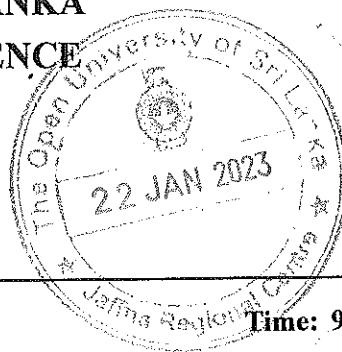**THE OPEN UNIVERSITY OF SRI LANKA**
ADVANCED CERTIFICATE IN SCIENCE
PHF2524/TAF2524 -PHYSICS – 2
FINAL EXAMINATION 2021/22
DURATION – THREE HOURS

Date: 22.01.2023   Time: 9.30 am to 12.30 pm

Part -A

- The Question paper (Part A) consists of 25 multiple choice questions
- Answers for the all Multiple Choice Questions, by underline the correct answer
- At the end of the examination you should submit the question paper with answer sheet.
- Maximum marks for this part is 50%.

$(g = 10 \text{ ms}^{-2})$

1. The dimensional formula for amplitude of Simple Harmonic Motion (SHM) is

   1. MLT   2. $M^0L^0T^0$ 3. M^0LT^0 4. MLT^0 5. MLT^2

2. A simple pendulum is attached to the roof of a lift. Its time period of oscillation, when the lift is stationary is 0.5 s. Its frequency of oscillation when the lift falls freely will be

   1. Infinite   2. zero   3. 2 Hz   4. 20 Hz   5. 40 Hz

3. The fundamental frequency in a stretched string is 100Hz. To double the frequency, the tension in it must be changed to

   1. $T_2 = 2T_1$ 2. $T_2 = 4T_1$ 3. $T_2 = T_1$ 4. $T_2 = T_1/4$ 5. None of above

4. An object is placed at a distance of 10 cm from a co-axial combination of two lenses A and B. The combination forms a real image three times the size of the object. If lens B a concave with a focal length of 30 cm, what is the type and focal length of lens A?

   1. Convex, 12 cm   2. Concave, 12 cm   3. Convex, 6 cm

   4. Concave, 6 cm   5. Convex,18 cm

5. A telescope has an objective lens of a focal length of 100 cm and an eye-piece of a focal length of 5 cm. what is the magnifying power of the telescope when it is in normal adjustment?

   1. 0.2   2. 2.0   3. 20.0   4. 100   5. 200

6. The refractive index of the material of an equilateral prism is $\sqrt{3}$. What is the angle of minimum deviation?

   1. 30°   2. 45°   3. 60°   4. 75°   5. 80°

7. A source of sound moves towards a stationary listener with the velocity of sound. If the actual frequency of the sound produced by the source be f, then change in frequency will be

   1. f   2. f/2   3. f/4   4. f/8   5. none of these

8. A sonar inside sea works at 40 kHz. A submarine is approaching it with a velocity 360 Kmh^{-1}. If the speed of sound in water is 1450 ms^{-1} then the apparent frequency of waves after reflection from submarine will be

   1. 11.5 kHz   2. 36.8 kHz   3. 45.9 kHz   4. 98.6 kHz   5. 100 kHz

9. What is the correct order of colour of the emergent ray, with increasing angle of deviation falling onto the screen in the given figure?
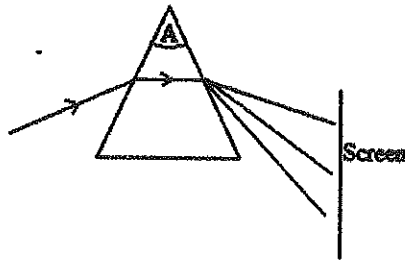

Figure 01

   1. RBY   2. BYR   3. RGO   4. GOR   5. RGV

10. A monochromatic beam of light passes from a denser medium to a rarer medium. As a result, its

    1. Velocity increases   2. Velocity decreases   3. Frequency decreases

    4. Frequency increases   5. Wave length decreases

11. Mirage is observed in a desert due to the phenomenon of

    1. Inference   2. Scattering   3. Total internal reflection

    4. Diffraction   5. Refraction

12. A person cannot see objects clearly beyond 2.0 m. The power Lens required to correct vision will be

    1. +2.0 D   2. -1.0 D   3. +1.0 D   4. -2.0 D   5. -0.5 D

13. Two lenses have magnifying power M_1 and M_2. The magnifying power of their combination is

    1. $M_1 + M_2$ 2. $M_1 - M_2$ 3. $M_1 M_2$ 4. M_1/M_2 5. M_2/M_1

14. At what angle should the ray of light be refracted on the face of a Prism with angle of prism 60^0. So that it just suffer total internal reflection at the opposite surface. Refractive index material of the prism is $\sqrt{2}$

    1. 15° 2. 30° 3. 45° 4. 60° 5. 75°

15. Final image of a compound microscope at normal adjustments

    1. Virtual, inverted, and larger than object   2. Virtual, erect, and larger than object

    3. Real, inverted, and larger than object   4. Real, erect, and larger than object

    5. Real, inverted, and small than object

16. If F is restoring force, k is force constant and y is displacement, which of the following expressions represent the equation of simple harmonic motion?

    1. F = -ky   2. F = √ky   3. F = ky   4. F = ky²   5. None of these

17. The number of beats produced per second by two tuning forks when sounded together is 4. One of them has a frequency of 250 Hz. The frequency of the other cannot be less than

    1. 254 Hz   2. 252 Hz   3. 248 Hz   4. 246 Hz   5. 250 Hz

18. The distance between two consecutive antinodes of simple wave is 0.5 m. The distance travelled by the wave in half the time period is

    1. 2 m   2. 1 m   3. 0.5 m   4. 0.25 m   5. 1.5 m

19. The first resonance length in a closed organ pipe is 50 cm. Then the second resonance length will be

    1. 50 cm   2. 100 cm   3. 150 cm   4. 200 cm   5. 250 cm

20. The fundamental frequency of an open organ pipe is n. If one end is closed, then its fundamental frequency will be

    1. n/2   2. 3n/4   3. n   4. 2n   5. 3n

21. The X – ray beam coming from an X- ray tube

    1. Is monochromatic

    2. Has all wavelengths smaller than a certain maximum wavelength.

    3. Has all wavelengths greater than a certain minimum wavelength.

    4. Has al wavelengths lying between a minimum and maximum wavelength.

    5. None of above

22. The half-life of radioactive radon is 3.8 days. The time in which 1/2 fraction of radon remains un-decayed, is

    1. 16.5 days   2. 76 days   3. 3.8 days   4. 33 days   5. 66 days

23. The half-life of C^{14} is 5730 years. What fraction of C^{14} will remain unchanged after 5 half-lives?

    1. $\frac{1}{16}$ 2. $\frac{1}{8}$ 3. $\frac{1}{64}$ 4. $\frac{1}{32}$ 5. $\frac{1}{4}$

24. In a photoelectric experiment, the stopping potential V_s is plotted against the frequency v of incident light. The resulting curve is a straight line which makes an angle θ which (tan θ) is equal to (φ = work function of surface)

    1. h/e 2. e/h 3. $-\phi/e$ 4. eh/ϕ 5. $2e/h$

25. Electrons of mass m and charge e are accelerated through a potential difference V and strike the target. The maximum speed of these electrons is

    1. $\frac{eV}{m}$ 2. $\frac{eV^2}{m}$ 3. $\sqrt{\frac{eV}{m}}$ 4. $\sqrt{\frac{2eV}{m}}$ 5. $\sqrt{\frac{4eV}{m}}$

3

Part - B

1. (A). What is mean by "Simple Harmonic Motion (SHM)? **(2 marks)**

(i). Write down the equation for period (T) of the simple harmonic motion of the simple pendulum in the terms of length of the pendulum (l), and the acceleration of gravity (g). **(2 marks)**

(ii). State the condition under which this equation applies. **(2 marks)**

(B). A simple pendulum consist of a 35 g mass tied to the end of a light string 650 mm long. Mass is drawn to the side until it is 10 mm above its rest position, as shown in figure 02.

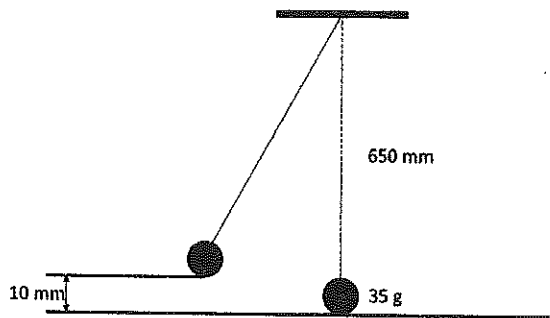When it was released, it swings with simple harmonic motion.

Figure 02

(i). Calculate the period of the pendulum. **(4 marks)**

(ii). Calculate the frequency of the pendulum. **(4 marks)**

(C). Calculate,

(i). The maximum speed of the mass during the first oscillation. **(4 marks)**

(ii). The initial amplitude of the oscillation. **(4 marks)**

(D). Sketch a graph to show how the kinetic energy of the simple pendulum varies with the time over the two complete cycles of the motion.

Start your graph from the time when the pendulum is 10 mm above its rest position. You are not required to mark a scale on either axis. **(3 marks)**

4

2. What are stationary waves? **(1 marks)**

(A) (i). Draw the first, second, and third harmonics for a closed tube and write down for their frequencies in the terms of velocity of air (v) and length (*l*) of the tube. **(2 marks)**

(ii). An air column in a glass tube is open at one end and closed at the other by a movable piston. The air in the tube is warmed above the room temperature, and a 384 Hz tuning fork is held at the open end. Resonance is heard when the piston is 22.8 cm from the open end and again when it is 68.3 cm from the open end.

(a). What speed of sound is implied by these data? **(4 marks)**

(b). How far from the open end will the piston be when the next resonance is heard? **(4 marks)**

(B). (i). Draw the first, second, and third harmonics for a string which is fixed both ends of the string and write down for their frequencies (f) in the terms of tension of the string (T), length of the string (l) and mass per unit length of the string (μ). **(2 marks)**

(ii). A standing wave is set in a string of variable length and tension by a vibrator of variable frequency. When the vibrator has a frequency f, in a string of length l and under tension T, *n* antinodes are set up in the string.

(a). If the length of the string is doubled, by what factor should the frequency be changed so that the same number of antinodes is produced? **(4 marks)**

(b). If the frequency and length are held constant, what tension will produce $n + 1$ antinodes?

(4 marks)

(c). If the frequency tripled and the length of the string is halved, by what factor should the tension be change so that twice as many antinodes are produced? **(4 marks)**

3. (i). How do you obtain the angle of minimum deviation (d_{min}) of a Prism? **(4 marks)**

(ii). Write down an expression for the refractive Index of a Prism using an angle of minimum deviation (d_{min})

(4 marks)

(iii). An angle of incidence of a prism produces the same deviation of $62^{0}48'$ in cases $40^{0}6'$ and $82^{0}42'$. Find the angle of prism. **(5 marks)**

(iv). Sketch the ray diagram of the prism in the above case. **(4 marks)**

(v). When the angle of minimum deviation is $51°$, Calculate refractive index of material of the prism.

(4 marks)

(vi). Find the angle of incident and angle refracted during the minimum deviation **(4 marks)**

4. (i) Explain briefly that what would happen when the following beams of rays falling onto
the convex lens (draw rays diagram)   (2× 3 marks)

a) Diverging beam of rays coming from point of source

b) Converging beam of rays heading towards the point

c) Parallel beam of rays

(ii). State the sign convention used in lens formula.   (4 marks)

(iii). Write down the lens formula.   (3 marks)

(iv). Convex lens having focal length of 10 cm produce real image of magnification 3. Find
the objective distance and image distance.   (4 marks)

(v). Find objective distance and image distance when it is produce virtual image of magnification 3.
                                                                        (4 marks)

(vi). Draw Ray diagrams for question iv and v.   (4 marks)

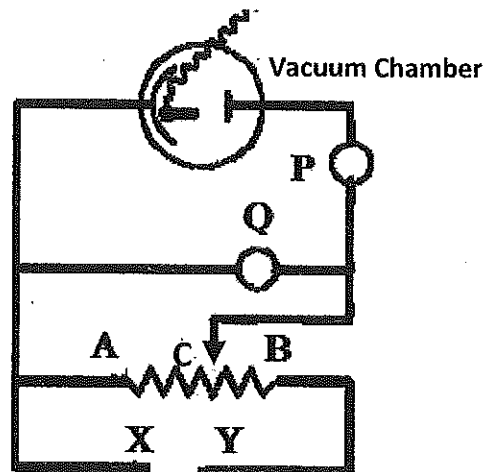5. (i). Briefly explain, the Photoelectric effect   (2 marks)

Figure 3

Figure 3 shows that the instrument to investigate the photoelectric effect with unknown parts.

(ii). Name the P and Q components in the figure 3.   (4 marks)

(iii). Name correctly the polarities of the X and Y in the figure 3.   (4 marks)

(iv). Explain briefly that the pointer C varies from A to B what would happen in the instrument.

                                                                        (4 marks)

(v). Clearly mention the steps that you should follow to obtain the stopping potential (V_S).

                                                                        (4 marks)

(vi). Draw the variation of the current and the voltage with the different Electromagnetic (EM) radiation with same intensity level falling onto the cathode.

(4 marks)

(vii). Write down the Einstein equation related to the photoelectric effect. Describe the parameters in your written equation.

(3 marks)

6. (A). Explain what "Black body" is. **(2 marks)**

(i). The radius of our Sun is 6.96×10^8 m, and its total power output is 3.85×10^{26} W. (Wien's constant = 5 $0.289\ 8 \times 10^{22}$ m K)

(a) Assuming the Sun's surface emits as a black body, calculate its surface temperature.

(4 marks)

(b) Using the result of part (a), find λ_{max} for the Sun. **(3 marks)**

(B). Define the half-life time of the radioactive element. **(2 marks)**

(i). The half-life of ^{131}I is 8.04 days.

(a). Convert the half-life to seconds. **(2 marks)**

(b). Calculate the decay constant for this isotope. **(4 marks)**

(c). Suppose the activity of a certain ^{131}I sample is 64 Bq at a given time. Find the number of half-lives the sample goes through in 40.2 d and the activity at the end of that period.

(4 marks)

(ii). $^{66}_{28}Ni$ (mass 5 65.929 1 u) undergoes beta decay to $^{66}_{29}Cu$ (mass 5 65.928 9 u).

(a) Write the complete decay formula for this process. **(2 marks)**

(b) Find the maximum kinetic energy of the emerging electrons. **(2 marks)**