For Performance Measurement

# ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

**General Certificate of Education Advanced Level**

## PHYSICS 6032/3

PAPER 3 THEORY

**SPECIMEN PAPER** 2 hour 30 minutes

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

**TIME** 2 hour 30 minutes

**INSTRUCTIONS TO CANDIDATES**

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **four** questions.

**Question1** is compulsory.
Answer any other **three** from the remaining questions.

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 reminded of the need for good English and clear presentation in your answers.

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**This question paper consists of 12 printed pages.**

# DATA

| | |
|---|---|
| speed of light in free space | $c$ = 3.00 x $10^{8}$ms$^{-1}$ |
| permeability of free space | $\mu_o$ = 4$\pi$ x $10^{-7}$ Hm$^{-1}$ |
| permittivity of free space | $\varepsilon_0$ = 8.85 x $10^{-12}$ Fm$^{-1}$ ( 1/ 4$\pi\varepsilon_0$ = 8.99 x $10^{9}$ mF$^{-1}$) |
| elementary charge | e = 1.60 x $10^{-19}$ C |
| the Planck constant | h = 6.63 x $10^{-34}$ Js |
| unified atomic mass unit | 1 u = 1.66 x $10^{-27}$ kg |
| rest mass of electron | $m_e$ = 9.11 x $10^{-31}$ kg |
| rest mass of proton | $m_p$ = 1.67 x $10^{-27}$ kg |
| molar gas constant | $R$ = 8.31 JK$^{-1}$mol$^{-1}$ |
| the Avogadro constant | $N_A$ = 6.02 x $10^{23}$mol$^{-1}$ |
| the Boltzmann constant | $k$ = 1.38 x $10^{-23}$ JK$^{-1}$ |
| gravitational constant | $G$ = 6.67 x $10^{-11}$Nm$^{2}$kg$^{-2}$ |
| acceleration of free fall | g = 9.81 ms$^{-2}$ |

**FORMULAE**

| | |
|---|---|
| uniformly accelerated motion | $s = ut + ½at^2$ |
| | $v^2 = u^2 + 2as$ |
| work done on/by a gas | $W = p\,\Delta V$ |
| gravitational potential | $\emptyset = -\,Gm/r$ |
| hydrostatic pressure | $p = \rho gh$ |
| pressure of an ideal gas | $p = \frac{1}{3}\frac{Nm}{V} < c^2 >$ |
| simple harmonic motion | $a = -\omega^2 x$ |
| velocity of particle in s.h.m. | $v = v_o \cos \omega t$ |
| | $v = \pm\omega\sqrt{(x_o^2 - x^2)}$ |
| Doppler effect | $f_o = \frac{f_s v}{v \pm v_s}$ |
| Attenuation of x-rays | $I = I_o e^{-\mu x}$ |
| electric potential | $V = \frac{Q}{4\pi\varepsilon_0 r}$ |
| 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 | $W = \frac{1}{2}QV$ |
| electric current | $I = Anvq$ |
| resistors in series | $R = R_1 + R_2 + \ldots$ |
| resistors in parallel | $1/R = 1/R_1 + 1/R_2 + \ldots$ |
| Hall voltage | $V_H = \frac{BI}{ntq}$ |
| alternating current/voltage | $x = x_o \sin\omega t$ |
| radioactive decay | $x = x_o \exp(-\lambda t)$ |
| decay constant | $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$ |



**[Turn over**

**Answer question 1 and any other 3 from the remaining questions.**

**1** **(a)** **(i)** Define *systematic error*.

**(ii)** List any **two** possible causes of random error.

**(iii)** **Fig. 1.1(a)** and **Fig. 1.1(b)** shows the distribution of measurements taken by two students.

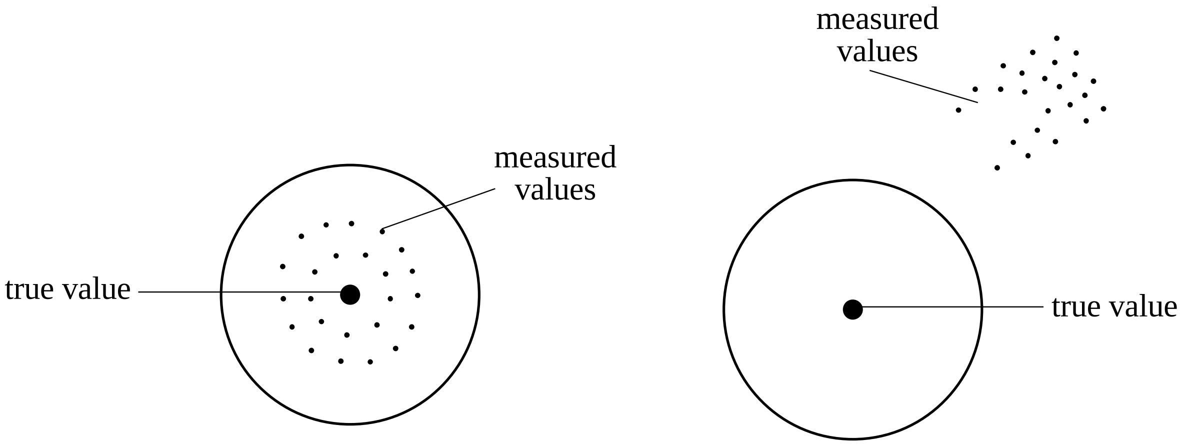


**Fig. 1.1(a)** **Fig. 1.1(b)**

Comment on the precision and accuracy of the measurements.

[5]

**(b)** **Fig. 1.2** shows the paths of a ball thrown against a vertical wall.

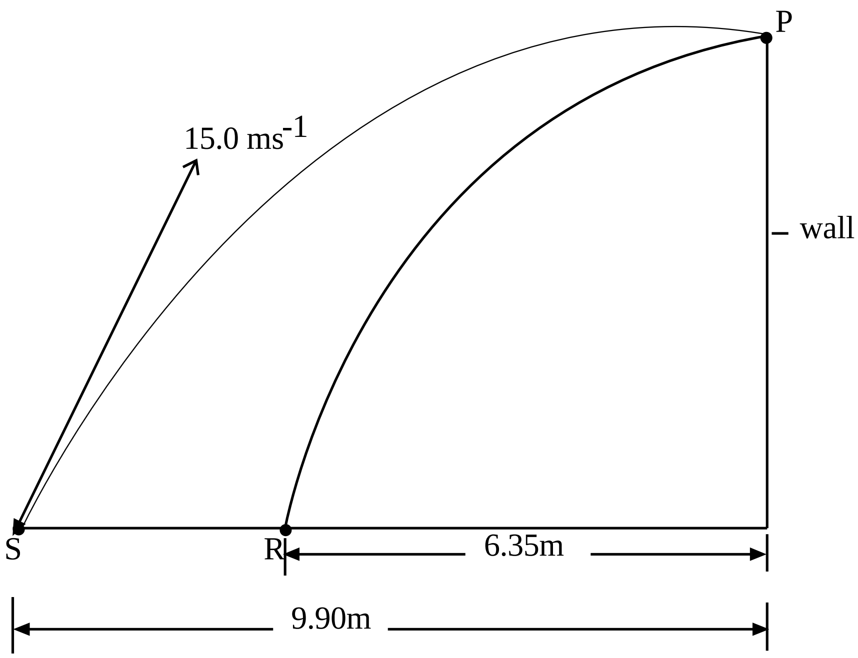


**Fig. 1.2**

The ball is thrown from S with an initial velocity of 15.0 $ms^{-1}$ at 60° to the horizontal. The horizontal distance from S to the wall is 9.90 m. The ball hits the wall at P with a velocity at right angles to the wall and rebounds to point R.

Assume no air resistance.

**(i)** Determine the vertical height gained by the ball as it travels from S to P.

**(ii)** Calculate the time taken by the ball to travel from **S** to **P**.

**(iii)** Show that the velocity of the ball immediately after rebounding from the wall is about 4.80 $ms^{-1}$.

**(iv)** The mass of the ball is $60 \times 10^{-3}$kg. Calculate the change in momentum as it rebounds from the wall.

[6]

**(c)** **Fig. 1.3** shows a box of mass 3.0 kg projected up a rough incline at 30° to the horizontal with an initial velocity of 10 $ms^{-1}$. The velocity decreases to 4.0 $ms^{-1}$ at B. The length of the plane is 4.0 m.

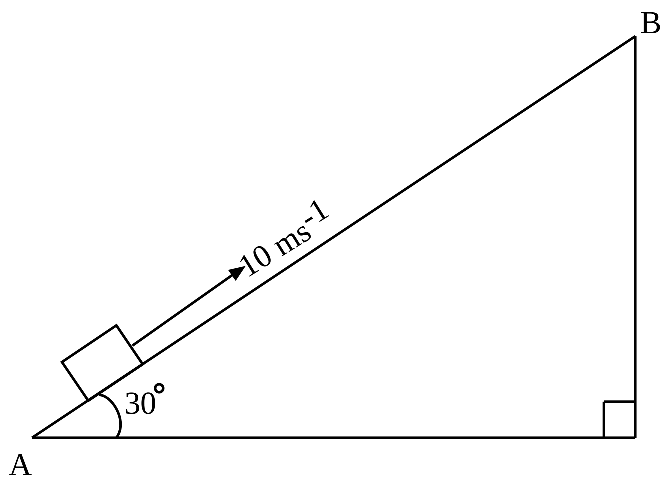


**Fig. 1.3**

**(i)** Draw a free body diagram showing all forces acting on the box.

**(ii)** Calculate the gain in gravitational potential energy.

**(iii)** Determine the work done against friction.

[7]

**(d)** A satellite of mass m, travels at an angular speed ω, in a circular orbit at a height h, above the surface of planet of mass M and radius R.

**(i)** State in words Newton's law of universal gravitation.

**(ii)** Show that the period T, of the satellite is given by

$$T = 2\pi\sqrt{\frac{(R+h)^3}{GM}}$$

**(iii)** Suggest with a reason, what happens to the speed of the satellite if it moves to an orbit closer to the surface of the planet.

[7]

**2** **(a)** **(i)** Define *simple harmonic motion*.

**(ii)** One end of a spring of spring constant k, is attached to a rigid support. A mass m, hanging from the lower end of the spring is displaced downwards from equilibrium and released.

Show that the mass execute simple harmonic motion.

[5]

**(b)** **(i)** **1.** Draw a labelled diagram showing apparatus required to determine the wavelength of red light using a pair of slits.

**2.** Give estimates for slit separation and slit to screen distance from the diagram in (i)1.

**(ii)** Explain the part played by diffraction in the production of fringes.

**(iii)** Use the estimate values in **(b)(i)** to calculate fringe separation for light of wavelength 590 nm.

[8]

**(c)** An X-ray beam of intensity $8.00 \times 10^5 Wm^{-2}$ passes through an aluminium filter and linear attenuation coefficient μ of 250 $m^{-1}$. The filter allows 10% of the X-ray radiation to pass through it to a patient whose bone under examination has a thickness of 4.0 cm and attenuation coefficient of 1.05 $m^{-1}$.

**(i)** Calculate the

1. thickness of aluminium,

2. intensity of the X-ray radiation transmitted by the bone.

**(ii)** Suggest the advantages of passing the X-rays through the filter before passing it through the patient.

**(iii)** Explain how an anti-scatter grid improves the X-ray image produced.

[8]

**(d)** **(i)** Outline how X-rays are used to build up the images produced in a CT scan.

**(ii)** Explain why CT scanning requires a powerful computer. [4]

**3** **(a)** **(i)** Explain what is meant by *magnetic field*.

**(ii)** Sketch four lines to show the magnetic field around a long straight current carrying conductor.

**(iii)** **Fig. 3.1** shows two parallel sides of a rectangular frame carrying a current. The frame is in a magnetic field.

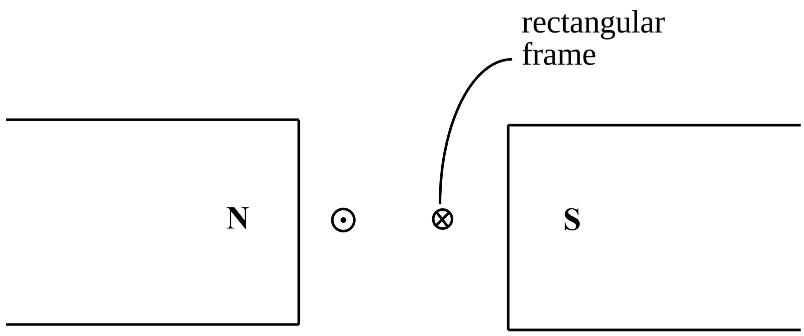


**Fig. 3.1**

1. Copy Fig. 3.1 and show the direction of the magnetic forces acting on the frame.

2. State and explain the effect of the forces on the frame.

[8]



**[Turn over**

**(b)** **(i)** **Fig. 3.2** shows a magnet plunging into a solenoid.

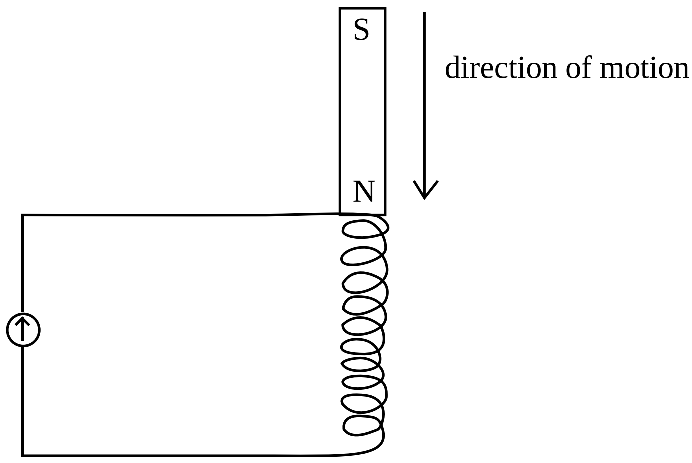


**Fig. 3.2**

With reference to **Fig. 3.2** explain how Lenz's law is an example of the principle of conservation of energy.

**(ii)** **Fig. 3.3** shows the variation of the magnetic flux linking a coil of 200 turns.

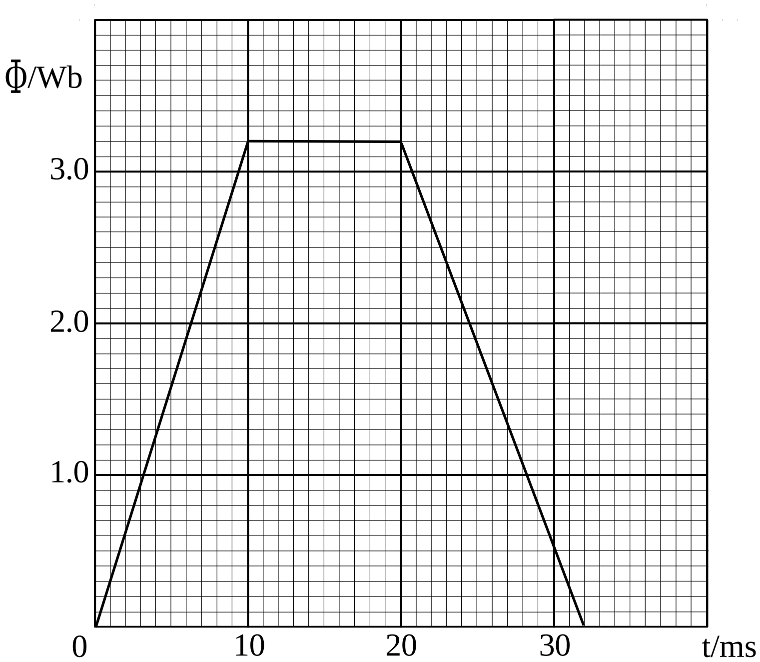


**Fig. 3.3**

**(ii)** **1.** Sketch a graph to show how the induced e.m.f. varies with time.

**2.** Suggest **two** ways by which the magnitude of the induced e.m.f. can be increased.

[8]

**(c)** **(i)** State the function of a transformer.

**(ii)** A transformer has 600 turns in its primary coil and a sinusoidal input voltage of r.m.s. value 230 V. The output has a peak to peak voltage of 120 V.

1. Calculate the number of turns in the secondary coil.

2. Explain why r.m.s. values are considered and not mean values in a.c. circuits.

**(iii)** In a transformer, there is thermal energy produced. Describe and explain the sources of the thermal energy.

[9]

**4** **(a)** Define

**(i)** laminar flow,

**(ii)** incompressible flow.

[2]

**(b)** Ethanol of density $\rho = 791$ kg $m^{-3}$ flows smoothly through a horizontal pipe that tapers in cross-sectional area from $A_1$ to $A_2 = \frac{1}{2} A_1$. The pressure difference between the narrow and wider sections of the pipe is $\Delta p$. If R is the volume flow rate,

**(i)** Express in terms of R and $A_1$

1. $v_1$,

2. $v_2$.

**(ii)** Show that the pressure difference,

$$\Delta p = \frac{3\rho R^2}{2A_1^2}$$

**(iii)** Calculate R if $\Delta P$ is 4 120 Pa and $A_1$ is $1.20 \times 10^{-3}$ $m^2$.

[6]

**(c)** **(i)** Outline how molecular movement causes pressure exerted by a gas.

**(ii)** A car's tyre contains a gas at a pressure of $3.00 \times 10^5$ Pa. After a long drive the tyre becomes hot and expand. The volume of the gas increases by 1% while its temperature increases by 5%.

Calculate the final pressure, assuming the gas behaves ideally.

[4]

**(d)** **Fig. 4.1** shows a mass hanging from free end of a copper wire which is passed over a pulley.

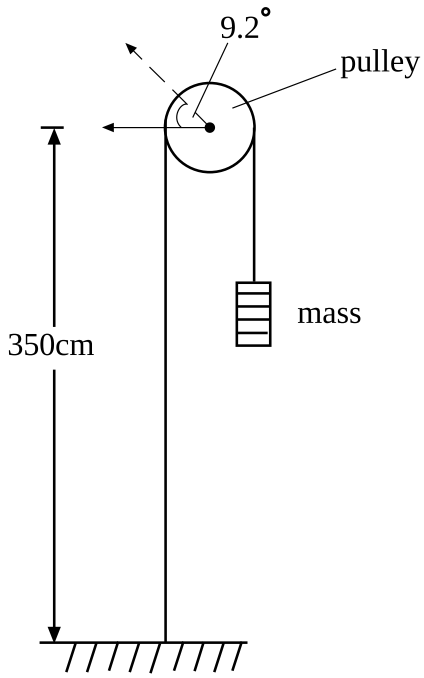


**Fig. 4.1**

When the mass is increased by 2.04 kg, a pointer attached to the pulley of diameter 3.0 cm rotates through an angle of 9.2°.

**(i)** For the increase in mass,

1. show that the wire extends by $2.4 \times 10^{-3}$ m,

2. calculate the increase in strain in the wire.

**(ii)** Calculate the increase in the strain energy produced by the increase in the load if the initial load was 2.00 kg.

**(iii)** The specific heat capacity of copper is 420 J/kg/k and the mass of the wire is 6.2 g.

1. Calculate the change in temperature of the wire as it extends.

2. State the assumption you have made in your calculation.

[8]

**(c)** **(i)** Explain what is meant by thermometric property.

**(ii)** Suggest with a reason, the suitable type of thermometer for measuring temperature of

1. boiling liquid oxygen,

2. molten iron in a blast furnace.

[5]

**5** **(a)** **Fig. 5.1** shows a coaxial cable.

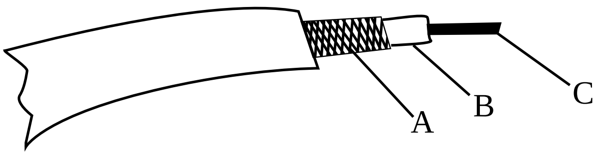


**Fig. 5.1**

**(i)** State the

1. names of the components labeled A, B and C,

2. functions of component A.

**(ii)** List **three** advantages of coaxial cables over wire pairs.

[8]

**(b)** **(i)** Define the term *modulation*.

**(ii)** Explain why

1. the reception of amplitude modulated signals is poorer than the frequency modulated signals,

2. frequency modulated transmissions are more expensive than amplitude modulated transmissions.

[6]

**(c)** **Fig. 5.**2 shows an original analogue signal before transmission.

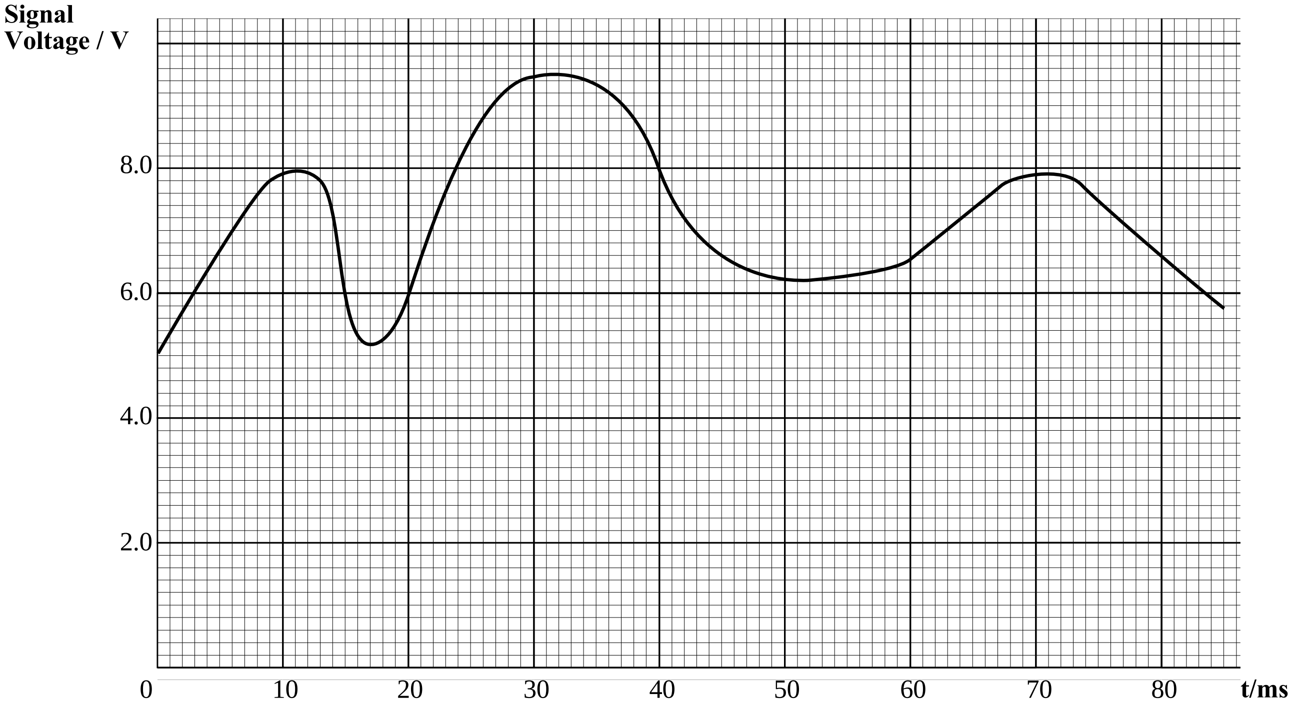


**Fig. 5.2**

**(i)** Copy **Table 5.1** and complete it using **Fig. 5.2**.

**Table 5.1**

| **Time/μs** | 0 | 40 | 70 |
|---|---|---|---|
| **Voltage/V** | 5.0 | | |
| **Digital code** | 0101 | | |

**(ii)** Using a sampling frequency of 100 kHz,

1. reconstruct **Fig. 5.2** to produce the **"recovered"** analogue signal after transmission and sketch it.

2. Explain how the reconstruction can be improved to have a more accurate representation of the original signal.

[11]