UNIVERSITY OF KWAZULU-NATAL

FIRST SEMESTER MAIN EXAMINATION
JUNE 2014
SUBJECT AND COURSE: PHYSICS 131

TIME: 3 hours **TOTAL MARKS:** 180

Internal Examiners:	Prof. D. Wang, Dr. S. Mthembu & Mr. S. Ntombela
Moderator:	Dr. M. Cavero (PIETERMARITZBURG CAMPUS)

GENERAL INSTRUCTIONS:

1. 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.

2. Please make sure that your question paper has 18 Pages and 60 Questions.

3. Use only an HB pencil to fill in the MCQ sheet.

4. Do your rough work for a question on the paper provided. Rough work will not be marked.

5. The last page of this exam, which is printed separately, is an information sheet.

6. No part of this exam paper may be torn off.

7. There is no negative marking.

8. 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.

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

QUESTION 1

A passenger on a boat travelling due north at 4.00 m s^{-1} tosses a ball to her companion. If she throws the ball due west at 3.00 m s^{-1}, the speed of the ball with respect to the water is

A) 1.00 m s^{-1}
B) 4.00 m s^{-1}
C) 5.00 m s^{-1}
D) 7.00 m s^{-1}.

QUESTION 2

A snail is moving at 0.10 mm s^{-1}. In SI units, this speed is

A) 1.0×10^{-3} cm s^{-1}
B) 1.0×10^{-4} m s^{-1}
C) 1.0×10^{9} km s^{-1}
D) 1.0×10^{6} m s^{-1}.

QUESTION 3

The length of the side of a cube is 13.0 cm. The volume of the cube (to the correct number of significant figures) is

A) 2.197×10^{-3} m^3
B) 2.20×10^{-3} m^3
C) 2197 cm^3
D) 2.20×10^{3} cm^3.

QUESTION 4

A tennis ball is thrown vertically upward. At the highest point in its trajectory

A) the acceleration is zero;
B) the displacement is zero;
C) the velocity is zero;
D) the speed is a maximum.

QUESTION 5

A vehicle travelling at 15.0 m s^{-1} stops in 3.00 s. If it accelerates uniformly, its stopping distance is

A) 5.00 m
B) 11.2 m
C) 22.5 m
D) 45.0 m.

QUESTION 6

A tourist drops a stone over the edge of a cliff. It takes 7.50 s to reach the bottom. Ignoring the effects of air resistance and the speed of sound, the height of the cliff is

A) 73.5 m
B) 138 m
C) 276 m
D) 552 m.

QUESTION 7

A circus strong man drags a huge steel ball across the arena at constant velocity. If the ball weighs 700 kg and the maximum force that the man can exert is 1000 N, the net force on the ball is

A) 1000 N
B) 1.43 N
C) 0.7 N
D) 0 N.

QUESTION 8

A person stands in a lift which is accelerating **downward**. If W is the weight of the person and R is the upward force exerted on the person by the lift,

A) $R = W$
B) $R > W$
C) $R < W$
D) the relationship between R and W depends on other factors.

QUESTION 9

A horse is pulling a cart of mass 500 kg along a flat, level road. The acceleration of the horse is 2.00 m s^{-2} in the forward direction. Ignoring friction, the force exerted by the horse on the cart is

A) 250 N
B) 1.00×10^3 N
C) 9.80 kN
D) impossible to tell without the mass of the horse.

QUESTION 10

A ball bounces off a wall. If F_a is the magnitude of the force exerted by the ball on the wall and F_b is the magnitude of the force exerted by the wall on the ball,

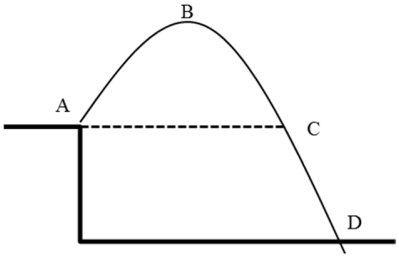
A) $F_a > F_b$
B) $F_a < F_b$
C) $F_a = F_b$.
D) further information is required to determine the relative size of the forces

QUESTION 11

A body of mass 5.0 kg slides down a frictionless plane at an acceleration of 4.90 m s^{-2}. The angle between the plane and the horizontal is

A) not determinable from this information
B) 0°
C) 30°
D) 60°.

QUESTION 12



The diagram shows the 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**?

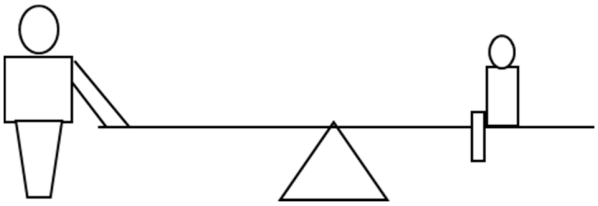
A) The speed is a maximum at A;
B) The speed is zero at B;
C) The velocity at C is the same as the velocity at A;
D) The speed is a maximum at D.

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.

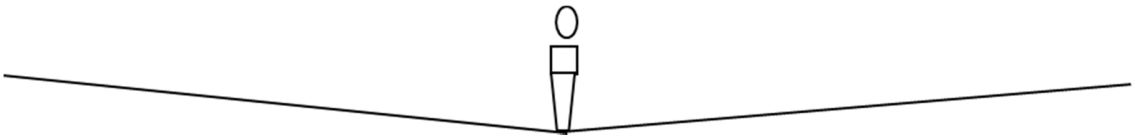
QUESTION 14



A father is playing with his child on a uniform see saw. The child weighs 20 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, 4.0 m from the pivot. The downward force exerted on the see saw by the parent when the see saw is level is

A) 15 N
B) 120 N
C) 147 N
D) 261 N.

QUESTION 15



A tightrope walker stands in the middle of the rope which forms an angle of 3.0º 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) 11.5 kN
D) 5.73 kN.

QUESTION 16

Astronauts and their equipment are "weightless" in orbit because

A) there is no atmosphere in space
B) there is no gravity in space
C) they and their equipment are in free fall
D) their mass becomes zero.

QUESTION 17

A distant planet has a mass twice that of the Earth. Its radius is also twice that of the Earth. The acceleration due to gravity on the planet will be

A) ½g
B) g
C) 2g
D) 4g.

QUESTION 18

A worker exerts a horizontal force of 0.5 kN on a crate to move it at constant velocity over a distance of 10.0 m. The work done by the worker on the crate is

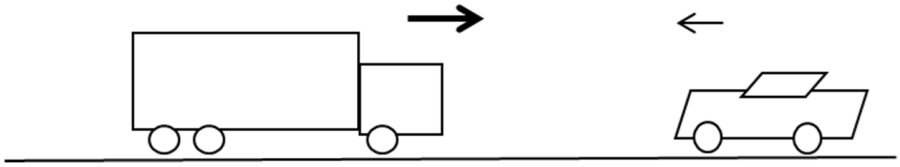
A) 5.0 kJ
B) 2.0 kJ
C) 0 kJ
D) 0.50 kJ.

QUESTION 19

A rugby ball is punted up into the air. As the ball moves upward,

A) kinetic energy and gravitational potential energy are reduced;
B) kinetic energy and gravitational potential energy are increased;
C) kinetic energy is converted into gravitational potential energy;
D) gravitational potential energy is converted into kinetic energy.

QUESTION 20



A car of mass 1000 kg is travelling at 60 km hr^{-1} when it has a head on collision with a truck of mass 5000 kg travelling at 100 km hr^{-1} in the opposite direction. The vehicles become entangled and stick together. Their combined speed immediately after collision is

A) 40 km hr^{-1}
B) 73.3 km hr^{-1}
C) 80 km hr^{-1}
D) 146 km hr^{-1}.

QUESTION 21

A solar water heater collects energy at an average rate of 1.5 kW. The amount of electrical energy that this saves in one day is

A) 1.5 kWh
B) 16 kWh
C) 24 kWh
D) 36 kWh.

QUESTION 22

A winch raises a 1000 kg load at a rate of 0.250 m s^{-1}. The power delivered by the winch motor is

A) 2.45 kW
B) 250 W
C) 4.00 kW
D) 39.2 W.

QUESTION 23

A speeding car crashes into a brick wall and stops. The total momentum before the crash is P, the momentum of the car. The total momentum after the crash appears to be zero, when the car and the wall are not moving. This is because

A) momentum is not conserved under these circumstances;
B) the mass of the wall and the earth to which it is fixed is very much greater than that of the car;
C) the momentum of the wall is initially equal and opposite to that of the car;
D) nature abhors a vacuum.

QUESTION 24

Steel cables 20 m long are used to suspend a bridge. Young's modulus for steel is $Y = 2.00 \times 10^{11}$ Pa. If the anticipated load on each cable is 3.5 kN and the maximum displacement of the bridge under load is 1.00 cm, the minimum area of cross section of the cable must be

A) 7.0×10^{-11} m^2
B) 3.5×10^{-5} m^2
C) 2.9 m^2
D) 3.5×10^{11} m^2.

QUESTION 25

A spring with a spring constant of 240 N m^{-1} is extended by 12.0 cm. The load applied to the spring to achieve this is

A) 28.8 N
B) 2.88 kN
C) 2.00 kN
D) 20.0 N.

QUESTION 26

A spring with spring constant k is cut in half. The spring constant for the new spring will be

A) ¼k
B) ½k
C) k
D) 2k.

QUESTION 27

A body has a density twice that of water. If it weighs 20.0 kg in air, when it is immersed in water, the scale will read

A) 40.0 kg
B) 20.0 kg
C) 10.0 kg
D) 5.0 kg.

QUESTION 28

A body which weighs 120 g in air weighs 100 g in water and 80 g in an unknown liquid. The relative density of the unknown liquid is

A) 4
B) 2
C) ½
D) ¼.

QUESTION 29

A climber notes that the mercury in her barometer drops by 1.00 cm between the bottom of the mountain and the top. If the mean density of the air is 1.20 kg m^{-3}, the height of the mountain is

A) 0.88 mm
B) 8.80 m
C) 113 m
D) 1.13×10^3 m.

QUESTION 30

A rectangular slide of clean glass is dipped vertically into water with its longer edge lying parallel to the surface. The slide is 2 mm thick and 10 cm long and the angle of contact between water and the glass is 0°. If the appropriate surface tension coefficient is the downward force exerted on the slide by surface tension is $\gamma = 7.20 \times 10^{-2}$ N m^{-1}, the downward force exerted on the slide by surface tension is

A) 7.35×10^{-3} N
B) 1.47×10^{-2} N
C) 0.74 N
D) 1.47 N.

Section B: Waves: 8 Questions 24 marks

QUESTION 31

While waiting at the doctor's office you notice a pendulum of a wall clock executing 15 complete oscillations in 20 s. The frequency of the oscillation is

A) 1.33 Hz
B) 0.75 Hz
C) 2.55 Hz
D) 3.33 Hz.

QUESTION 32

Which of the following statements is **true** about transverse waves?

A) All transverse waves propagate at the speed equal to that of light in a vacuum
B) Transverse wave propagates parallel to oscillating object producing a wave
C) Transverse wave propagates perpendicular to oscillating object producing a wave
D) One example of a transverse wave is a sound wave.

QUESTION 33

A school bell produces a sound wave whose frequency is 450 Hz. The speed of the sound in air at 0°C is 331 m s^{-1}. At noon, when the outside temperature is 30°C, the speed of the sound wave is

A) 168 m s^{-1}
B) 276 m s^{-1}
C) 349 m s^{-1}
D) 298 m s^{-1}.

QUESTION 34

A police car emits a sinusoidal sound wave with a frequency of 300 Hz. The speed of sound in air can be taken as 340 m s^{-1}. If the speed of a police car is 30 m s^{-1}, the frequency of the wave heard by a stationary listener behind the police car is

A) 276 Hz
B) 327 Hz
C) 300 Hz
D) 376 Hz.

QUESTION 35

The listener situated at some point P, receives sound waves of a same frequency emanating from two speakers. The speed of sound in air is 340 m s^{-1}. If the path difference between the speakers and the listener is 5 m and the frequency of the waves is 102 Hz, the listener will hear

A) Maximum
B) Minimum
C) Partial destructive interference
D) None of the above.

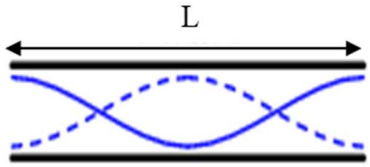
QUESTION 36

Two guitar strings are out of tune. When they play a same note simultaneously, the sounds they produce have wavelengths of 0.776 m and 0.769 m. On a day when the speed of sound is 340 m s^{-1}, the beat frequency heard is

A) 4 Hz
B) 2 Hz
C) 6 Hz
D) 1 Hz.

QUESTION 37

The second harmonic of the sound wave is created in the pipe of the length 6 m which is open on both sides as shown in the diagram below. If the speed of the sound wave in air is 340 m s^{-1}, a frequency of this wave is



A) 0.017 Hz
B) 0.027 Hz
C) 66.7 Hz
D) 56.7 Hz.

QUESTION 38

A radio station broadcasts at a frequency of 1.33×10^{6} Hz. The wavelength of the radio wave

A) 206 m
B) 236 m
C) 256 m
D) 226 m.

Section C: Geometrical Optics: 7 Questions 21 marks

QUESTION 39

A microscope is sharply focused on a mark. When a parallel plate of glass 4800 μm thick is placed over the mark, the microscope has to be raised 1.8 mm to refocus. What is the refractive index of the glass?

A) 0.73
B) 1.6
C) 1.0
D) 2.7.

QUESTION 40

An object is 25 cm from a concave spherical mirror of radius 80 cm. Determine the position and a relative size of its image by calculation.

A) 66.7 cm & 2.67 times
B) 80 cm & 3 times
C) -66.7 cm & 2.67 times
D) 25 cm & 2 times.

QUESTION 41

A prism whose refractive angle is 60º causes a minimum deviation of 48º in monochromatic beam of light. Calculate the refractive index of the prism for that wavelength.

A) 1.00
B) 1.53
C) 1.33
D) 1.62.

QUESTION 42

A double convex lens is made of glass, which has a refractive index of 1.65. One surface has a radius of curvature of 12 cm and the other has a radius of curvature of 18 cm. Determine the focal length of this lens.

A) 111 mm
B) 0.0903 cm
C) 30 cm
D) 6 cm.

QUESTION 43

An observer, standing 4 m from the edge of a pond 16 m wide, sees the reflected image of a tree situated 8 m from the opposite side of the pond. The image of the top of the tree is seen just at the edge of the pond nearest to him. If the observer's eyes are 2 m above the water level, find the height of the tree.

A) 12000 mm
B) 40 m
C) 100 m
D) 240 m.

QUESTION 44

Light travels at 1.76×10^{8} m s^{-1} through an optical medium. What is the medium?

A) Water
B) Crown glass
C) Flint glass
D) Diamond

QUESTION 45

A light ray moving through CR39 at an angle of 49^{o} exits into another medium at an angle of 41^{o}. What is the index of the second medium?

A) 1.33
B) 1.70
C) 1.72
D) 2.45

Section D: Thermal Physics: 15 Questions 45 marks

QUESTION 46

When temperature decreases, water vapour is converted into liquid water. The process associated with this conversion is called

A) Evaporation
B) Condensation
C) Sublimation
D) Freezing.

QUESTION 47

The amount of heat required to convert 2.3 g of ice at 0°C into 2.3 g of water at the temperature of 80°C is

A) 1.5×10^3 J
B) 2.5×10^3 J
C) 3.5×10^3 J
D) 4.5×10^3 J.

QUESTION 48

A certain mass of milk at a temperature of 2.0°C is poured into a cup of tea of a mass 350 g and a temperature of 96°C. The final temperature of the mixture is 89°C. Given that the specific capacities are c_{milk} = 3770 J kg^{-1} K^{-1}, c_{tea} = 4180 J kg^{-1} K^{-1} and if heat exchange between the mixture and cup is negligibly small, what is the mass of milk?

A) 22 g
B) 42 g
C) 31 g
D) 55 g.

QUESTION 49

A rectangular metal plate has a small circular hole drilled in the middle. If the plate expands on being uniformly heated, what will happen to the hole?

A) Stay the same
B) Expand
C) Shrink
D) Disappear.

QUESTION 50

An aluminum coin has a diameter of 1.900 cm at 20.00°C. What would its diameter be if its temperature is raised to 148.0°C?

A) 1.600 cm
B) 1.703 cm
C) 1.906 cm
D) 1.809 cm.

QUESTION 51

The temperature of an aluminium cube with the dimensions 2.00×2.00×2.00 cm is increased from 25°C to 125°C. Determine the change in its volume.

A) 3.01 cm^3
B) 2.01 cm^3
C) 0.06 cm^3
D) 1.02 cm^3.

QUESTION 52

On the very cold night Peter is driving from Pietermaritzburg to Durban. He decides to turn the air conditioner on to warm up the interior of a car. The mechanism responsible for transferring heat from the car engine to the interior of the car is

A) Radiation
B) Convection
C) Conduction
D) Evaporation.

QUESTION 53

A goose down sleeping bag has an exposed area of 2.500 m^2 and is insulated with a 6 cm of goose down whose thermal conductivity is 0.025 W m^{-1} $°C^{-1}$. If a person in the sleeping bag is at 37°C and the outside temperature is 17°C, the amount of heat lost by the person in 60 s is

A) 1250 J
B) 1350 J
C) 1450 J
D) 1550 J.

QUESTION 54

An unclothed person is standing in the room whose temperature is 25°C. The person has a surface area of 1.5 m^2, emissivity of 0.7 and skin temperature of 35°C. The heat transfer rate of the person's body is

A) 87 J/s
B) 90 J/s
C) 66 J/s
D) 99 J/s.

QUESTION 55

The pressure *P* of a fixed mass of ideal gas is changed at constant temperature until the volume of the gas is doubled. The new pressure of the gas is

A) $P/2$
B) P
C) $2P$
D) P^2.

QUESTION 56

The absolute pressure in a car tire is 310 kPa at 15.0°C. After a long drive the temperature rises to 45.0°C, the new pressure is

A) 170 kPa
B) 250 kPa
C) 342 kPa
D) 427 kPa.

QUESTION 57

A sample of H_2 gas has a mass of 0.038 g and occupies a volume of 4.65×10^{-4} m^3. Its molecular mass is 2.015 g mol^{-1}. If the pressure of H_2 gas is 100658 Pa and it behaves like an ideal gas, what is its temperature?

A) 299 K
B) 280 K
C) 283 K
D) 265 K.

QUESTION 58

An air-tight cylinder fitted with a piston is filled with 2.5 g of gas at the temperature of 30°C. If the system is heated to a temperature of 150°C, the gas expands and pushes the piston outward while the pressure of the gas remains constant at 101325 Pa. If the molar mass of the gas is 31.99 g mol^{-1}, work done by the gas is

A) -25 J
B) -34 J
C) -52 J
D) -78 J.

QUESTION 59

The process in Question 58 above is called

A) Isochoric
B) Isobaric
C) Isothermal
D) Isomorphic.

QUESTION 60

During an isochoric process, work done by the system on its surrounding is given by

A) $W = -nR\Delta T$
B) $W = \Delta U - Q$
C) $W = 0J$
D) $W = -P\Delta V$.