ZIMSEC
For Performance Measurement

ZIMBABWE SCHOOL EXAMINATIONS COUNCIL

General Certificate of Education Advanced Level

PHYSICS

PAPER 3

9188/3

JUNE 2011 SESSION

50 minutes

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

TIME 50 minutes

INSTRUCTIONS TO CANDIDATES

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

Answer **three** questions.

Question 1 is compulsory.
Answer any other **two** 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.

Candidates are advised to spend 25 minutes on **question 1**.

This question paper consists of 10 printed pages and 2 blank pages.

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,	$p = \frac{1}{3}\frac{Nm}{V}<c^2>$
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,	$F = Br^2\rho v^2$

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,	$g = 9.81\ \mathrm{m\,s^{-2}}$

*Answer **question 1** and **any other 2** from the remaining questions.*

1 (a) (i) Name any **two** physical quantities and their S.I. units.

(ii) State any **two** properties that can be used to describe a physical quantity.

(iii) Give **one** advantage of the S.I. system of units.

(iv) Explain why the homogeneity of a physical equation is not sufficient for the equation to be correct.

State how the correctness of the equation can be verified.

(v) Describe how a reading can be **precise** but not **accurate**.

[7]

(b) (i) A body with a constant speed in a uniform circle experiences an acceleration towards the centre of the circle.

Use Newton's laws to explain how this is possible.

(ii) **Fig. 1.1** shows a stone of mass, m, being whirled continuously in a vertical circle of radius r.

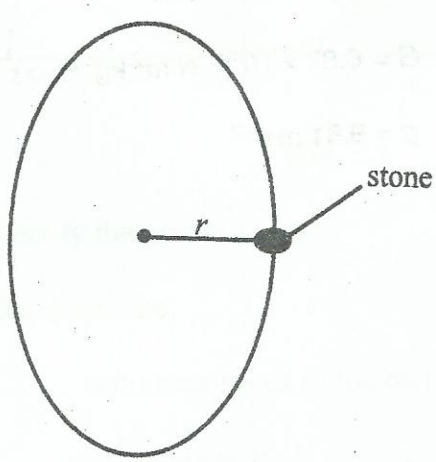

Fig. 1.1

State and explain when the tension in the string is

1. greatest,

2. lowest.

(iii) A brick falls from the top of a building of height, h, above the ground. If the brick has a mass, m, show that the gain in kinetic energy ΔE_k, by the time it hits the ground, is given by

$$\Delta E_k = \frac{GMmh}{R^2},$$

where G is the universal gravitation constant, M is the mass of the earth and R is the radius of the earth.

[7]

(c) **Fig. 1.2** shows the variation of the *kinetic* and *potential energies* with *displacement* for a particle of mass, 2.0 g, on a spring executing simple harmonic motion.

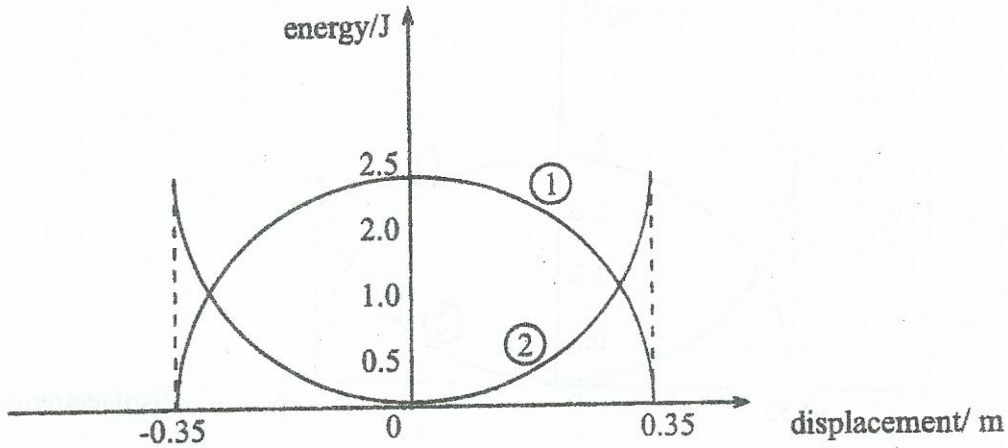

Fig. 1.2

(i) Identify the graphs 1 and 2.

(ii) Determine the

1. maximum speed of the particle,

2. spring constant, k.

(iii) Explain the effect, if any, of using a driver force of increasing frequency on the oscillations of the particle.

[6]

2 (a) (i) Distinguish between *damped* and *forced oscillations*.

(ii) Describe the effect of damping on resonance.

[4]

(b) A ray of light enters a 60° triangular prism and is just totally internally reflected when it meets the opposite face of the prism as shown in **Fig. 2.1.**

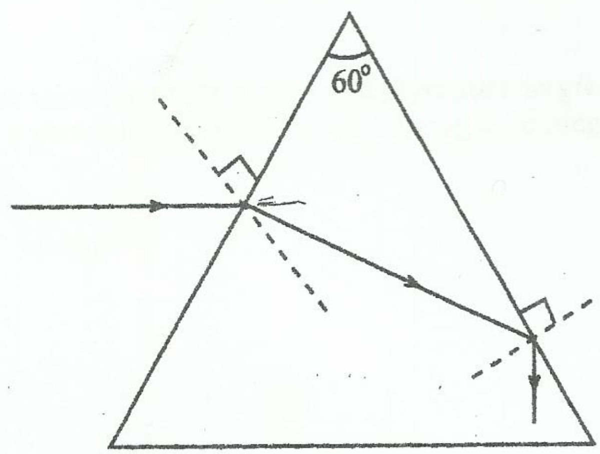

Fig. 2.1

(i) State the law of refraction relating the angle of incidence to the angle of refraction.

(ii) Given that the refractive index of the prism is 1.5, calculate the angle of incidence of the ray of light on the first face.

[6]

3 (a) Fig. 3.1 shows a steel ball falling freely in a viscous fluid under laminar conditions.

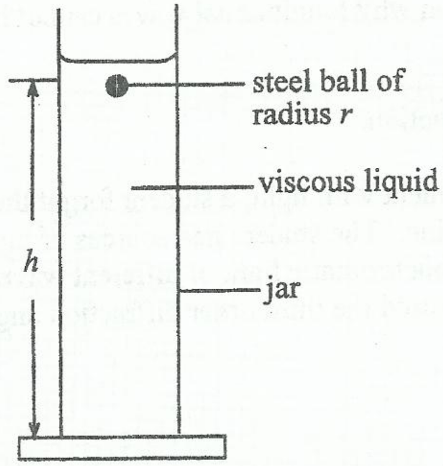

Fig. 3.1

(i) On a sketch diagram, show all the forces acting on the steel ball.

(ii) Explain quantitatively how the sphere attains terminal velocity, v_t, giving the expression for v_t.

[7]

(b) Fig. 3.2 shows a wooden cubic block floating in oil of density 860 kgm^{-3}.

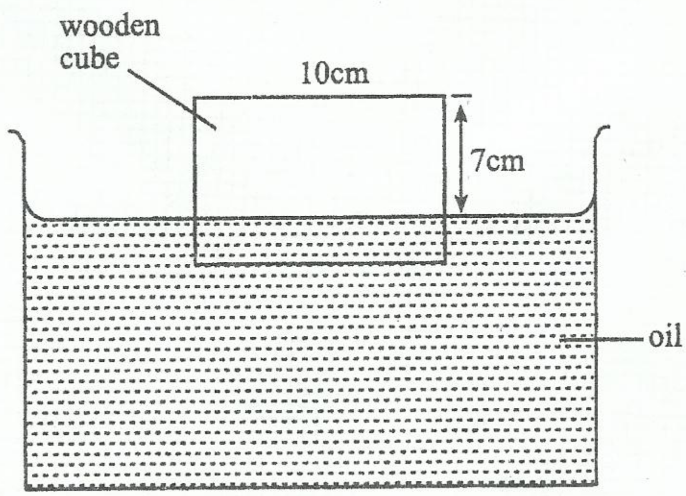

Fig. 3.2

Calculate the weight of the block.

[3]

[Turn over

4 (a) (i) State **one** similarity and **one** difference between *reflection* and *refraction*.

(ii) Give a reason why longitudinal waves cannot be plane polarised.

[3]

(b) (i) Define diffraction.

(ii) In an experiment with light, a student forgot the value of the grating spacing. The student had sources of light which could produce monochromatic light of different wavelengths. The student measured the third order diffraction angle for each of the light.

Fig. 4.1 shows the results for **four** different wavelengths.

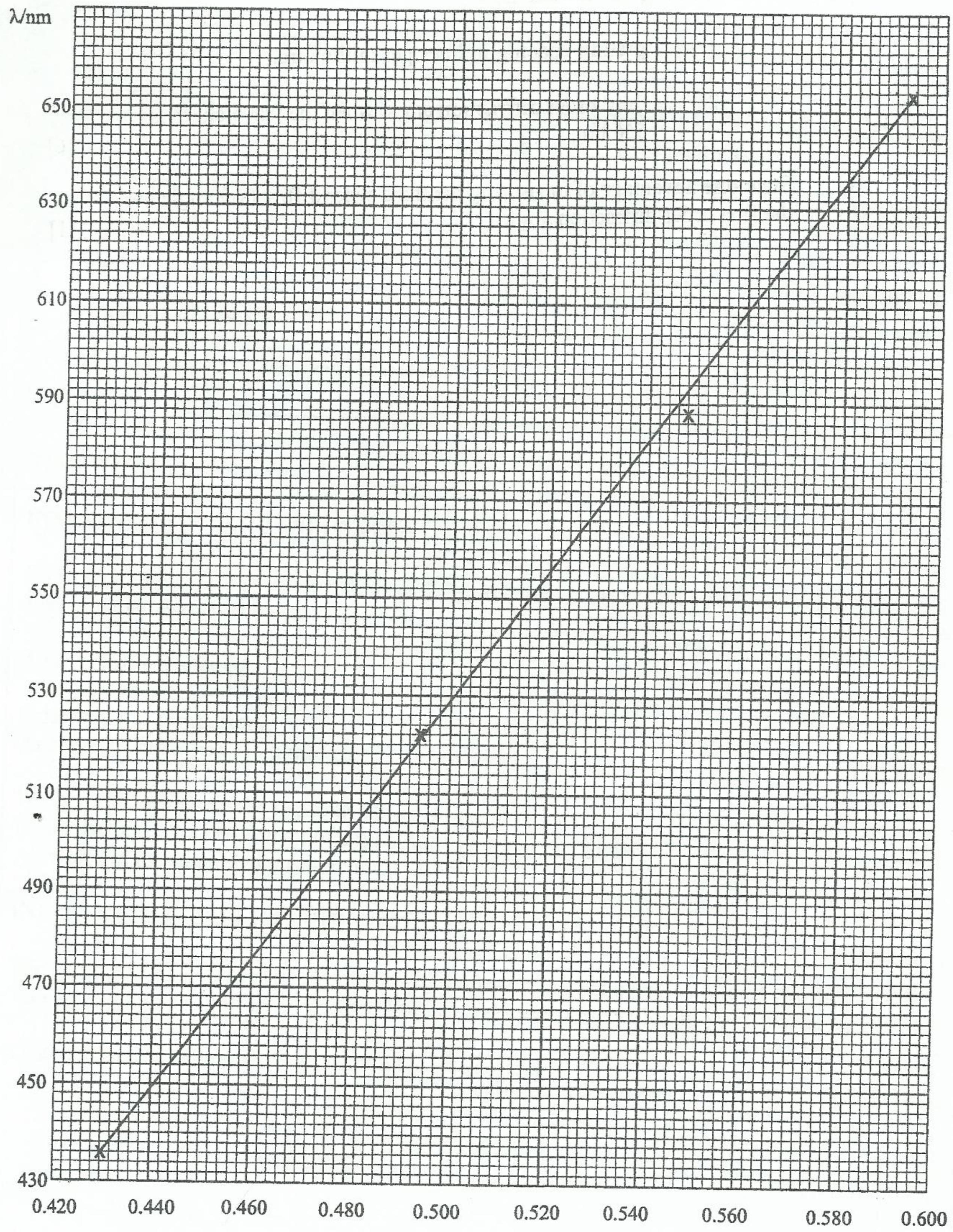

Fig. 4.1

[Turn over

Use **Fig. 4.1** to find the

1. grating spacing in lines per millimetre.

2. third order diffraction angle when the wavelength is 556 nm. [6]

(c) State **one** advantage of measuring the third order diffraction angle over the first order diffraction angle. [1]