SECONDARY SCHOOL ANNUAL EXAMINATIONS 2011

Directorate for Quality and Standards in Education
Educational Assessment Unit

FORM 5 **PHYSICS** **TIME: 1h 45min**

Name: _____ **Class:** _____

Answer ALL questions in the spaces provided on the Exam Paper.
All working must be shown. The use of a calculator is allowed.
Where necessary take the acceleration due to gravity, g = 10 m/s^2 .

Equations for Annual Exam Physics

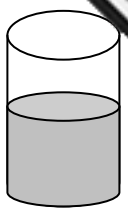
Density	$m = \rho V$	
Pressure	$P = h \rho g$	$P = F/A$
Energy and Work	$PE = m g h$	$KE = \frac{1}{2} m v^2$
	$E \text{ (or } W) = P t$	$W \text{ (or WD)} = F s$
Force	$F = m a$	$W = m g$
Motion	$\text{average speed} = \frac{\text{total distance}}{\text{total time}}$	$v = u + a t$
	$s = \frac{(u + v) t}{2}$	$s = \frac{1}{2} a t^2$
	$\text{momentum} = m v$	$h = \frac{1}{2} g t^2$
Electricity	$Q = I t$	$W = Q V$
	$V = I R$	$R = R_1 + R_2 + R_3$
	$P = I V = I^2 R = \frac{V^2}{R}$	$R \alpha \frac{\text{length}}{\text{area}}$
Electromagnetism	$\frac{N_1}{N_2} = \frac{V_1}{V_2}$	
Heat	$\text{Heat energy} = m c \Delta\theta$	
Waves and Optics	$c = f \lambda \quad f = \frac{1}{T}$	$m = \frac{h_i}{h_o} = \frac{\text{image distance}}{\text{object distance}}$

Marks Grid: For the Examiners' use ONLY

Question	1	2	3	4	5	6	7	8	Theory	Practical	Total
Max. Mark	8	8	8	8	8	15	15	15	85	15	100
Score											

Section A. **This Section carries 40 m**

1. A volume of 6×10^{-5} m^3 (0.00006 m^3) of olive oil is poured into a heat resistant container having a base area of 0.03 m^2. The density of olive oil at 20 °C is approximately 900 kg/m^3.



a. Calculate the:

i. mass of the olive oil in kg, **1**

ii. weight of the olive oil in N, **1**

iii. pressure this mass of the olive oil exerts on the base of the heat resistant container, in Pa **1**

b. The olive oil in the heat resistant container is heated from 20 °C to 45 °C. The specific heat capacity of olive oil is approximately 1970 J/kg°C. Calculate the heat energy required assuming no energy losses. **2**

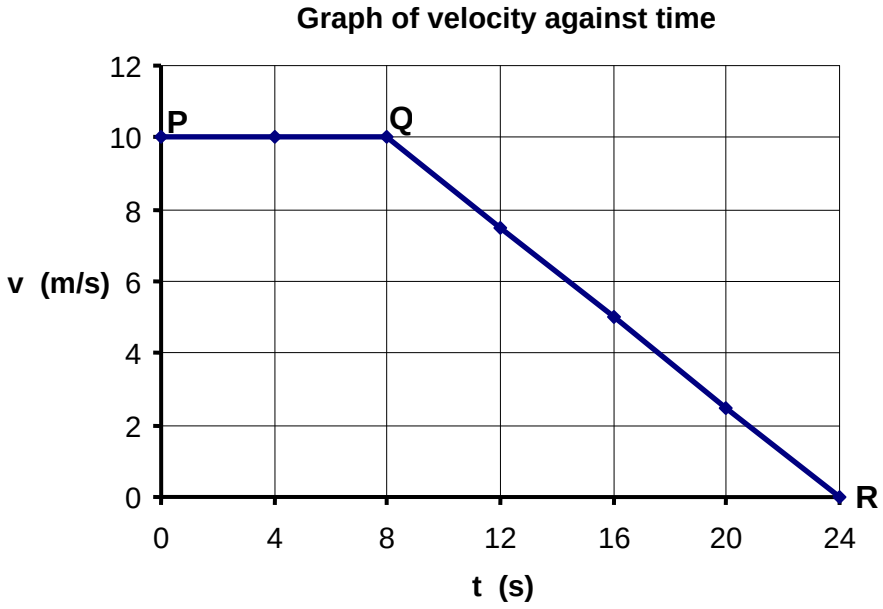
c. What changes, if any, take place when the olive oil is heated from 20 °C to 45 °C to the:

i. volume occupied by the olive oil, _____ **1**

ii. mass of the olive oil, _____ **1**

iii. density of the olive oil. _____ **1**

2. The graph below shows the motion of Luca's car during the last 24 s before comi
complete stop in front of his house.



a. From the graph:

i. PQ shows that the car was moving at a constant velocity of _____ m/s **1**

ii. The car decelerates uniformly during the last _____ s of Luca's journey. **1**

b. Luca's car has a mass of 920 kg while Luca has a mass of 80 kg. Calculate the:

i. total mass of Luca and his car, **1**

ii. total kinetic energy in J of Luca and his car just before he started to brake, **2**

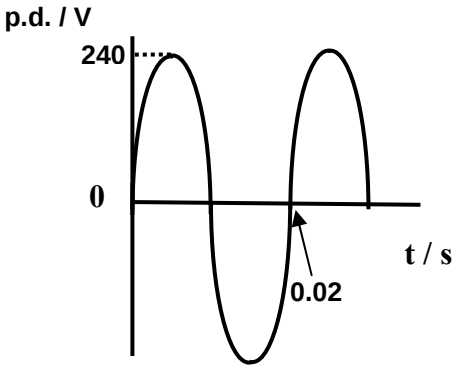
c. Using the graph or otherwise calculate the:

i. value of the deceleration of Luca and his car in m/s^2, **2**

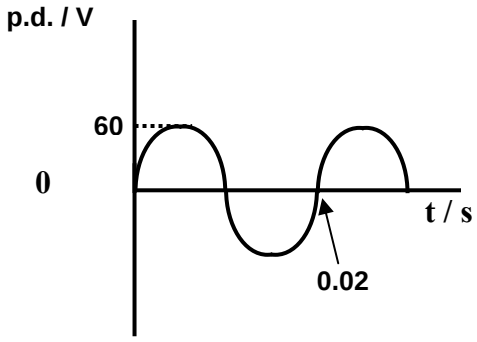
ii. average force in N required during deceleration. **1**

3. In 1831, Michael Faraday conducted the first experiments about electromagnetism. Later he invented the first transformer.

The figures below show the input and output voltage waveforms obtained on the screen of a cathode ray oscilloscope for Transformer X.



Input voltage



Output voltage

a. Complete the statements below:

i. Transformer X is a **step-down** transformer because the output peak voltage is _____ than the input peak voltage. **1**

ii. What kind of electrical supply is a 9 V battery? _____. **1**

iii. What kind of electrical supply is the input and output voltage of any transformer? _____. **1**

b. Using waveforms shown above obtained for Transformer X:

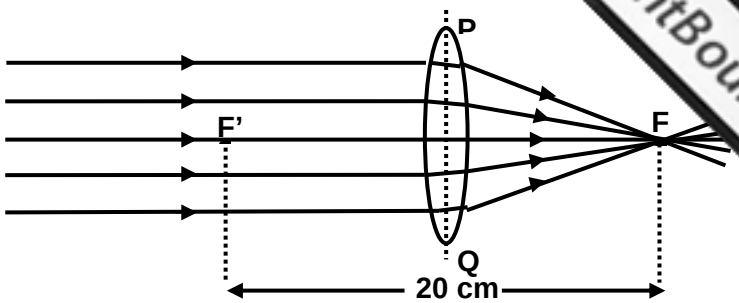
i. Calculate the frequency of the **input** voltage. **2**

ii. What is the value of the frequency of the **output** voltage? _____ **1**

c. Referring to the above waveforms, calculate the number of turns of the secondary coil of Transformer X given that its primary coil has 2000 turns and assuming 100% efficiency. **2**

4.

a. The figure shows a parallel beam of light incident on to a convex lens PQ.



i. What kind of beam is the emergent beam? _____ **1**

ii. Determine the size of the focal length of the lens PQ. _____ **1**

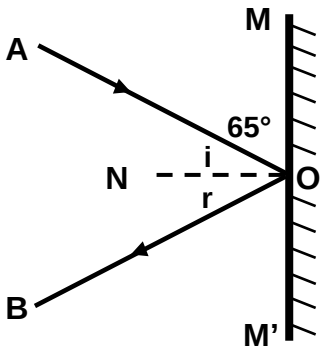
iii. Name the phenomenon which takes place when light rays bend as they pass through he glass lens. _____ **1**

b. The speed of light in air is 3×10^8 m/s (300 000 000 m/s).

Calculate the speed of light through the lens in m/s given that the refractive index of air to glass ($_a\eta_g$) lens is 1.5. **1**

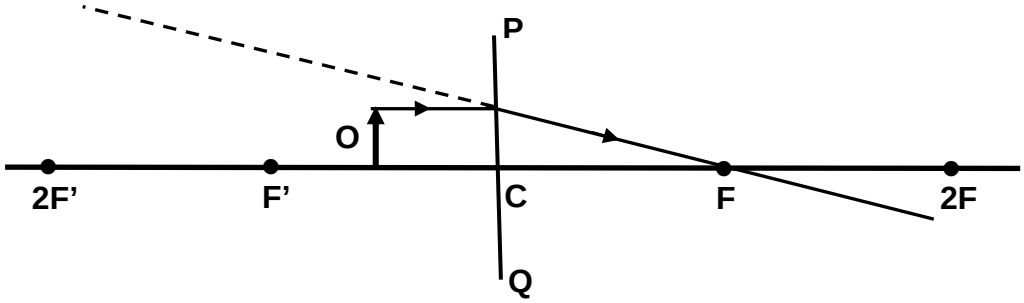
c. The ray diagram shows a ray of light AO incident on to a plane mirror MM' and the corresponding reflected ray OB.

Use this ray diagram to determine the angle of reflection **r**. _____°



2

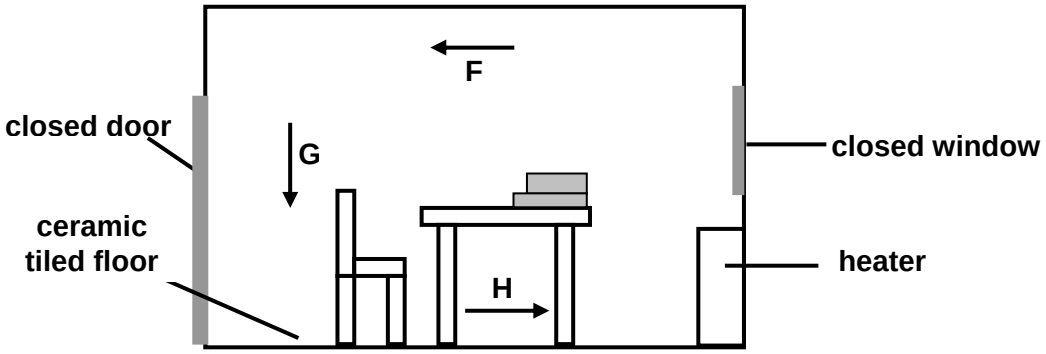
d. An object O is placed in front of the lens PQ as shown in the incomplete ray diagram below.



i. Complete the above diagram by drawing a ray to show the position of the virtual image obtained. **1**

ii. On the above diagram draw the **virtual** image obtained. **1**

5. The diagram below shows Martha's study. On a very cold Sunday evening, Martha turns the gas heater on. The three arrows F, G and H show the air movement in the room while the heater is turned on. **1**



a. Which **arrow** shows the:

i. coldest volume of the air in the room? _____ **1**

ii. hottest volume of the air in the room? _____ **1**

b. Heat energy is transferred throughout Martha's room by _____. **1**

c. Martha turns the gas heater on for 1 hour. Assuming that no air escapes from the room, state what changes, if any, take place to the:

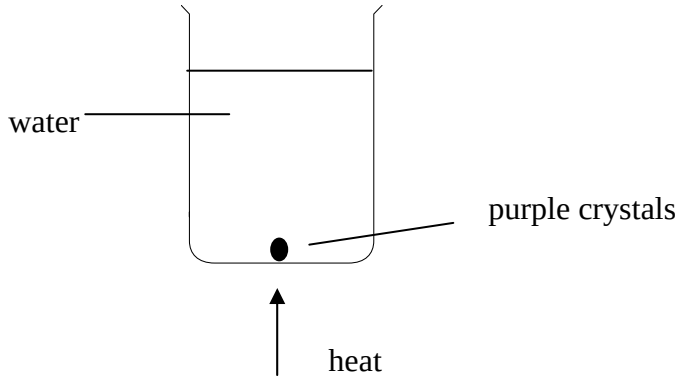
i. mass of the air inside the room, _____ **1**

ii. total volume of the air inside the room, _____ **1**

iii. density of the air **directly above** the heater, _____ **1**

iv. average air pressure inside the room. _____ **1**

d. A few purple crystals were placed in a beaker full of water as shown in the diagram below. Draw what is observed when the beaker is heated.



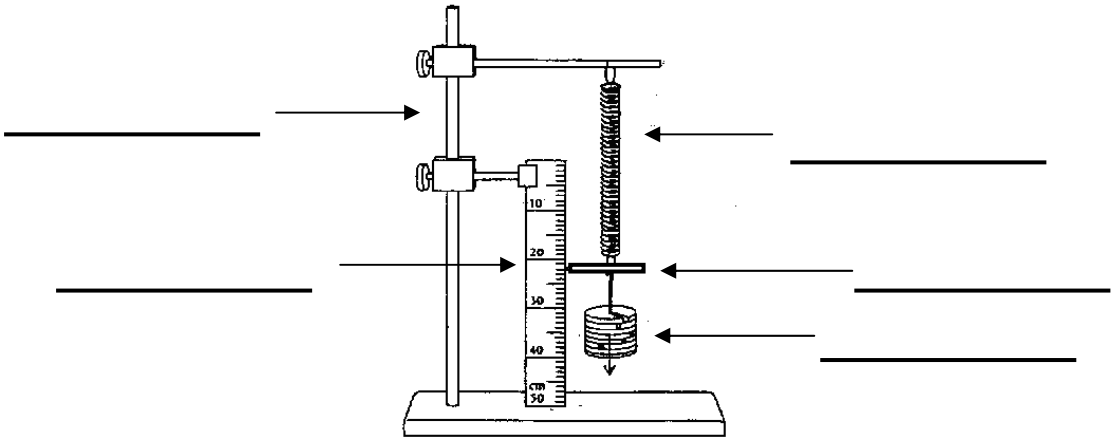
1

Section B. **This Section carries 45 [illegible]**

6. This question is about the design of an experiment to study Hooke's Law.

The diagram below shows the experimental set up by Robert to investigate the behaviour of a spring **without permanently deforming it**.

a. Label the diagram of Robert's experimental set-up.



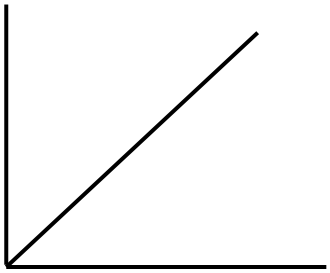
1
1
1
1
1

b. Fill in the missing **titles/units** in the table of results drawn by Robert.

Reading	**Load W in ____**	**_____ e in mm**

1
1

c. Robert plotted the graph with the results obtained.



2

i. On the above graph, label both axes by entering the appropriate quantities and their units.

ii. From the graph, it can be concluded that the _____ of the spring **1**

is _____ proportional to the _____. **1, 1**

iii. The elastic limit of the spring is 5 N. This means that the spring looses its elasticity and becomes _____if the load is greater than 5 N. **1**

iv. Calculate the greatest **mass** which can be applied to this spring without damaging it using the formula $m = \frac{W}{g}$ **2**

7. This question is about Nuclear Physics.

Carbon-14 is a radioactive substance. The symbol for a carbon-14 nucleus is ${}^{14}_{6}C$

a. Using this information about ${}^{14}_{6}C$ determine its:

i. proton number Z, _____ **1**

ii. mass (nucleon) number A, _____ **1**

iii. neutron number N. _____ **1**

b. Carbon-14 decays by emitting beta particles. Write down the:

i. symbol for a beta particle, _____ **1**

ii. mass (nucleon) number of a beta particle, _____ **1**

iii. charge of a beta particle. _____ **1**

c. There are three naturally occurring **isotopes** of carbon on Earth: 99% of the carbon is carbon-12, less than 1% is carbon-13, and carbon-14 which occurs in very small amounts.

i. Complete the following statement about isotopes:

Isotopes are nuclei of the same element having the same _____ number but different mass number. **1**

ii. The following symbols represent six nuclei.

${}^{40}_{18}A$	${}^{41}_{19}B$	${}^{12}_{6}C$	${}^{39}_{19}D$	${}^{40}_{20}E$

Which **two** nuclei are isotopes of each other? **1**

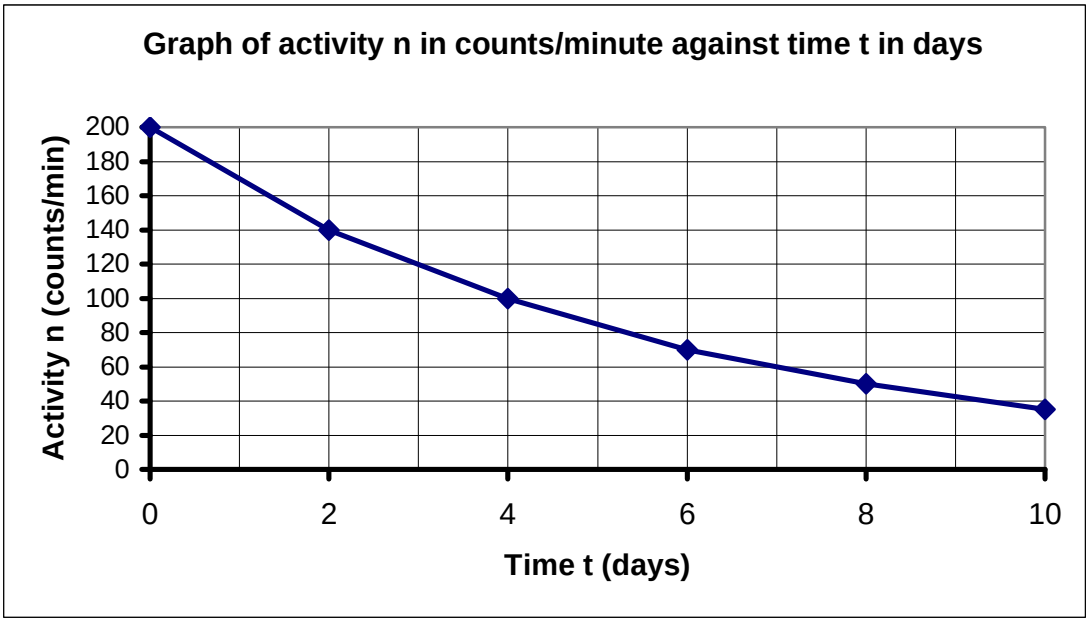
d. A radioactive detector connected to a counter gives a count even though a radioactive source is not present. **1**

i. This radioactive count is due to _____ **1**

ii. State **two** sources of this radiation. **1**

iii. Name the instruments used to **detect and measure** background radiation rate. **1**

e. A radioactive sample Y is placed in front an appropriate instrument and the count [illegible] recorded. A graph of the corrected count rate **n** in counts per minute is plotted against time **t** in days as shown:



i. Complete the following statement about half-life:

Half-life is the time taken for _____

_____. **1**

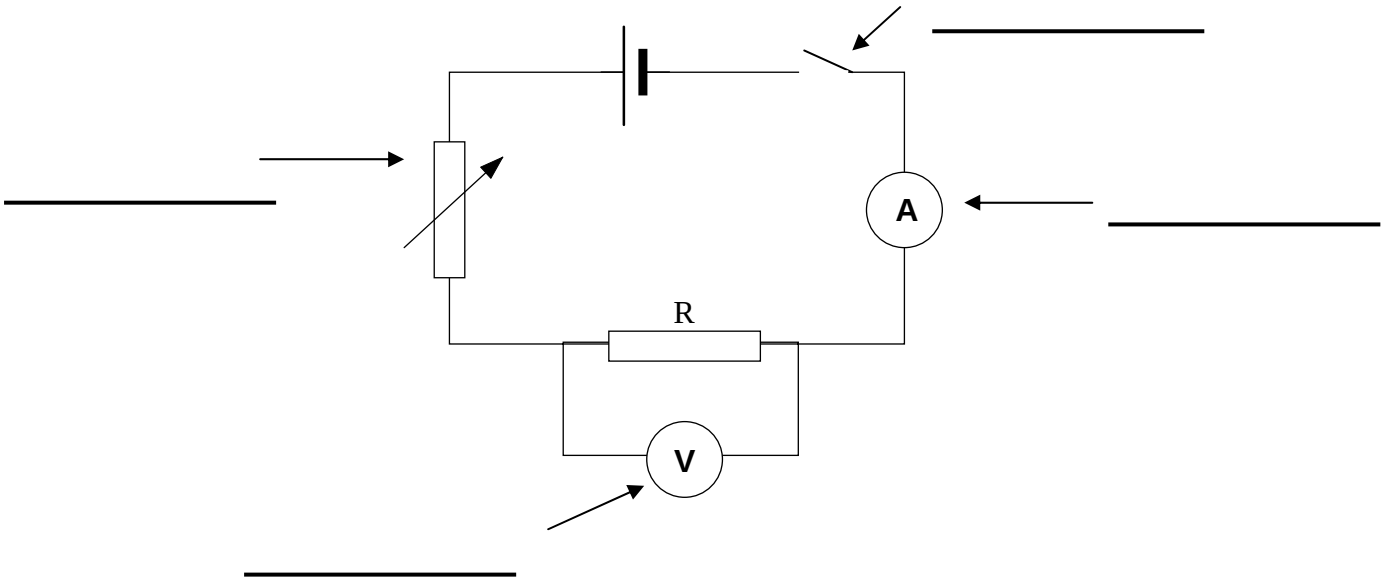
ii. The count rate **n** in counts/min for a radioactive sample Y after 4 days drops from 200 counts/min to 100 counts/min. This means that the half-life of radioactive sample Y is ____ days. **1**

iii. Use the graph to find count rate, **n** in counts/min, of radioactive sample Y after 6 days.

_____ counts/min. **1**

8. This question is about the relationship between current and voltage for an unknown resistor R

David and Charlene set up the circuit using the apparatus shown below to investigate the effect on the size of current through an unknown resistor R as the voltage across R is changed.



a. Label the four items indicated by an arrow in the circuit. **4**

b. Name the apparatus which:

i. shows the size of the current flowing through the resistor R, _____ **1**

ii. is used to change the voltage across the resistor R, _____ **1**

iii. shows the size of the potential difference (voltage) across resistor R, _____. **1**

c. Plot a graph of current I (y-axis) against voltage **V** (x-axis) using the table of results below completed by David and Charlene.

I /Amps	**0.0**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**
V / Volts	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**

5

d. From your graph determine the size of the:

i. current flowing through the resistor when the voltage across it is 3.5 V. _____ **1**

ii. voltage across the resistor when the current flowing through it 0.45 A. _____ **1**

e. Calculate the resistance of the resistor R using the formula $R = {}^{V}\!/_{I}$. **1**