SECTION A: ATTEMPT ALL QUESTIONS (55 MARKS)

1) State whether each of the following statements is **true** or **false**

a) Photons have a non-zero rest mass ..... **(1mark)**

b) A black body reflects all incident electromagnetic radiations.

..... **(1mark)**

c) Monochromatic light consists of a single wavelength. .....**(1mark)**

d) Photoelectric effect provides evidence for the particle nature of light.

..... **(1mark)**

2) Choose the correct option

I) In a mechanical longitudinal wave, the particles of the medium

a)vibrate in a direction perpendicular to the direction of propagation of wave.

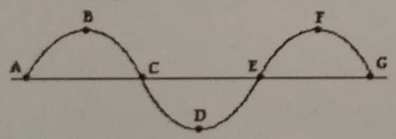
b) vibrate in a direction parallel to the direction of propagation of wave.

c)move in a circle.

d)move in ellipse.

(1 mark)

II) Indicate the interval which represents one full wavelength in the wave diagram below.



a) A to C b) B to D c) A to G d) A to E

(1mark)

III) State the essential condition for diffraction of light to occur.

a)The size of the aperture must be less when compared to the wavelength of light.

b) The size of the aperture must be more when compared to the wavelength

of light.

c)The size of the aperture must be comparable to the wavelength of light.

d) The size of the aperture should not be compared to the wavelength of light.

(1 mark)

IV) Which one of the following types of waves is **NOT** an example of a mechanical wave?

a) Sound waves b) Light waves c) Water waves d) Seismic waves

(1mark)

V) Refraction occurs at a boundary between two mediums because

a)the speed and wavelength of the waves change.

b)the speed of the waves changes.

c)the speed and amplitude of the waves change.

d)the wavelength and the amplitude of the waves change.

(1 mark)

3)Fill in the blank spaces using the terms from the box

Non-renewable	Internal	Plants and animals
Agriculture waste	Oil	Wood

a) Biomass energy is produced from organic materials like ..... and ..... **(1mark)**

b) Geothermal energy is derived from the ..... heat within the Earth. **(1 mark)**

c)Fossil fuels are formed from the remains of ancient .... **(1mark)**

d) One type of fossil fuel is ..... **(1mark)**

e) Fossil fuels are considered .....resources because they take millions of years to form. **(1mark)**

4)Answer by **true** or **false** if the statement is true or false

a) Satellites used for GPS navigation are positioned in geostationary orbits.

..... **(1mark)**

b) The force that keeps planets in orbit around the Sun is gravity.

..... **(1mark)**

c) Gravitational field strength increases as you move higher above Earth's surface. ..... **(1mark)**

d) A planet moves at the same speed throughout its entire orbit.

..... **(1mark)**

5) Fill in the blanks with appropriate terms

a) Thermionic emission occurs when electrons gain sufficient ..... energy to overcome the work .....of a material. **(2 marks)**

b) Cathode rays can be deflected by electric and .....fields. **(1mark)**

c)In television sets, cathode ray tubes function by emitting ,,,,,,,,,,,,,,,,,,,,,,,,, beams onto a phosphorescent screen to create images. **(1mark)**

6)Choose the correct option

I)Which of the following is one of the two basic postulates of special relativity formulated by Albert Einstein?

a) Accelerating reference frames are equivalent to non-accelerating reference

frames

b) The speed of light does not change in all inertial reference frames

c) Speed of photons is more than the speed of light waves

d) Physical laws are relative

(1mark)

II)What does the first postulate of special relativity state?

a) The laws of Physics are the same in all inertial frames of reference

b) The speed of light is constant in all inertial frames of reference

c) Time and space are absolute

d) Gravity affects all objects equally

(1mark)

III) Which of the following is an example of an inertial frame of reference?

a) A car accelerating on a highway

b) A person standing still on the Earth's surface

c) A spaceship orbiting Earth at constant speed

d) A rotating merry-go-round

(1mark)

7) Match the layer of the Sun in column A with its description in column B

Column A	Column B
a)Core	i) The visible surface of the Sun, emitting most of its light
b) Radiative Zone	ii) The innermost layer where nuclear fusion occurs
c) Photosphere	iii) The outermost layer of the Sun's atmosphere, extending millions of kilometers into space
d) Corona	iv) The layer above the core where energy is transported outward by radiation

(4marks)

8) Fill in the blank with appropriate term

a)In Einstein's equation for the photoelectric effect, $KE_{max} = h\nu - \emptyset, \nu$ represents the .....of the incident light. **(1mark)**

b) The minimum energy of incident light required to remove an electron from the surface of a material is called the..... **(1mark)**

c)The momentum of a photon is inversely proportional to its .... **(1mark)**

d) In Compton scattering, the energy lost by the photon is transferred to the ....., which recoils with kinetic energy. **(1mark)**

9) Match each thermodynamic process in column A with its description in column B

Thermodynamic process	Description
a)Adiabatic	i) Process in which pressure remains constant.
b) Isothermal	ii) Process in which volume remains constant.
c) Isochoric	iii) Process in which temperature remains constant.
d) Isobaric	iv) Process in which no heat is exchanged with the surroundings.

(4 marks)

10) Choose the correct option

I)Which method is primarily used to measure the distance to nearby stars?

a) Spectroscopic parallax

b) Redshift measurement

c) Cepheid variable method

d) Stellar parallax

(1mark)

II) The mass-luminosity relation indicates that:

a) More massive stars are less luminous

b) More massive stars are more luminous

c) Luminosity is independent of mass

d) Luminosity decreases with mass

(1mark)

III)What type of star is the Sun classified as?

a) Main Sequence

b) White Dwarf

c) Red Giant

d) Supernova

(1mark)

11) Answer by **true** or **false** if the statement is respectively correct or wrong

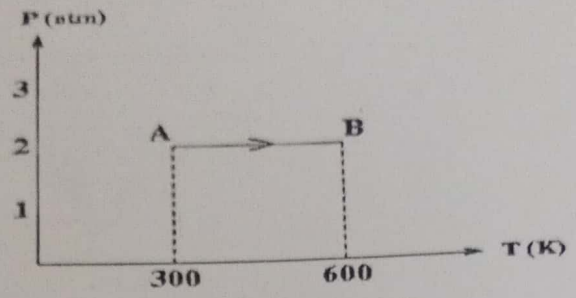
a) Time dilation means that time appears to move faster for a moving observer relative to a stationary one. **(1 mark)**

b) Two events that are simultaneous in one frame of reference are always simultaneous in another. **(1mark)**

c) According to Special Relativity, no object with mass can reach the speed of light. **(1mark)**

12) I) Two moles(n=2) of a monatomic ideal gas undergoes the process from A to B shown in the diagram below by solid line.

Ideal gas constant R= 8.31 $J \cdot mol^{-1} \cdot K^{-1}$



a) i) Is the gas expanding? Yes, or no? **(1 mark)**

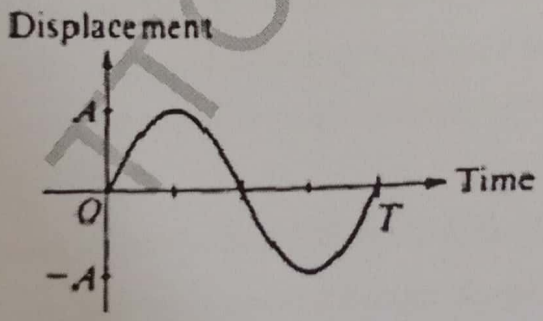
ii)Do the surroundings do work on the system? Yes, or no? **(1mark)**

b) Using the sign convention that work is positive when surroundings do work on the system, how much work is done in the process AB?

i)4986 J ii) 1200 J iii)-1200 J iv)-4986 J

(1mark)

13) I) An object is attached to a spring and oscillates with amplitude A and period T, as represented on the graph.



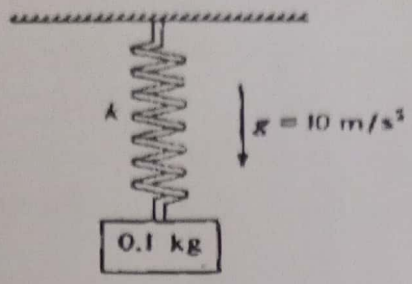
The nature of the velocity v and acceleration a of the object at time $T/4$ is best represented by which of the following?

a)$v > 0, a > 0$ b)$v > 0, a < 0$ c)$v > 0, a = 0$ d)$v = 0, a < 0$

(1 mark)

II) A 0.1 kg block is attached to an initially unstretched sprind of force

constant k=40 N/m as shown below.



The block is released from rest at time t=0

What is the resulting period of oscillation?

a) $\frac{\pi}{40}s$ b) $\frac{\pi}{20}s$ c) $\frac{\pi}{10}s$ d) a) $\frac{\pi}{4}s$

(2 marks)

14) I) Evaluate the effectiveness of using cell splitting versus frequency reuse for increasing mobile network capacity in a dense urban environment.

Which of the following best explains when to prefer cell splitting?

a) When the network lacks available frequency spectrum

b) When managing power consumption in base stations

c)When needing to increase capacity in areas with high user density

d)When aiming to reduce inter-cell interference.

(2 marks)

II) An engineer must select a handoff technique for a high-speed train network. Evaluate the best choice based on performance.

Which technique would be most effective to maintain call continuity?

a)Hard handoff in GSM

b)Soft handoff in CDMA

c) Manual handoff in LTE

d) No handoff is necessary at high speeds

(1mark)

15) I) You are designing a digital communication system for a remote healthcare facility. Which of the following choices best integrates the advantages of digital technology to ensure reliability and efficiency in patient data transmission?

a) Use analog transmission with fax machines to preserve medical records

b) Use a digital network with error detection, compression, and encryption for data transfer.

c) Use analog phones with voice recording to log patient updates

d) Use digital-to-analog converters to transmit signals through older telephone lines.

(1mark)

II) You're tasked with designing a home intercom system where family members can talk to each other from different rooms at the same time. Which communication mode is most appropriate and why?

a)Simplex, since only one room needs to speak

b) Half-duplex, to reduce wiring and cost

c) Full-duplex, to enable natural, simultaneous conversation

d)Simplex with one central receiver.

(1mark)

III)You're building a low-power satellite telemetry system where data is continuously sent from the satellite to Earth. Which transmission mode should you use and how should the system be configured?

a) Full-duplex, with voice and data channels

b)Half-duplex, using alternate data transmission intervals

c) Simplex, since the satellite only sends data and does not receive

d) Full-duplex with echo cancellation.

(1mark)

SECTION B: ATTEMPT ANY THREE QUESTIONS (30 MARKS)

16) I) Use the laws of Thermodynamics to choose the correct option

A)Work done $W = 0$ for the .....process.

a) isochoric b) isobaric c) isothermal d) adiabatic

(1 mark)

B) ..... of Thermodynamics is used to understand the concept of energy conservation.

a) Zeroth law b) First law c) Second law d) Third law

(1mark)

C) Internal energy of ideal gas depends on

a) pressure b) volume c) size of molecule d) temperature

(1 mark)

D) The .....of Thermodynamics states that it is impossible for a self –acting machine to transfer heat from a colder body to a hotter one without the aid of an external agency.

i)zeroth law ii) first law iii) second law iv) third law

(1 mark)

II) The high temperature of a Carnot engine is 600 K. The engine absorbs 600 J of heat and the low temperature is 127°C.

a) Convert 127°C to Kelvin. **(2 marks)**

b) What is the efficiency e of this engine? **(2 marks)**

c)Determine the work done by the engine. **(2 marks)**

17) I) In Young's double slit experiment, if instead of monochromatic light white light is used, what would be the observation?

a) The pattern will not be visible

b) The shape of the pattern will change from hyperbolic to circular

c) Colored fringes will be observed with a white bright fringe at the center

d) The bright and dark fringes will change position

(2 marks)

II)What kind of sources are required for Young's Double Slit experiment?

a) Coherent

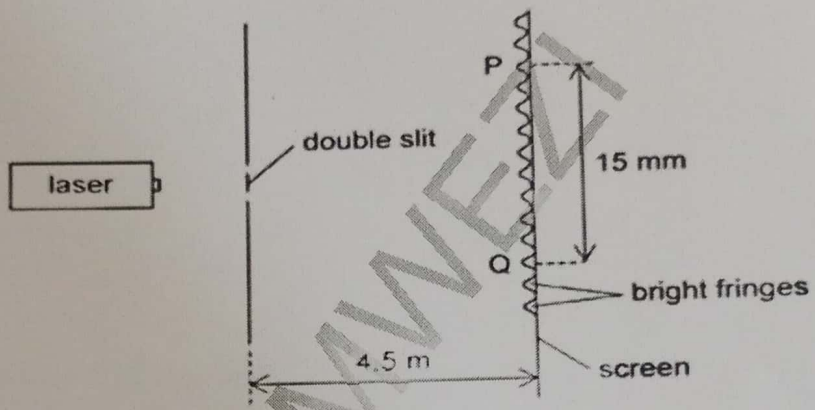
b) Incoherent

c) Intense

d) Bright

(2 marks)

II)A laser is placed in front of a double –slit as shown in the diagram below



The laser emits light of frequency 7.50 x10^{14}Hz. The separation of the maxima P and Q observed on the screen is 15 mm. The distance between the double slit and the screen is 4.5 m. The speed of light is 3 x10^{8} m/s

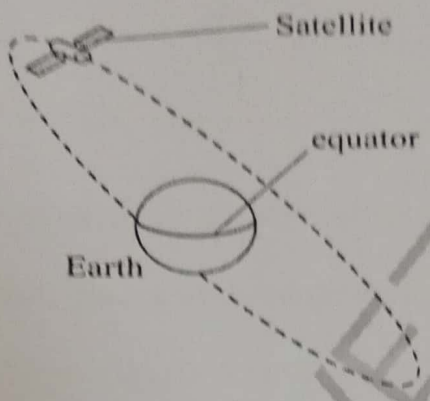
a) Find the wavelength of the light emitted by the laser. **(2 marks)**

b) i) Find the fringe width. **(2 marks)**

ii)Calculate the separation of two slits. **(2 marks)**

18) The global positioning syatem (GPS) is a network of satellites orbiting the Earth. The satellites are arranged in six different orbital planes at a height of 20 200 km above the Earh's surface.Whenever you are,at least four GPS satellites are visible at any time.The diagram shows a signle satellite.

Assume that its orbit is circular.Mass of the Earth $M_E = 6.0x10^{24}\ kg$, radius of the Earth $R_E = 6400\ km$ and the universal gravitational constant, denoted by 'G', is approximately $6.674 \times 10^{-11}\ N\ m^2/kg^2$.



a)Find the radius r of the orbit in km then in m. **(3 marks)**

b) Show that the GPS satellite take about 43 000 s (12 h) to complete one orbit about the Earth. **(3 marks)**

c)Find the orbital speed of this GPS satellite. **(2 marks)**

d)Communication satellite are places in orbit with an orbital time of 24 h. Explain why it is essential for communication satellite to be in such an

e) State how the orbit of a GPS satellite differs from that a communication satellite. **(1mark)**

19) Use essay form to discuss the following topic whose title is "Fossil Fuels: A Double-Edged Sword in Modern Society". **(10 marks)**

20) The table below shows two different metals and their corresponding work functions.

Metal	Work function($\times 10^{-19}$J	Threshold frequency $f_0/10^{14}Hz$
Gold	7.8	
Calcium	4.3	

a) Calculate the threshold frequency for each of the four metals listed above to two decimal places and complete the table.

Planck's constant $h=6.63\times10^{-34}$Js. Electron's mass $me=9.1\times10^{-31}$ kg

(2 marks)

b) When radiation of frequency 8×10^{14}Hz is applied to Calcium, calculate or find

i) energy of a photon. **(2 marks)**

ii) kinetic energy of the photoelectrons leaving the Calcium. **(2 marks)**

iii) speed of the photoelectrons leaving the Calcium. **(2 marks)**

c)Will this light produce photoelectric effect on gold? Explain **(2 marks)**

SECTION C: COMPULSORY QUESTION (15 MARKS)

21) A learner investigated the relationship between the period and the length of a simple pendulum. The learner measured the length l of the pendulum. The pendulum was then allowed to swing through a small angle and the time t for 30 oscillations was measured. This procedure was repeated for different values of the length of the pendulum.

The learner recorded the following data

l/m	t/s	Time for 1 swing T/s	T^2/s^2
0.4	38.4		
0.5	42.6		
0.6	47.4		
0.7	51.6		
0.8	54.6		
0.9	57.9		

a) Calculate T to two decimal places and T^2 to one decimal place and complete the table. **(4 marks)**

b) The pendulum used consisted of a small heavy bob attached to a length of inextensible string. Explain

i) why a small heavy bob was used. **(1mark)**

ii)why the string was inextensible. **(1mark)**

c)Why did the learner measure the time for 30 oscillations instead of measuring the time for one oscillation? **(1mark)**

d)Using the recorded data, plot a suitable graph of l (y-axis)against T^2 (x-axis) Draw a best fit straight line. **(5marks)**

e) i) Use the slope of graph and the relation between T and l to calculate the acceleration due to gravity g. **(2marks)**

ii)Evaluate the validity of your results. **(1 mark)**

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