UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF APPLIED PHYSICS AND ENGINEERING PHYSICS

NATIONAL DIPLOMA IN ANALYTICAL CHEMISTRY

MODULE PHYSICS PHY2ZAT

CAMPUS **DFC**

AUGUST EXAMINATION

DATE 17/08/2016	**SESSION: 9:00 – 12:00**
ASSESSOR	**DR. J. CHANGUNDEGA**
INTERNAL MODERATOR	**DR. L. REDDY**
DURATION 3 HOURS	**MARKS 120**

NUMBER OF PAGES: 14 PAGES, INCLUDING 2 INFORMATION SHEETS

INSTRUCTIONS: **MULTIPLE CHOICE GRID PAPER IS PROVIDED**
CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT)

SECTION A
ANSWER ALL QUESTIONS ON THE GRID PAPER PROVIDED

QUESTION A1

In the visible spectrum, violet (purple) light has a shorter wavelength than red light. Which of the following coloured bodies is associated with the lowest temperature blackbody?

A A violet body
B A blue body
C A green body
D A red body

QUESTION A2

The energy of photon X is E. If photon Y has twice the wavelength as that of photon X, the energy of photon Y is

A 2E
B 4E
C ¼ E
D ½ E

QUESTION A3

In the photoelectric effect, the maximum kinetic energy of photoelectrons depends on which of the following?

I. The light intensity
II. The frequency of the light
III. The material of the photoelectric cell

A Only I
B Only I and II
C Only I and III
D Only II and III

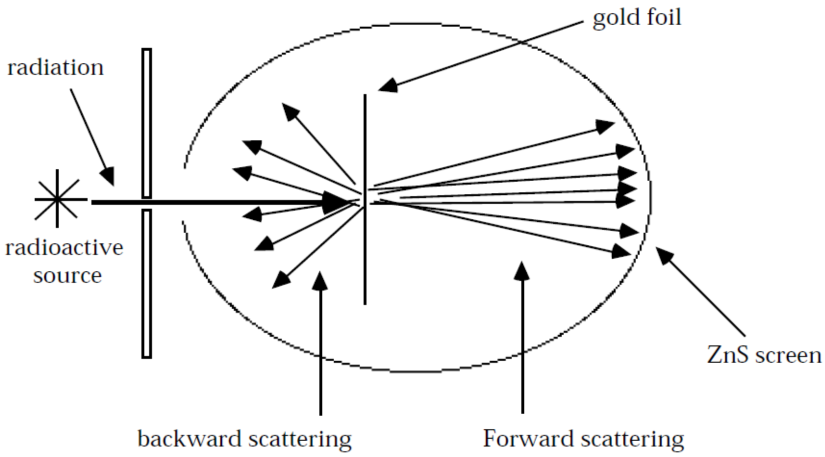
QUESTION A4

Which of the following sets of quantum numbers are not possible? (The symbols have their usual meaning)

A $n = 0, l = 0, m_l = 0, m_s = +\frac{1}{2}$
B $n = 1, l = 0, m_l = 0, m_s = -\frac{1}{2}$
C $n = 3, l = 1, m_l = 0, m_s = +\frac{1}{2}$
D $n = 2, l = 1, m_l = 0, m_s = -\frac{1}{2}$

QUESTION A5

A sketch of Rutherford's equipment setup and observations is reproduced below.



Which observation let him to conclude that the atom contained a nucleus?

A The amount of radiation scattered backward
B The amount of radiation continuing straight through.
C Both A and B.
D Neither A or B.

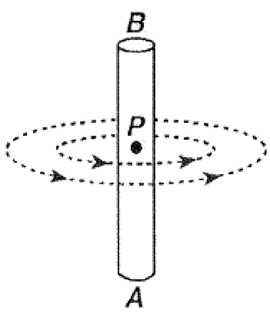
QUESTION A6

When an electron falls from an orbit where n = 2 to n = 1,

A a photon is emitted.
B a photon is absorbed.
C there is no change in atomic energy.
D the atomic energy increases.

QUESTION A7

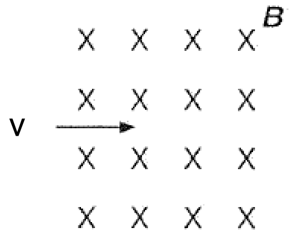
The diagram shows the magnetic field around point P at the centre of a current-carrying wire. What is the direction of current flow in the wire?



A Out of the page
B Into the page
C From A to B
D From B to A

QUESTION A8

The diagram below represents a proton travelling with a velocity v towards the right and entering a region with a magnetic field directed into the page.

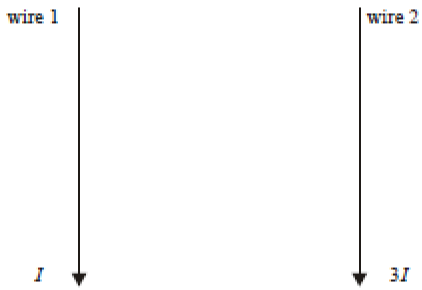


If the velocity v of the proton were doubled, the magnetic force on the proton would

A remain the same.
B be halved.
C double.
D be 4 times greater.

QUESTION A9

The currents in two parallel wires are I and 3I in the directions shown in the diagram below.

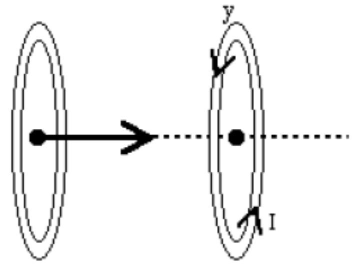


The magnetic force on wire 2 due to the current in wire 1 is F. The magnitude of the force on wire 1 due to the current in wire 2 is

A F/3
B –F
C 3F
D None of the above

QUESTION A10

A closed, circular loop y has a current flowing through it. If a second, closed, circular loop with the same radius approaches this loop along a common axis as shown.

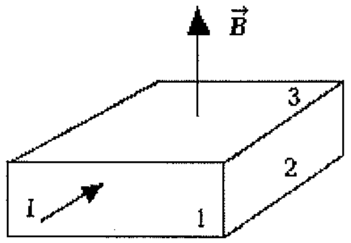


In what direction will a current flow in the approaching loop?

A No current will flow
B Opposite to the direction of current flowing in loop y
C Same direction as the current flowing in loop y
D Towards the left

QUESTION A11

The rectangular aluminium strip in the diagram is in a uniform magnetic field $\vec{B}$. The current i is flowing perpendicular to Surface 1 as shown.

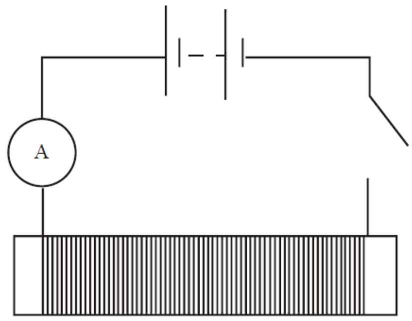


Negative charges will accumulate on

A Surface 1.
B Surface 2.
C Surface 3.
D the surface opposite Surface 2.

QUESTION A12

The diagram shows a coil of wire wound on an iron core.



When the switch is closed, the ammeter reading gradually increases from zero to a maximum value. What is the explanation for this gradual growth of current?

A An e.m.f. is induced in the coil.
B The e.m.f. of the battery is increasing.
C The iron core has a very low resistance.
D The battery has a large internal resistance.

QUESTION A13
Which of the following are the longest wavelength electromagnetic waves?

A Ultraviolet waves
B Microwaves
C Infrared waves
D Visible waves

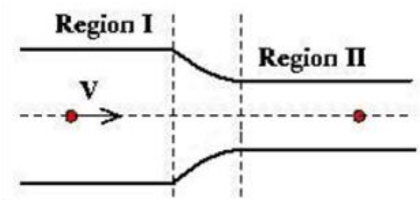
QUESTION A14
Thin film interference is caused due to a single source of light

A changing its wavelength after a reflection.
B increasing its speed after a reflection.
C being totally internally reflected inside the film.
D being reflected from the top and bottom of the film.

QUESTION A15
The polarization of light shows that light is made of

A waves.
B longitudinal waves.
C transverse waves.
D electromagnetic radiation.

QUESTION A16
A piece of an ideal fluid is marked as it moves horizontally through a pipe, as shown in the diagram. In Region I, the speed of the fluid is v. The cylindrical, horizontal pipe narrows so that the radius of the pipe in Region II is half of what it was in Region I.



What is the speed of the marked fluid when it is in Region II?

A 4v
B 2v
C v/2
D v/4

QUESTION A17
Which of the following statements relating to the Poiseuille law are correct?

1) The volume flow rate is inversely proportional to the length of the tube.
2) The volume flow rate is directly proportional to the pressure difference between the two ends of the tube.
3) The volume flow rate is directly proportional to the viscosity of the liquid.

A 1 and 2
B 1 and 3
C 2 and 3
D All the above

QUESTION A18

A flow in which the velocity at a point does not change with time is called

A Velocity of Efflux
B Turbulent flow
C Streamline flow
D Stoke's Flow

QUESTION A19

The following represents a sequence of radioactive decays involving two α-particles and one β-particle.

$$^{217}_{85}\mathrm{At} \xrightarrow{\alpha} \mathrm{V} \xrightarrow{\alpha} \mathrm{W} \xrightarrow{\beta} \mathrm{X}$$

What is the nuclide X?

A $^{213}_{85}\mathrm{At}$ **B** $^{215}_{77}\mathrm{Ir}$ **C** $^{209}_{82}\mathrm{Pb}$ **D** $^{217}_{81}\mathrm{Tl}$

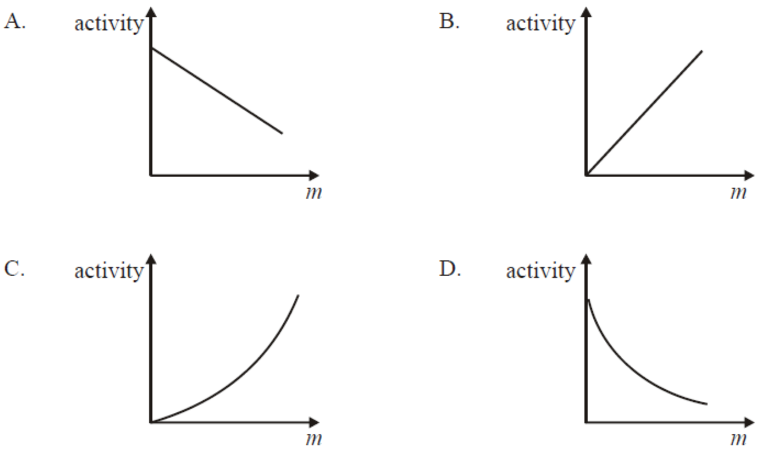
QUESTION A20

Substance A has a decay constant l that is three times that of B. Find the ratio of the half-life of substance A to the half-life of substance B.

A 1/3
B 1
C 3
D None of the above

QUESTION A21

Which of the following graphs shows the variation with mass m of the activity of a sample of a radioactive material?



QUESTION A22

If you were in a spaceship traveling at a speed close to the speed of light (relative to earth) you would notice that

A your pulse rate is slower than normal.
B your mass is greater than normal.
C your height is shorter.
D none of the above effects would be observed.

QUESTION A23

In everyday life, we don't see the effects of relativity because

A they only occur when travelling at velocities close to c.
B they are too small to detect easily.
C we have become accustomed to them, so we don't notice.
D they are too complicated to understand when they occur in everyday life.

QUESTION A24

The rest energy of a particle when considering relativity effects is

A $E = ½\, m\, v^2$
B $E = m_0\, c^2 + ½\, m\, v^2$
C $E = m\, c^2$
D $E = m_0\, c^2$

(The symbols have their usual meanings)

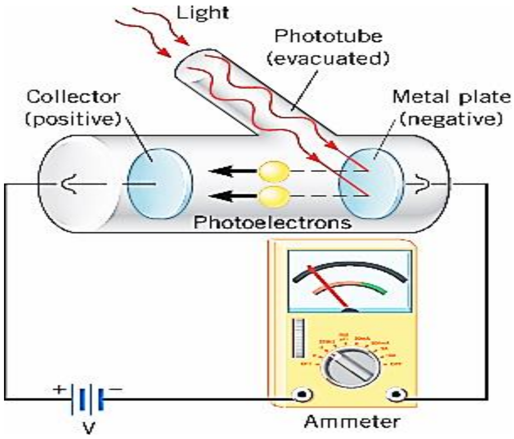
SUB-TOTAL : SECTION A [48]

SECTION B
ANSWER ALL QUESTIONS IN THE ANSWER BOOK PROVIDED

QUESTION B1

1.1. During Compton's experiment, a beam of x-rays is scattered by electrons in graphite. The x-rays scattered at 45^0 have a wavelength of 2.2 pm. What is the wavelength of the x-rays that are not deflected at all by the graphite? (5)

1.2. The diagram shows the photoelectric experiment.



State two of the main observations made in this experiment that could not be explained if light did not consist of photons. (4)

[9]

QUESTION B2

2.1. A sample of Hydrogen initially has all its atoms in the n = 5 energy state. How many different spectral lines would you expect in the emission spectrum of this hydrogen spectrum? (4)

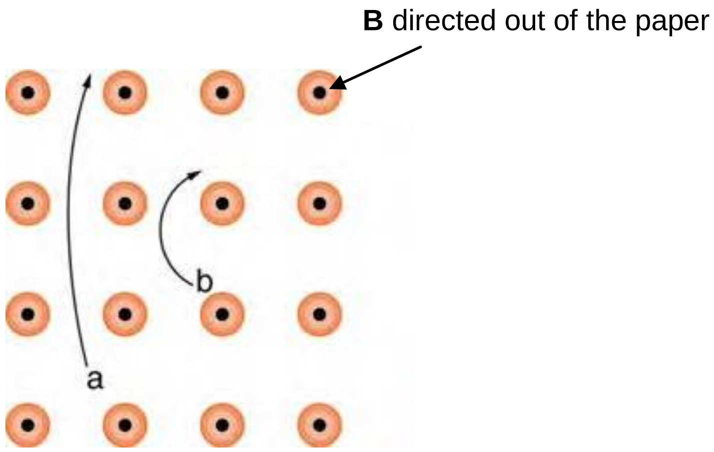
2.2. In the quantum mechanical model of the atom, if the principle quantum number n = 4, state all the possible magnetic quantum numbers. (5)

[9]

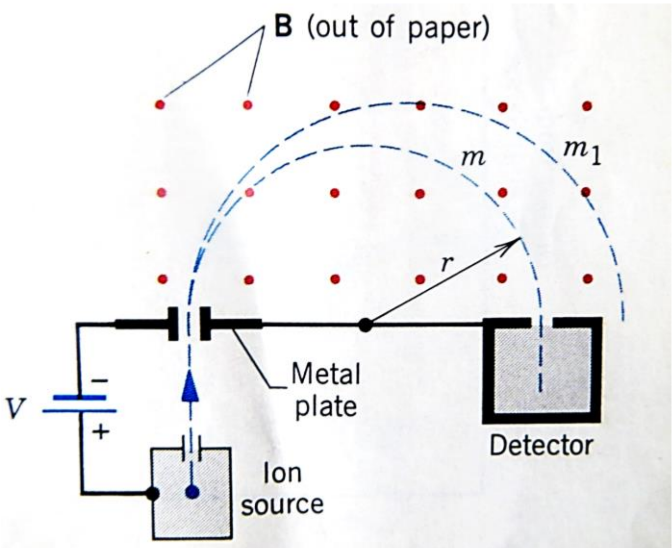
QUESTION B3

3.1. Which of the particles (a) or (b) in the following diagram has the greatest velocity, assuming they have identical charges and masses? (1)

Justify the answer. (3)



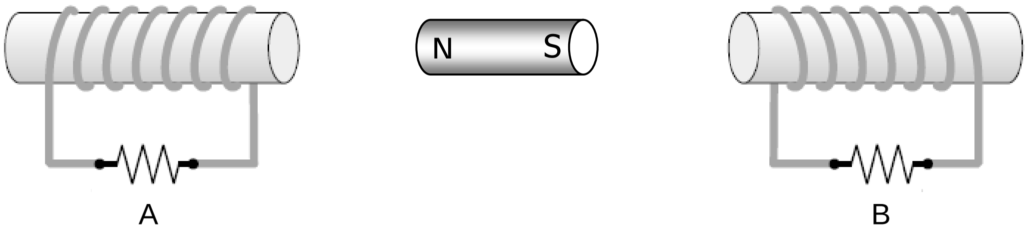
3.2. The diagram shows a simplified design of the mass spectrometer. Explain how it works. You are expected to use at least one equation in your explanation. (5)



[9]

QUESTION B4

4.1. A magnet is placed between two coils as shown in the diagram.



If the magnet was moved towards the right, state the direction (left OR right) of the current induced in resistor

4.1.1. A. (2)

4.1.2. B. (2)

4.2. The battery in a cell phone is recharged using a ‘charger’ unit that is plugged into a wall socket. Inside the charger, there is a step-down transformer. The ratio of turns between the secondary and primary coil in one cell phone charger is 1:13. If the wall socket supplies 120 V, what output voltage reaches the phone battery through the charger’s transformer? (3)

4.3. Whenever electricity is transmitted, power can be lost in the transmission lines before reaching consumers. Power plants like Eskom produce electricity with voltages as high as 12 000 V. These companies use transformers to reduce the power loss. Explain how transformers help in reducing the power loss. [Recall that (Power loss = I^2R where I = current and R = resistance) (2)

[9]

QUESTION B5

5.1. Suppose single-wavelength light falls on a diffraction grating. What happens to the interference pattern if the same light falls on a grating that has more lines per centimetre? (1)

Using an equation, justify the answer. (2)

5.2. State two methods of detecting gamma rays. (2)

5.3. What is a

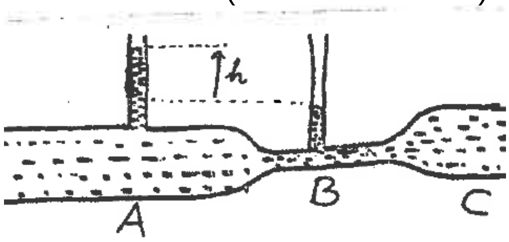
5.3.1. *polaroid*? (2)

5.3.2. a dextro-rotatory substance. (2)

[9]

QUESTION B6

6.1. The diagram shows a venturimeter. (Not drawn to scale)



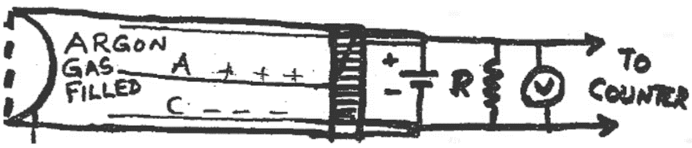
The diameter of the pipe is 6 cm at A and 4 cm at B. If the pressure difference shown by the venturimeter is 5 cm of water, determine the volume of water flowing through the pipe every minute. (4)

6.2. Describe an experiment to determine the viscosity of a highly viscous liquid by Stoke's formula. You are required to draw a diagram and refer to your diagram in the explanation. (5)

[9]

QUESTION B7

7.1. With reference to the diagram below, explain how a Geiger-Müller counter works. (5)



7.2. State four differences between beta radiation and gamma radiation. (4)

[9]

QUESTION B8

8. An electron is accelerated through a voltage of 10^5 V.
Determine

8.1. the rest energy of the electron. (2)

8.2. the kinetic energy of the electron. (2)

8.3. the total relativistic energy of the electron. (2)

8.4. the velocity of the electron. (3)

[9]

SUB-TOTAL : SECTION B [72]

. **TOTAL [120]**