the acceleration of this object. [2 marks]

b. After the object starts moving, when will it reach its maximum speed for the first time ? [1 mark]

c. Show that the maximum acceleration is equal to ($a = 3\pi^2 cm/s^2$). [2 marks]

Extended Questions continued

16) A (4 kg) mass attached to a spring is moving with (SHM) of period (24 s) between two points (A) and (B) as shown in figure below.



a. Find the time taken for the particle to travel between the following positions:

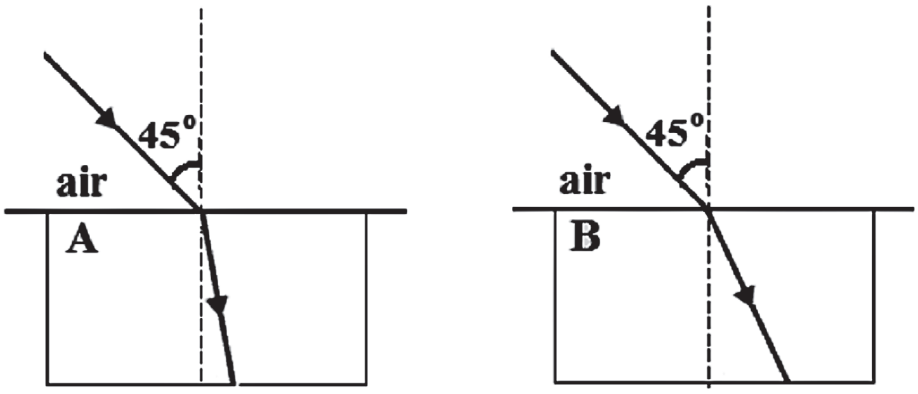
i. From (A) to (B) [1 mark]

ii. From (O) to (C) [2 marks]

b. What will be the period of the oscillation if (6 kg) mass is added to the same spring? [2 marks]

Extended Questions continued

17) The figure below shows rays of light entering two transparent materials (A) and (B).



Which material (A) or (B) has a greater refractive index? [1 mark]

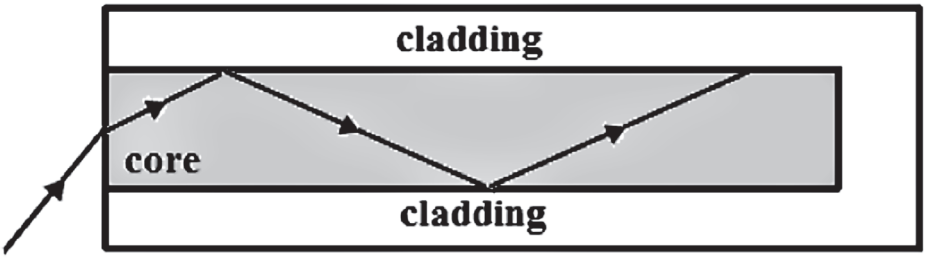
Explain your answer. [1 mark]

18) What is meant by longitudinal waves? Give one example. [2 marks]

Extended Questions continued

19) A wave is travelling with amplitude (A) and energy (E). By how much the energy transferred by the wave will change if the amplitude is reduced by half?
Show your work [2 marks]

20) The figure below shows a fiber optic cable. The core is made of glass of refractive index (1.47) and the cladding is made of glass of refractive index (1.45).



a. Calculate the speed of light in the following:

i. The core [2 marks]

ii. The cladding. [2 marks]

Extended Questions continued

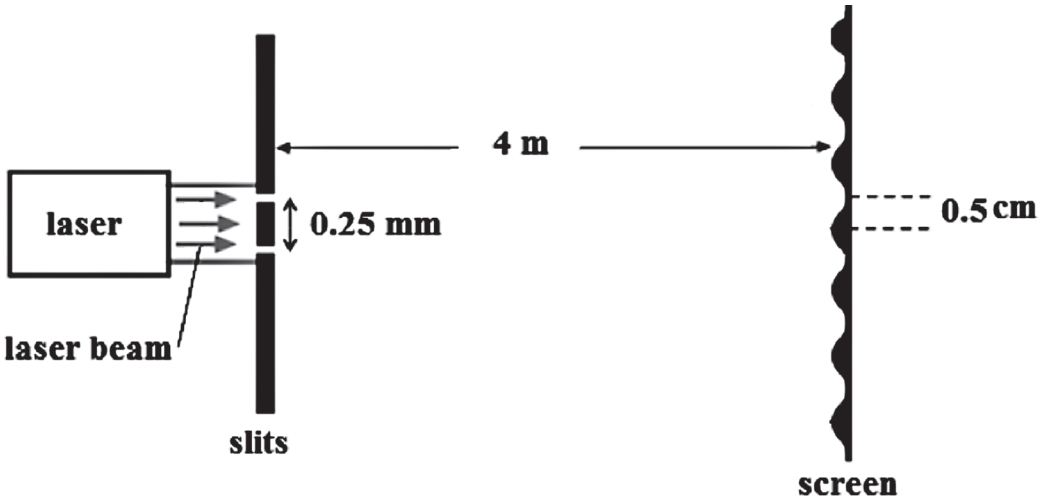
b. Find the critical angle for the light to stay inside the fiber optic cable. [2 marks]

21) You can block sunlight from your eyes by using your hands, while you cannot block sound from your ears by the same way. Explain why that happen. [2 marks]

22) A diffraction grating (1.0 cm) in length contains (3600 slits). Find the angle of the first intensity maximum in the diffraction pattern with red light (λ = 670nm)? [2 marks]

Extended Questions continued

23) The figure below shows an arrangement used to determine the wavelength of a laser beam.



a. First dark and bright fringes are observed on screen, what is the phase difference of the waves arriving at the center of the dark fringe? [1 mark]

b. Calculate the wavelength of the laser beam. [3 marks]

c. If the distance between the screen and the slits is decreased, describe the effect of this on the appearance of the fringes. [1 mark]

Explain your answer. [1 mark]

Extended Questions continued

24) In a photoelectric effect, an incident light emits monoenergetic photons of energy (5.0 eV) from a metallic surface of work function (3.0 eV).

a. Define the work function. [2 marks]

b. Calculate the maximum kinetic energy in (J) of the emitted photoelectrons. [2 marks]

c. Find the ratio of the wavelength of incident light to the de-Broglie wavelength of the fastest photoelectron emitted. [2 marks]

Extended Questions continued

25) Two sources produce electromagnetic waves. Source (B) produces a wavelength that is four times the wavelength produced by source (A). Each photon from source (A) have energy of (2.1×10^{-18}J). What is the energy of a photon from source (B)? [2 marks]

26) If the energy (E) of a photon is (6.40×10^{-19}J) and its momentum (P) is (1.33×10^{-27}kg.m/s). Calculate the velocity (v) of the photon. [2 marks]

[End of Examination]

Periodic Motion

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

$$\omega = 2\pi f = \frac{2\pi}{T}$$

$$a = -(2\pi f)^2 x$$

$$x = A\sin(2\pi f t)$$

$$\upsilon = \pm 2\pi f\sqrt{A^2 - x^2}$$

$$\upsilon_{max} = \pm 2\pi f A$$

$$T = 2\pi\sqrt{\frac{l}{g}} = 2\pi\sqrt{\frac{m}{k}}$$

$$E = \frac{1}{2}m\omega^2 A^2$$

$$KE = \frac{1}{2}m\omega^2(A^2 - X^2)$$

Mechanical Waves

$$\upsilon = f\lambda$$

$$\upsilon = \frac{\Delta x}{\Delta t}$$

$$c = f\lambda$$

$${}_1n_2 = \frac{\sin i}{\sin r} = \frac{\upsilon_1}{\upsilon_2} = \frac{n_2}{n_1}$$

$$n = \frac{1}{\sin c}$$

Superposition of waves

$$\sin\theta = \frac{\lambda}{b}$$

$$n\lambda = d\sin\theta$$

$$Young's\ equation\ \frac{\lambda}{s} = \frac{x}{D}$$

$$Doppler\ effect\ \frac{\Delta\lambda}{\lambda} = \frac{\Delta f}{f} = \frac{\upsilon}{c}$$

Atomic Physics

$$E = hf = h\frac{c}{\lambda}$$

$$KE_{max} = hf - hf_t$$

$$De\ Broglie\ wavelength = \frac{h}{m\upsilon}$$

$$2\pi r_n = n\lambda$$

$$\lambda = \frac{h}{p}$$

Constants

$c = 3\times10^8\ m/s$

$\upsilon_{air} = 340\ m/s$

$m_{proton} = 1.673\times10^{-27}\ kg$

$m_{electron} = 9.11\times10^{-31}\ kg$

$e = 1.6\times10^{-19}\ C$

$h = 6.63\times10^{-34}\ J.s$

$g = 9.8\ m/s^2$

$n_{air} = 1$

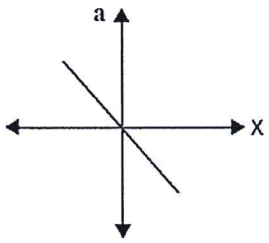
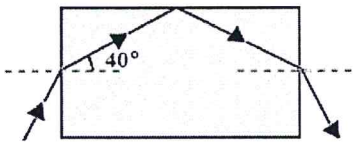
مُسَوَّدَة

Physics 2014/2015 Bilingual Exams

2nd Semester, 1st Session

Marking Guid

ANSWERS TO MULTIPLE CHOICE QUESTIONS:(28 marks)

Item	Answer	Answer	Mark	CL	OB
1	a	Velocity	2	K	1.3 1.7
2	c		2	A	1.4
3	a	$v(t) = \frac{\pi}{2}\cos\left(\frac{\pi}{4}t\right)$	2	A	1.5
4	c	Does not change | Decreases	2	K	2.3 2.4
5	b	$\frac{\pi}{2}$	2	A	2.2
6	b	2.67 m/s	2	A	2.3
7	a		2	R	2.10 2.14
8	c	X	2	K	3.9
9	c	0.6 m	2	A	3.3
10	d	1.59 λ	2	A	3.8
11	d	Decreases by (0.125m) | Increases by (37.6Hz)	2	R	3.12

Marking Guid

ANSWERS TO MULTIPLE CHOICE QUESTIONS:(28 marks)

Item	Answer	Answer	Mark	CL	OB
12	a	1	2	K	4.2
13	b	311 nm	2	A	4.7 4.8
14	b	$\sqrt{\frac{4}{3}}\,v$	2	R	4.1

ANSWERS TO EXTENDED QUESTIONS :(42 marks)

Item		Answer	Mark	CL	OB
15	a	• Directly proportional to the displacement. • Always towards the equilibrium position. Opposite to the direction of the displacement. • Always with minus (-) sign. **(Any two of them)**	2	K	1.4
	b	At t = 1 s	1	K	1.4
	c	$a = \omega^2 A = (4\pi^2 f^2)A$ $a = \left(\frac{4\pi^2}{T^2}\right)A$ $a = \left(\frac{4\pi^2}{4}\right)3$ $a = 3\pi^2\ cm/s^2$	1 1	A	1.5
16	a-i	From (A) to (B): half oscillation $\therefore$ t = 24/2 = 12s	1	R	1.3
	a-ii	From (O) to (C): $x = A\ sin\omega t$ $2 = 4\sin(\frac{2\pi}{T}t)$ $\therefore \sin(\frac{2\pi}{24}t) = \frac{2}{4}$ $sin^{-1}\left(\frac{1}{2}\right) = \frac{\pi}{12}t$ $\therefore t = \frac{12\times0.524}{\pi}$ $t = 2\ s\ \ (use\ radians)$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	R	1.5

ANSWERS TO EXTENDED QUESTIONS :(42 marks)

Item	Answer	Mark	CL	OB
16	b		R	1.5
	$T = 2\pi\sqrt{\frac{m}{k}}$			
	$T^2 = 4\pi^2\frac{m}{k}$	$\frac{1}{2}$		
	$k = \frac{4\pi^2 m}{T^2} = \frac{4\times\pi^2\times4}{24} = 0.27$ N/m	$\frac{1}{2}$		
	$T = 2\pi\sqrt{\frac{4+6}{0.27}}$	$\frac{1}{2}$		
	$T = 37.95\ s \approx 38$ s	$\frac{1}{2}$		
	Or			
	$\frac{T_1^2}{T_2^2} = \frac{m_1}{m_2}$ $(1\ mark)$			
	$T_2 = 24 \times \sqrt{\frac{10}{4}} = 37.95\ s \approx 38$ s (1 mark)			
17	- Material A - Because the light is deviated or bend more towards the normal line. **OR** because the refractive angle in A is smaller. **OR** because the medium in A is denser.	1 1	K	2.10
18	The longitudinal waves are the waves in which the oscillations are in the same direction (parallel) in which the wave is moving.	1	K	2.7
	Examples: Earthquake waves Water waves Sound waves Spring waves **(Any one of these examples)**	1		

ANSWERS TO EXTENDED QUESTIONS :(42 marks)

Item		Answer	Mark	CL	OB
19		$E \propto (\frac{1}{2}A)^2 = \frac{1}{4}A^2$ It will reduce by 1/4	2	A	2.6
20	a-i	$n = \frac{c}{v}$ $v = \frac{3\times10^8}{1.47}$ $v = 2.04 \times 10^8 m/s$	 1 1	A	2.12
	a-ii	$v = \frac{3\times10^8}{1.45}$ $v = 2.07 \times 10^8 m/s$	1 1	A	2.12
	b	Refractive index: $_{cladding}n_{core} = \frac{2.07\times10^8}{2.04\times10^8} = 1.014$ $sinC = \frac{1}{1.014}$ $\therefore C = 80.4^\circ$ ***OR*** $_{core}n_{cladding} = \frac{n_{cladding}}{n_{core}} = \frac{1.45}{1.47}$ $\frac{1}{2}$mark $= 0.9864$ $\frac{1}{2}$mark $sinC = 0.9864 \quad \therefore C = 80.5^\circ$ $(\frac{1}{2}+\frac{1}{2})$ **OR** $\frac{n_2}{n_1} = \frac{sin_i}{sin_r} \rightarrow \frac{1.45}{1.47} = \frac{sinC}{sin90}$ $(\frac{1}{2}+\frac{1}{2})$ $sinC = \frac{1.45}{1.47} \rightarrow sin^{-1}\left(\frac{1.45}{1.47}\right) = 80.5^\circ(\frac{1}{2}+\frac{1}{2})$ $\therefore C = 80.5^\circ$	$\frac{1}{2}+\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	R	2.13

ANSWERS TO EXTENDED QUESTIONS :(42 marks)

Item		Answer	Mark	CL	OB
21		Because light waves are not diffracted when they pass through a very narrow gap, while sound waves passing through your fingers are diffracted so you can hear the voice. OR Because the wavelength of the sound wave is greater than the size of the gab, and the wavelength of the light is shorter than the size of the gab.	1 1	K	3.5
22		$d = \frac{1cm}{3600} = 2.78 \times 10^{-6}m$ $n\lambda = dsin\theta$ $n = 1$ $sin\theta = \frac{n\lambda}{d} = \frac{670\times10^{-9}}{2.78\times10^{-6}} = 0.24$ $\theta = 13.9^{\circ}$	$\frac{1}{2}+\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	R	3.11
23	a	Phase difference = 180° **Or** π radians	1	K	3.2
	b	$x = 2 \times 0.5 = 1cm = 1 \times 10^{-2}$ $\frac{\lambda}{s} = \frac{x}{D} \gg \lambda = \frac{(s)(x)}{D}$ $\lambda = \frac{0.25\times10^{-3}\times1\times10^{-2}}{4}$ $\therefore \lambda = 6.25 \times 10^{-7}m$	1 1 1	A	3.10

ANSWERS TO EXTENDED QUESTIONS :(42 marks)

Item		Answer	Mark	CL	OB
23	c	The separation between the dark (or bright) fringes will decrease. Because the fringe separation x is directly proportional to the distance D between the slits and the screen. $x = \frac{\lambda D}{s} \rightarrow x \propto D$	1 1	A	3.10
24	a	The Work function is: the smallest amount of energy the electron must have to escape from the surface of a metal.	1 1	K	4.8
	b	$KE_{max} = 5.0 - 3.0 = 2.0$ eV $= 2.0\times1.6\times10^{-19} = 3.2\times10^{-19}$ J	$\frac{1}{2} + \frac{1}{2}$	A	4.8
	c	$v_{max} = \sqrt{\frac{2KE_{max}}{m}}$ de- Broglie wavelength: $\lambda' = \frac{h}{mv_{max}} = \frac{h}{\sqrt{m}.\sqrt{m}.\sqrt{\frac{2KE_{max}}{m}}} = \frac{h}{\sqrt{2mKE_{max}}}$ Incident photon wavelength: $\lambda = \frac{hc}{5\times(1.6\times10^{-19})} = \frac{hc}{8\times10^{-19}}$ $\frac{\lambda_{incident}}{\lambda_{de-Broglie}} = \frac{3\times10^{8}}{8\times10^{-19}} \times \sqrt{2\times9.1\times10^{-31}} \times$ $\sqrt{2.0\times1.6\times10^{-19}} = \frac{3.75\times10^{26}}{1.13\times10^{24}}$ $= 286.1$	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	A+R	4.9

Item	Answer	Mark	CL	OB
24	c **Other Solution** $\lambda_\circ = \frac{6.6\times10^{-34}}{7.65\times10^{-25}}$ $\frac{1}{2}$ $= 8.64\times10^{-10}m$ $\frac{1}{2}$ $\frac{\lambda_i}{\lambda_\circ} = \frac{2.475\times10^{-7}}{8.64\times10^{-10}} = 286.46m$ $(\frac{1}{2}+\frac{1}{2})$ **Other Solution** $\frac{\lambda_i}{\lambda_\circ} = \frac{\frac{hc}{E}}{\frac{h}{p}} = \frac{hc}{E}\times\frac{P}{h}$ $KE = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\frac{2\times3.2\times10^{-19}}{9.1\times10^{-31}}}$ $v = 8.38\times10^5$ $\frac{1}{2}$ $\frac{\lambda_i}{\lambda_\circ} = \frac{mvc}{E}$ $\frac{1}{2}$ $= \frac{9.1\times10^{-31}\times8.38\times10^5\times3\times10^8}{5\times1.6\times10^{-19}}$ $= 286.1m$ $(\frac{1}{2}+\frac{1}{2})$		A+R	4.9
25	$E_A = \frac{hc}{\lambda_A} \rightarrow E_B = \frac{hc}{4\lambda_A}$ $\frac{E_A}{E_B} = 4$ $E_B = \frac{E_A}{4} = \frac{2.1\times10^{-18}}{4}$ $= 5.25\times10^{-19}J$	1 $\frac{1}{2}$ $\frac{1}{2}$	A	4.1

ANSWERS TO EXTENDED QUESTIONS :(42 marks)

Item	Answer	Mark	CL	OB
26	$E = \frac{hv}{\lambda}$ $\lambda = \frac{h}{p}$ $E = vp$ $v = \frac{E}{p} = \frac{6.40\times10^{-19}}{1.33\times10^{-27}}$	1	A	4.1
	$= 4.81\times10^{8} m/s$ **Other Solution**	1		
	$\lambda = \frac{h}{P} = \frac{6.63\times10^{-34}}{1.33\times10^{-27}} = 4.98\times10^{-7}m$ ½ $E = hf$ $f = \frac{6.40\times10^{-19}}{6.63\times10^{-34}} = 9.65\times10^{14}Hz$ ½ $v = \lambda f = 4.98\times10^{-7}\times9.65\times10^{14}$ ½ $=4.8\times10^{8}m/s$ ½			
	Other Solution $\lambda = \frac{h}{P} = \frac{6.63\times10^{-34}}{1.33\times10^{-27}} = 4.98\times10^{-7}m$ ½ $v = \lambda f = 4.98\times10^{-7}\times\frac{c}{4.98\times10^{-7}}$ 1 $c = 3\times10^{8}m/s$ ½			

End of Marking Guide