FUKIEN SECONDARY SCHOOL

S5 First Term Uniform Test (2021-2022)

Physics

(1 hour)

Date: 9th November 2021 Name: _____

Time: 10:30a.m. – 11:30a.m. Class: _____ No.: _____

Instructions to students:

1. Write your name, class and class number on both the question paper and the answer sheets.
2. Answer ALL questions.
3. Write down all the answers on the answer sheets.
4. Hand in the question paper and the answer sheets at the end of the examination.
5. The total mark of the paper is 60.
6. The paper consists of two sections: Section A Multiple Choice Questions (20 marks) and Section B Structured Questions (40 marks).
7. You may use the following data and equations.

Formula

C1.	$\Delta y = \frac{\lambda D}{a}$	fringe width in double-slit interference
C2.	$d \sin\theta = n\lambda$	diffraction grating equation
C3.	$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$	equation for a single lens

Section A: Multiple Choice Questions (20 marks)

1. A train of water waves is produced in a ripple tank. The frequency of the dipper of the ripple tank is 8 Hz. The separation of two adjacent wavefronts is 2 cm. Which of the following statements is/are correct?

   (1) A water particle takes 0.0625 s to move from the crest to the trough of the wave.

   (2) The water particles move at a speed of 16 cm s^{-1}.

   (3) The amplitude of the water wave depends on the frequency of the dipper.

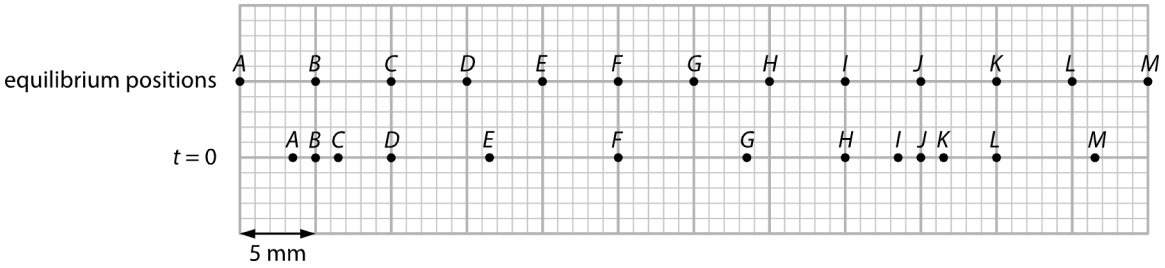
   A. (1) only

   B. (2) only

   C. (1) and (3) only

   D. (2) and (3) only

2. A train of longitudinal wave travels through a medium. The figure below shows the positions of particles *A* to *M* at time $t = 0$. At the moment shown, particle *G* is moving towards the right.



   Which of the following statements is correct?

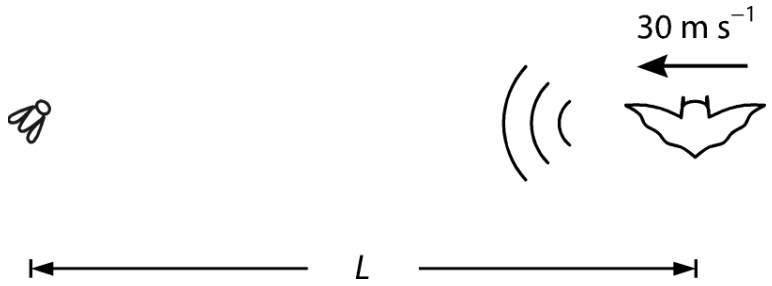
   A. The wavelength of the wave is 20 mm.

   B. The wave is travelling from right to left.

   C. Particle *C* is moving towards the right at $t = 0$.

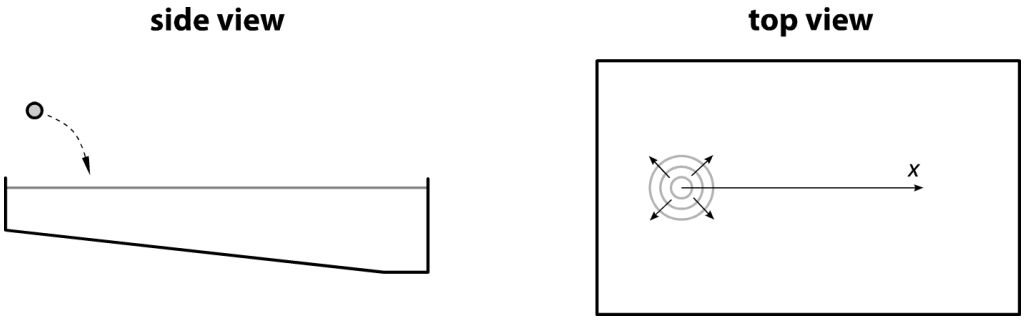
   D. Particle *J* is momentarily at rest at $t = 0$.

3. A bat is flying at a uniform speed of 30 m s^{-1} towards an insect in mid-air. At that instant when the bat is at distance *L* in front of the insect, the bat sends an ultrasound signal towards the insect. After 0.02 s, the bat receives the echo of the signal. Neglect the speed of the insect. Estimate *L*. Given: speed of sound in air = 340 m s^{-1}.



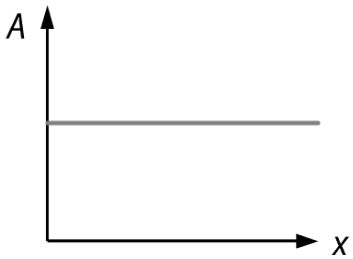
A. 3.1 m
B. 3.4 m
C. 3.7 m
D. 4.5 m

4. The figure below shows a swimming pool with one end deeper and the other end shallower. When a stone is thrown into the swimming pool, a train of circular ripples is produced.

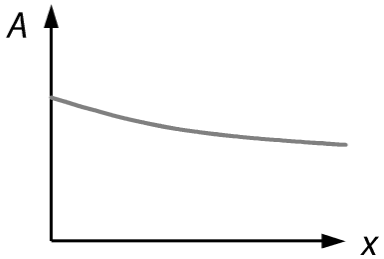


Which of the following best shows the variation of the amplitude *A* of the ripples along the direction *x* as the ripples propagates? Assume no energy loss during propagation.

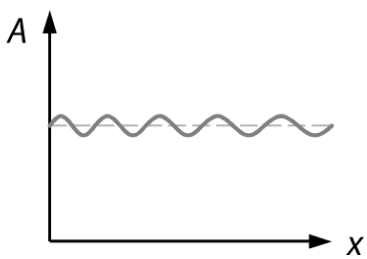
A.



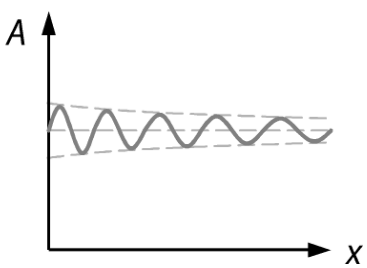
B.



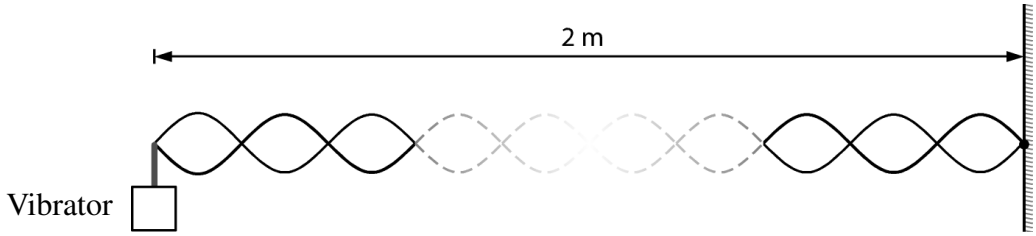
C.



D.



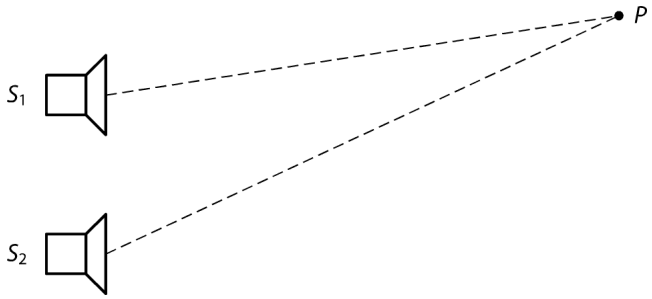
5. A string of length 2 m is tied to a vibrator at one end while the other end is fixed at the wall. Stationary waves are formed at frequencies 400 Hz and 450 Hz.



If no other frequency in-between can produce a stationary wave, what is the speed of the mechanical waves along the string?

A. 25 m s^{-1}
B. 50 m s^{-1}
C. 100 m s^{-1}
D. 200 m s^{-1}

6. The figure below shows two loudspeakers S_1 and S_2 connected to a signal generator. They produces identical sound waves which are in phase and of the same wavelength λ. At point P, the path difference is λ and maximum loudness is detected.



Which of the following are correct?

(1) Both distances S_1P and S_2P must be integral multiples of λ.
(2) If the wavelength of the sound is doubled, minimum loudness will be detected at P.
(3) If the sound waves produced by the two loudspeakers were in antiphase, minimum loudness would be detected at P.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

7. When a monochromatic light strikes a double slit at a right angle, an interference pattern consisting of alternate bright and dark fringes is formed on a screen. Which arrangement would produce the largest fringe separation?

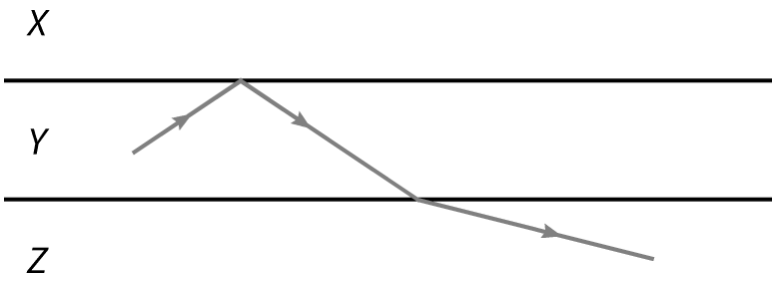
	Slit separation (mm)	**Colour of light**
A.	0.4	Red
B.	0.4	Blue
C.	0.2	Red
D.	0.2	Blue

8. In a room *ABCD*, a tall plane mirror of width 1 m is placed at the middle of the wall *BD*. The top-view of the room is shown below.

A student facing the mirror wants to see the objects placed at corners *A* and *C* at the same time. At most how far can he stand away from the mirror?

A. 3 m
B. 3.5 m
C. 4.5 m
D. 6 m

9. The figure below shows three parallel layers *X*, *Y* and *Z*. A light ray undergoes total internal reflection and refraction at the two boundaries.



Which of the following are correct?

(1) The speed of light in layer *X* is larger than that in layer *Y*.
(2) The wavelength of the light in layer *Y* is longer than that of layer *Z*.
(3) The refractive index of layer *Z* is larger than that in layer *X*.

A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)

10. When an object is placed 30 cm behind a lens, an image is formed 15 cm away from the object. The lens can be a

A. convex lens of focal length 10 cm.
B. convex lens of focal length 30 cm.
C. concave lens of focal length 10 cm.
D. concave lens of focal length 30 cm.

End of Section A

Section B: Structured Questions (40 marks)

1. A train of longitudinal wave travels through a medium at a speed of 6 cm s^{-1}. Figure 1.1 shows the positions of particles *A* to *M* at time $t = 0$.

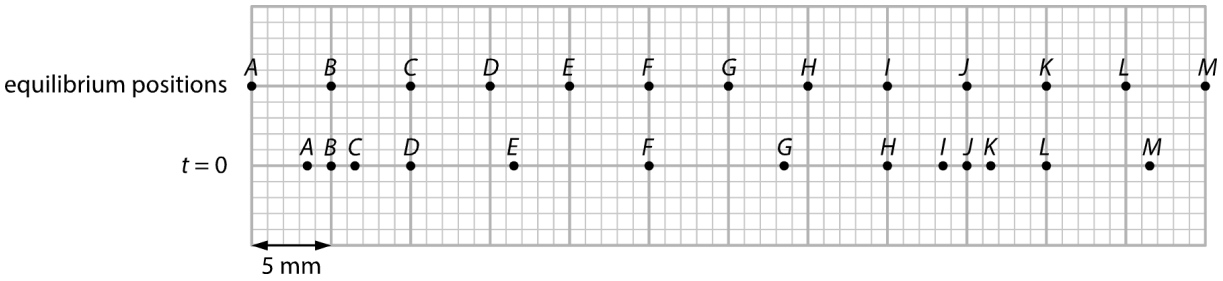


Figure 1.1

(a) Find the frequency of the wave. (2 marks)

(b) Figure 1.2 shows the displacement–time graph (*s*–*t* graph) of particle *E*. A positive displacement means a displacement to the right.

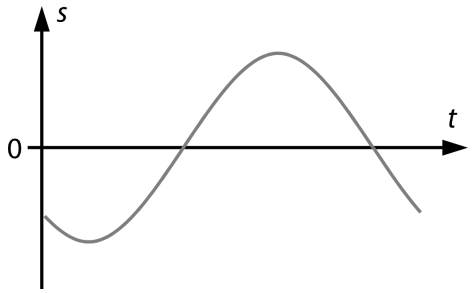


Figure 1.2

(i) In which direction does the wave travel? (1 mark)

(ii) In Figure 1.2 on the answer sheet, sketch the *s*–*t* graph of particle *H* using a dotted line. (2 marks)

(c) The speed of the wave increases when it travels to another medium. State and explain how the wavelength of the wave changes. (2 marks)

(d) A student claims that particle *B* is always at rest as the wave travels. Comment on his claim. (2 marks)

2. (a) A stationary wave is produced on a string. Figure 2.1 shows the shape of the string at time $t = 0$ and $t = 3$ ms.

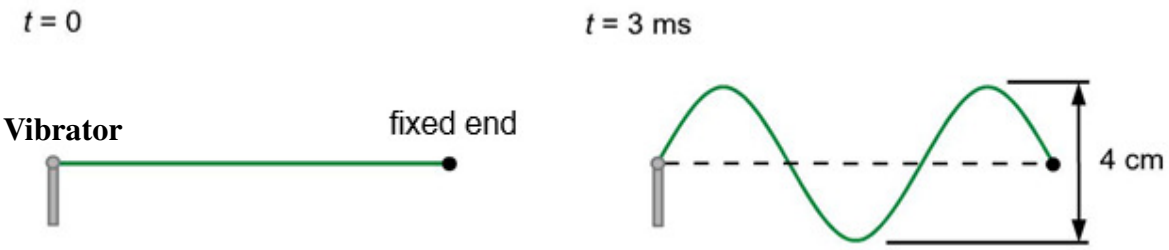


Figure 2.1

At $t = 0$, all points on the string have zero displacement. At $t = 3$ ms, all points on the string have their maximum displacements. The initial motion of the left antinode is moving upwards. Suppose the period of the wave is longer than 3 ms.

(i) What is the earliest possible time when the string appears to be the same as $t = 0$? (1 mark)

(ii) The frequency is gradually increased until a stationary wave with a higher frequency f_1 is formed. Based on your answer in (a), find f_1. (3 marks)

(b) In a ripple tank experiment, two sets of circular water waves are produced by two coherent sources S_1 and S_2. OP is the perpendicular bisector of the line joining S_1 and S_2.

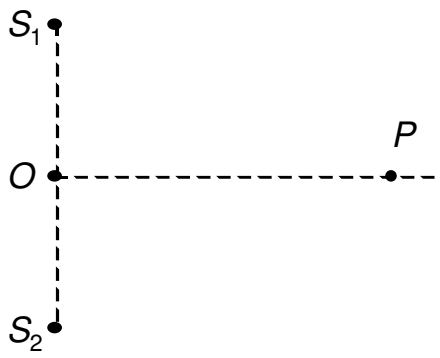


Figure 2.2

(i) What is meant by "coherent sources"? (2 marks)

(ii) If S_1 and S_2 vibrate in antiphase, does constructive interference or destructive interference occur at P? (1 mark)

3. A compact disc (CD) is a plastic plate covered with a reflective coating. The surface of the plastic plate has many closely and evenly spaced tracks that carry information. With the reflective coating removed, the tracks can behave like the lines of a plane transmission grating. Bright dots can be produced when a beam of monochromatic light passes through the plastic plate.

(a) Name the two wave phenomena that explain how a plane transmission grating works.

(1 mark)

(b) A student studies the spacing of CD tracks using the setup shown in Figure 3.1. Monochromatic light of wavelength 650 nm is directed normally onto a CD with the reflective coating removed. A screen is 5.5 cm behind the CD. Some bright dots are formed on the screen. The distance between the second-order bright dots is 18.5 cm.

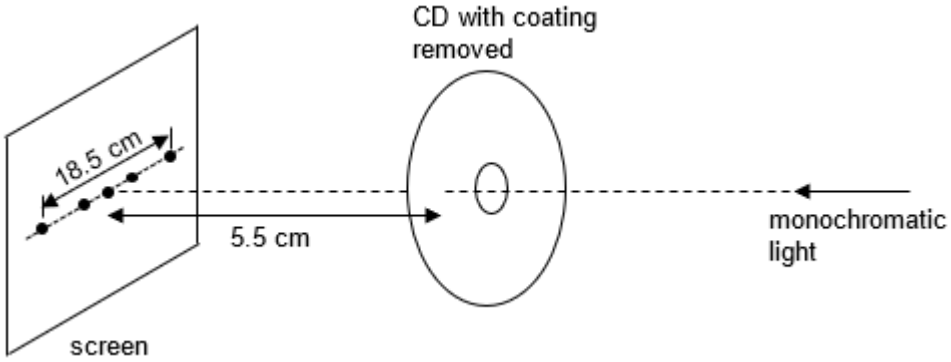


Figure 3.1

(i) Estimate the distance between two adjacent tracks on the CD. (3 marks)

(ii) Find the maximum number of bright dots that are formed. (2 marks)

(c) The student then directs a beam of white light onto the CD. In Figure 3.2 on the answer sheet, sketch the resulting pattern from the central maximum up to the second order maximum on one side of the screen. Indicate the colour of each end of the maxima.

(2 marks)

4. When white light travels from air into glass at an angle, it spreads into different colours as shown in Figure 4.1.

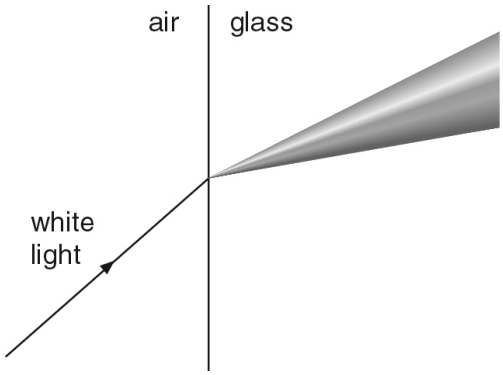


Figure 4.1

(a) Explain this phenomenon. (2 marks)

(b) The speeds of red light and violet light in the glass are about 1.95×10^8 m s^{-1} and 1.92×10^8 m s^{-1} respectively, while the speeds of them in air are both 3.00×10^8 m s^{-1}. Estimate the refractive index of the glass for red light and that for violet light. (2 marks)

(c) A ray of white light passes through a prism. Figure 4.2 shows how red light and violet light emerge from surface *X* of the prism.

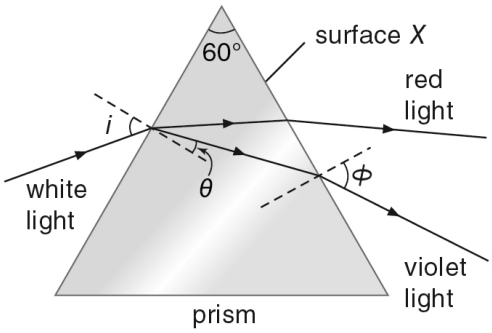


Figure 4.2

(i) Estimate θ and ϕ when $i = 60°$. (3 marks)

(ii) When the angle of incidence *i* of the white light is below a certain value *a*, violet light does not emerge from surface *X*. Calculate the value of *a*. (2 marks)

5. Peter studies the image formation of a lens using the set-up shown in Figure 5.1. The lens is placed at a distance *u* from an illuminated letter 'F'. The image of the letter is captured on a translucent screen which is placed at a distance *v* from the lens.

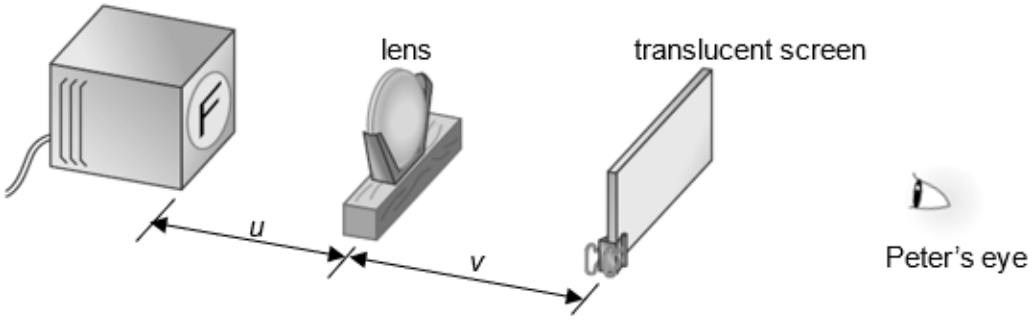


Figure 5.1

(a) Sketch the image on the screen as seen by Peter. (1 mark)

(b) The distance *u* is varied and the position of the screen is adjusted until it captures a sharp image. The corresponding distance *v* is measured. Figure 5.2 shows a graph of $\frac{1}{v}$ against $\frac{1}{u}$.

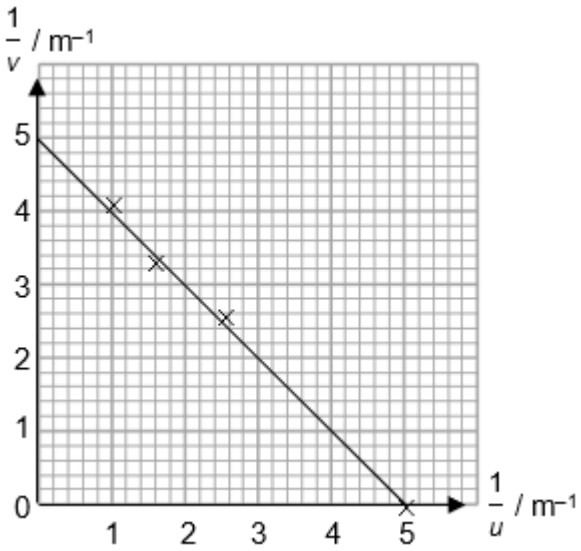


Figure 5.2

(i) Determine what kind of lens is used by Peter and find out the focal length of the lens. (3 marks)

(ii) In Figure 5.3 on the answer sheet, *AB* represents the illuminated letter "F" which is 30 cm from the lens *L*. *r* is a light ray from *B*. Use a graphical method to find the location of the image of *AB* (denoted it as *I*). Hence, draw the refracted ray of *r*. (3 marks)

End of Section B

END OF PAPER