S6 PHYSICS II

March, 2024

8:30 AM – 11:30 AM

NYAGATARE DISTRICT

ADVANCED LEVEL DISTRICT EXAMINATION, TERM II 2024

SUBJECT: PHYSICS

PAPER II: THEORY

COMBINATIONS:

- PHYSICS-CHEMISTRY-MATHEMATICS **(PCM)**
- MATHEMATICS-PHYSICS-COMPUTER SCIENCE **(MPC)**
- PHYSICS-CHEMISTRY-BIOLOGY **(PCB)**
- MATHEMATICS-PHYSICS-GEOGRAPHY **(MPG)**

DURATION: 3HOURS

TOTAL MARKS: 100

INSTRUCTIONS:

This paper consists of two sections **A** and **B**

1. **Section A:** this section is compulsory. **(55marks)**
2. **Section B:** answer **any three** questions. **(45marks)**
3. Non-programmable scientific calculators, Periodic table of elements and student geometrics instruments (mathematical set) may be used

Useful constants

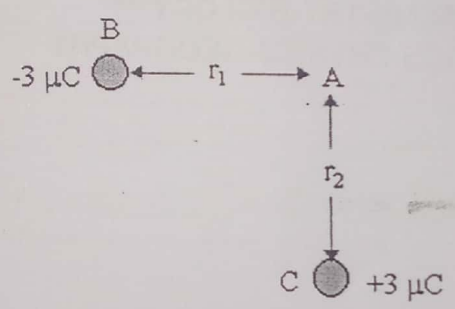
Speed sound in air v=343m/s; 1eV=1.6x10^{-19}J; h=6.63x10^{-34}J.s; Speed of light c=3x10^{8}m/s; mass of electron m_e=9.1x10^{-31}kg; g=9.8m/s^2; Charge of electron e=1.6x10^{-19}C, gravitational constant G=6.67x10^{-11}Nm^{2}kg^{-2}, coulomb's constant k= 9x10^9 Nm^{2}c^{-2} Wien's constant k= 2.9x10^{-3}mk

CamScanner

SECTION A: Answer all questions (55marks)

1. a)
   i) What is gravitational potential at a point in gravitational field? **(1mark)**
   ii) Write down an expression of gravitational potential at a point in gravitational field. **(1mark)**
   b) State the Kepler's law called law of harmonies (law of period) **(1mark)**

2. a) State the principle of superposition of the electric fields. **(1mark)**
   b) From the diagram below, determine the magnitude and direction of the net electric field at the point A shown below. Coulomb's constant $k = 9 \times 10^9\ Nm^2/C^2$. The distances are r_1=12.0 cm and r_2 = 20.0 cm. **(2marks)**



3. a) What are the fundamental differences between analog and digital systems? **(2marks)**
   b) Describe the advantages and disadvantages of analog and digital systems. **(2marks)**

4. a) What is the primary advantage of AM radio broadcasting over FM? **(3marks)**
   i) Higher audio fidelity
   ii) Resistance to noise and interference
   iii) Greater range and coverage
   iv) More efficient use of bandwidth

CamScanner

b) Which of the following is a characteristic feature of Shortwave (SW) radio broadcasting?

i) Limited range

ii) High susceptibility to atmospheric disturbances

iii) Limited international coverage

iv) Long-distance communication capability

c) Which of the following is a notable disadvantage of Shortwave (SW) radio broadcasting?

i) Limited availability of content

ii) Limited frequency coverage

iii) Susceptibility to ionospheric disturbances

iv) Higher cost of receivers

5. a) What is meant by time dilation in Einstein's theory of special theory of relativity? **(1mark)**

b) A spaceship travels away from Earth at a velocity of 0.8c (where c is the speed of light). How much time passes on the spaceship for every 10 years that pass on Earth, according to special relativity? **(2marks)**

6. a) In Young's double slit experiment, what must be the condition for the path different for the formation of?

i) The bright fringes **(1mark)**

ii) Dark fringes **(1mark)**

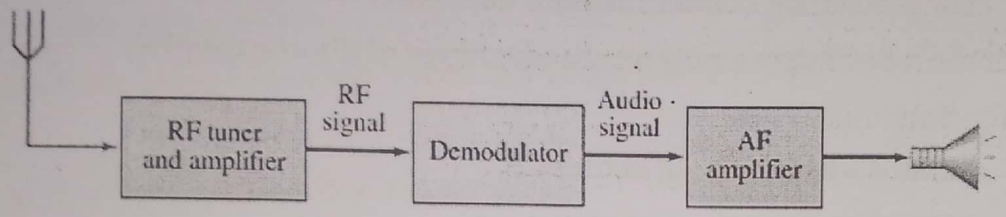
b) In Young's double slit experiment, the 8th bright fringe is formed 5mm away from the center of the fringe system when the wavelength of light used is 6.2×10^{-7}m. Calculate the separation of the two slits if the distance from the slits to the screen is 80cm. **(2marks)**

7. a) State the factors influencing the luminosity of a star **(2marks)**

CamScanner

b) Given a star whose radius is 3 R_s and surface temperature that is 2 T_s with R_s and T_s being the radius and surface temperature of the Sun. By using Stefan-Boltzmann law, express the star's luminosity in terms of the Sun's luminosity, L_s. **(2marks)**

8. a) What does the following diagram indicate? **(1mark)**



b) Explain the function of each device shown in the above diagram **(3marks)**

9. Complete the following sentences with the appropriate term:

a) Particles that make up the family of hadrons are called .....and..... **(1mark)**

b) Two fermions of spin 1/2 are called ....and ..... **(1mark)**

c) The ..... are only stable baryons **(1mark)**

d) The Sub-atomic particle made up of 3 anti-quarks are called ..... **(1mark)**

10. For each of the following composite particle; give the name for the entire combination and the meaning of each latter in the combination:

a) uud **(2marks)**

b) $b\bar{u}$ **(2marks)**

11. a) State any one cause of each of the following natural phenomena:

i) Earthquake **(1mark)**

ii) Tsunami **(1mark)**

b)

CamScanner

i) State one way of preventing landslide. **(1mark)**

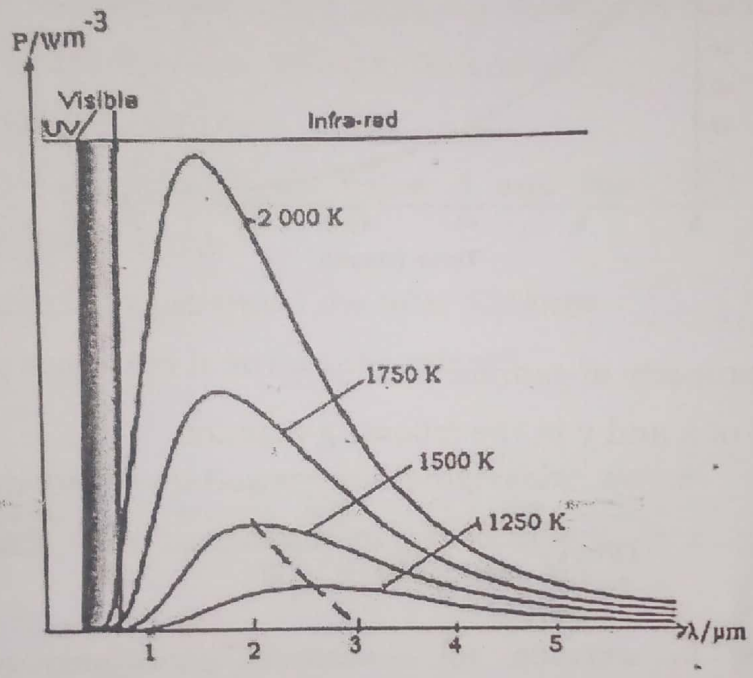
ii) Identify one effect of cyclones on environment. **(1mark)**

12. a) What do you understand by the following physical terms?

i) blackbody radiation. **(1mark)**

ii) Albedo **(1mark)**

b) Use the diagram below to answer the following questions, where **P** is the power density of emitted radiations and **λ** is the corresponding wavelength.



i) None of the graphs touches the $x-axis$, explain why. **(1mark)**

ii) Determine the peakwavelength of radition emitted by the blackbody whose temperature is 2000 K **(1mark)**

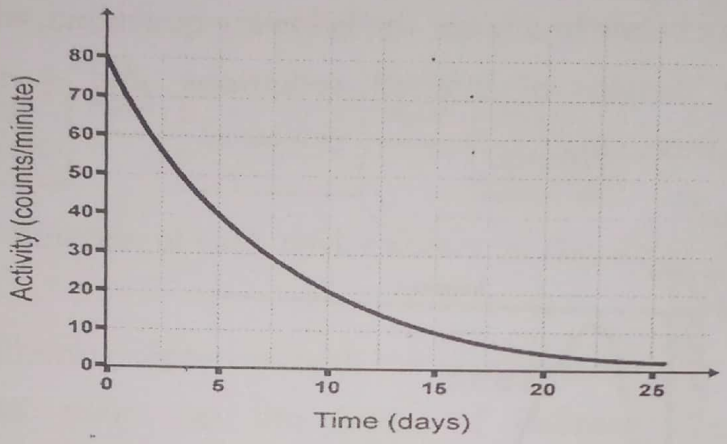
iii) How does the peak of the wavelength of radiation emitted by the blackbody vary with temperature of the blackbody? **(1mark)**

13. a) Define the term binding energy. **(1mark)**

CamScanner

b) Calculate the binding energy (in MeV) for a carbon -14 ($^{14}_{6}C$) nucleus m_p = 1.007276 u, m_n = 1.008665 u and the measured mass is 14.003240 u. Take u = 1.66 x 10 $^{-17}$ kg. **(2marks)**

c) What is the half-life of the isotope whose activity is shown in the figure below? **(1mark)**



14. a) Give any one property of gamma radiation. **(1mark)**

b) Give the value of x and y in the following reaction. **(2marks)**

$$^{214}_{83}Bi \rightarrow {}^{x}_{y}Po + {}^{0}_{-1}e$$

15. a) What is the critical angle when light is going from a diamond (n= 2.42) to air? **(1mark)**

b) Using the answer to (a), what happens when the angle of incidence is more than the critical angle? **(1mark)**

CamScanner

SECTION B: Attempt any three questions (45marks)

16. a) What do you understand by the term uniform circular motion? **(2marks)**

b) A car travelling at uniform velocity of 52.5km/h. the wheels roll along the road without sliding. There is a white do on the tyre. Use the SI unit to find angular velocity ω for the tyre. Given that the diameter of the wheel is 60cm. **(3marks)**

c) Give two applications of projectile motion in real life. **(2marks)**

d) From the top of a cliff 100m high, a projectile is fired at angle 45°. The initial speed is 400m/s. Determine:

i) The maximum height. **(2marks)**

ii) The horizontal distance below A and the point where it strikes the ground. **(2marks)**

iii) The time taken to travel the total distance. **(2marks)**

iv) The speed when it strikes the ground. **(2marks)**

17. a) Compare between stationary and progressive waves. **(2marks)**

b) Differentiate wave number from phase difference as applied to waves. **(2marks)**

c) State the conditions necessary for sources of waves for destructive interference to take place. **(2marks)**

d) A plane progressive wave is given by $y = asin\left[100\pi t - \frac{10\pi}{9}x\right]$ *where x and y* are in millimeters and t is in seconds.

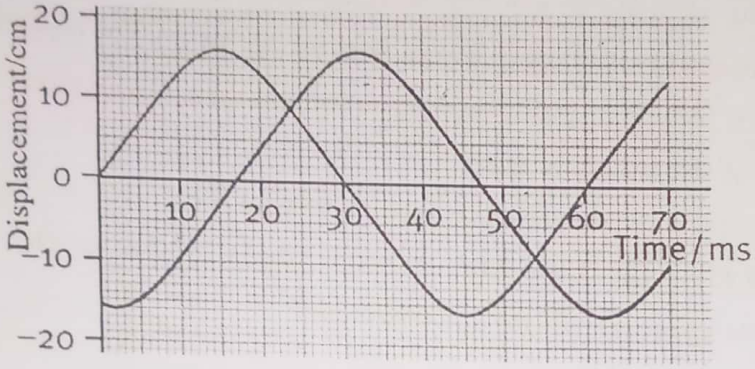
i) Write the equation of the progressive wave which would give rise to a stationary wave if superposed on the one above **(1mark)**

ii) Find the equation of the stationary wave and hence determine its amplitude of vibration. **(4marks)**

iii) Determine the frequency and velocity of the stationary wave. **(2marks)**

CamScanner

e) The figure below shows displacement – time graphs for two identical oscillators. Calculate the Phase difference between the two oscillations. Give your answer in degrees **(2marks)**



18. a) The submarines send a pulse of ultrasound to the sea floor. The pulse returns 0.55 seconds after leaving the submarine. The speed of sound in water is 1500m/s. calculate the distance from the submarine to the sea floor. **(2marks)**

b) (i) what is Doppler effect as applied to sound waves? **(1mark)**

(ii) state any two real life applications of Doppler effect. **(2markS)**

c) Explain why an open pipe (tube) is preferred to a closed tube as a musical instrument. **(2marks)**

d) A closed pipe of length 0.68m is blown at its open end so that it produces the first harmonic.

(i) Sketch the wave pattern of the pipe **(1mark)**

(ii) Determine the frequency of the note produced (End correction of the pipe is 0.002m and the velocity of sound is 340 m/s) **(2marks)**

e) Two trains, A & B have identical sirens of frequency 500 Hz. Train A is stationary and Train B is moving towards the right, away from A at a speed of $V_B = 35$ m/s. An observer between the

CamScanner

two sirens moves towards the right with a speed of $V_O = 20$ m/s as shown in figure below.



Assuming the speed of sound in air to be 340 m/s,

(i) With what frequency does the observer hear the siren emitted from Train A? **(2marks)**

(ii) With what frequency does the observer hear the siren emitted from Train B? **(2marks)**

(iii) What is the difference in frequency heard by the observer? **(1mark)**

19. a) A gas has a volume of $0.02m^3$ at a pressure of $2x10^5$Pa and a temperature of 27°C. It is heated at constant pressure until its volume increases to $0.03m^3$

i) Find the work done by this expanding gas **(2marks)**

ii) Convert 27°C to Kelvin. **(2marks)**

iii) What is the new temperature of the gas? **(2marks)**

b) During one cycle, an engine extracts $2.00x10^3$ J of energy from a hot reservoir and transfers $1.50x10^3$ J to a cold reservoir.

i) Find the thermal efficiency of the engine. **(2marks)**

ii) How much work does this engine do in one cycle? **(2marks)**

iii) How much power does the engine generate if it goes through four cycles in 2.50 s? **(2marks)**

c) Plot a graph of temperature against pressure of sub-question (b) **(3marks)**

CamScanner

20. a) What are X-rays? **(2marks)**

b) Why is the cathode of an X-ray tube made of Tungsten? **(2marks)**

c) What is the charge of the anode of an X-ray tube? **(1mark)**

d) Give any two applications of X-rays **(2marks)**

e) State any two dangers of X-rays **(2marks)**

f) Medical x-ray machines typically operate at a potential difference of 1.00×10^5 V. Calculate the maximum frequency their x-ray tubes produce when electrons are accelerated through this potential difference. **(3marks)**

g) X-rays of wavelength 0.0600 nm are scattered from a crystal with a grazing angle of 11.7°. Assume m=1 for this process. Calculate the spacing between the crystal plane **(3marks)**

-END-

CamScanner