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UNIVERSITY OF SWAZILAND

FACULTY OF EDUCATION

SEMESTER 2 EXAMINATION PAPER 2011

MAIN EXAMINATION PAPER

PGCE F/T B Ed III

TITLE OF PAPER : Curriculum Studies in Physics

COURSE NUMBER: EDC 382

TIME ALLOWED Three (3) hours

INSTRUCTIONS

1. This paper contains FIVE questions
2. Question 1 is COMPULSORY. You may then choose ANY THREE questions from questions 2, 3, 4, 5
3. Each question 2 to 5 is worth 20 marks
4. Any piece of material or work which is **not** intended for marking purposes should be clearly CROSSED OUT
5. Ensure that responses to questions are NUMBERED CORRECTLY

1. SPECIAL REQUIREMENTS: Graph pad.

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR

Question 1 (Compulsory 40 marks)

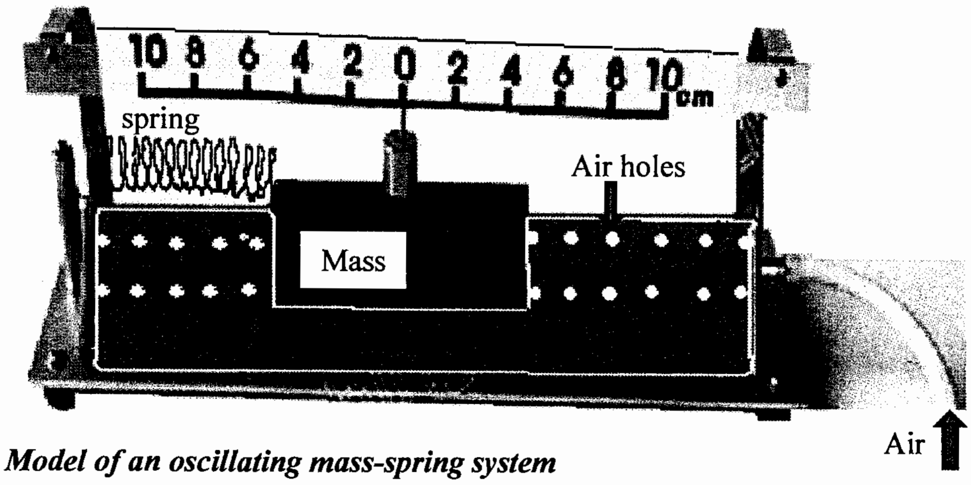

Figure 1 Model of an oscillating mass-spring system

Figure 1 is a **physical model** designed for teaching concepts of oscillations. Analyse the model and answer the questions that follow.

i. Develop a mathematical model of the mass-spring system from the physical model in Figure 1 so that a class can relate mathematical model to reality? [5]

ii. Use the air pump to show the effect of varying the resistive component in the simple harmonic motion of a mass-spring system. [5]

iii. A feather-light pen is attached to the mass and it writes on a strip of paper moving at a constant speed of 1cm/s. Draw the resultant trace if

   a. Air is pumped at high pressure [3]

   b. Air is pumped at low pressure [3]

   c. No air pumped. [3]

iv. Use the model to show the necessary conditions for an oscillation to take place [5]

v. Design a Form 3 experiment to record the frequency of a **model mass-spring system**. [7]

A mass-spring system is thought to have a frequency relationship $f = (1/2\pi)\,[k/m]^{1/2.}$

vi. Explain the use of graphical analysis to test the following:

   a. Proportionality constant [3]

   b. Force constant ***k*** [3]

   c. Instrument error in measurement of m [3]

Question 2 (20marks)

It is possible to visualize some of the concepts in the photoelectric effect by using colliding balls to represent scattering particles and obstacles to represent energy thresholds. In order to illustrate the concept in a clearer way, a life-size model of a photon ejecting an electron has been constructed. The model consists of the following:

An inclined track to roll a metal 2.5cm-diameter metal ball down

- PVC tubes cut to approximately 18cm-length
- One metal 2.5cm-diameter ball
- Two collisions ball: plastic, aluminum, brass, or wood

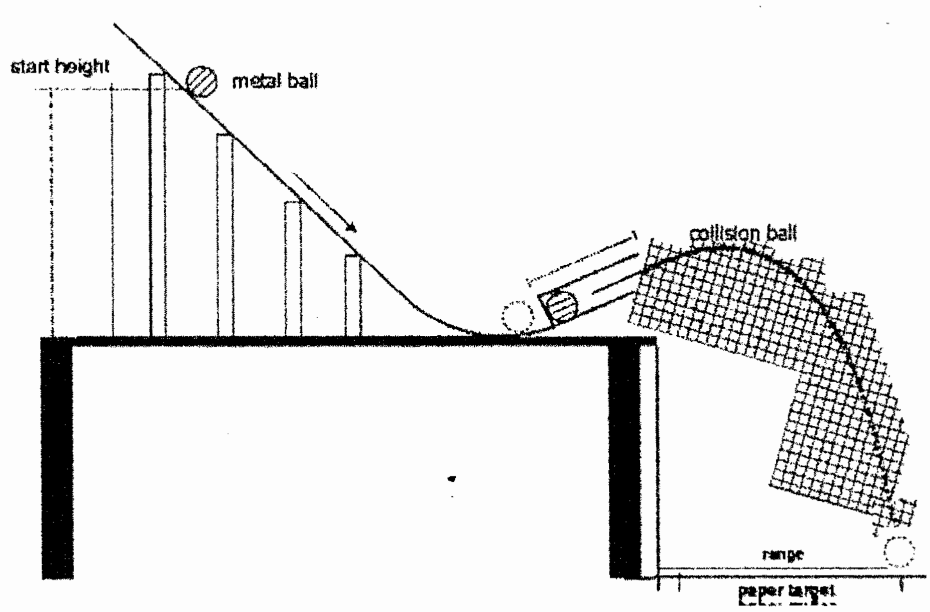

Figure 5.Mechanical model to teach the photo-electric effect.

i. Which particle does the metal ball represent? [2]

ii. What property of the metal ball were you changing by placing it higher or lower on the track? [2]

iii. What effect does this represent in the photoelectric effect equation? [2]

iv. What does the tilted height of the PVC tube represent in the photoelectric effect equation? [2]

v. What property were you changing using different collision ball? [2]

vi. What possible misconception can be caused by this analogy? [4]

vii. Suggest another model you could use to show that : [6]

a threshold frequency exists for each metal surface to experience photoelectric emission

Question 3 (20 marks)

Karplus (1969) asserts that a progression from exploratory activities to laboratory-typeinvestigative activities is necessary for effective science learning.

Karplus and colleagues (1977) developed a three-stage cycle of learning that optimizes effective learning in science.

(i) exploration stage which is based on students' experiences and they are challenged to

make connections with their existing experiential background with the areas of study,

(ii) concept introduction stage where the teacher guides the students toward a model/theory which can be used to explain the observations made in the exploratory stage, and

(iii) concept application stage where students undertake problem solving and laboratory investigation tasks, applying the knowledge in the second stage to new situations.

Excerpt from *Investigating the integration of everyday phenomena and practical work in physics teaching in Vietnamese high schools.*Wan Ng and Van Thanh Nguyen
International Education Journal, 2006, 7(1)

Use the Karplus cycle to design a concept development project in which leaners get to answer the question: Is it cheaper to keep the geyser switched on all the time or off when not in use. Use readings from the digital prepaid electricity meter in the home. Your design must show the following:

- Theory (appropriate to the problem) [4]
- Procedure [6]
- Data collected over a week [4]
- Analysis of data [4]
- Conclusions [2]

Question 4 (20 marks)

Construct concept maps for a Form 5 class to interrelate the following terms:

i. **Electricity**: potential difference, current, ohms, volts, amperes, watts, series circuit, parallel connection, conductor, resistivity, resistor, energy, light, heat, power, sound. [10]

ii. **The electromagnetic spectrum:** light, corpuscles, photons, energy, radiometer, photo-electric effect, threshold frequency, photoelectrons, alkali metal, ionization, discrete particles, wave-particle duality, $E = hf$, Einstein, photo-resistor. [10]

Question 5

An experiment is carried out to investigate how the time t for a steel ball to fall through air varies with the height h through which it falls.
The equipment is set up as shown in Fig. 2.1.

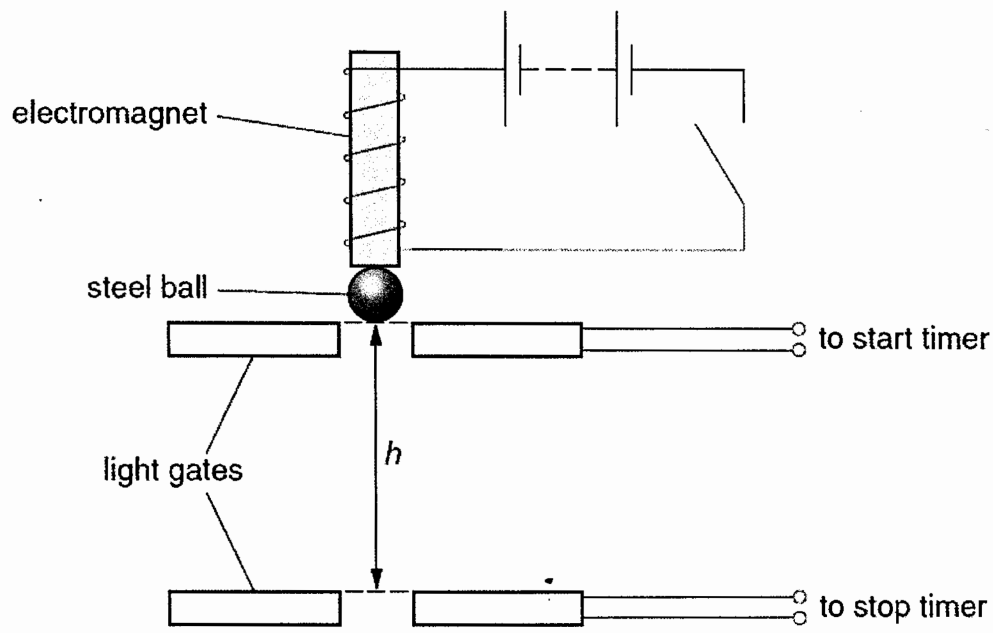

Fig. 2.1

An electromagnet is used to release the ball. As soon as the ball is released, it passes a light gate, which starts a timer. As the ball passes the lower light gate, the timer is stopped.

It is suggested that t and h are related by the equation $h = \frac{1}{2}gt^2$ where g is the acceleration of free fall.

(a) A graph is plotted with t^2 on the y-axis and h on the x-axis.
Express the gradient in terms of g. [1]

(b) Values of ***h*** and ***t*** are given in Fig 2.2

h/m	t/s	
0.60	0.35 ± 0.01	
0.75	0.39 ± 0.01	
0.90	0.43 ± 0.01	
1.00	0.45 ± 0.01	
1.15	0.49 ± 0.01	
1.30	0.52 ± 0.01	

Fig. 2.2

Calculate and record values of t^2 in Fig. 2.2. Include the absolute uncertainties. [3]

(c) (i) Plot a graph of t^2/s^2 against h / m. Include error bars for t^2 [3]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [3]

(iii) Determine the gradient of the line of best fit. Include the uncertainty in your answer. [3]

(d) Using your answer to **(c)(iii)**, determine the value of g. Include the absolute uncertainty in your value and an appropriate unit. [3]

(e) The experiment is repeated from the top of a building.

(i) The time taken for the steel ball to fall is 2.21 ± 0.01 s.
Using your value of g, calculate the height b of the building. [2]

(ii) Determine the percentage uncertainty in b. [2]