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For performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

GENERAL CERTIFICATE OF EDUCATION
ADVANCED LEVEL
QUESTION AND ANSWER BOOKLET

FOR

PHYSICS 9188

2003-2004 EXAMINATIONS

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

GENERAL CERTIFICATE OF EDUCATION ADVANCED LEVEL

1

QUESTION AND ANSWER BOOKLET

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PHYSICS 9188

NOVEMBER 2002 - 2004

Zimbabwe School Examinations Council
Upper East Road
Mount Pleasant
Harare

FOREWORD

This is the first series of the Zimbabwe School Examinations Council Question and Answer Booklets at the Advanced Level of General Certificate of Education. The booklet is made up of question papers and expected answers for the November 2003, June 2004 and November 2004 examinations. The Council hopes that the booklets will help both teachers and students in their preparations for examinations.

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS 9243/1

PAPER 1 Multiple Choice

Friday 1 NOVEMBER 2002 Morning 1 hour

Additional materials:
- Electronic calculator and/or Mathematical tables.
- Multiple Choice answer sheet
- Soft clean eraser
- Soft pencil (Type B or HB is recommended)

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, Centre number and candidate number on the answer sheet in the spaces provided unless this has already been done for you.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers, **A, B, C** and **D**. Choose the **one** you consider correct and record your choice in **soft pencil** on the separate answer sheet.

Read very carefully the instructions on the answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

This question paper consists of 22 printed pages and 2 blank pages.

[Turn over

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ ms^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} Hm^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} Fm^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19}\ C$
the Planck constant,	$h = 6.63 \times 10^{-34}\ Js$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ kg$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ kg$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ kg$
molar gas constant,	$R = 8.31\ JK^{-1}mol^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ mol^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23} JK^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ N\ m^2kg^{-2}$
acceleration of free fall,	$g = 9.81\ ms^{-2}$

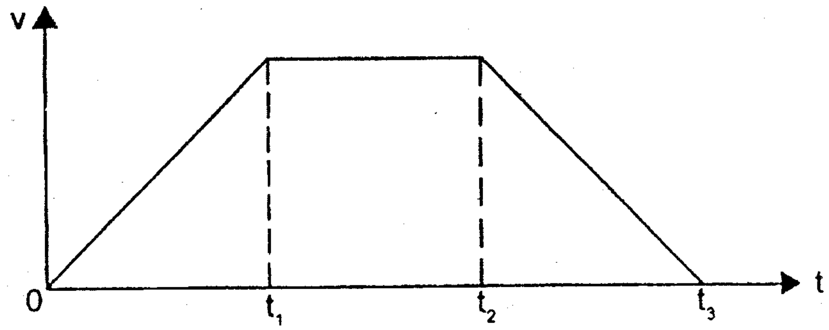
Formulae

Uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
refractive index,	$n = \frac{1}{\sin C}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \frac{Q}{4\pi \epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin\omega t$
hydrostatic pressure,	$p = \rho gh$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
radioactive decay,	$x = x_0\exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the universe,	$\rho_0 = \frac{3H_0^2}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number	$R_e = \frac{\rho v r}{\eta}$
dag force in turbulent flow,	$F = Br^2\rho v^2$

1 The base unit for gravitational field strength is

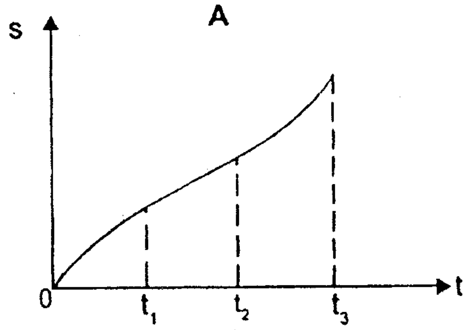
A Nm^{-1}
B kgs^{-1}
C ms^{-2}
D Nkg^{-1}

2 A body travelled in a straight line as shown in the velocity(v) - time(t) graph.

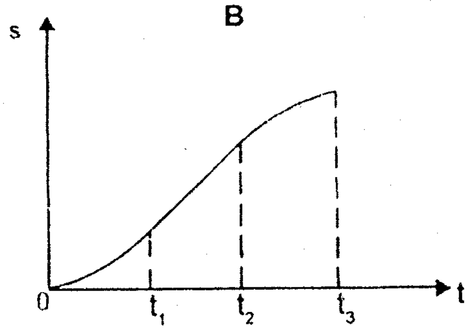


Which distance(s)-time(t) graph correctly represents the motion of the body?

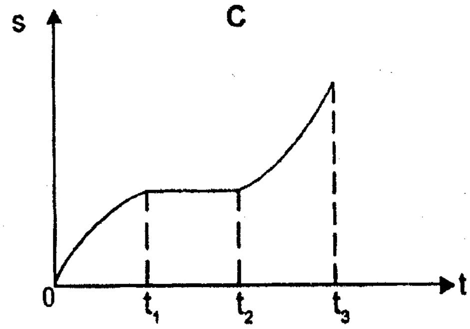
A



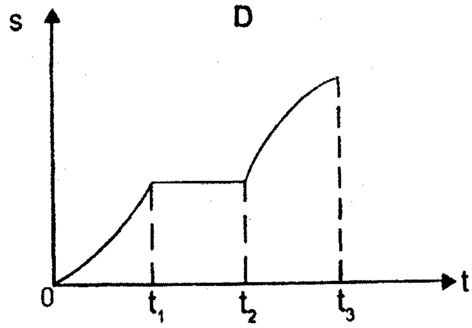
B



C



D

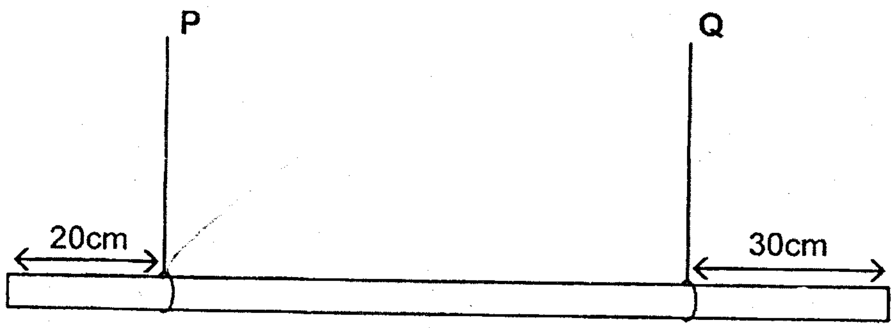


3 A missile is launched at an acute angle to the horizontal. Half-way through its trajectory, it explodes into several fragments due to entirely internal forces. Assuming free fall throughout, which statement is true?

A The fragments fall vertically down to the ground.
B The kinetic energy before and after the explosion is conserved.
C The momentum before and after the explosion is conserved.
D The path of each fragment is independent of that of the missile.

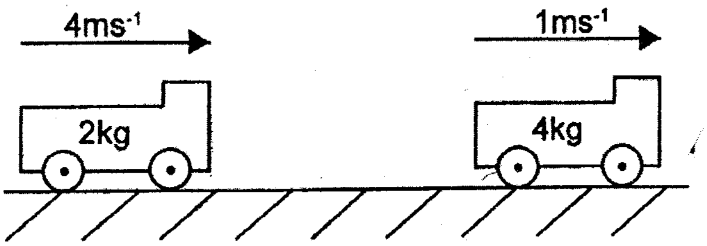
4 A uniform metre rule of weight 0.9N is suspended horizontally by two vertical loops of thread P and Q placed at 20cm and 30cm from its ends respectively.

Find the shortest distance from the centre of the rule at which a 2N weight must be suspended to make loop P become slack.



A 9.0cm
B 13.5cm
C 29.0cm
D 43.5cm

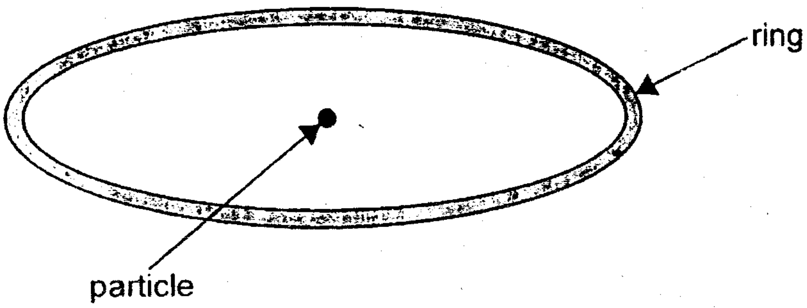
5 Two trolleys are travelling in the same direction as shown in the diagram. The trolleys collide.



After impact they move off together. What is the amount of kinetic energy lost?

A 6J
B 12J
C 18J
D 36J

6 A particle of mass m is placed in the centre of a large uniform circular ring of mass M as shown in the diagram. The radius of the ring is r.



What is the magnitude of the gravitational force acting on the particle due to the ring?

A $\frac{3GMm}{2r^2}$

B $\frac{GMm}{r^2}$

C $\frac{GMm}{2r^2}$

D zero

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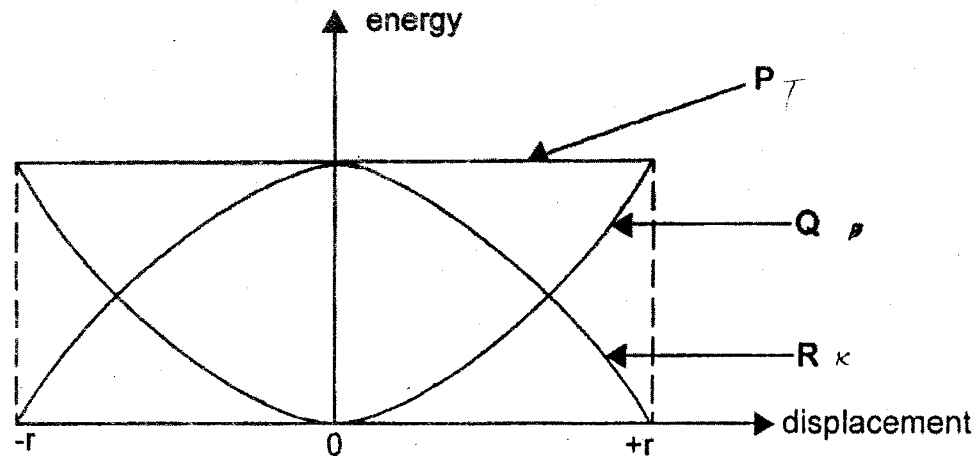
7 The energy variation of a particle which is subjected to simple harmonic motion is illustrated graphically as shown.



Which combination correctly explains the graph?

	P	Q	R
A	kinetic energy	potential energy	total energy
B	potential energy	total energy	kinetic energy
C	total energy	potential energy	kinetic energy
D	total energy	kinetic energy	potential energy

8 In a Young's double slit experiment using red light the fringe separation was 0.25mm.

wave length of red light = 6.5×10^{-7}m
wave length of green light = 5.2×10^{-7}m

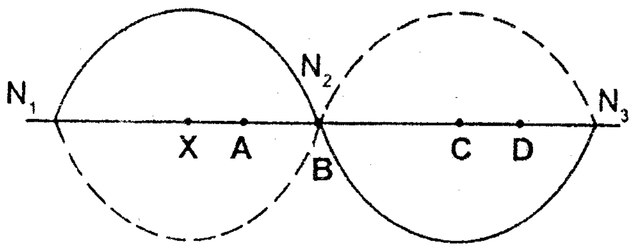
What is the fringe separation when the green light is used in this experiment?

- A 0.13mm
- B 0.20mm
- C 0.25mm
- D 0.31mm

9 **Which of the following is an experimental evidence that light is transverse in nature?**

A diffraction
B superposition
C reflection
D polarization

10 The following diagram shows part of a stationary wave where N_1, N_2 and N_3 are nodes. Which of the following points is in phase with point **X**.



11 The ratio of the wavelength of radio waves to X-rays is given by $10^m : 1$.

Which of the following is a possible value for m?

A 12
B 8
C + 12
D + 8

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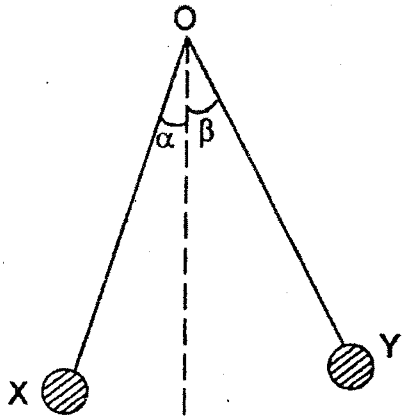
12 **Two small charged spheres X and Y of small masses are hung by identical fine nylon threads from a fixed point O. In equilibrium, the angle α is less than angle β.**



Which of the following statements must be correct?

A mass of **X** is greater than that of **Y**.
B the mass **X** is less than that of **Y**.
C the charge on **X** is greater than that on **Y**.
D the charge on **X** is smaller than that on **Y**.

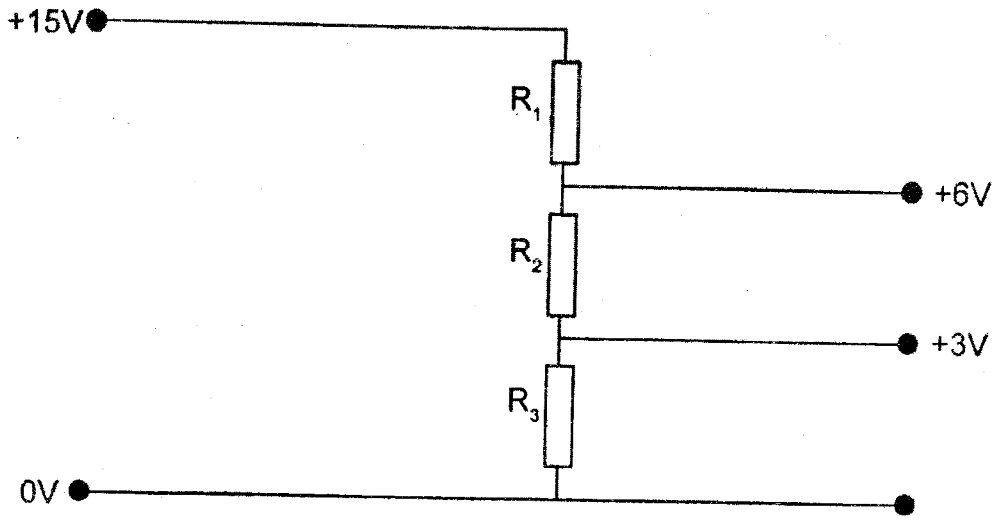
13 The electric potentials (V) at different distances, x, from a point **P** along a line **PQ** are shown in the table.

V/V	13	15	18	21	23
x/m	0.020	0.030	0.040	0.050	0.060

The electric field strength when x = 0.040m is approximately

A 450Vm^{-1} towards **Q**.
B 300Vm^{-1} towards **Q**.
C 300Vm^{-1} towards **P**.
D 450Vm^{-1} towards **P**.

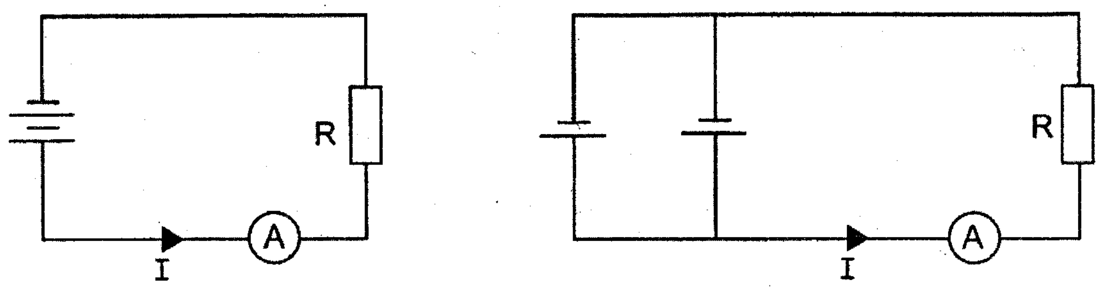
14 The diagrams shows a potential divider which is used to give outputs of 3V and 6V from a 15V source.



What are the correct values of resistors?

	$R_1/k\Omega$	$R_2/k\Omega$	$R_3/k\Omega$
A	1	3	1
B	3	1	1
C	2	2	1
D	1	2	2

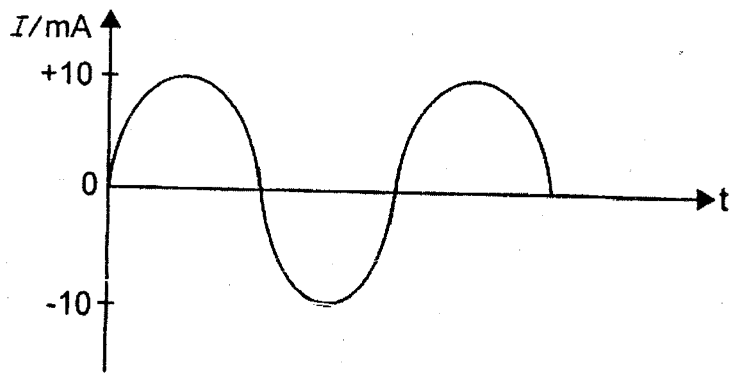
15 Two identical cells are connected to a resistor R and an ammeter in two ways as shown in the diagrams.



The current flowing through the ammeter in both circuits are equal. What is the internal resistance of each cell?

A R/4
B R/2
C R
D 2R

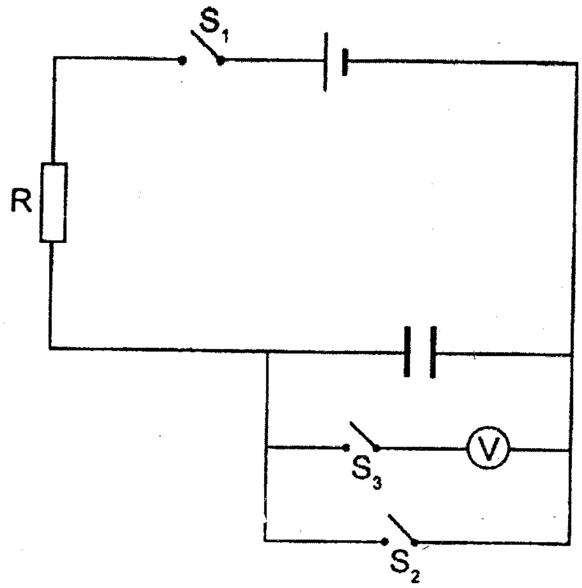
16 An alternating current with the wave form and magnitude shown in the diagram passes through a milliameter calibrated for r.m.s. readings of current.



What current, in mA, will the meter record?

A 5
B $5\sqrt{2}$
C 10
D $10\sqrt{2}$

17 **The following circuit is used to investigate the charging and discharging of a capacitor.**



Which combination of positions of switches is true when the capacitor is charging?

	S_1	S_2	S_3
A	closed	closed	open
B	closed	closed	closed
C	closed	open	closed
D	open	open	closed

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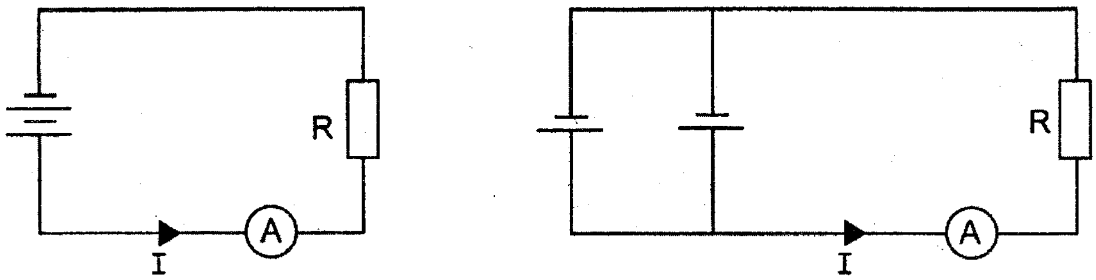

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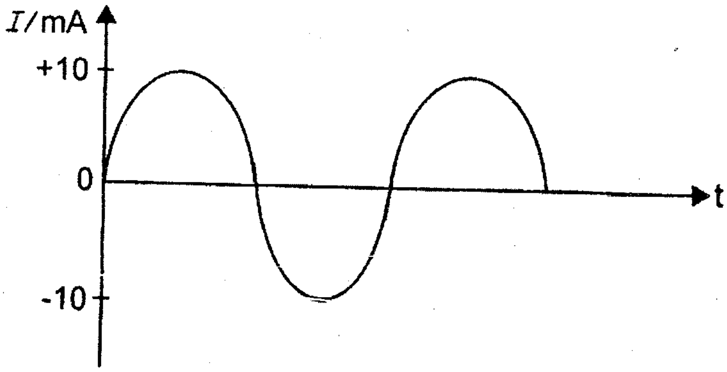

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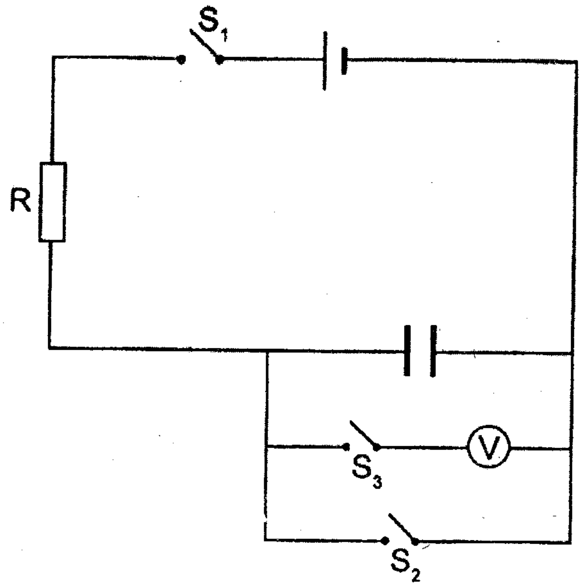

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	S_1	S_2	S_3
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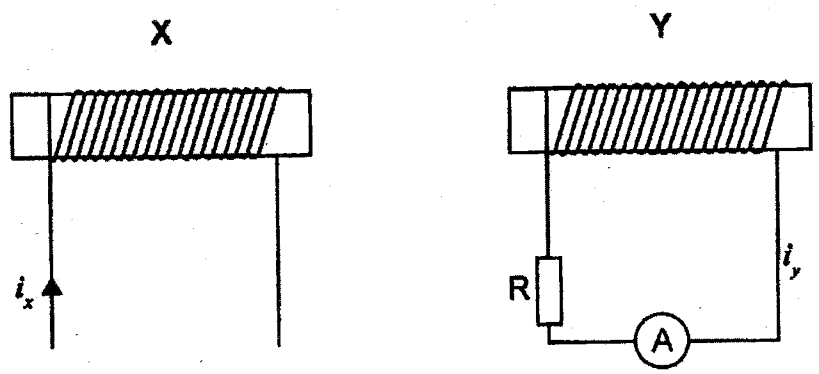
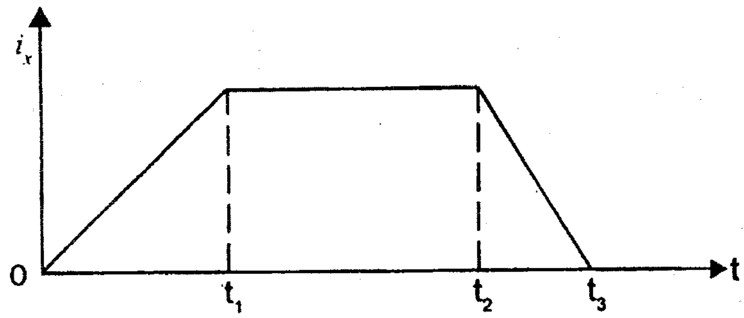
B	closed	closed	closed
C	closed	open	closed
D	open	open	closed

18 **The diagram shows two coils X and Y which are positioned with their axes in the same line.**

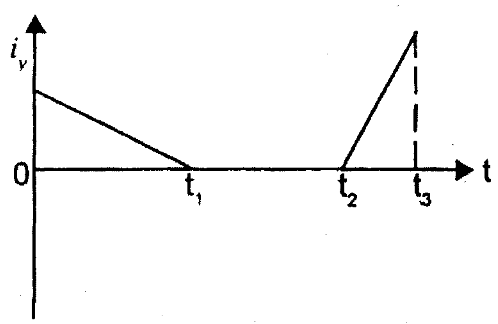


The current flowing through **X**, i_x varies with time t as shown in the graph below.

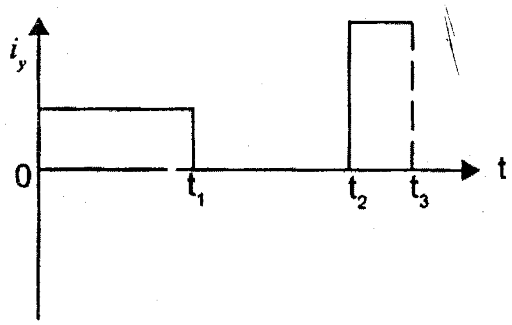


Which graph best illustrates the variation of the induced current i_y with the time t in the coil **Y**?

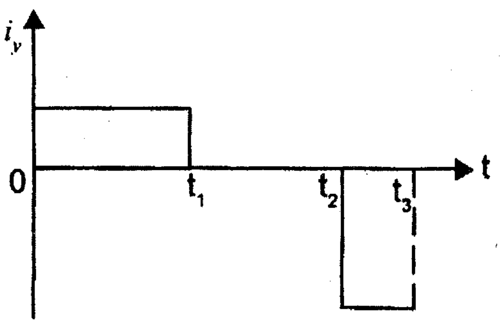
A



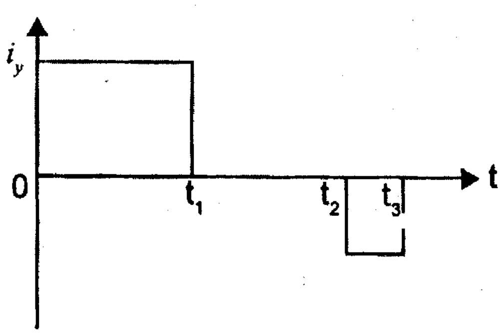
B



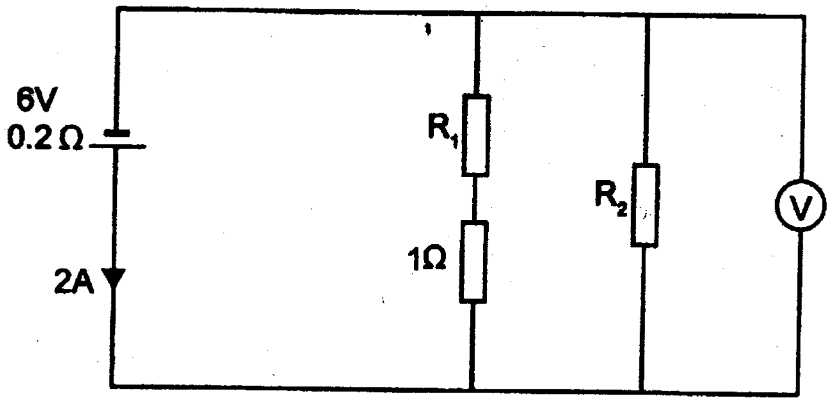
C



D



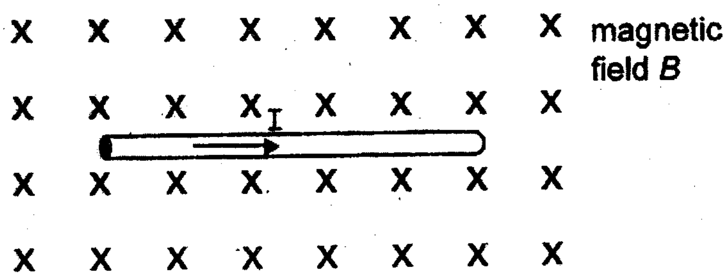
19 In the circuit shown below the internal resistance of the cell is 0.2Ω. The electromotive force of the cell is 6V.



What is the voltmeter reading when the current flowing through the cell is 2A?

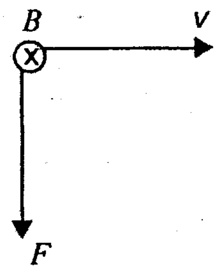
A 5.4 V
B 5.6 V
C 5.8 V
D 6.0 V

20 A copper rod carrying a current I is placed at right angles to a uniform magnetic field B as shown in the diagram.

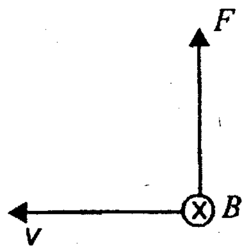


Which one of the following diagrams shows correctly the relative directions of the field (B), the drift velocity (v) of the electrons and the force F on the electrons?

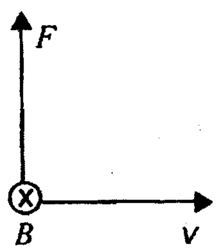
A



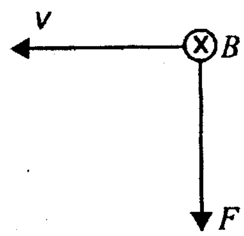
B



C



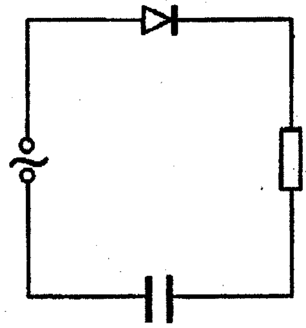
D



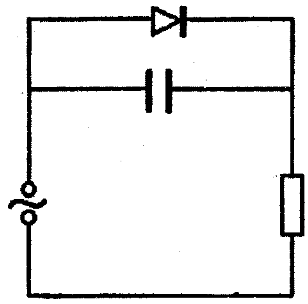
[Turn over

21 A capacitor is used for smoothing in a half–wave rectifier. In which of the following circuits is the capacitor correctly connected?

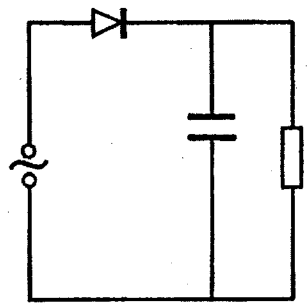
A



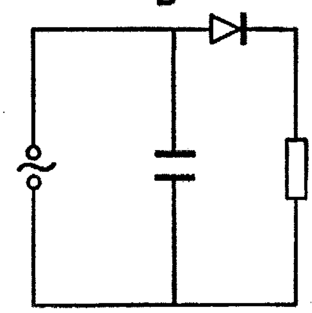
B



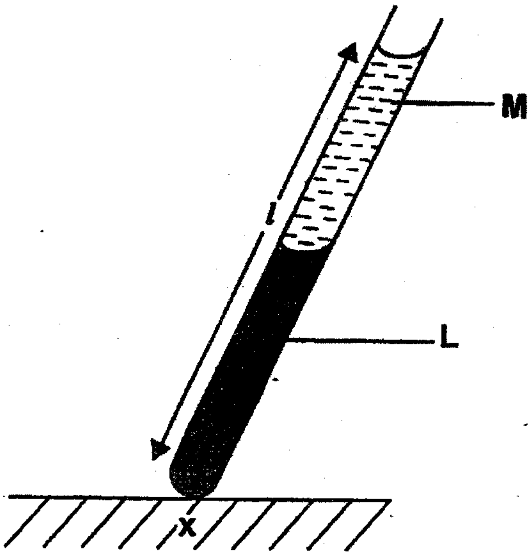
C



D

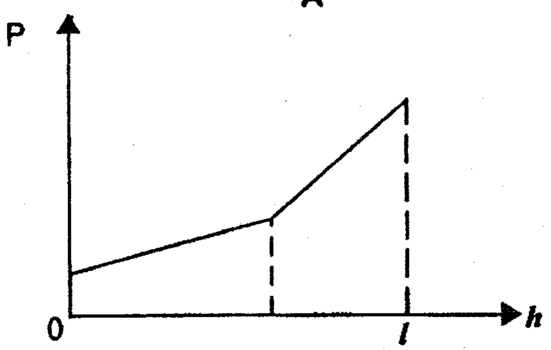


22 Two different liquids L and M, which do not mix, settle in a tube in two layers as shown in the diagram. The tube is inclined to the horizontal. The densities of the liquids are 2ρ for L and ρ for M.

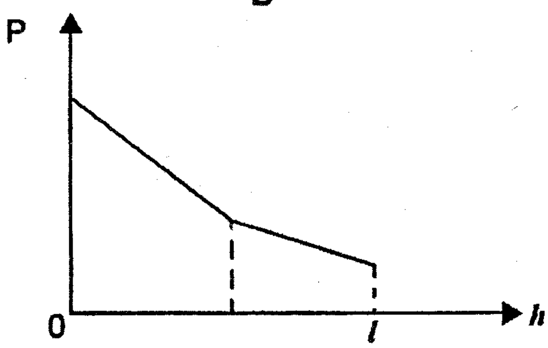


Which graph shows the variation of pressure with height h from point X along the tube?

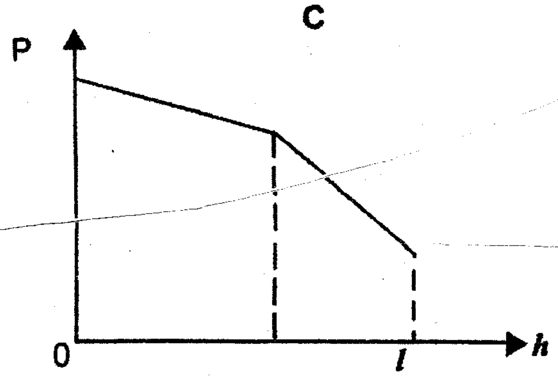
A



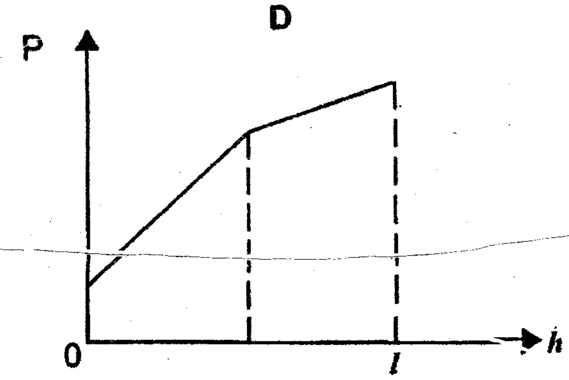
B



C



D



23 A wire with the initial length ℓ and the cross sectional area a was used to hang a weight W from the ceiling. It was found when the weight W was halved the extension was reduced by $\ell/10$. What is the Young's modulus of the material of the wire?

A $5W/a$
B $5W\ell/a$
C $10W\ell/a^2$
D $5W/a^2$

24 Which statement about the thermodynamic temperature scale is false?

A It is the standard temperature scale adopted for scientific measurement.
B It has one fixed point which is the triple point of water.
C It measures in *kelvin*, symbol K which is the SI unit of temperature.
D Its fixed point is called absolute zero and it is measured at atmospheric pressure.

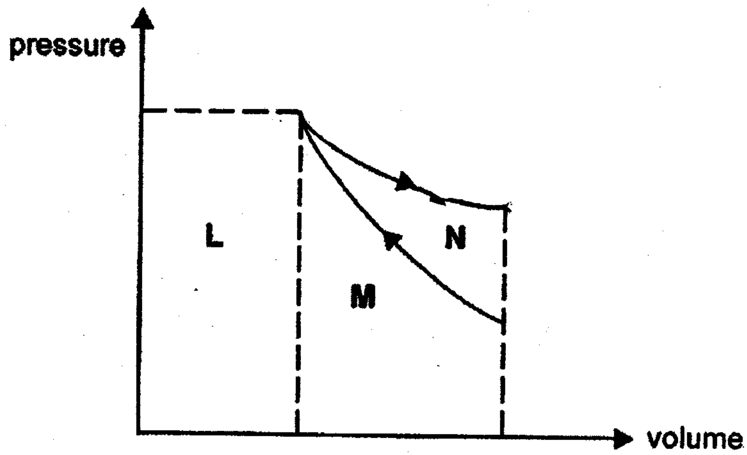
25 Study the following statements about the specific heat capacity of a material.

1. The amount of heat energy needed to raise the temperature of a material by 1°C is the specific heat capacity of the material.
2. Water is a very good coolant because it has a high specific heat capacity.
3. The specific heat capacity depends on the temperature and the mass of the material.

Which statement is/are true?

A 1 only
B 2 only
C 1 and 2 only
D 1 and 3 only

26 A gas is compressed and then allowed to expand as shown in the graph.

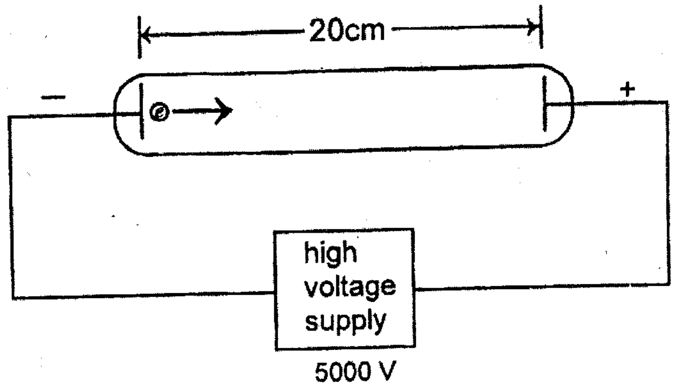


What could be the correct representation of the internal energy change of the gas at the end?

A area L + area M
B area L + area M + area N
C area M + area N
D area N

[Turn over

27 The diagram shows a discharge tube in which an electron is accelerated through a high voltage between the cathode and the anode. The cathode and the anode are 20cm apart and the high voltage is 5000V.



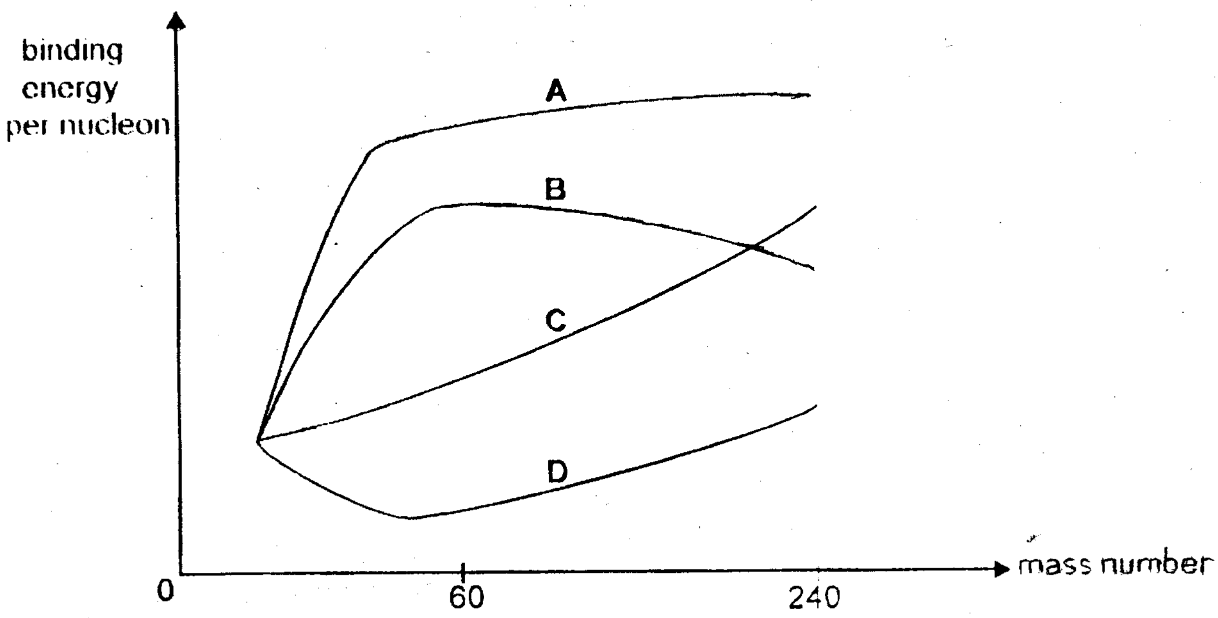
What is the speed of the electron when it hits the anode?

A $3.0 \times 10^{7} ms^{-1}$
B $4.2 \times 10^{7} ms^{-1}$
C $9.1 \times 10^{14} ms^{-1}$
D $1.8 \times 10^{15} ms^{-1}$

28 The eye can detect light when it absorbs energy at a rate of 10^{-17}W. The average wavelength of light is 5.0×10^{-7}m. Approximately how many photons can the eye absorb in one second when it detects light?

A 25
B 50
C 75
D 100

29 Which curve roughly illustrate the variation of binding energy per nucleon of all elements?



30 **Naturally occurring radioactive elements such as uranium, actinium and thorium disintegrate to form new elements.**

element	**atomic number**
radium	88
actinium	89
thorium	90
protactinium	91
uranium	92

Which disintegration is **wrong**?

A A uranium nucleus emits an α-particle and forms a thorium nucleus.

B A thorium nucleus emits a β-particle and forms a protactinium nucleus.

C A thorium nucleus emits an α-particle and a γ-ray and forms a radium nucleus.

D An actinium nucleus emits a β-particle and a γ-ray and forms a protactinium nucleus.

6 A particle moves in a horizontal circle at a constant speed. If the mass is halved, the angular speed doubled and the radius unchanged, what happens to the centripetal force?

A doubled
B halved
C reduced by a quarter
D remains the same

7 The distance between the centre of the Earth and a communications satellite is 42 000km. What is the gravitational force between the satellite and the earth? (Mass of Earth = 6.0×10^{24}kg, Mass of satellite = 50kg).

A 2.3×10^{-1} N
B 1.1×10^{1} N
C 4.8×10^{8} N
D 1.7×10^{11} N

8 Two planets, X and Y have masses M_x and M_y and radii of r_x and r_y respectively. The free fall acceleration on the surfaces of both planets is the same.

Deduce the value of $\frac{M_x r_y^2}{M_y r_x^2}$ from the given information.

A $\frac{1}{4}$

B $\frac{1}{2}$

C 1

D 2

MARKING SCHEME - NOVEMBER 2002

1.	C	16.	B
2.	B	17.	C
3.	C	18.	C
4.	C	19.	B
5.	A	20.	B
6.	D	21.	C
7.	C	22.	B
8.	B	23.	A
9.	D	24.	D
10.	A	25.	B
11.	C	26.	D
12.	A	27.	B
13.	C	28.	A
14.	B	29.	B
15.	C	30.	D

Candidate Name

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL
General Certificate of Education Advanced Level

PHYSICS — 9243/2
PAPER 2

Friday **1 NOVEMBER 2002** Morning 1 hour 45 minutes

Candidates answer on the question paper.
Additional materials:
Electronic calculator and/or Mathematical tables
Protractor
Ruler (300 mm)

TIME 1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided on the question paper.
For numerical answers, **all** working should be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
The quality of your language will be taken into account in the marking of your answers which contain explanations.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
7	
8	
Quality of language	
TOTAL	

This question paper consists of 20 printed pages.

[Turn over

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ ms^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} Hm^{-1}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12} Fm^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19}\ C$
the Planck constant,	$h = 6.63 \times 10^{-34}\ Js$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ kg$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ kg$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ kg$
molar gas constant,	$R = 8.31\ JK^{-1}\ mol^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ mol^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ JK^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$
acceleration of free fall,	$g = 9.81\ ms^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
refractive index,	$n = \frac{1}{\sin C}$
resistors in series,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
electric potential,	$V = \frac{Q}{4\pi \epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel,	$C = C_1 + C_2 + \dots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin \omega t$
hydrostatic pressure,	$p = \rho g h$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^{\ 2}}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number,	$R_e = \frac{\rho v r}{\eta}$
Drag force in turbulent flow,	$F = Br^2 \rho v^2$

For Examiner Use

1 (a) The following equations may or may not be correct. Use base units to check if they represent the given relationships.

(i) The fundamental frequency f, of an open pipe of length L when the speed of sound is v, $f = \frac{v}{2L}$.

(ii) The pressure p at a point in a fluid of density ρ moving with a speed v, $p = \frac{1}{2}\rho v$.

(iii) The angle θ at which an aeroplane moving with a speed v should be banked to describe a path of radius of curvature r, $\tan\theta = \frac{v^2}{rg}$.

[6]

For Examiner Use

(b) Torque and energy have the same dimensions.

(i) Explain why it would be inappropriate to measure torque in joules.

____

____

____

____

(ii) Write down an appropriate unit of torque.

____ [2]

2 A basketball player shoots a 'free throw' as shown in **Fig 2.1** below. He throws the ball at an angle of 55° to the horizontal and gives it an initial velocity u.

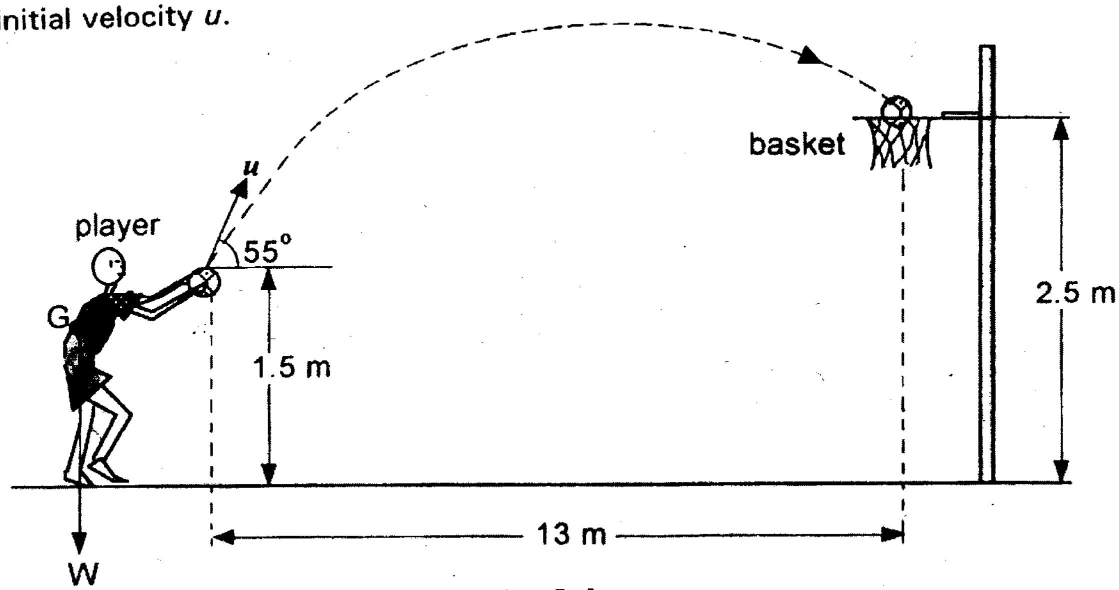


Fig. 2.1

Assume that air resistance is negligible.

(a) What is the component of the ball's initial speed in terms of u?

(i) horizontally ____

(ii) vertically ____ [2]

[Turn over

For Examiner's Use

3 A 'torque wrench' is a tool used to tighten nuts and bolts to a precise measurement. One model is shown in **Fig. 3.1**.

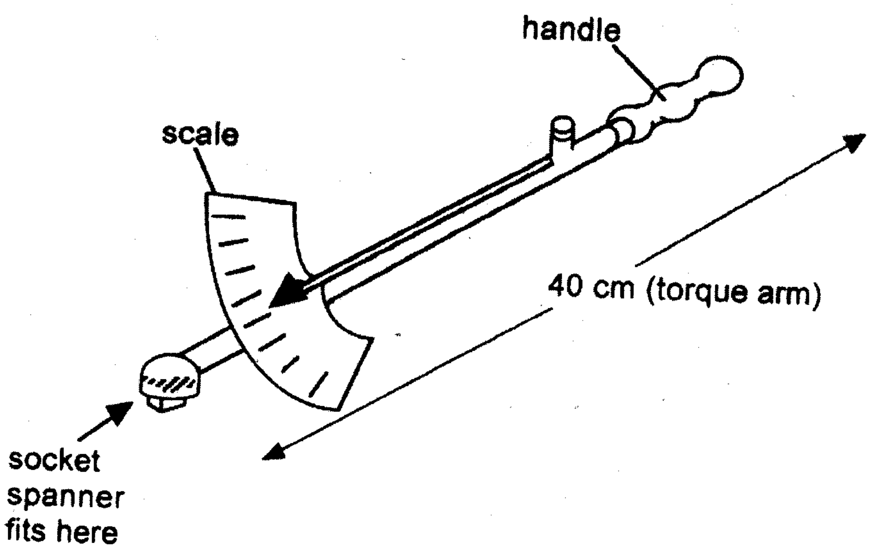


Fig. 3.1

(a) (i) Explain what is meant by a *torque*.

____

____ [2]

(ii) Explain briefly how the torque wrench is used to tighten a nut by the required amount.

____

____

____ [2]

(iii) Calculate the torque for the wrench shown if the force applied to the end of the handle is 200 N.

torque = ______________________________ [2]

For Examiner's Use

(b) Using your answer to **a(i)**, write down an expression for the time t, taken to reach the basket in terms of u.

t = ______________________________ [1]

(c) Using your answers to **(a)** and **(b)**, calculate the value of u.

u = ______________________________ [3]

(d) When taking the shot, the player must be in stable equilibrium. His weight W acts through the line shown in **Fig. 2.1** where G is the centre of gravity of his body.

(i) State **two** conditions for a system to be in equilibrium.

____

______________________________ [2]

(ii) Suggest **two** ways by which the player can ensure that he remains in equilibrium.

____

____

______________________________ [2]

(b) **(i)** **Why does a torque wrench have a long handle or torque arm?**

For Examin Use

____

____

____ [2]

(ii) State one risk of using a wrench whose torque arm is too long.

____

____ [1]

(c) **(i)** Calculate the distance moved by the end tip of the handle during one complete turn when the force in **a(iii)** is applied.

distance = ______________________________ [2]

(ii) Hence calculate the energy transferred.

energy transferred = ______________________________ [3]

For Examiner's Use

(d)

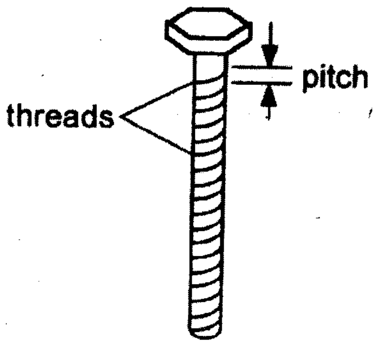


Fig. 3.2

Fig. 3.2 shows the pitch of a screw thread which is 1.5 mm. To stretch the tightened bolt by 1.5 mm, 30% of the energy calculated in **3c(ii)** is required.

(i) Calculated how much force is being used to stretch the bolt.

force = ... [3]

(ii) What happens to the other 70% of the energy transferred?

....

.... [2]

4 (a) (i) What do you understand by *diffraction* of waves?

....

....

.... [2]

[Turn over

(ii) **Demonstrate your appreciation of diffraction by completing Fig. 4.1, showing the wave fronts after passing the following obstacle.**

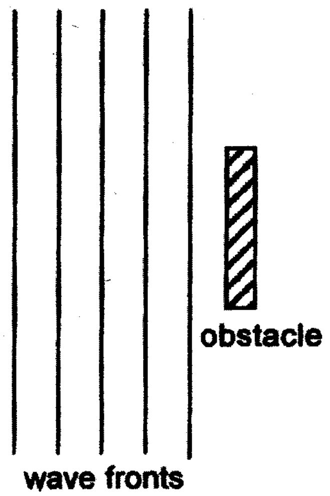


Fig. 4.1

[2]

(b) **Fig. 4.2** shows wave fronts after passing through a narrow and a wide gap positioned on the left-hand end of the pattern.

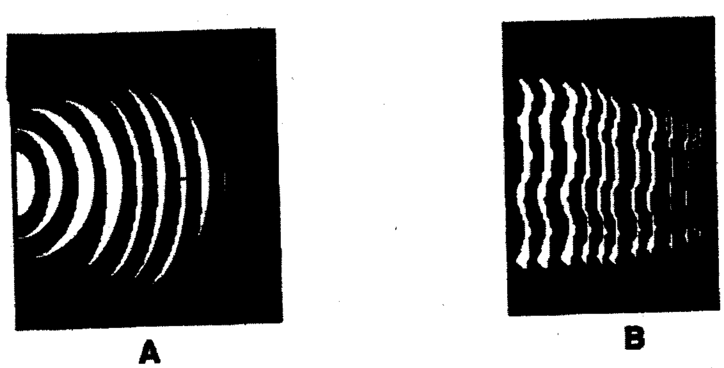


Fig. 4.2

(i) State which one of **A** or **B** is the pattern of wave fronts from a narrow gap.

______________________________ [1]

(ii) Give a reason for your choice.

For Examiner's Use

[2]

Why is diffraction of sound waves a common phenomenon but diffraction of light waves is not?

[3]

Turn over

For Examiner Use

5 A force acts on a current–carrying conductor placed in a magnetic field. Electromagnetic propulsion devices such as the rail gun (refer to Fig. 5.1) use this principle to propel objects such as a slug.

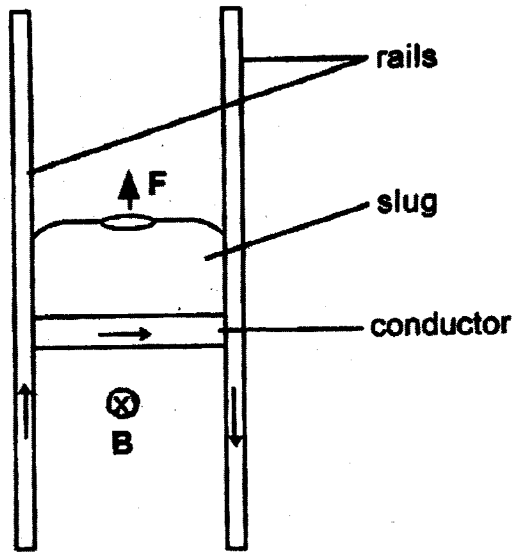


Fig. 5.1

A current that flows through the conducting rails as shown in **Fig.5.1** will give rise to a magnetic field **B** that is directed into the page. The conductor falls within this field and thus experiences a force **F**.

(a) Define the *telsa*, the unit of magnetic flux density.

____

____

____ [1]

(b) State and explain how the direction of the force F on the conductor is predicted.

____

____ [2]

(c) (i) Draw on **Fig. 5.1** the magnetic field pattern due to the conducting rails. [2]

For Examiner's Use

(ii) Hence draw arrows showing the forces acting on the rails. [1]

(iii) The forces in **(ii)** above may present problems. State one possible problem and explain how it can be taken care of.

____

____

____ [2]

(d) State **two** factors that the force **F** depends on.

____

____ [2]

(e) Suggest one use for such a railgun other than for military purposes.

____ [1]

6 For two conductors **P** and **Q**, current **I** varies with voltage **V** as shown in **Fig. 6.1**. below.

For Examin Use

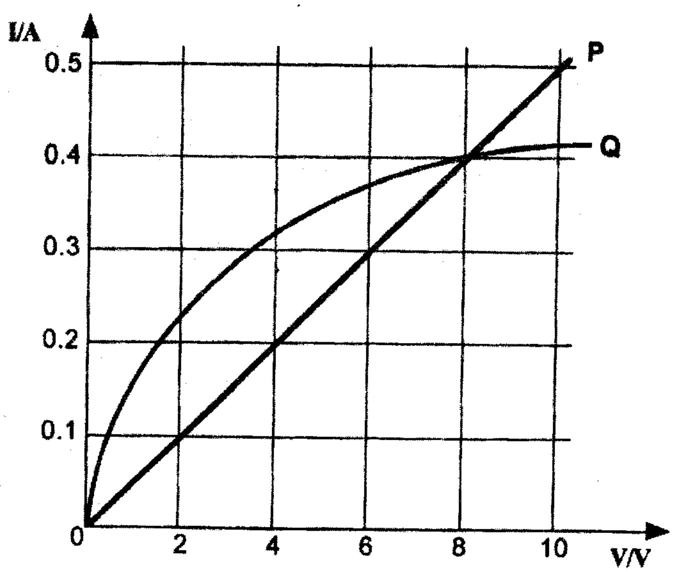


Fig. 6.1

(a) When P and Q are connected in series to a voltage supply, a current of 0.2 A flows. Use the graph to estimate the potential difference of the supply (Assume that its internal resistance is negligible).

potential difference = ______________________ [2]

For Examiner' Use

(b) The voltage supply in **(a)** is now connected to a parallel combination of **P** and **Q**. Calculate the current drawn from the supply.

current = ______________________________ [2]

7 **(a)** Give an expression for E, the energy of a photon in terms of f, its frequency, and h the Planck constant.

______________________________ [1]

(b) Some of the energy levels of an atom of one substance are shown in **Fig. 7.1** below.

For Examiner' Use

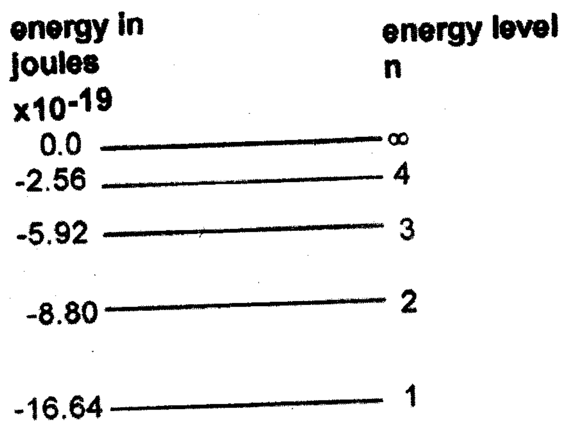


Fig. 7.1

(i) How much energy is required to raise an electron from n = 1 to n = 4.

energy = ______________________________ [1]

(ii) Calculate the wavelength of the radiation that is given off by the electron.

wavelength = ______________________________ [2]

(iii) What part of the electromagnetic spectrum does this radiation belong to?

______________________________ [1]

For Examiner Use

8 Fig. 8.1 shows the apparatus used to investigate radiant energy.

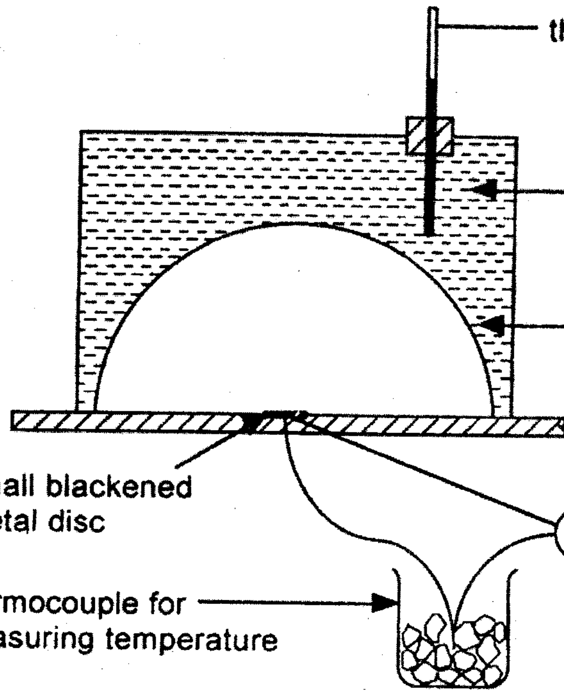


Fig. 8.1

As the blackened metal disc receives radiation from the dome, its temperature, which is measured by the thermocouple rises. The disc is pre-cooled, and then the dome which is at temperature T is put in place over it. Readings are taken for the disc temperature T at a time t as shown on the table below.

t/s	0	15	30	45	60	90	120	150	180
T/K	262	274	283	290	295	303	309	314	317

For Examine Use

(a) Explain why different thermometers used to measure the same temperature may not give the same reading.

____

____ [1]

(b) Suggest **two** reasons in each case, why

(i) the liquid-in-glass thermometer is suitable for measuring the temperature of the water bath.

1 ____

2 ____

(ii) the thermocouple is suitable for measuring temperature T.

1 ____

2 ____ [4]

(c) Explain why the disc and the dome are blackened.

____

____ [2]

(d) How can you tell from the data that the disc has been pre-cooled.

____

____ [1]

(e) **On the following grid, Fig. 8.2, plot a graph of T (y-axis) against t(x – axis).** **[4]**

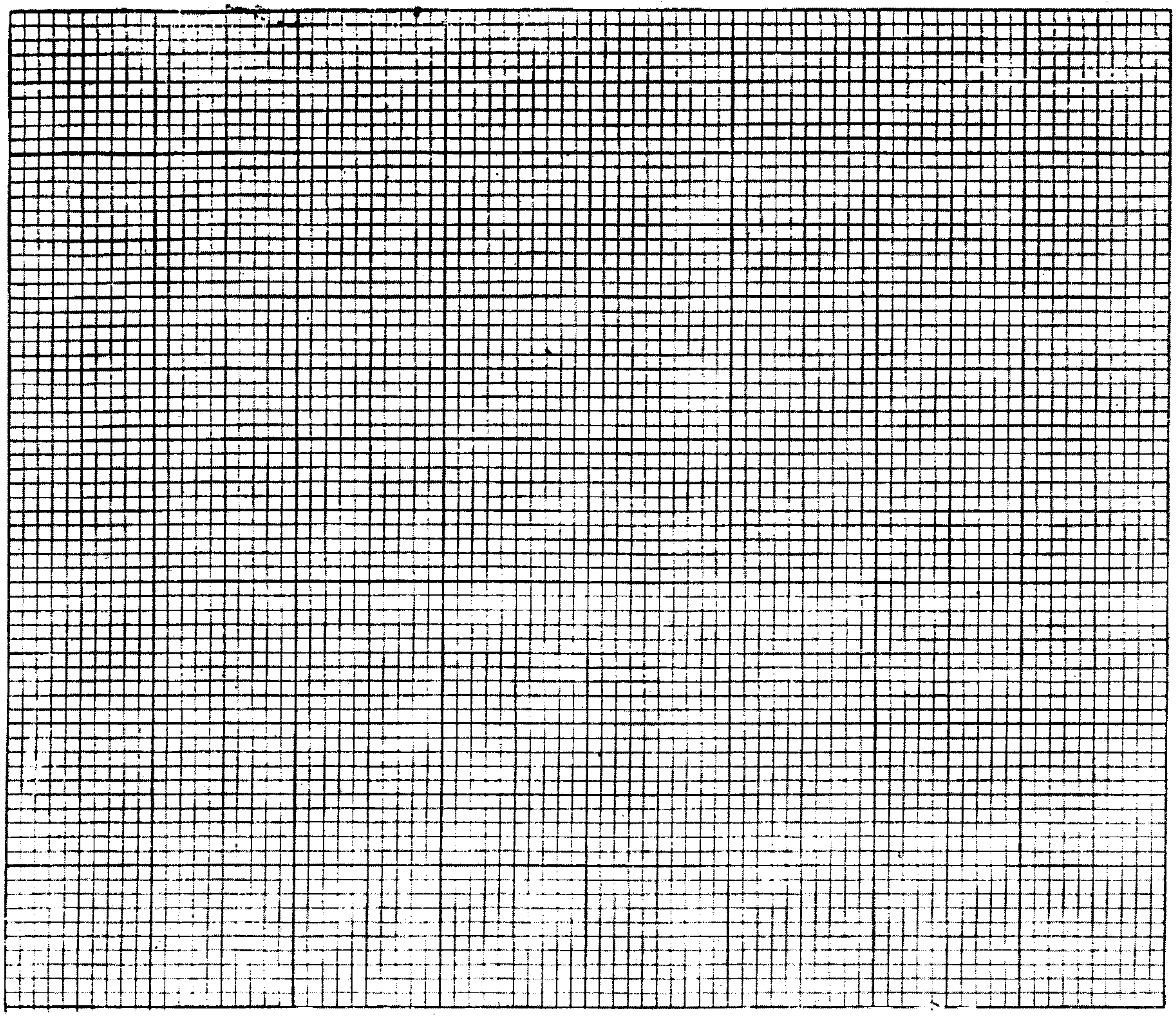


Fig. 8.2

(f) Use the graph to find the rate of change of temperature R_c at $T = 293$ K.

rate of change of temperature = ______________________ K/s [3]

For Examiner Use

(g) Theory suggests that: $\frac{C.R_c}{A} = \delta \left\{(T_d)^4 - (293)^4\right\}$,

where : C = the heat capacity of the disc = 0.297JK^{-1}

A = the surface area of the disc = 1.51 x 10^{-4} m^2

T_d = the temperature of the dome = 373 K

δ = a constant

Determine the value of δ

δ = ______________________ [2]

(h) Similar investigations are carried out with the dome at different values of temperature T_d. In each of these investigations, a graph is drawn and R_c is determined at T = 293 K.

T_d/K	311	328	345	358	373
R_c/Ks^{-1}	0.056	0.118	0.193	0.251	

Complete the table above by recording your value of R_c for T_d = 373 K and then comment on the results.

____

______________________ [1]

Quality of Language [4]

1 (a) (i) LHS = s^1
RHS = $ms^{-1} \times m^{-1}$
LHS ≡ RHS
Relationship is possible. (2)

(ii) LHS = $hgms^{-2}\ m^{-2}$
= $hgm^{-1}s^{-2}$
RHS = $hgms^{-1}\ m^{-3}$
= $kgm^{-2}s^{-1}$
LHS ≠ RHS
Therefore, relationship is not possible. (2)

(iii) LHS has no units
RHS = $m^2s^{-2}m^{-1}m^{-1}s^2$
i.e. no unit
Therefore LHS ≡ RHS
Relationship is possible (2)

1.(b)

Body	Car	Satellite	100m Sprinter	Passenger Plane
Speed/km/h	120	24000	35	1000

(2)

2. (a) (i) ucos 55° (1)
(ii) usin 55° (1)

(b) $t = \frac{13}{u\cos 55°}$ (1)

(c) $S = ut + ½at^2$

$l = u\sin 55° \frac{13}{u\cos 55°} - \frac{1}{2} \times 9.81 \times \left(\frac{13}{u\cos 55°}\right)^2$

u = 11.98 m/s (3)

(d) (i) no resultant force
no resultant torque (2)

(ii) lower his body
feet wide apart
does not bend forward/backward/sideways (2)

3 (a) (i) moment or turning effect of a force or couple. (2)
(ii) force bends the wrench slightly and pointer moves over scale or required point. (2)

(iii) T = F x r
= 200 x 40 x 10^{-2} = 80 Nm (2)

3 (b) (i) From torque = F x r, increasing r means there is a greater turning effect. (2)

(ii) May cause bolts to snap or threads stripping due to over tightening. (1)

3 (c) (i) circumference = $2\pi r$ = $2\pi \times 40 \times 10^{-2}$ (1)
= 2.5 m (1)

(ii) energy transferred = F X S
= 200 x 2.5 = 500J (3)

3 (d) (i) $\frac{30}{100} \times 500 = 150J$

Work done = 150J

$F = \frac{150}{1.5 \times 10^{-3}} = 100000N$ (3)

(ii) Sound/internal energy/heat energy, heat energy comes form the work done against friction. (2)

4 (a) (i) Spreading of waves when they pass through an opening or obstacle into regions we would not expect them. (2)

[STD TEXT]

(1)

4 (b) (i) A

(ii) Size of aperture to be of same order as wavelength. (1)
The smaller the slit the greater the diffraction. (1)

4 (c) Diffraction occurs when size of aperture is of comparable magnitude to wavelength. (1)

Sound waves are usually of long wavelengths so can be diffracted on doorways, windows, etc. (1)

Light waves (on the contrary) have extremely short wavelengths and very narrow openings are needed for their diffraction. (1)

5 (a) A magnetic flux density of a field which will produce a force of 1 N on a conductor 1m long carrying a current of 1A. (1)

5 (b) Fleming's left hand rule. (1)
Thumb (force) first finger (field), second finger (current) (1)

5 (c) (i) concentric circles (1)
(ii) combination of magnetic forces to give F. (1)
(iii) rails pushed apart and material for construction of the railgun must withstand this force. (1)

5 (d) size of current through rails length of conductor. (2)

5 (e) space travel (1)

6 (a) In series $V = V_p + V_q$
$= 4 + 1,5$
$= 5,5$ V (2)

6 (b) Current from source $= Ip + Iq$
$= 0,28 + 0,36$
$= 0.64$A (2)

7(a) E = hf (1)

7 (b) (i) $[-2.56 - (-16.64)]10^{-19}$J
$= 14.08 \times 10^{-19}$J (1)

(ii) $E = h\frac{c}{\lambda}\left(f = \frac{c}{\lambda}\right)$

$14.08\times10^{-19} = 6.63 \times 10^{-34} \times 3 \times 10^{8}/\lambda$

$\lambda = 1.41 \times 10^{-7}$ m (2)

(iii) U.V. (1)

8 (a) Different thermometers respond differently since they have different thermometric properties hence giving different values for the same temperature. (1)

8 (b) (i) (1) Thermometer can measure the possible range (0 – 100°C) (1)

(2) Thermometer suitable for steady temperatures. (1)

(ii) (1) Measures rapidly varying temperature. (1)

(2) Measures temperature at a point. (1)

8 (c) Disc – makes it good absorber of radiation. (1)
Dome – makes it good emitter.

8 (d) 262K, the temperature at t = 0 is below standard room temperature (1)

8 (e) Graph:
Axes labelled and numbered (1)
Acceptable scale + good spread (1)
Plotting accuracy (1)
Smooth curve (1)

8 (f) Tangent drawn at T = 293 K

R_c = Gradient of tangent : $\frac{\Delta T}{\Delta t}$, value [0.31 – 0.35].

8 (g) $d = \frac{CR_c}{A\{(T_d)^4 - (293)^4\}}$

$\doteq$ *** (depends on Rc) (2)

T_d/K					373
R_c/K5^{-1}					Value from above.

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS — 9243/3

PAPER 3

Thursday 7 NOVEMBER 2002 Afternoon 2 hours 30 minutes

Additional materials:
Answer paper
Electronic calculator and/or Mathematical tables
Ruler (mm)

TIME 2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.
Answer **six** questions.
Answer **four** questions form Section A and any two questions from Section B.
Write your answers on the separate answer paper provided.
If you use more than one sheet of paper, fasten the sheets together.
All working for numerical answers must be shown.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You are advised to spend about 40 minutes on Section B.
You are reminded of the need for good English and clear presentation in your answers.

This question paper consists of 21 printed pages and 3 blank pages.

[Turn over

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ ms^{-1}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7} Hm^{-1}$
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the Planck constant,	$h = 6.63 \times 10^{-34}\ Js$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ kg$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ kg$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ kg$
molar gas constant,	$R = 8.31\ JK^{-1}\ mol^{-1}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ mol^{-1}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ JK^{-1}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$
acceleration of free fall,	$g = 9.81\ ms^{-2}$

Formulae

uniformly accelerated motion,	$s = ut + \frac{1}{2}at^2$
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work done on/by a gas,	$W = p\Delta V$
gravitational potential,	$\phi = -\frac{Gm}{r}$
refractive index,	$n = \frac{1}{\sin C}$
resistors in series,	$R = R_1 + R_2 + \ldots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential,	$V = \frac{Q}{4\pi \epsilon_0 r}$
capacitors in series,	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel,	$C = C_1 + C_2 + \ldots$
energy of charged capacitor,	$W = \frac{1}{2}QV$
alternating current/voltage,	$x = x_0 \sin\omega t$
hydrostatic pressure,	$p = \rho g h$
pressure of an ideal gas,	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
radioactive decay,	$x = x_0 \exp(-\lambda t)$
decay constant,	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$
critical density of matter in the Universe,	$\rho_0 = \frac{3H_0^{\ 2}}{8\pi G}$
equation of continuity,	$Av = \text{constant}$
Bernoulli equation (simplified),	$p_1 + \frac{1}{2}\rho v_1^2 = p_2 + \frac{1}{2}\rho v_2^2$
Stokes' law,	$F = Ar\eta v$
Reynolds' number	$R_e = \frac{\rho v r}{\eta}$
Drag force in turbulent flow,	$F = Br^2\rho v^2$

Section A

Answer any **four** questions from this section.

1 **(a)** **(i)** What is meant by *linear* momentum?

(ii) State the principle of conservation of linear momentum.

(iii) Explain how the principle is linked to Newton's third law. [6]

(b) Two spheres **A** and **B** moving in the same directions as shown in **Fig. 1.1** collide elastically. Sphere **A** has mass m and speed 4u and sphere **B** has mass 2m and speed u. The final speeds of **A** and **B** after collision are v_1 and v_2 respectively.

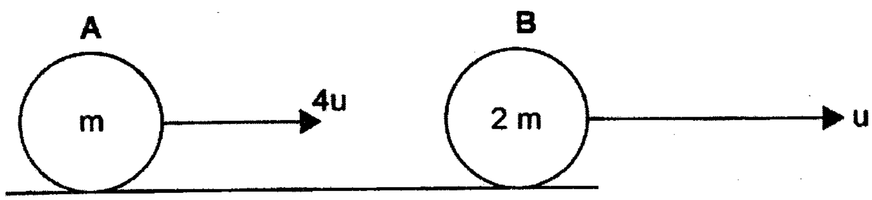

Fig. 1.1

(i) What is meant by an *elastic* collision?

(ii) Write down an equation for the conservation of momentum.

(iii) Write down an equation for the conservation of energy.

(iv) Deduce the value of v_2 in terms of u. State what happens to the motion of **A** after collision. [7]

(c) In another interaction, a plasticine sphere of mass 0.30 kg is dropped from a height of 5.00 m and sticks to the ground.

(i) Deduce the momentum of the sphere just before impact.

(ii) State and explain the transfer of energy and momentum after impact. [7]

2 **(a)** State two differences between transverse and longitudinal waves. [3]

(b) **Fig. 2.1** shows the graph of a snapshot of the waveform of a water wave. A particle **A** is 0.60 m from the origin O.

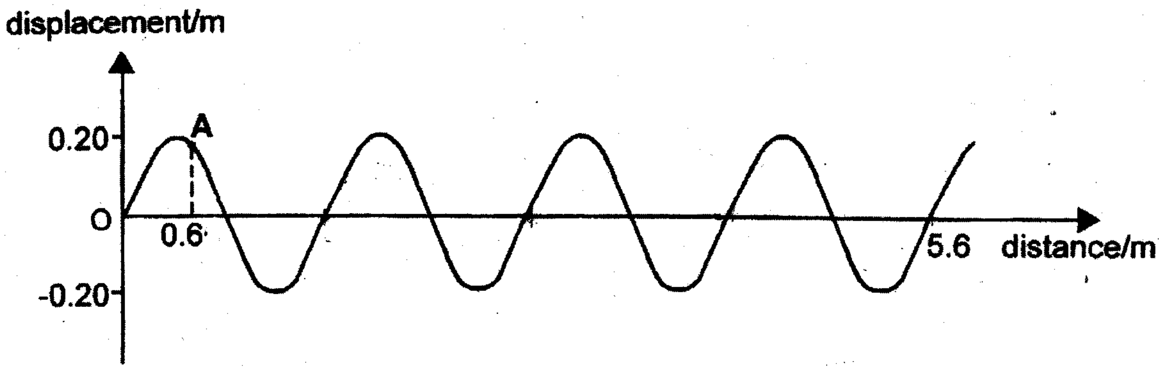

Fig. 2.1

From **Fig. 2.1** determine:

(i) the wavelength,

(ii) the phase difference between particles at O and **A**. [2]

(c) **Fig. 2.2** shows the graphs of displacement against time for the particle **A**.

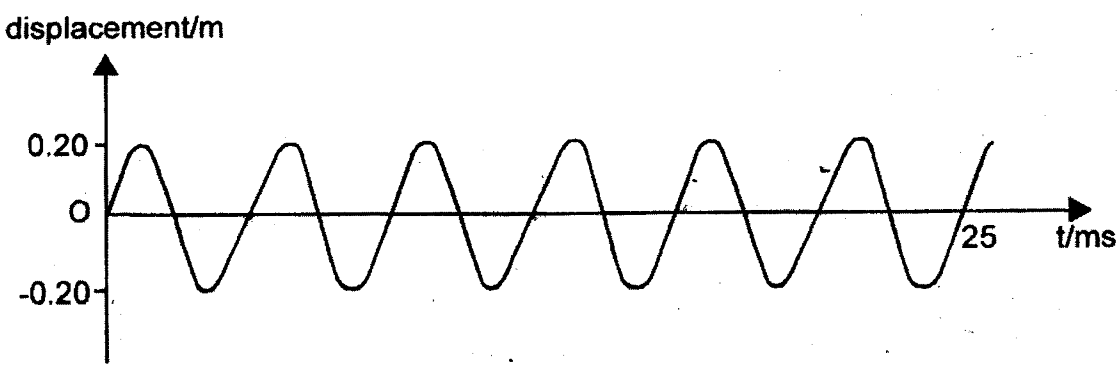

Fig. 2.2

Determine:

(i) the period, T of the oscillations of particle **A**,

(ii) its frequency,

(iii) the speed of the water waves. [5]

(d) Given that particle **A** describes simple harmonic motion, calculate its

(i) angular frequency,

(ii) maximum velocity,

(iii) maximum acceleration. [6]

(e) (i) What is meant by *resonance*?

(ii) Describe two situations in which critical damping is employed. [4]

3 **(a)** **Fig. 3.1** shows curves (not drawn to scale) relating pressure p, and volume V, for a fixed mass of an ideal monatomic gas at temperature 300 K and 600 K. The gas is enclosed in a container fitted with a piston which can move with negligible friction.

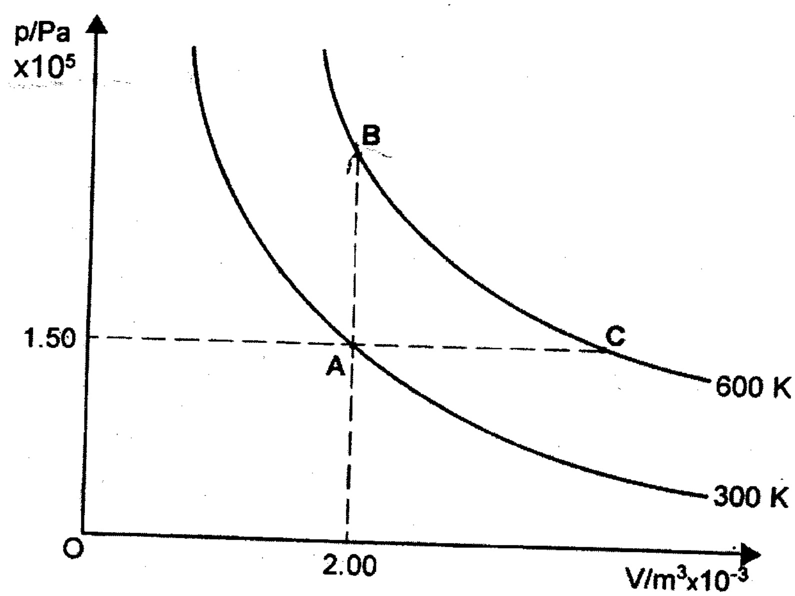

Fig. 3.1

(i) State the ideal gas equation for n moles of the gas, explaining the symbols used.

(ii) Calculate the number of moles of the gas.

(iii) Calculate the volume of gas corresponding to point **C** on the graph. [6]

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(b) The pressure of an ideal gas is given by $p = \frac{1}{3}\rho < c^2 >$ where ρ is the density of the gas.

(i) What is meant by $<c^2>$?

(ii) Using the equation above, derive an expression for the total internal energy of one mole of an ideal monoatomic gas at kelvin temperature T.

(iii) Calculate the total internal energy of the gas in the container corresponding to point **A** on the graph. [8]

(c) **(i)** State the first law of thermodynamics.

(ii) Using the first law of thermodynamics, calculate the heat absorbed during changes represented on the graph from **A** to **B** and **A** to **C**. [6]

4 (a) A body can be charged by friction. With the aid of a diagram, describe another method which can be used to charge an insulated metalic sphere. [2]

(b) (i) Explain how electrostatics is used to extract dust particles from chimneys of factories. [2]

(ii) Define the term *voltage* and state its SI units. [2]

(c) From your definition of voltage in **(b)(ii)** show that electrical power, $P = I^2R$, where R and I of a conductor represent resistance and current respectively. [2]

(d) State **two** differences between voltage and electromotive force(e.m.f). [2]

(e) Write down an equation of the law of conservation of energy for a circuit of e.m.f. E, internal resistance, r and resitors R_1, R_2 and R_3 connected in series. [1]

(f) A light–dependent resistor (LDR) is connected in series with a 10 kΩ resistor and a 12 V d.c. supply as shown in Fig. 4.1.

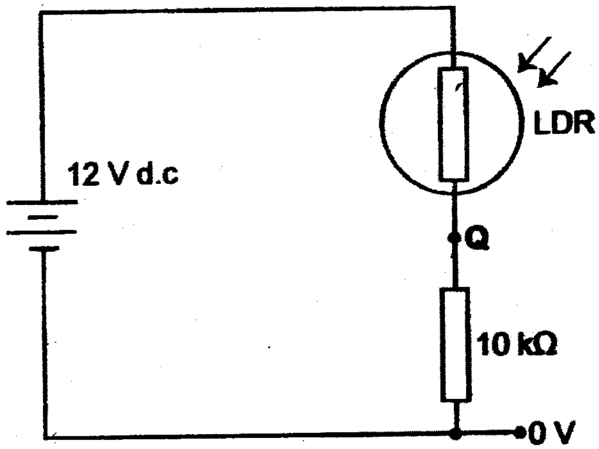

Fig. 4.1.

Find the potential at the point Q when the LDR is

(i) in the dark and has a resistance of 60 kΩ.

(ii) in bright sunlight and has a resistance of 2 kΩ. [3]

(g) What is the resistance of the LDR if the potential at Q is 3.5 V. [2]

(h) Two lamps **M** and **N** labelled 3 V, 0.20 A and 6 V, 0.06 A respectively, light up with normal brightness (see **Fig 4.2**).

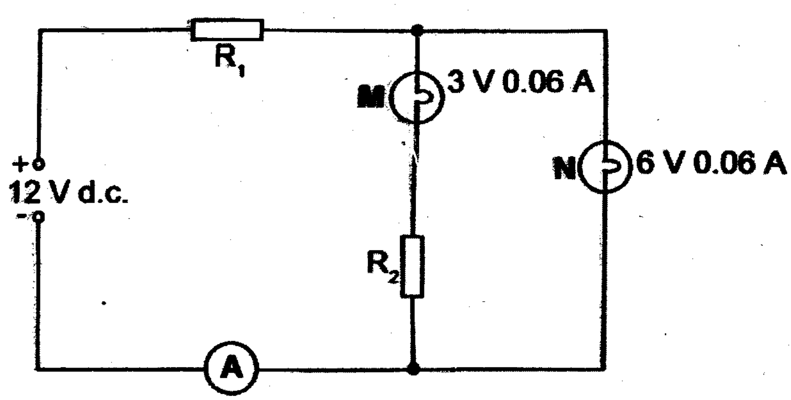

Fig. 4.2

(i) Determi... the values of R_1 and R_2.

(ii) What is the ammeter reading?

(iii) Explain what happens to M if N .lows out. [4]

5 (a) (i) Write down Einstein's photoelectric equation and explain the meaning of each term. [2]

(ii) Sodium has a work function of 2.3 eV.

Calculate

1 its threshold frequency,

2 the maximum velocity of the photoelectrons produced when the sodium is illuminated by light of wavelength of 5.0×10^{-7}m,

3 the stopping potential with light of this wavelength. [8]

(b) An electron travels with speed v in a circle of radius r in a plane perpendicular to a uniform magnetic fluid of flux density B.

(i) Write down an algebraic equation relating the centripetal and electromagnetic forces acting on the electron.

(ii) Hence deduce that the time T for one orbit of the electron is given by the expression $T = \frac{2\pi m}{Be}$. [3]

(c) If the speed of the electron is changed to $4v$, what effect, if any, would this change have on

(i) the orbital radius r?

(ii) the orbital period T? [3]

(d) Radio waves from outer space are used to obtain information about interstellar magnetic fields. These waves are produced by electrons moving in circular orbits. The radiowave frequency is the same as the electron orbital frequency. If waves of frequency 1.4 MHz are observed calculate;

(i) the orbital period of the electrons,

(ii) the magnetic flux density of the field. [4]

6 (a) In terms of the constituents of atomic nuclei, explain the meaning of

(i) atomic number,

(ii) mass number,

(iii) isotopes. [3]

(b) Account for the fact that, although nuclei do not contain electrons, some radioactive nuclei emit beta particles. [2]

(c) Cobalt has only one stable isotope ^{59}Co. What form of radioactive decay would you expect the isotope ^{60}Co to undergo to form ^{59}Co? Give a reason for your answer. [2]

(d) ^{60}Co decays to ^{59}Co with a half-life of 5.3 years.

(i) What is the activity of a source containing 0.015 g of ^{60}Co?

(ii) What is the activity of the source 3 years later? [6]

(e) The radioactive nuclei $^{210}_{84}Po$ emit alpha particles of a single energy, the product nuclei being $^{206}_{82}Pb$.

(i) Using the data below, calculate the energy in MeV, released in each decay.

(ii) Explain why the alpha particle does not take up all this energy as its kinetic energy.

(iii) Calculate the kinetic energy of the alpha particle taking the integer values of the nuclear masses. [7]

Nucleus	Mass(u)
$^{210}_{84}Po$	209.936 730
$^{206}_{82}Pb$	205.929 421
α - particle	4.001 504

1 unified atomic mass unit, u = 931 MeV

SECTION B

Answer any **two** questions from this section.

A question is set on each of the seven optional topics, namely;

Option A,	Astrophysics and Cosmology,
Option C,	The Physics of Materials
Option E,	Electronics
Option F,	The Physics of Fluids
Option M,	Medical Physics
Option P,	Environmental Physics and
Option T,	Telecommunications

You should spend approximately 40 minutes answering this section.

Option A

Astrophysics and Cosmology,

(a) (i) State and explain the Olber's paradox.

(ii) Explain why Olber's paradox suggests that the model of an infinite static universe is correct. [5]

(b) Describe the **three** possibilities for the future of the universe. [5]

(c) A graph of the recessional speed of galaxies is a straight line through the origin. The gradient of the graph is approximately $2.8 \times 10^{-18}\,s^{-1}$ Use this information to deduce

(i) the approximate value of Hubble's constant, H_o,

(ii) the speed of recession of a galaxy which is 5 million light-years away from the earth,

(iii) the approximate age of the universe. [5]

Option C

The Physics of Materials

8 (a) When steel is heated its properties change according to the heat treatment method.

Describe the following methods:

(i) annealing,

(ii) quenching,

(iii) tempering. [3]

(b) State the changes in physical properties of the material resulting from each of the processes in (a) above. [3]

(c) State the meanings of the terms *strain* and *stress*. [2]

(d) An athlete participated in a tug-of-war where his arm bones were under tensile stress. When he did some press-ups, his arm hands were subjected to a compressive stress. The strain-stress graph of a typical bone is as shown in Fig. 8.1.

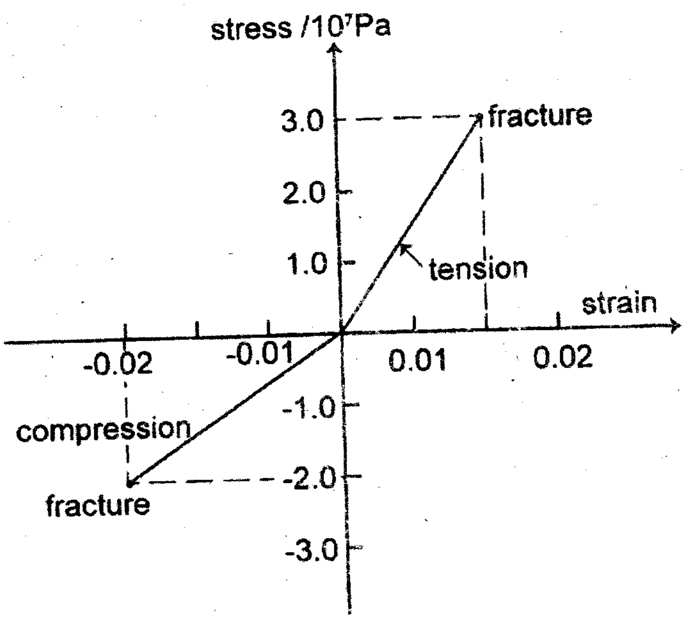

Fig. 8.1.

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(i) What evidence from the graph, shows that a bone is a brittle material?

(ii) Use the graph to determine a value for the Young's Modulus of the bone in compression and in tension.

(iii) If the athlete were to choose between doing press-ups or tug-of-war with others, in which activity is he safer than the other? Explain your answer. [7]

Option E

Electronics

9 (a) (i) Describe the structure of a relay switch.

(ii) Explain how a relay switch works. [4]

(b) The output at X in **Fig. 9.1** is controlled by connecting A and B to either +5 V line or 0V line.

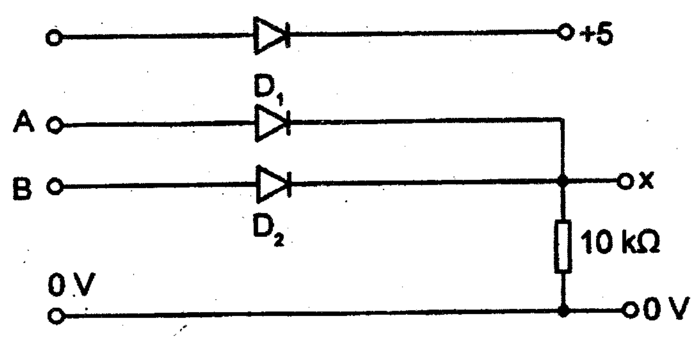

Fig. 9.1

Write the truth table of the circuit shown in **Fig. 9.1**. [3]

(c) The inputs A and B are connected to a sine wave generator of peak value 5 V, but diode D_2 is reversed in direction (see **Fig. 9.2**).

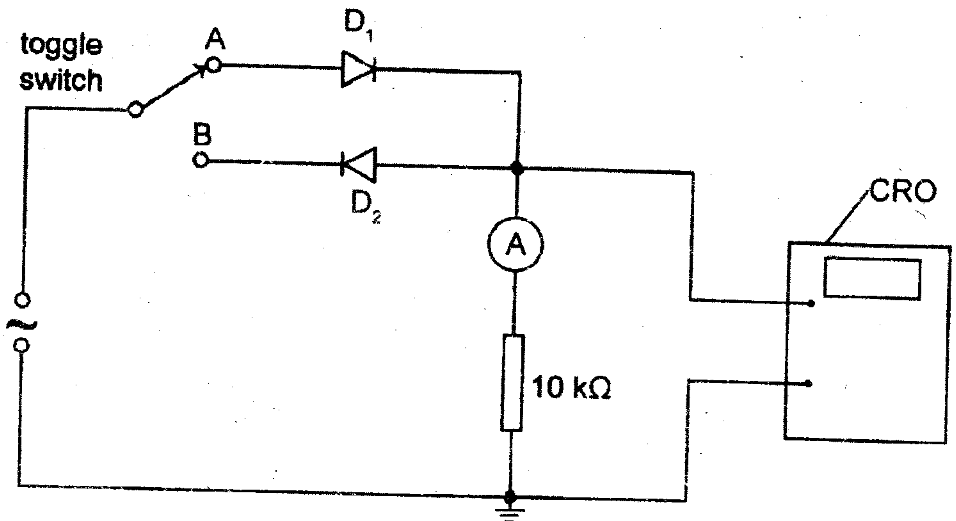

Fig. 9.2

The time of switching from A to B is equal to twice the period of the alternating voltage.

(i) Sketch a graph of the output signal on the C.R.O when the switch is at A.

(ii) Sketch another graph of the output signal when the switch is at B.

(iii) Explain your answer in **c(i)** and **c(ii)**.

(iv) What is the peak current that flows through the 10 kΩ resistor? [8]

Option F

The Physics of Fluids

10 (a) What is meant by the terms

(i) laminar flow,

(ii) turbulent flow. [2]

(b) Explain why Bernoulli's equation is not strictly applicable to

(i) a gas,

(ii) a viscous fluid flowing through a narrow tube. [4]

(c) With the aid of a diagram, describe the Bernoulli effect in which the flow of air around an aerofoil section results in a lift force. [4]

(d) (i) Show that the Reynold's number $R_e = \rho v r / \eta$ is dimensionless.

(ii) The average speed of oil in a pipe is about 2.0 cm/s. Is the flow of the oil in the tube laminar or turbulent if the diameter of the pipe is 0.25m?
(ρ_0 = 860kgm^{-3}, η_0 = 8.4 × 10^{-2} Pas) [5]

Option M

Medical Physics

11 (a) (i) Explain how X-rays are produced. [3]

(ii) State and explain a way of reducing overheating of the anode. [2]

(b) X-rays cannot be focused on a screen in order to produce sharp images. Suggest and explain **two** ways of improving sharpness of images. [4]

(c) **Fig. 11.1** and **Fig. 11.2** show oscilloscope displays for scanning.

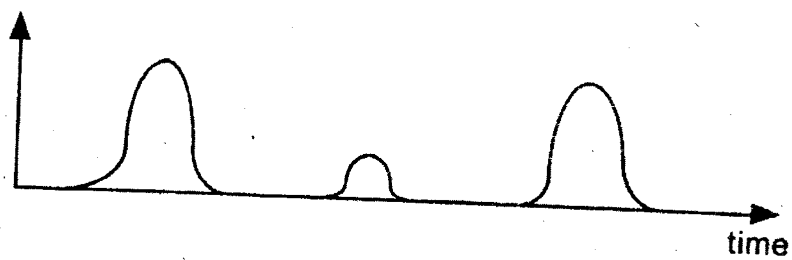

Fig. 11.1

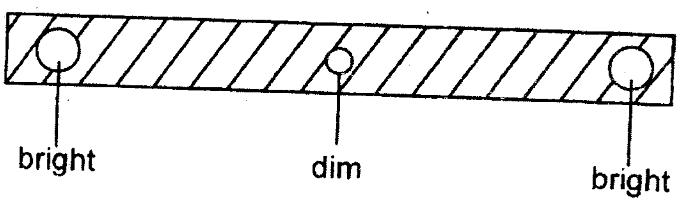

Fig. 11.2

(i) Name the scanning shown in **Fig. 11.1** and **Fig. 11.2**. [2]

(ii) Suggest what

1. the peaks in **Fig. 11.1** show and
2. the separation of peaks in **Fig. 11.1** measure apart from time. [4]

Option P

Environmental Physics

12 **(a)** Define the terms *isothermal* and *adiabatic* changes. [2]

(b) **Fig. 12.1** shows three lines on an indicator diagram for an ideal gas. The increases in internal energy for condition C of the ideal gas is 3.0 J.

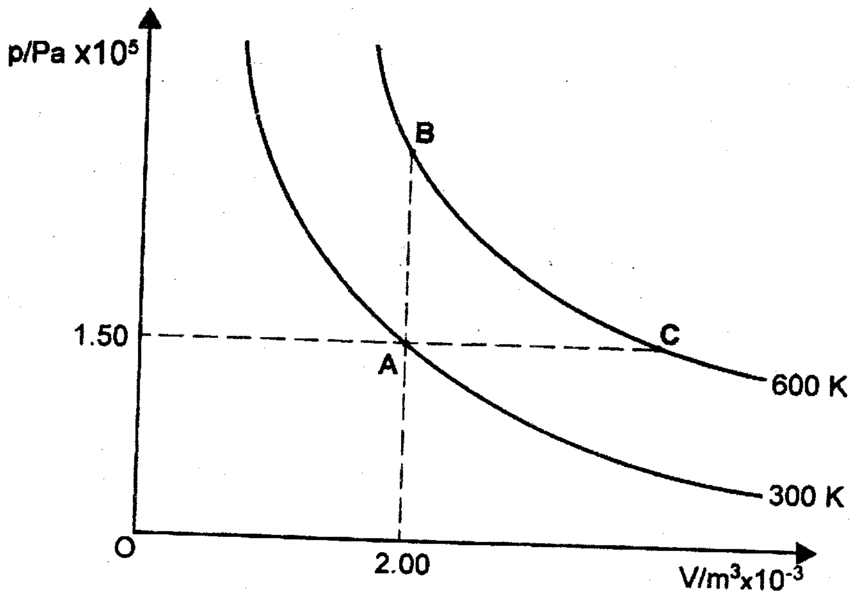

Fig. 12.1

(i) Deduce the work done and energy supplied to the gas in C.

(ii) Identify the lines labelled A, B and C. Explain your choices. [6]

(c) (i) State the second law of thermodynamics.

(ii) Suggest why an engine's efficiency is never 100% .

(iii) A car driver decides to travel from Mutare to Harare in the early hours of the morning. The driver thinks that it is good for his car. Comment on the driver's statement. [7]

Option T

Telecommunications

13 (a) Write four advantages of optical fibre over copper cables. [4].

(b) The input power to a cable is 1.45 W. The length of the cable is 30 km. The attenuation per unit length of the cable is 2 dB km^{-1}.

(i) What is *attenuation*?

(ii) Calculate the output power at the end of the cable.

(iii) Suggest a way of ensuring that the output is not reduced to such a low level. [6]

(c) (i) Describe with the aid of a diagram, the conversion of analogue into a 4 bit digital signal and the transmission of the digit signal using a parallel part.

(ii) Serial transmission is often used. Explain why this alternative is needed. [5]

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Question 1

(a)(i) Linear momentum is the product of mass and velocity.

(ii) Principle of conservation of linear momentum states that in a system of colliding bodies in which there are no external forces acting, the total momentum is a constant.

(iii) Newton's third law states that action and reaction are equal and opposite. The time of contact of two bodies is the same therefore magnitude of impulse is the same. Change in momentum which is impulse is also the same.

(b)(i) An elastic collision is one in which kinetic energy is conserved.

(ii) Equation for conservation of momentum is

$$4MU + 2MU = 6MU = MV_1 + 2MV_2$$

(iii) Equation for conservation of kinetic energy is

$$\tfrac{1}{2} M (4U)^2 + \tfrac{1}{2}\, 2MU^2 = \frac{MV^2}{2} + \tfrac{1}{2}\, 2MV_2^2$$

(iv) Use (ii) and (iii) to obtain

$$6V_2^2 - 24UV_2 + 18U^2 = 0$$

$$\therefore (V_2 - 3U)(V_2 - U) = 0$$

$$\therefore V_2 = 3U \text{ or } U$$

$$\therefore V_2 = 3U$$

Body A comes to rest.

(c)(i) Final velocity of sphere before impact is from

$V^2 = 2gh$

$= 2 \times 9{,}81 \times 5$

$\therefore V = \sqrt{9{,}81 \times 10}$

$\therefore momentum = mv$

$= 0{,}3 \times \sqrt{98{,}1}$

$= 2{,}97 kgm/s$

(ii) Kinetic energy of plasticine is converted into heat and sound. Momentum is conserved. Momentum of the plasticine is transferred to the earth but motion of the earth is not observed owing to the large mass.

Question 2

(a) Transverse waves have displacements which are perpendicular to the direction of the wave. Transverse waves can be polarized, longitudinal waves have displacement of particles that are parallel to the direction of travel of waves. They cannot be polarized.

(b)(i) Wave length $\lambda = 1{,}4$m

(ii) Phase difference $\theta = \frac{2\pi x}{\lambda}$

$$= \frac{2\pi(0{,}6)}{1{,}4}$$

$= 2{,}7$ rads

(c)(i) Period T = 4,2 ms

(ii) Frequency $f = \frac{1}{T}$

$= \frac{1}{4,2 \times 10^{-3}}$

= 240HZ

(iii) Speed of the wave waves $v = f\lambda$

= 1,4 x 240

= 336m/s

(d)(i) Angular velocity w = $2\pi f$

= 2π x 240

= 1,5 x 10^3 rads/s

(ii) Velocity of particle

$v = w\sqrt{r^2 - x^2}$ in which $x = 0$

= 1508 x 0,20

= 302m/s

(iii) a = w^2r

= $(1508)^2$ x 0,2

= 4,6 x 10^5 m/s^2

(e)(i) Resonance occurs when forced frequency is equal to the natural frequency such that amplitude is a maximum.

(ii) Critical damping is used in analogue meters and shock absorbers in vehicles.

Question 3

(a)(i) Ideal equation is stated as $PV = nRT$ where the symbols have their usual meaning.

(ii) Number of moles $n = \frac{PV}{RT}$

$$= \frac{1,5 \times 10^5 \times 20 \times 10^{-3}}{8,31 \times 300}$$

$$= 0,120 \text{ moles}$$

(iii) Volume of gas V $= \frac{nRT}{P}$

$$= \frac{0,12 \times 8,31 \times 600}{1,5 \times 10^5}$$

$$= 3,99 \times 10^{-3} m^3$$

(b)(i) $< c^2 >$ is mean square speed.

(ii) The total internal energy of an ideal gas $^3/_2$ NKT is derived using $PV = {}^1/_3 NM < c^2 >$

and PV = nRT such that $n = \frac{N}{N_A}$

$\therefore {}^1/_3 NM < c^2 > = \frac{N}{N_A} RT$

$$\frac{NM < c2 >}{2} = \frac{3}{2} NKT \quad \text{where} \quad K = \frac{R}{N_A}$$

for one mole $\frac{N}{N_A} = 1$

Total internal energy is

$\frac{1}{2} NM < c^2 > = {}^3/_2 RT$

(iii) Total internal energy at A = ${}^3/_2$ nRT

$$= \frac{3 \times 0{,}12 \times 8{,}31 \times 300}{2}$$

= 449J

(c)(i) The first law can be stated as dQ = du + dw where the symbols have their usual meaning.

(ii) Heat absorbed during the change from A to B

$$= \frac{3nR\Delta T}{2}$$

$$= \frac{3 \times 0{,}12 \times 8{,}31 \times (600-300)}{2}$$

= 449J

(ii)(2) Heat absorbed during the change A to C

$$= \frac{3nR\Delta T}{2} + P\Delta V$$

$= 449 + 1{,}5 \times 10^5(0{,}004 - 0{,}002)$

= 748J

Question 4

(a) Different diagrams can be drawn to illustrate charging by induction.

(b)(i) In the extraction of dust particles from chimneys of factories it should be noted that dust particles are attracted to the cathode which is the cylindrical part of the chimney. Dust particles slide down due to gravity.

(ii) Voltage is work done per unit charge. The unit of voltage is the volt.

(c) From the definition of voltage, work done

W = VQ

Power $P = \frac{work}{time}$

$\therefore \quad P = \frac{VQ}{t}$ but Q/t = I = current

$\therefore \quad P = VI$

also V = IR

$\therefore \quad P = I^2R$

(d) Differences between voltage and emf are that voltage involves a portion of a circuit and emf involves the whole circuit. When current I = 0 voltage is zero but when I = 0, emf is equal to voltage.

(e) Equation for conservation of energy is

$E = Ir + I(R_1 + R_2 + R_3)$

(f)(i) Potential at Q is calculated from the potential divide circuit: in the dark

$$V_Q = \frac{R_2}{R_1 + R_2} V_o$$

$$= \frac{10}{60 + 10} \times 12$$

= 1,71V

(ii) In light potential at Q is

$$\frac{10}{2+10} \text{ x } 12$$

= 10V

(g) If potential at Q is 3,5V then Pd across

LDR = 12 – 3,5 = 8,5V

$\therefore V_{LDR} = 8{,}5 = \frac{R}{10+R} \text{ x } 12$

$\therefore$ R = 24,3kΩ

(h)(i) Current through R_1 = 0,2 + 0,06 = 0,26A

$\therefore R_1 = {}^{V}\!/_{I} = {}^{6}\!/_{0,26}$

= 23Ω

$R2 = \frac{3V}{0,2}$ = 15Ω

(ii) Ammeter reading = $I_1 + I_2$ = 0,2 + 0,06 = 0,26A

(iii) $I_m = \frac{12}{(23+15+15)}$ = 0,23A if N blows.

0,23A > 0,2A

$\therefore$ M will also blow.

Question 5

(a) The photoelectric equation is

$hf = Ø + ½ MV^2$

hf = photon energy, $Ø$ = work function and $½ MV^2$ is maximum kinetic energy of electrons

(ii)(1) Threshold frequency is calculated from

$Ø = hf_o \Rightarrow F_o = \frac{Ø}{h}$

$= \frac{2,3 \times 1,6 \times 10^{-19}}{6,63 \times 10^{-34}}$

$= 5,6 \times 10^{14}\ H_2$

(2) Maximum velocity is calculated from

$½ MV^2 = hf - Ø,\ f = {}^{c}/_{\lambda}$

$\therefore ½ MV^2 = 6,63 \times 10^{-34} \times \frac{3 \times 10^8}{5 \times 10^{-7}} - 2,3 \times 1,6 \times 10^{-19}$

$\therefore V = \sqrt{\frac{3,0 \times 10^{-20} \times 2}{9,11 \times 10^{-31}}}$

$= 2,5 \times 10^5$ m/s

(3) Stopping potential V_s is calculated from

$eV_s = ½ MV^2$

$\therefore V_s = \frac{3,0 \times 10^{-20}}{1,6 \times 10^{-19}}$

$= 0,19V$

(b) Equation relating centripetal force and magnetic force is $\frac{MV^2}{r}$ = BeV.

(ii) Velocitv v̄ of a particle moving in a circular manner is rw

$\therefore$ from $\frac{MV^2}{r} = BEV$

mw = Be

$\therefore w = \frac{Be}{m}$

but $w = 2\pi/T$

$\therefore 2\pi/T = Be/m$

$\therefore T = \frac{2\pi m}{Be}$

(c)(i) If V is increased by four times then radius will also increase by a factor of 4 from $V \alpha r$

(ii) An increase in V does not affect T from

$T = \frac{2\pi m}{Be}$

(d)(i) Orbital period of electrons $T = \frac{1}{f}$

$= \frac{1}{1{,}4 \times 10^6}$

$= 7{,}1 \times 10^{-7} s$

(ii) Magnetic flux density $B = \frac{2\pi m}{Te}$

$$= \frac{2\pi \times 9{,}1 \times 10^{-31}}{7{,}14 \times 10^{-7} \times 1{,}6 \times 10^{-19}}$$

$= 5{,}0 \times 10^{-5}$ T

Question 6

(a)(i) Atomic number is number of protons in the nucleas.

(ii) Mass number is sum of protons and neutrons.

(iii) Isotopes are atoms of different mass numbers but the same proton number.

(b) Beta articles are emitted because neutrons disintegrate into protons and electrons. Protons remain in the nucleas and electrons are emitted as Beta particles.

(c) ^{60}CO to ^{59}CO undergoes neutron emission so that mass and charge are conserved.

(d)(i) Activity A is calculated from λN_o.

$$N_o = \frac{M}{M_A} \times N_A$$

$$= \frac{0{,}015}{60} \times 6{,}02 \times 10^{23}$$

$= 1{,}5 \times 10^{20}$

$$\therefore \lambda N_o = \frac{1{,}5 \times 10^{20}\ 1n\,2}{5{,}3 \times 365 \times 24 \times 3600}$$

$= 6{,}22 \times 10^{11}$Bq

(ii) Activity of the source three years later is

$\lambda N = \lambda N_o e^{-\lambda t}$

$= 6{,}22 \times 10^{11} e^{-3h2}/_{5,3}$

$= 4{,}19 \times 10^{11}$Bq

(e)(i) Mass defect = 209,936730 – (205,929421 + 4,001504)

= 0,0058069

$\therefore$ Energy released = 0,005806 x 931Mev

= 5,405 Mev

(ii) The α particle does not take up all the energy because some energy is used up as kinetic energy of the recoiling ^{206}Pb.

(iii) Kinetic energy is conserved

$\therefore \frac{1}{2} MV^2 + \frac{1}{2} mv^2 = 5{,}41$Mev

M is mass of recoiling ^{205}Pb and m is mass of α particle.

Momentum is conserved

$\therefore MV = mv$

$\therefore V = \frac{mv}{M}$

$$\therefore \tfrac{1}{2}mv^2\left(\frac{M+m}{M}\right)=5{,}41$$

$$\therefore \tfrac{1}{2}mv^2 = \frac{5{,}41 \times 205}{(205+4)}$$

$$= 5{,}31\text{Mev}$$

Question 7

(a)(i) Olber's paradox states that if the stars continued to infinity then the night sky should be white not dark. This is because light should be coming from every other possible direction in the sky.

(ii) Olber's paradox suggest that the model of an infinite static universe is correct because if the universe is uniform we should have bright night skies because the light will be coming from static stars. We have dark night skies because of the red shift of the visible light.

(b) The three possible future of the universe are (i) open structure that continues to expand indefinitely, (ii) the flat structure which expands such that the rate falls to zero after infinite time and (iii) the closed system which expands up to a maximum and then contracts.

(c)(i) Hubble's constant $H_o = 2{,}8 \times 10^{-18}s^{-1}$

(ii) Speed of recession of a galaxy

$v^{\cdot} = H_o r = 2{,}8 \times 10^{-18} \times 5 \times 10^6 \times 9{,}46 \times 10^{15}$

$= 1{,}32 \times 10^5 m/s$

(iii) Age of the universe $= \dfrac{1}{Ho}$

$= (2{,}8 \times 10^{-18})^{-1}$

$= 3{,}57 \times 10^{17}s$

= 38 light years

Question 8

(a)(i) Annealing is the removal of dislocations by heating and cooling slowly.

(ii) Quenching involves heating a metal to a very high temperature and then cool rapidly.

(iii) Tempering involves heating hard and brittle materials very gently for a controlled period.

(b) Materials become soft and strong as a result of annealing. Materials become hard and brittle as a result of quenching. Tempering restores toughness of materials.

(c) Strain is extension per unit length stress is force per unit cross-sectional area.

(d)(i) The graph does not have the plastic region and this shows that bones are brittle.

(ii) Young Modulus E = $\frac{stress}{strain}$

= gradient on the stress – strain graph

∴ E compression = $\frac{2{,}0 \times 10^7}{0{,}02} = 1{,}0 \times 10^9\,Pa$

E tension = $\frac{3{,}0 \times 10^7}{0{,}015} = 2{,}0 \times 10^9\,Pa$

(iii) Breaking stress during tension is greater than during compression therefore the bone is strong during tension than during compression. It is therefore safer for the boy to do tug or war.

Question 9

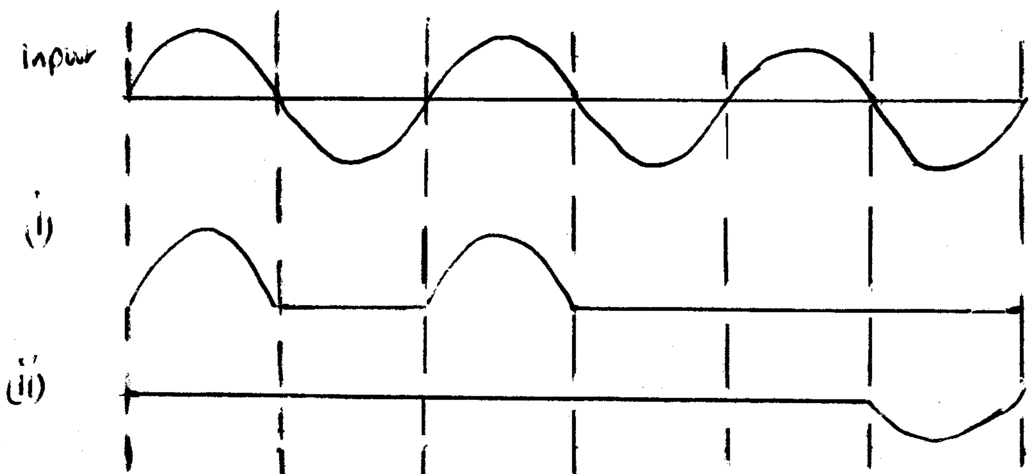
(a)(i) A relay switch consists of a coil of wire wound on a soft iron core to form on electromagnet. A rocking switch made of iron closes the second circuit.

(ii) Current flows in the coil of a relay and the soft iron becomes a magnet. The rocking switch is attracted, thereby closing the circuit which allows a higher current.

(b) Truth table for the circuit shown is

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1

(c) Sketch graphs for parts (i) and (ii). The input signal has also been included.



(iii) Diodes D1 and D2 are in opposite directions relative to supply, hence they allow opposite halves to be rectified.

(iv) Peak current flowing through 10kΩ resistor is

$$I_o = \frac{Vo}{R} = \frac{5}{10 \times 10^3}$$

$= 5{,}0 \times 10^{-4}$A

Question 10

(a)(i) In a lamina flow each particle of the fluid follows a smooth path.

(ii) In a turbulent flow each particle of the fluid follows an irregular and random path

(b)(i) Benoulli's equation is not strictly applicable to gases because gases are compressible hence density does not remain constant.

(ii) Benoulli's equation is not strictly applicable to viscous fluids because fluids give rise to retarding forces between layers of molecules hence mechanical energy is not conserved.

(c) In the description of how lift is generated it should be noted that air above the aerofoil travels a longer distance than below the aerofoil hence speed of air higher above aerofoil than below the aerofoil. Pressure below the aerofoil is higher than pressure above the aerofoil.

(d)(i) To show that Re is dimensionless

Use $[\ell]$ = kgm^{-3}, [V] = m/s, [r] = m and

[n] = $kgm^{-1}\ 5^{-1}$ in the equation Re = $\frac{\ell r v}{n}$

(ii) Re = $\frac{\rho r v}{n} = \frac{860 \, x \, 0{,}25 \, x \, 0{,}020}{8{,}4 \, x \, 10^{-2}}$

= 51

∴ Re is less than the onset value of 2000, therefore the flow is laminar.

Question 11

(a)(i) In the production of x-rays electrons are emitted from a filament and they are accelerated by a high voltage in a vacuum. The electrons are suddenly decelerated by a target metal hence the energy is converted into radiation in the x-ray region.

(ii) Overheating of the anode is reduced by rotating the target metal since this reduces localization of energy in one spot.

(b) Sharpness of images can be improved by reducing the area of target metal since this increases the area of the shadow cost by an object. Sharpness can also be improved upon by using a lead grid in front of the photographic film. The grid will absorb scattered x-rays.

(c)(i) Fig 11.1 is showing A scan and Fig 11.2 is showing B scan.

(ii) The peaks in Fig 11.1 show the wave that is reflected from different tissue boundaries.

(d) The separation of the peaks in Fig 11.1 is a measure of the distance that is traveled by incident wave before reflection.

Question 12

(a) An isothermal change is one in which temperature remains constant. An adiabatic change is one in which no heat is allowed to enter or leave a system.

(b)(i) From $Q = \Delta U + P\Delta V$

$Q = OJ$ since process C is adiabatic

$\therefore O = 310 + P\Delta V$

$\therefore$ Work done = $\underline{-310J}$

The negative means work is done on the system.

(ii) A and B are isothermal changes and C is an adiabatic change. For lines A and B there is no change in temperature as the system is expanding. For C there is a change in temperature since the line is cutting A and B.

(c)(i) The second law of thermodynamics states that no continually working heat engine can take in heat and completely convert it to work.

(ii) Efficiency is never 100% because heat engines work at higher temperatures than the surrounding hence some of the heat is lost to the surrounding. Work output is thus less than work input.

(iii) From the second law of thermodynamics efficiency = 1 - $\frac{T_L}{T_H}$

In the morning T_L is low hence the ratio $\frac{T_L}{T_H}$ decreases

$\therefore 1 - \frac{T_L}{T_H}$ turns to 1

$\therefore$ efficiency increases.

Question 13

(a) Advantages of optical fibre over copper cables are (i) high information carrying capacity, (ii) less noise due to interference, (iii) signals can travel longer distances before regeneration and (iv) optical fibre cables are smaller and lighter.

(b)(i) Attenuation is the loss of power of a signal when the signal travels through a cable.

(ii) Total loss of signal = 2 x 30 = 60dB

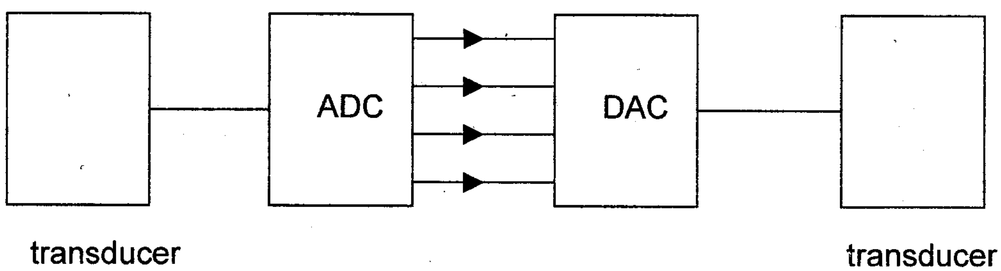
Power loss = 10 log $\left(\frac{Pin}{Pout}\right)$

$$\therefore 60 = 10\log\left(\frac{1,45}{P_o}\right)$$

$$\therefore P_o = 1,45\mu W$$

(iii) To ensure that the signal is not reduced to low levels regeneration must be used along the way to amplify the pulse.

(c)(i) The diagram for analogue to digital transmission is as follows:



An analogue signal is sampled and converted to digital signal by analogue to digital converter. The digital signal is transmitted by a four parallel port connector. The digital signal is converted into analogue by the digital to analogue converter.

(ii) Serial transmission is often used because it is less expensive because only one cable is used. It can therefore be used for long distance transmission.

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL
General Certificate of Education Advanced Level

PHYSICS **9243/1**

PAPER 1 Multiple Choice

Wednesday **11 JUNE 2003** Morning 1 hour

Additional materials:
- Electronic calculator and/or Mathematical tables
- Multiple Choice answer sheet
- Soft clean eraser
- Soft pencil (Type B or HB is recommended)

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, Centre number and candidate number on the answer sheet in the spaces provided unless this has already been done for you.

There are **thirty** questions in this paper. Answer **all** questions. For each question there are four possible answers, **A, B, C** and **D.** Choose the **one** you consider correct and record your choice in **soft pencil** on the separate answer sheet.

Read very carefully the instructions on the answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any rough working should be done in this booklet.

This question paper consists of 18 printed pages and 2 blank pages.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}\ \mathrm{m\,s^{-1}}$
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}\ \mathrm{H\,m^{-1}}$
permittivity of free space,	$\epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F\,m^{-1}}$
elementary charge,	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant,	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27}\ \mathrm{kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
molar gas constant,	$R = 8.31\ \mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant,	$N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
the Boltzmann constant,	$k = 1.38 \times 10^{-23}\ \mathrm{J\,K^{-1}}$
gravitational constant,	$G = 6.67 \times 10^{-11}\ \mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall,	$g = 9.81\ \mathrm{m\,s^{-2}}$