

SCHOOL OF CHEMISTRY & PHYSICS
UNIVERSITY OF KWAZULU-NATAL, PIETERMARITZBURG CAMPUS
PHYS131: INTRO PHYSICS FOR LIFE SCIENCES & AGRICULTURE
JUNE 2013 MAIN EXAMINATION

DURATION: 180 MINS

TOTAL MARKS: 180

Internal Examiner/s:

Professor D Wang

External Examiner or Moderating Board:

Professor J Rash (UKZN, Westville Campus)

General Instructions:

- This exam must be answered on the MCQ sheet provided. Please ensure that you fill in all the details on the MCQ answer sheet. **Failure to do so** will result in a mark of zero for this Exam
- Use only an HB pencil to fill in the MCQ sheet.
- It is the candidate's responsibility to ensure that this paper has 16 numbered pages.
- Do your rough work for a question on the 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:

- 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.
- 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.
- 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.
- they communicate or attempt to communicate any information relating to the examination to another candidate while the examination is in progress.
- they use a false name or identity number in an examination.
- 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:

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

Section A: Mechanics and Properties of Matter 30 Questions 90 marks

QUESTION 1

As part of a treasure hunt, a child walks 15.0 m due north followed by 24.0 m due west and then 5.0 m due south. The magnitude of her total displacement is

- a) 10.3 m
 - b) 26.0 m
 - c) 31.2 m
 - d) 34.0 m
-

QUESTION 2

A speed limit of 90.0 kmh^{-1} can be expressed in S.I. units as

- a) $2.50 \times 10^{-2} \text{ kms}^{-1}$
 - b) 56.3 mph
 - c) 25.0 ms^{-1}
 - d) $9.0 \times 10^4 \text{ mhr}^{-1}$.
-

QUESTION 3

A small piece of paper has an area of 3.3 mm^2 . In SI units, this area is

- a) 0.33 cm^2
 - b) $3.3 \times 10^{-2} \text{ cm}^2$
 - c) $3.3 \times 10^{-3} \text{ m}^2$
 - d) $3.3 \times 10^{-6} \text{ m}^2$
-

QUESTION 4

Which of the following statements regarding a velocity versus time graph is **true**?

- a) The slope of the graph equals the displacement;
 - b) The area under the graph equals the velocity;
 - c) The slope of the graph equals the acceleration;
 - d) The area under the graph equals the acceleration.
-

QUESTION 5

A farmer drops a stone into a borehole and hears the splash 3.50 seconds later. Neglecting the effects air resistance and the speed of sound, the depth of the borehole is

- a) 6.12 m
 - b) 17.2 m
 - c) 60.0 m
 - d) 120 m.
-

QUESTION 6

A vehicle decelerates uniformly from a velocity of 20.0 ms^{-1} to rest in 10.0 s . The distance travelled while stopping is

- a) 10.0 m
 - b) 980 m
 - c) 49.0 m
 - d) 100 m.
-

QUESTION 7

A large boulder weighing 2000 kg is lifted at constant velocity by a giant crane. The net force on the boulder is

- a) 2 tonnes
 - b) 19.6 kN
 - c) -19.6 kN
 - d) 0 N .
-

QUESTION 8

A woman is standing in a lift which is accelerating upward. If her weight has magnitude W and the force exerted on her by the lift has magnitude R , which of the following statements is **true**?

- a) $R < W$
 - b) $R > W$
 - c) $R = W$
 - d) $R = 0$.
-

QUESTION 9

A truck is pulling a trailer while accelerating at 0.30 ms^{-2} . If the mass of the trailer is 200 kg , the net horizontal force exerted on the trailer is

- a) unknown if the mass of the car is unknown;
 - b) 0 N
 - c) 60 N
 - d) 667 N .
-

QUESTION 10

A lecturer pushes against the wall of a lecture theatre to make a point to the students. If L is the magnitude of the force exerted by the lecturer on the wall and W is the magnitude of the force exerted by the wall on the lecturer then which of the following statements is **true**?

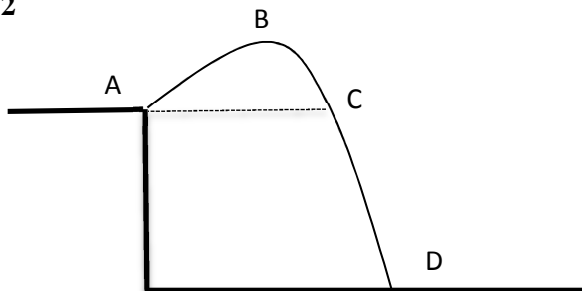
- a) $L > W$
 - b) $L < W$
 - c) $L = W$
 - d) $L = 0$.
-

QUESTION 11

Two bodies A and B of mass 0.5 kg and 2.5 kg respectively are allowed to slide down a frictionless plane set at an angle of 30° to the horizontal. If a_A is magnitude of the acceleration of A and a_B is the magnitude of the acceleration of B, then

- a) $a_A = a_B = 0$
 - b) $a_A = a_B > 0$
 - c) $a_A > a_B$
 - d) $a_B > a_A$.
-

QUESTION 12



The diagram shows the parabolic trajectory of a projectile launched from A at the top of a cliff. It reaches its highest point at B and lands at D. A and C are at the same height. Which of the following statements about the projectile is **true**?

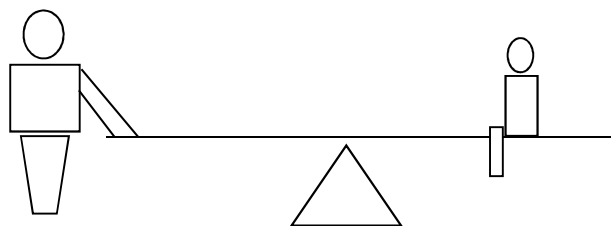
- a) The speed is a maximum at A;
 - b) The speed is zero at B;
 - c) The velocity at C is the same as the velocity at A;
 - d) The speed is a maximum at D.
-

QUESTION 13

In the projectile motion shown in question 12 above, which of the following statements is **false**?

- a) The acceleration at B is zero;
 - b) The acceleration at A and C is the same;
 - c) The horizontal component of the velocity at A and C is the same;
 - d) The vertical component of the velocity at B is zero.
-

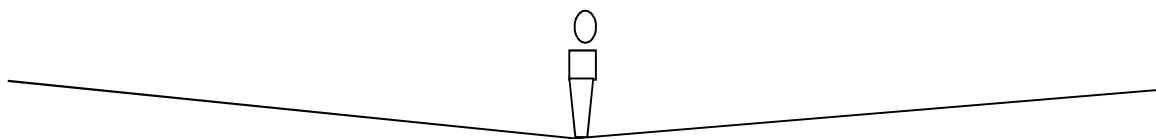
QUESTION 14



A father is playing with his child on a uniform see saw. The child weighs 40 kg and is sitting 3.0 m from the pivot. The parent lifts the child by pushing down on the other side of the see saw, 3.5 m from the pivot. The downward force exerted on the see saw by the parent is

- a) 40 N
- b) 120 N
- c) 336 N
- d) 392 N.

QUESTION 15



A tightrope walker stands in the middle of the rope which forms an angle of 3.0° to the horizontal on either side. If the weight of the tightrope walker is 600 N, the tension in the rope is

- a) 300 N
- b) 600 N
- c) 2866 N
- d) 5732 N.

QUESTION 16

Astronauts are often described as being “weightless” in orbit around the Earth. This is because

- a) There is no gravity in space;
- b) They are out of the Earth’s atmosphere;
- c) Their craft is travelling at constant velocity;
- d) They are falling freely toward the Earth.

QUESTION 17

A distant planet has a mass which is half that of the Earth and a radius which is twice that of the Earth. The acceleration due to gravity g_p at the surface of the planet is

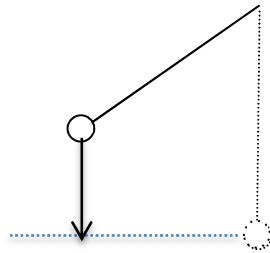
- a) 1.23 ms^{-2}
- b) 2.45 ms^{-2}
- c) 39.2 ms^{-2}
- d) 78.4 ms^{-2} .

QUESTION 18

A person is dragging a crate across a warehouse by pulling on a rope attached to the crate. The work done by the person on the crate will be a maximum for a given force if the angle between the rope and the horizontal is

- a) 90°
- b) 45°
- c) 30°
- d) 0° .

QUESTION 19



A child of mass 25.0 kg is sitting on a swing. Her friend pushes her so that she is moving with a speed of 5.0 ms^{-1} as the swing passes its lowest point. The maximum height that the child will reach at the end of the swing is

- a) 0.26 m
- b) 1.3 m
- c) 2.0 ms
- d) 2.6 m .

QUESTION 20

A coin is tossed vertically upward. Which of the following statements is **true**?

- a) The kinetic energy is a maximum when the gravitational potential energy is a maximum;
- b) The sum of the kinetic energy and the gravitational potential energy increases as the coin rises;
- c) As the coin rises, its kinetic energy is converted into gravitational potential energy;
- d) The acceleration falls to zero.

QUESTION 21

You have a hairdryer which generates 1000 W . When you leave it on for 30 minutes, the amount of electricity you have wasted is

- a) 0.5 kWh
 - b) 2 kWh
 - c) 5 kWh
 - d) 500 kWh .
-

QUESTION 22

An electric winch can raise a piano of mass 1000 kg at a rate of 5.00 ms^{-1} . The power delivered by the winch motor is

- a) 200 W
 - b) $1.96 \times 10^3 \text{ W}$
 - c) $5.00 \times 10^3 \text{ W}$
 - d) $4.90 \times 10^4 \text{ W}$.
-

QUESTION 23

When an object is in free fall close to the Earth,

- a) It will accelerate since air resistance decreases;
 - b) It will accelerate initially but, due to the increase in air resistance with velocity, the acceleration will cease;
 - c) It will keep accelerating at a constant rate;
 - d) The velocity will increase gradually to a maximum after which it will begin to decrease.
-

QUESTION 24

Two children of mass 20.0 kg and 43.5 kg are at rest on the frozen surface of a pond. They push each other apart so that the lighter child is moving at 8.00 ms^{-1} . The speed of the heavier child is

- a) 0.27 ms^{-1}
 - b) 1.54 ms^{-1}
 - c) 3.68 ms^{-1}
 - d) 17.4 ms^{-1} .
-

QUESTION 25

A car of mass 1000 kg is moving at a speed of 18.0 ms^{-1} when it strikes a stationary truck of mass 5000 kg. If the vehicles stick together, immediately after the collision, their speed is

- a) 1.00 ms^{-1}
 - b) 2.00 ms^{-1}
 - c) 3.00 ms^{-1}
 - d) 5.00 ms^{-1}
-

QUESTION 26

A steel column 3.0 m long is designed to carry a load of 50 kN with a maximum compression of 1.0 mm. Young's modulus for steel is $Y_s = 20 \times 10^{10} \text{ Pa}$. The minimum area of cross section of the column is

- a) $8.3 \times 10^{-3} \text{ m}^2$
 - b) $7.5 \times 10^{-4} \text{ m}^2$
 - c) $5.3 \times 10^{-2} \text{ m}^2$
 - d) 1.0 m^2 .
-

QUESTION 27

A spring has a spring constant of 200 Nm^{-1} . A force applied to the spring causes it to be extended by 6.00 mm. The force applied to the spring to do this is

- a) $3.33 \times 10^{-3} \text{ N}$
 - b) 1.20 N
 - c) 3.33 N
 - d) $1.20 \times 10^3 \text{ N}$.
-

QUESTION 28

The weight of a body in air is 23.0 N. When immersed in water, the weight of the body is 18.3 N. The relative density of the body is

- a) 0.079
 - b) 1.26
 - c) 3.89
 - d) 4.89.
-

QUESTION 29

A traveller measures the atmospheric pressure at the bottom of a hill. After climbing the hill he finds that the level of mercury in his barometer has fallen by 2.20 mm. If the density of air is 1.20 kg m^{-3} , the height of the hill is

- a) 0.194 m
 - b) 3.59 m
 - c) 24.9 m
 - d) 35.9 m.
-

QUESTION 30

The pipes and joints in some plumbing have been designed to withstand an excess water pressure of $2.0 \times 10^5 \text{ Pa}$. How high can the pipework be connected before there is a danger of a pressure burst at the bottom?

- a) 2.04 m
 - b) 4.90 m
 - c) 20.4 m
 - d) 49.0 m.
-

Section B: Waves and Optics 15 Questions 45 Marks

QUESTION 31

A flute produces a note of wavelength 0.75 m. If the speed of sound in air is 331 ms^{-1} , the frequency of this note is

- a) 441 Hz
 - b) 248 Hz
 - c) 596 Hz
 - d) $2.27 \times 10^{-3} \text{ Hz}$.
-

QUESTION 32

In the morning, when the air temperature is 0°C , the speed of sound is 331 ms^{-1} . At noon the air temperature is 25°C . At this time the speed of sound is

- a) 13.2 ms^{-1}
 - b) 20.6 ms^{-1}
 - c) 346 ms^{-1}
 - d) 361 ms^{-1} .
-

QUESTION 33

A ship is sailing toward the shore when it sounds its fog horn which has a frequency of 800 Hz. If an observer on the shore measures the frequency of the fog horn's note as 820 Hz and the speed of sound at the time is 330 ms^{-1} , the speed of the ship is

- a) 4.02 ms^{-1}
 - b) 8.05 ms^{-1}
 - c) 12.0 ms^{-1}
 - d) 40.2 ms^{-1} .
-

QUESTION 34

A guitarist finds that one of two strings corresponding to a single note is sharp (tuned too high). If the correctly tuned string emits a note of frequency 330 Hz and the piano tuner hears the combined note 'beating' at 2 Hz, the frequency emitted by the other string is

- a) 2.0 Hz
 - b) 328 Hz
 - c) 331 Hz
 - d) 332 Hz.
-

QUESTION 35

The tension in a stretched string is halved while the mass per unit length is doubled. The speed of a transverse wave in the string will be

- a) Quartered
 - b) Halved
 - c) Doubled
 - d) Quadrupled (multiplied by 4).
-

QUESTION 36

A stretched string has a fundamental frequency of 110 Hz. When it is vibrating at 330 Hz, how many nodes are there on the vibrating string (excluding those at the fixed ends)?

- a) 0
 - b) 1
 - c) 2
 - d) 3.
-

QUESTION 37

A pipe closed at one end and an open pipe produce a note of the same pitch (frequency) when they vibrate at their first harmonic or fundamental tone. The ratio of the length of the closed pipe to that of the open pipe is

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

QUESTION 38

An organ pipe which is open at both ends produces a fundamental tone of frequency 440 Hz. When it is vibrating at 880 Hz, the number of nodes (points of no vibration) in the pipe is

- a) 0
 - b) 1
 - c) 2
 - d) 3.
-

QUESTION 39

A shortwave radio station broadcasts on the 60 m band (with a wavelength of 60.0 m). The frequency of this signal is

- a) 2.00 MHz
 - b) 5.00 MHz
 - c) 10.0 MHz
 - d) 0.50×10^{-7} Hz.
-

QUESTION 40

A solar eclipse occurs

- a) when a portion of the sun is in the moon's shadow;
 - b) when the moon moves into the earth's shadow;
 - c) when the sun obscures the moon;
 - d) when a portion of the earth is in the moon's shadow.
-

QUESTION 41

A coin at the bottom of a swimming bath appears to lie 1.50 m below the surface where the water is 2.00 m deep. The refractive index of water relative to air is

- a) 0.75
 - b) 1.33
 - c) 1.50
 - d) 2.00.
-

QUESTION 42

A prism is made from glass with a refractive index of 1.55 relative to air. The critical angle for light passing from this prism to air is

- a) 0.65°
 - b) 1.55°
 - c) 4.02°
 - d) 40.2° .
-

QUESTION 43

A concave spherical mirror has a focal length of 80 cm. An object is placed on the principal axis, 25 cm from the mirror. The image formed of this object is

- a) real and magnified;
 - b) virtual and magnified;
 - c) real and diminished;
 - d) virtual and diminished.
-

QUESTION 44

An object 6 cm tall is situated 10 cm from a thin lens of focal length 20 cm. The height of the erect virtual image formed is

- a) 12 cm
 - b) 9 cm
 - c) 6 cm
 - d) 3 cm.
-

QUESTION 45

Two thin lenses are placed in contact to form a combined lens system with focal length – 20 cm. If one of the lenses is convex with focal length 30 cm, the focal length of the other lens is

- a) -6 cm
 - b) -12 cm
 - c) 6 cm
 - d) 30 cm.
-

Section 3 Thermal Physics 15 Questions 45 marks

QUESTION 46

On a sunny day the thermometer shows a temperature of 90 °F. The temperature in °C is

- a) 21 °C
 - b) 32 °C
 - c) 50 °C
 - d) 121 °C.
-

QUESTION 47

The pressure in a constant volume gas thermometer is 70 cm Hg when it is at 0 °C. When the pressure rises to 92 cm Hg, the temperature of the gas is

- a) 0 °C
 - b) -65 °C
 - c) 86 °C
 - d) 359 °C.
-

QUESTION 48

Body A has a thermal capacity larger than that of body B. No change of state occurs when the same amount of heat is added to body A as to body B. The increase in temperature of body A, Δt_A , and the increase in temperature of body B, Δt_B , are related by

- a) $\Delta t_A > \Delta t_B$;
 - b) $\Delta t_A < \Delta t_B$;
 - c) $\Delta t_A = \Delta t_B$;
 - d) There is not enough information to decide.
-

QUESTION 49

A man runs 100 litres of water at 75 °C into the bath. He adds cold water at 20 °C to reduce the temperature to 55 °C. Neglecting losses, the mass of cold water he adds is

- a) 15 kg
 - b) 45 kg
 - c) 57 kg
 - d) 175 kg.
-

QUESTION 50

500 J of heat is added to a large pot of water at its boiling point. The mass of steam at boiling point which evaporates from the water is

- a) 2.22 g
 - b) 0.22 g
 - c) 2.22 kg
 - d) 22.2 kg.
-

QUESTION 51

A steel ruler is calibrated at 20 °C. When it is used to measure the length of a rod at 50 °C, the result is 86.53 m. The correct reading for the length of the rod is

- a) 86.38 cm
 - b) 86.53 cm
 - c) 86.56 cm
 - d) 96.64 cm.
-

QUESTION 52

A metal plate has a small hole drilled in it. If the plate expands on being uniformly heated, the hole will

- a) Expand;
 - b) Contract;
 - c) Stay the same size;
 - d) Be distorted.
-

QUESTION 53

The following is an example of heat transfer by conduction:

- a) The handle of a metal spoon becomes hot when you stir soup on the stove;
 - b) The air near the ceiling is usually hotter than the air near the floor;
 - c) Water boiling in a microwave oven;
 - d) You can feel the heat of a bonfire over several metres horizontally.
-

QUESTION 54

Two pots A and B have the same dimensions and are made of the same materials, except that the base of pot A is twice as thick as the base of pot B. If heat is conducted through the base of pot A at 7.2 kW under certain conditions, the rate at which heat is conducted through the base of pot B under the same conditions is

- a) 1.8 kW
 - b) 3.6 kW
 - c) 14.4 kW
 - d) 28.8 kW.
-

QUESTION 55

Radiation is heat transfer by

- a) molecular and electronic collisions;
 - b) bulk fluid motion;
 - c) electromagnetic waves;
 - d) direct contact.
-

QUESTION 56

The maximum altitude of the sun on midwinter's day is 36° . Two identical sunbathers are arguing about the best strategy for being warmed by the sun. If A is standing and B is lying down in full sun,

- a) A will receive more radiation than B;
 - b) B will receive more radiation than A;
 - c) A and B will receive the same amount of radiation;
 - d) It is impossible to decide without more information.
-

QUESTION 57

A cylinder contains a fixed volume of ideal gas at constant temperature. If the mass of gas in the container is doubled, the pressure will be

- a) Quartered
 - b) Halved
 - c) Doubled
 - d) Quadrupled (multiplied by 4).
-

QUESTION 58

The temperature T of a fixed mass of ideal gas is changed at constant pressure until the volume is halved. The new temperature is

- a) $T/2$
 - b) T
 - c) $2T$
 - d) It is not possible to tell without further information.
-

QUESTION 59

At a certain temperature, the pressure due to gas A is 17 Pa. When a second gas (which does not interact with the first) is added, the pressure of the two gasses together is 28 Pa. The pressure due to the second gas by itself in an identical container at the same temperature would be

- a) 0;
 - b) between 0 and 11 Pa
 - c) 11 Pa
 - d) greater than 11 Pa.
-

QUESTION 60

According to the first law of thermodynamics, the internal energy of a system

- a) can be changed by heat transfer only;
 - b) can be changed by doing work on the system or letting it do work only;
 - c) can be changed both by doing work and heat transfer;
 - d) is fixed and cannot be changed.
-

