UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

DEPARTMENT OF APPLIED PHYSICS AND ENGINEERING MATHEMATICS

NATIONAL DIPLOMA IN BIOMEDICAL TECHNOLOGY

MODULE PHY1AET
PHYSICS I (Theory)

CAMPUS **DFC**

JUNE EXAMINATION

DATE: 30/05/2016 **SESSION: 12H30 – 15H30**

ASSESSOR: **DR. P.L. MASITENG**

INTERNAL MODERATOR: **DR. S.M. RAMAILA**

DURATION: 3 HOURS **MARKS: 116**

NUMBER OF PAGES: 14 PAGES, INCLUDING 2 INFORMATION SHEETS

INSTRUCTIONS:

SCIENTIFIC CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT).

REQUIREMENTS:

- **ONE EXAMINATION ANSWER SCRIPT PER STUDENT**
- **ONE UJ MULTIPLE CHOICE ANSWER SHEET**

INSTRUCTIONS TO CANDIDATES:

1. **Answer ALL the questions.**

2. **Answer SECTION A on the provided examination answer script.**

3. **Answer SECTION B on the UJ multiple choice answer sheet.**
   FOLLOW THE INSTRUCTIONS ON THE SHEET CAREFULLY.
   DO NOT MARK MORE THAN ONE ANSWER PER ROW.
   DO NOT FOLD OR CREASE THE SHEET.

4. **Place the multiple choice answer sheet inside the answer script when handing in.**

5. **An information sheet is attached at the end of the question paper.**

SECTION A [52 marks]

QUESTION 1 [10 marks] OPTICS

1.1 The image behind a convex mirror (radius of curvature = 68 cm) is located 22 cm from the mirror.

1.1.1 Where is the object located? (3)
1.1.2 What is the magnification of the mirror? (2)

Determine whether the image is

1.1.3 upright or inverted and (1)
1.1.4 enlarged or diminished with respect to the object. (1)

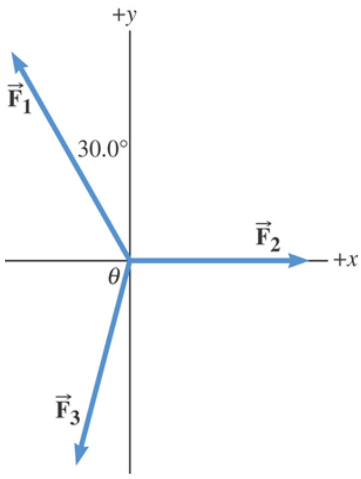
1.2 A concave mirror of focal length 10 cm forms a virtual image 2 times the size of an object placed in front of the mirror.

Calculate:

1.2.1 the object and
1.2.2 the image positions. (3)

QUESTION 2 [21 marks] MECHANICS

2.1 Three forces are applied to an object, as indicated in the drawing below. Force $\vec{F_1}$ has a magnitude of 21.0 N and is directed 30.0° to the left of the +*y* axis. Force $\vec{F_2}$ has a magnitude of 15.0 N and points along the +*x* axis. Use the component method to calculate the magnitude and direction (specified by the angle θ in the drawing) of the third force $\vec{F_3}$ such that the vector sum of the three forces is 0 N.

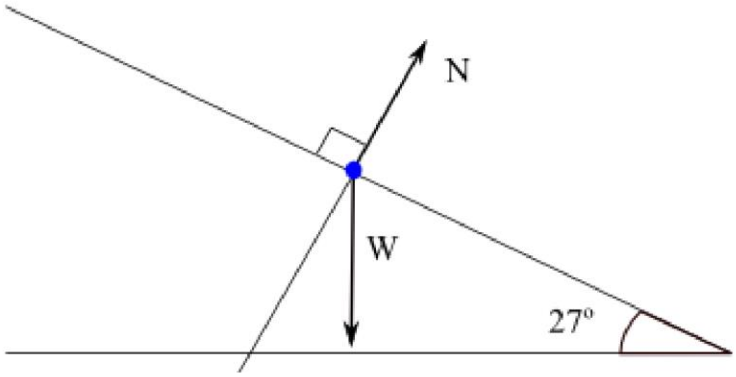


(7)

2.2 A biomedical student go on a shopping spree at the Mall of Africa. At first she travels 360 km northwest and then she turns due north and travels 400 km towards her destination. Determine by means of calculations the magnitude and direction of her displacement. (4)

2.3 A tennis ball is released from rest at the top of John Orr building. Neglecting air resistance, calculate

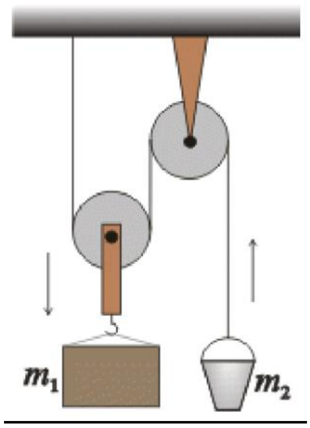
2.3.1 the position and
2.3.2 the velocity of the tennis ball after 3.00 s. (4)



2.4 A 2 Kg box is put on the surface of an inclined plane at 27^0 with the Horizontal as shown in a diagram above. The surface of the inclined plane is assumed to be frictionless.

2.4.1 Draw a free body diagram of the box on the inclined plane and label all forces acting on the box.
2.4.2 Determine the acceleration of the box down the plane.
2.4.3 Determine the magnitude of the force exerted by the inclined plane on the box. (6)

2.5 A bucket with mass m_2 = 10 kg and a block with mass m_1 = 5 kg are hung on a pulley system. Find the magnitude of the acceleration with which the bucket and the block are moving and the magnitude of the tension force *T* by which the rope is stressed. Ignore the masses of the pulley system and the rope. The bucket moves up and the block moves down. (6)



QUESTION 3 [11 marks] HYDROSTATICS

3.1 State Pascal's Principle. (2)

3.2 A hot piece of steel of mass 100 g is immersed in 500 g of water at 15 ^{o}C contained in a copper calorimeter of mass 200 g. The final steady temperature is observed to be 22.5^{o}C. Calculate the initial temperature of the steel, assuming that no heat is lost to the surroundings. (5)

3.3 In a diesel engine, the piston compresses air at 305 K to a volume that is one-sixteenth of the original volume and a pressure that is 48.5 times the original pressure. What is the temperature of the air after the compression? (4)

QUESTION 4 [10 marks] ELECTRICITY

4.1 State Ohm's Law. (3)

4.2 A battery charger is connected to a dead battery and delivers a current of 6.0 A for 5.0 hours, keeping the voltage across the battery terminals at 12 V in the process. How much energy is delivered to the battery? (3)

4.3 An electrical heater is rated 750 W. Calculate

4.3.1 the heat developed in one minute (2)

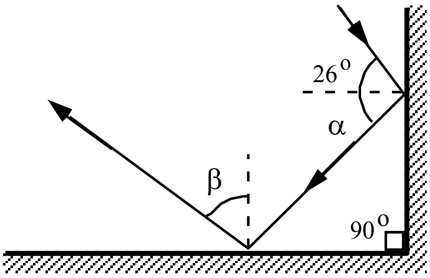
4.3.2 the current it draws from a 220 V supply (2)

SECTION B – MULTIPLE CHOICE QUESTIONS [64 marks]

1. Which one of the following statements is **NOT** a characteristic of a plane mirror?

A The image is real
B The magnification is one
C The image is always upright
D The image is reversed right to left

2. A ray of light is reflected off two plane mirror surfaces as shown in the diagram. What are the correct values of α and β?



	Value of α	*Value of* β
A	26°	26°
B	26°	64°
C	52°	26°
D	64°	26°

3. Refraction of light is by definition the

A ratio *sin(incident angle)* to *sin(refracted angle)*
B ratio *velocity of light in medium 1* to *velocity of light in medium 2*
C ratio of *real depth* to *apparent depth*
D change in direction of a light ray when travelling from one medium to another

4. An erect image, two times the size of the object, is obtained with a concave mirror of radius of curvature 18 cm. The position of the object from the mirror is

A 9 cm
B 4.5 cm
C 13.5 cm
D 18 cm

5. A fish swims 2.00 m below the surface of a pond. At what apparent depth does the fish appear to swim if viewed from directly above? The index of refraction of water is 1.33.

A 1.33 m
B 2.00 m
C 3.00 m
D 1.50 m

6. If no light is to refract at a water-air interface, then the angle of

A incidence in air must exceed the critical angle
B refraction in air must equal 90°
C incidence in water must exceed the critical angle
D refraction in water is equal to 90°

7. An object is placed 15 cm from a convex mirror of focal length 10 cm. The distance between the object and the image is:

A 30 cm
B 25 cm
C 21 cm
D 6 cm

8. Light propagates from soda lime glass (n = 1.518) into Pyrex glass (n = 1.473). Determine the critical angle for this situation.

A 13,99°
B 52,48°
C 76,01°
D 45,86°

9. A magnifying glass is a

A concave lens
B concave mirror
C converging lens
D diverging lens

10. A convex lens of focal length 15 cm forms an image of magnification +1. The distance between the object and the image measures

A 30 cm
B 60 cm
C 15 cm
D 45 cm

11. *Diffraction* of light is by definition the

A change in direction of light as it travels into another medium of different optical density
B separation of light into its component colours
C bending of light by corners or edges
D interaction of light waves according to the superposition principle

12. The image of an object placed in front of a convex mirror is:

A Inverted and real depending on the distance of the object from the mirror.
B Erect and virtual depending on the distance of the object from the mirror.
C Real, inverted and enlarged in size.
D Erect, virtual, and diminished in size.

13. *Average velocity* is by definition the

A rate at which distance is covered
B rate at which displacement takes place
C total displacement per total time taken
D total distance per total time taken

14. In the process of delivering mail, a postal worker walks 161 m, due east from his truck. He then turns around and walks 194 m, due west. What is the worker's displacement relative to his truck?

A 33 m, due west
B 194 m, due west
C 355 m, due west
D 33 m, due east

15. A ball is dropped from rest from a tower and strikes the ground 110 m below. Approximately how many seconds does it take the ball to strike the ground after being dropped? Neglect air resistance.

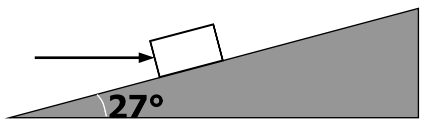
A 2.50 s
B 3.50 s
C 4.74 s
D 12.5 s

16. The *newton* is by definition that force that will

A accelerate a 1 kg mass by 1 m s^{-2} in 1 s
B cause an acceleration of 1 m s^{-2} to a body
C change the velocity of a body by 1 m s^{-1}
D change the velocity of a 1 kg mass by 1 m s^{-1} every second

17. A 250 N force is directed parallel to the plane to push a 29 kg box up an inclined plane at a constant speed. Determine the magnitude of the normal force, F_N, and the coefficient of kinetic friction, μ_k.

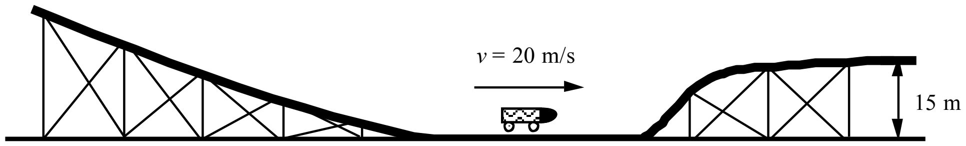
	F_N	μ_k
A	310 N	0.33
B	253 N	0.48
C	290 N	0.30
D	370 N	0.26



18. A rock is suspended from a string; and it accelerates downward. Which one of the following statements concerning the tension in the string is **TRUE**?

A The tension is less than the weight of the rock
B The tension is equal to the weight of the rock
C The tension is greater than the weight of the rock
D The tension is independent of the magnitude of the rock's acceleration

19. A roller-coaster car is moving at 20 m s^{-1} along a straight horizontal track. What will its speed be after climbing the 15 m hill shown in the figure, if friction is ignored?



A 17 m s^{-1}
B 14 m s^{-1}
C 7 m s^{-1}
D 10 m s^{-1}

20. A rock is thrown straight up from the surface of the Earth. Which one of the following statements describes the energy transformation of the rock as it rises? Neglect air resistance.

A The kinetic energy increases and the potential energy decreases
B Both the potential energy and the total energy of the rock increase
C The kinetic energy decreases and the potential energy increases
D Both the kinetic energy and the potential energy of the rock remain the same

21. The RD of an object is 3. This means that the

A density of the object is also equal to 3
B mass to volume ratio of the object is 3 kg m^{-3}
C ratio *density of the object* to *density of water* is equal to 3
D mass of the object is 3 times greater than its volume

22. The density of iron is 7 860 kg m^{-3}. What is the mass of a solid iron sphere of diametre is 0.50 m? [$V_{sphere} = \frac{4}{3}\pi r^3$].

A 123 kg
B 514 kg
C 4 110 kg
D 164 kg

23. The *pascal* is defined as

A the force acting over a 1 m^2 area
B a force of 1 N acting over a 1 m^2 area
C the pressure exerted by a 1 N force acting uniformly and perpendicularly over a 1 m^2 area
D the pressure being equally and undiminished transmitted throughout a confined fluid should a change in pressure be applied to it

24. How much force does the atmosphere exert on one side of a vertical wall 4.00 m high and 10.0 m long at sea level?

A 2.53 x 10^3 N
B 4.05 x 10^5 N
C 1.01 x 10^5 N
D 4.05 x 10^6 N

25. A barometer is taken from the base to the top of a 279 m tower. Assuming the density of air is 1.29 kg m^{-3}, what is the measured change in pressure?

A 359 Pa
B 2 120 Pa
C 3 527 Pa
D 927 Pa

26. Which one of the following statements is **INCORRECT**?

A Heat is energy in transfer
B Heat is measured in ^{o}C or K
C Temperature measures how hot or cold a substance is
D A change in temperature in ^{o}C converted to a change in temperature in K, yields the same answer

27. The coefficient of linear expansion of steel is 12×10^{-6} $(C°)^{-1}$. A railroad track is made of individual rails of steel 1.0 km in length. By what length would these rails change between a cold day when the temperature is –10 °C and a hot day at 30 °C?

A 0.62 cm
B 48 cm
C 620 cm
D 480 cm

28. Complete the following statement: The emf is

A the maximum potential difference between the terminals of a battery
B the force that accelerates electrons through a wire when a battery is connected to it
C the force that accelerates protons through a wire when a battery is connected to it
D the maximum electric potential energy stored within a battery

29. A 10 A current is maintained in a simple circuit with a total resistance of 200 Ω. What net charge passes through any point in the circuit during a 1 minute interval?

A 200 C
B 400 C
C 500 C
D 600 C

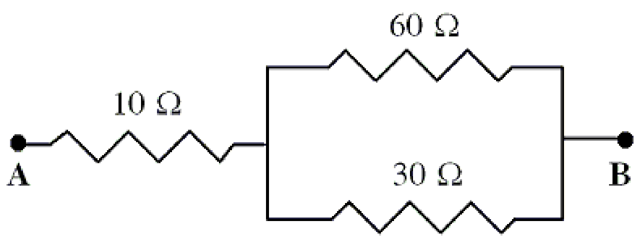
30. Three identical cells of emf 2 V each and internal resistance of 0.3 Ω are connected in parallel. The emf and internal resistance of the battery thus formed are respectively

A 6 V and 0.3 Ω
B 2 V and 0.3 Ω
C 2 V and 0.1 Ω
D 6 V and 0.1 Ω

31. Determine the length of a copper wire that has a resistance of 0.172 Ω and cross-sectional area of 1×10^{-4} m^2. The resistivity of copper is 1.72×10^{-8} Ω m.

A 10 m
B 100 m
C 1 000 m
D 10 000 m

32. The equivalent resistance of the combination shown below is



A 10 Ω
B 20 Ω
C 30 Ω
D 50 Ω

END OF EXAMINATION

TOTAL MARKS = 116
100% = 110