

**UNIVERSITY OF KWAZULU-NATAL**  
**SECOND SEMESTER EXAMINATION: NOVEMBER 2013**  
**SUBJECT AND COURSE: PHYS133**

**TIME: 2 hours**

**TOTAL MARKS: 120**

Internal Examiners: Professor D Wang

External Examiner: Dr M Cavero, (Pietermaritzburg Campus)

**GENERAL INSTRUCTIONS:**

- This exam must be answered on the MCQ sheet provided. It is the responsibility of the candidate to ensure that **all the details** are filled in on the MCQ answer sheet. **Failure to do so** will result in a mark of zero for this examination.
  - Use only an HB pencil to fill in the MCQ sheet.
  - Use numbers 1- 40 only.
- **It is the candidate's responsibility to ensure that this paper has 11 numbered pages, which includes the information sheet.**
- Do your rough work for a question on the question paper provided. Rough work will not be marked.
- The last page of this exam, which is printed separately, is an information sheet.
- No part of this exam paper may be torn off.
- Marks have been allocated in such a way that 1 mark corresponds approximately to one minute of time. Candidates are advised not to spend a disproportionate amount of time on any question.

**Rule 9 (1)(e) WARNING: CANDIDATES WILL BE DISQUALIFIED IF:**

- (a) they introduce, or attempt to introduce, into any place where an examination is about to be conducted or is being conducted, any paper, book, note, document or instrument, the use of which is not authorized by the examiner or the examination officer.
- (b) they possess, use, or attempt to use during an examination, any paper, book, note, document or instrument the use of which is not authorized by the examiner or the examination officer.
- (c) they remove or attempt to remove from the examination room, any examination book or writing paper supplied by the University for the purposes of answering an examination.
- (d) they communicate or attempt to communicate any information relating to the examination to another candidate while the examination is in progress.
- (e) they use a false name or identity number in an examination.
- (f) they commit any other fraudulent, deceitful or dishonest practice which would mislead or deceive the examiner or examination officer.

**IF A STUDENT IS FOUND GUILTY BY A STUDENT DISCIPLINE COURT OF CONTRAVENING THE ABOVE RULE –9(1)(e) – SHE/HE WILL SUFFER ONE OR MORE OF THE FOLLOWING CONSEQUENCES:**

- (i) Disqualification from entry to any examination.
- (ii) Cancellation or forfeiture of examination results.
- (iii) Deprivation of a degree, diploma or certificate obtained as a result of the offence.

**SECTION A:**      **Electricity and Magnetism**      **(18 Questions, 54 Marks)**

**QUESTION 1**

A charged particle in an electric field of  $3.00 \times 10^5 \text{ NC}^{-1}$  experiences a force of 10.3 N. The magnitude of the electric charge on the particle is

- a)  $3.09 \times 10^6 \text{ C}$
- b)  $0.32 \mu\text{C}$
- c)  $3.16 \times 10^4 \text{ C}$
- d)  $34.3 \mu\text{C}$ .

**QUESTION 2**

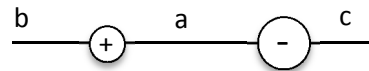
When two particles with charges  $8.00 \mu\text{C}$  and  $3.00 \mu\text{C}$  are placed near one another they give rise to a force of 25.0 N between them. The distance between the particles is

- a)  $3.00 \times 10^{-7} \text{ m}$
- b) 9.30 m
- c)  $3.00 \times 10^6 \text{ m}$
- d) 9.30 cm.

**QUESTION 3**

A relatively large negative charge is situated near a smaller positive charge. The combined electric field which they produce has a neutral point situated on the line joining the charges at a point which lies

- a) between the charges
- b) on the side nearer the positive charge
- c) on the side nearer the negative charge
- d) nowhere.



**QUESTION 4**

When a charge of 2.0 nC is moved from point A to point B, 16.0 J of energy is given out. The magnitude of the electric potential difference between A and B is

- a) 8.0 V
- b)  $64.0 \times 10^{-9} \text{ V}$
- c)  $8.0 \times 10^9 \text{ V}$
- d) -64.0 V.

**QUESTION 5**

An electron is initially at rest. After it has been accelerated across the space between two charged plates, its energy is 28.6 eV. The electric potential difference between the plates is

- a)  $4.58 \times 10^{-18} \text{ V}$
- b) 28.6 V
- c)  $1.79 \times 10^{20} \text{ V}$
- d)  $1.03 \times 10^{-19} \text{ V}$ .

**QUESTION 6**

A capacitor has a capacitance  $C = 1.6 \mu\text{F}$ . After charging, the capacitor has a charge of  $5.6 \mu\text{C}$  on each plate. The voltage applied to the capacitor to charge it is

- a)  $9.0 \times 10^{-11} \text{ V}$
- b)  $0.28 \text{ V}$
- c)  $1.1 \times 10^{10} \text{ V}$
- d)  $3.5 \text{ V}$ .

**QUESTION 7**

Two capacitors of capacitance  $3.20 \text{ nF}$  and  $5.62 \text{ nF}$  are connected in **series**. After charging, the larger capacitor has a charge of  $1.37 \mu\text{C}$ . The charge on the smaller capacitor is

- a)  $0.28 \mu\text{C}$
- b)  $1.37 \mu\text{C}$
- c)  $2.41 \mu\text{C}$
- d)  $3.57 \mu\text{C}$ .

**QUESTION 8**

Two capacitors of capacitance  $3.20 \text{ nF}$  and  $5.62 \text{ nF}$  are connected in parallel. After charging, the larger capacitor has a charge of  $1.37 \mu\text{C}$ . The charge on the smaller capacitor is

- a)  $2.40 \mu\text{C}$
- b)  $0.78 \mu\text{C}$
- c)  $1.37 \mu\text{C}$
- d)  $13.1 \mu\text{C}$ .

**QUESTION 9**

When an electric potential difference of  $160 \text{ V}$  is applied across two parallel plates, the uniform electric field produced between them has a magnitude of  $8.00 \times 10^3 \text{ NC}^{-1}$ . The distance between the plates is

- a)  $2.00 \text{ cm}$
- b)  $2.00 \text{ m}$
- c)  $1.28 \times 10^6 \text{ m}$
- d)  $0.50 \times 10^{-3} \text{ m}$ .

**QUESTION 10**

Two different electrical resistors are connected in parallel. The equivalent resistance is

- a) greater than the bigger resistance
- b) equal to the bigger resistance
- c) equal to the smaller resistance
- d) less than the smaller resistance.

**QUESTION 11**

Two wires made from the same metal have the same length. The diameter of one is twice that of the other. The ratio of the electrical resistance of the fatter wire to that of the thinner wire is

- a) 4
- b) 2
- c)  $\frac{1}{2}$
- d)  $\frac{1}{4}$ .

**QUESTION 12**

A kettle is designed to produce power  $P_{220}$  when connected to a 220 V supply. When it is connected to a 110 V supply it will generate  $P_{110}$  where  $P_{110}/P_{220}$  is

- a) 4
- b) 2
- c)  $\frac{1}{2}$
- d)  $\frac{1}{4}$ .

**QUESTION 13**

A 72.0 W light bulb is powered by a 12.0 V battery. If the battery lasts for 1.90 days, the capacity rating for the fully charged battery is

- a) 7.60 Ah
- b) 22.8 Ah
- c) 84.7 Ah
- d) 274 Ah.

**QUESTION 14**

When a  $5.00 \Omega$  resistor is connected across the terminals of a 12.0 V battery, the terminal voltage drops to 10.0 V. The internal resistance of the battery is

- a)  $0.05 \Omega$
- b)  $0.10 \Omega$
- c)  $0.50 \Omega$
- d)  $1.00 \Omega$ .

**QUESTION 15**

A conductor 5.00 cm long carries a current of 1.00 A. It lies parallel to a magnetic field of 10.0 T. The force exerted on the conductor by the magnetic field is

- a) 0.75 N
- b) 0 N
- c) 3.00 N
- d)  $-0.75 \text{ N}$ .

**QUESTION 16**

Two long straight wires each carry a current of 1.0 A, in the same direction. The force between them is

- a) attractive and equal to 1.0 N
- b) repulsive and equal to 1.0 N
- c) attractive and dependent on the separation of the wires
- d) repulsive and dependent on the separation of the wires.

**QUESTION 17**

A conductor carries a current normally out of the plane of the paper. Use the right hand rule to determine the direction of the magnetic field lines generated by the current. The magnetic field lines are directed

- a) in a clockwise direction in the plane of the paper
- b) in an anti-clockwise direction in the plane of the paper
- c) into the plane of the paper
- d) out of the plane of the paper.

**QUESTION 18**

A transformer converts a 220 V<sub>rms</sub> supply to 6 V<sub>rms</sub> for an electronic power supply. If the primary coil has 660 turns, the number of turns in the secondary coil will be

- a) 24200
- b) 20
- c) 18
- d) 2.

**SECTION B:**

**Physical Optics**

**(10 Questions, 30 Marks)**

**QUESTION 19**

The refractive index of a glass panel with respect to air is 1.50. If unpolarised light falling on the surface produces a completely polarised reflected beam, the angle of incidence of the light on the surface (Brewster's angle) is

- a)  $33.7^\circ$
- b)  $41.8^\circ$
- c)  $48.2^\circ$
- d)  $56.3^\circ$ .

**QUESTION 20**

The specific rotation of an optically active sugar is  $42.3^\circ\text{cm}^2\text{g}^{-1}$ . A solution of this sugar rotates an incident beam of plane polarised light by  $20.0^\circ$  when contained in a cell 20.0 cm long. The concentration of the solution is

- a)  $1.18 \times 10^{-4} \text{gcm}^{-3}$
- b)  $0.106 \text{gcm}^{-3}$
- c)  $21.2 \text{gcm}^{-3}$
- d)  $4.73 \text{gcm}^{-3}$ .

**QUESTION 21**

Blue light of wavelength 450 nm from a point source passes through two narrow parallel slits onto a screen 2.00 m away. If the slits are 1.00 mm apart, the distance between adjacent fringes on the screen is

- a) 1.80 mm
- b) 0.90 mm
- c)  $4.44 \times 10^{-5} \text{m}$
- d) 3.20 cm.

**QUESTION 22**

In any given arrangement of Young's double slit experiment, the spacing of the interference fringes will be decreased if

- a) the distance between the slits is decreased;
- b) the wavelength of the light is decreased;
- c) the distance between the screen and the slits is increased;
- d) wavelength of the light is increased.

**QUESTION 23**

When the air gap between two glass plates is one half of the wavelength of the illuminating light ( $\lambda/2$ ), the reflected light will

- a) interfere constructively
- b) interfere destructively
- c) be unchanged
- d) change in an unpredictable way.

**QUESTION 24**

A mixture of yellow light ( $\lambda = 580 \text{ nm}$ ) and blue light ( $\lambda = 450 \text{ nm}$ ) falls normally on an air film between two glass plates that is  $2.25 \times 10^{-4} \text{ mm}$  thick. The reflected light will be

- a) yellow and blue
- b) yellow
- c) blue
- d) red.

**QUESTION 25**

In a measurement on Newton's rings, the radius of the 10th dark ring is found to be 1.10 mm. The radius of the 20th dark ring is

- a) 0.550 mm
- b) 0.780 mm
- c) 1.10 mm
- d) 1.56 mm.

**QUESTION 26**

The wavelength of the light falling on a single slit is doubled. The corresponding width of the central maximum of the diffraction pattern will be

- a) quadrupled (multiplied by 4)
- b) doubled
- c) halved
- d) quartered.

**QUESTION 27**

Blue light ( $\lambda = 450 \text{ nm}$ ) falls normally on a diffraction grating with 5000 lines per cm. The angle between the first order beam and the beam passing straight through the grating will be

- a)  $47.2^\circ$
- b)  $35.4^\circ$
- c)  $23.6^\circ$
- d)  $13.0^\circ$ .

**QUESTION 28**

White light falls on a diffraction grating. In the spectrum formed for each order,

- a) blue light is deviated more than red light
- b) red light is deviated more than blue light
- c) red and blue light are not separated
- d) no red light passes through the grating.

**SECTION C**

**Atomic and Nuclear**

**(12 Questions, 36 Marks)**

**QUESTION 29**

In the Rutherford scattering experiment, most of a beam of positively charged alpha particles pass straight through a thin metal film, while a few are scattered through large angles.

Rutherford concluded that the metal film consists of

- a) mostly empty space with some massive positively charged particles
- b) mostly empty space with some massive negatively charged particles
- c) a continuous sheet of mixed positive and negative charges
- d) negative charges in a sea of positive charge.

**QUESTION 30**

The element  ${}^p_qE$  has a nucleus which consists of

- a) q protons and p neutrons
- b) p protons and q electrons
- c) q protons and p – q neutrons
- d) p – q protons and q neutrons.

**QUESTION 31**

The nucleus of an atom of carbon 12 has a mass of 12 u, by definition. This means that 1 u is approximately

- a)  $1.99 \times 10^{-28}$  kg
- b)  $1.66 \times 10^{-27}$  kg
- c) 12.0 g
- d) 12.0 kg.

**QUESTION 32**

Carbon has an atomic mass of 12 u. The number of carbon atoms in a 200 g carbon rod is

- a)  $3.27 \times 10^{-24}$
- b)  $1.00 \times 10^{25}$
- c)  $6.02 \times 10^{23}$
- d)  $3.06 \times 10^{23}$ .

**QUESTION 33**

A small coal fired power station produces power at the rate of 2.00 MW. The mass of fuel converted completely to energy in a day (24 h) is

- a)  $1.92 \times 10^6$  kg
- b)  $5.52 \times 10^{-6}$  kg
- c) 5.52 kg
- d)  $1.92 \times 10^{-6}$  kg.



**QUESTION 34**

In the production of X-rays, electrons in the X-ray tube are accelerated across a potential difference of 20 kV. The cut-off wavelength of the X-rays produced is

- a) 0.62 angstrom
- b) 1.61 angstrom
- c)  $8.29 \times 10^{-11}$  m
- d)  $1.33 \times 10^{-30}$  m.

**QUESTION 35**

X-rays with a cut-off wavelength  $\lambda = 1.5 \times 10^{-11}$  m give second order diffraction maxima at a Bragg angle of  $60^\circ$ . The spacing between the atomic planes is

- a) 1.6 angstrom
- b)  $1.73 \times 10^{-11}$  m
- c)  $8.65 \times 10^{-12}$  m
- d)  $1.60 \times 10^{-13}$  m.

**QUESTION 36**

A radioactive source emits 'radiation' which is capable of passing through several centimetres of most materials and which is undeviated by a magnetic field at right angles to its path. This radiation is most probably

- a)  $\alpha$  rays
- b)  $\beta$  rays
- c)  $\gamma$  rays
- d) cosmic rays.

**QUESTION 37**

A radioactive isotope has a half-life of 34 s. The proportion of a sample left after 2 min 16 s is

- a)  $\frac{1}{2}$
- b)  $\frac{1}{4}$
- c)  $\frac{1}{8}$
- d)  $\frac{1}{16}$ .

**QUESTION 38**

The decay constant for the decay of a certain isotope is  $\lambda = 0.59 \text{ s}^{-1}$ . The half-life for this decay is

- a) 0.117 s
- b) 0.25 s
- c) 1.17 s
- d) 8.49 s.

**QUESTION 39**

The relative biological effectiveness or quality factor for radiation exposure is about 1 for  $\gamma$ -rays and about 10 for  $\alpha$ -rays. This means that the typical biological danger from equivalent amounts of energy absorbed from  $\alpha$ -rays compared with  $\gamma$ -rays is

- a) 10 times
- b) 1/10
- c)  $10^{10}$  times
- d)  $\ln 10$  times.

**QUESTION 40**

In reducing the exposure to radiation in the laboratory one should

- a) keep spare radioactive sources in one's pockets
- b) hold the source close to the eye to see if there is any visible radiation
- c) use one's own handkerchief and avoid tissues.
- d) cover any open sores or wounds.

