The University of Nottingham Ningbo China

Centre for English Language Education

Sample end-of-semester exam

Foundation Physics

Time allowed: **TWO HOURS**

Candidates may complete the front cover of the answer book and sign the attendance card.

Candidates must NOT start writing their answers until told to do so.

There are 6 Questions. Answer any FOUR Questions.
All questions are worth 25 marks.

*No electronic devices except for approved calculators **(e.g. Casio FX82 Series)** can be used in this exam.*

Dictionaries are not allowed with one exception: those whose first language is not English may use a standard translation dictionary to translate between that language and English provided that neither language is the subject of this examination.
Subject-specific translation dictionaries are not permitted.

No electronic devices capable of storing and retrieving text, including electronic dictionaries and mobile phones, may be used.

DO NOT turn the examination paper over until instructed to do so.

All answers must be written in the Answer Sheet

ADDITIONAL MATERIALS:
All students should be provided with a copy of the Foundation Physics Formula Sheet

INFORMATION FOR INVIGILATORS:

Please collect the examination paper and the answer booklets at the end of the exam.
A 15-minute warning should be announced before the end of the exam.

Turn Over

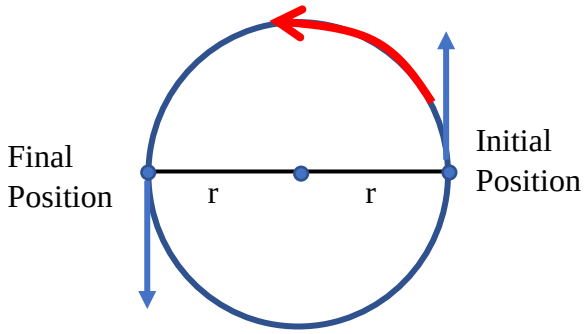
Q.1 (25 Marks)

Answer each of the following questions.

(a) Define speed and velocity. Which of these quantities can be negative? [3 marks]

(b) Define distance and displacement. Which of these quantities can be negative? [3 marks]

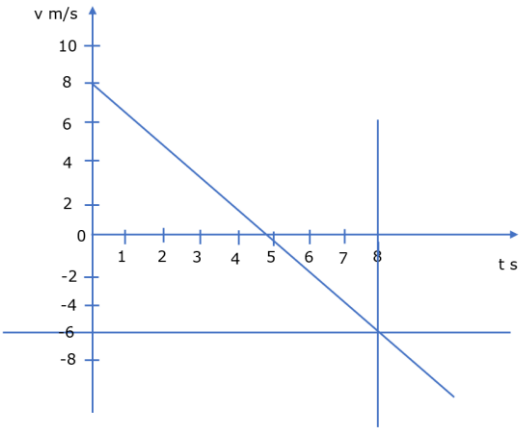
(c) An object moves in a circle with a radius of 3 m, as shown in the figure below. It takes the object 4 seconds to complete one revolution.



i. What is the average speed and the average velocity of the object after it completes one cycle/revolution? [4 marks]

ii. What is the average speed and the average velocity of the object after it completes one-half cycle/revolution? [4 marks]

(d) The particle is at x = −10 m initially. Find d, s, x, v and a at t = 8 s. where: **t** is time (s), **x** is position, **d** is total distance travelled (m), **s** is displacement (m), v is velocity (m/s), and a is acceleration (m/s^2). [6 marks]

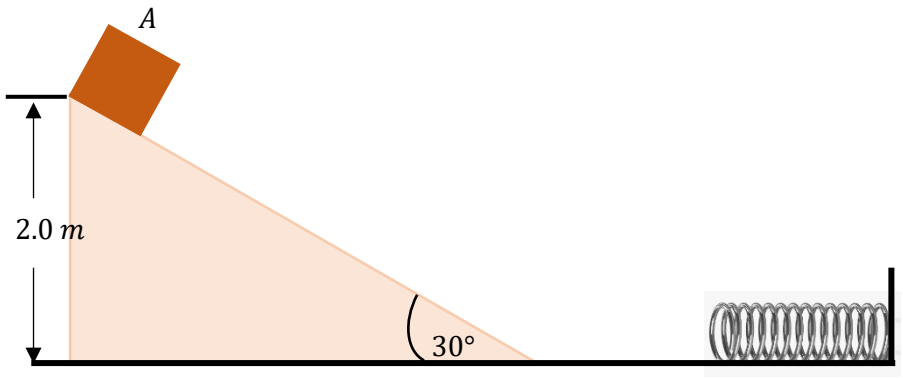


(e) A marble is dropped from a height of 15 m above the ground, and at the same time a stone is projected vertically upwards from a height of 5 m above the ground. They pass each other after 1.0 s. Find the speed of projection of the stone. [5 marks]

Q.2 (25 Marks)

Answer each of the following questions.

(a) An object of mass 10 kg is released at point A, slides to the bottom of the 30° incline starting from a height of 2 m above the spring, then collides with a horizontal massless spring, compressing it to a maximum distance of 0.75 m as shown below. The spring constant is 500 N/m, the height of the incline is 2.0 m, and the horizontal surface is frictionless.

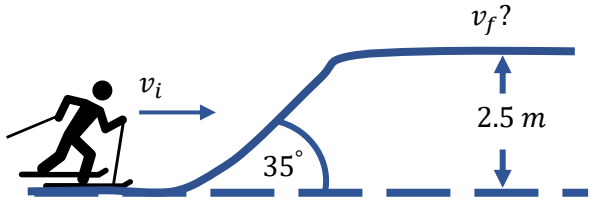


i. What is the speed of the object at the bottom of the incline? [3 marks]
ii. What is the work of friction on the object while it is on the incline? [3 marks]
iii. The spring recoils and sends the object back toward the incline. What is the speed of the object when it reaches the base of the incline? [2 marks]
iv. What distance does it move back up the incline? [2 marks]

(b) In the cartoon movie Pocahontas runs to the edge of a cliff and jumps off, showcasing the fun side of her personality.

i. If she is running at 3.0 m/s before jumping off the cliff and she hits the water at the bottom of the cliff at 20.0 m/s, how high is the cliff? Assume negligible air drag in this cartoon. [4 marks]
ii. If she jumped off the same cliff from a standstill, how fast would she be falling right before she hit the water? [3 marks]

(c) A 60.0 kg skier with an initial speed of 12.0 m/s coasts up a 2.50 m high rise as shown below. Find her final speed at the top, given that the coefficient of friction between her skis and the snow is 0.80. [8 marks]



Q.3 (25 Marks)

Answer each of the following questions.

(a) A certain battery has a 12.0 V emf and an internal resistance of 0.10 Ω. What is the terminal voltage when connected to a 10.0 Ω load? [4 marks]

(b) A filament lamp is operating at normal brightness. The potential difference across the lamp is 6.0 V. The current in the filament is 0.20 A. For the filament of this lamp, calculate:

i. the resistance. [2 marks]
ii. the power dissipated. [2 marks]

(c) A resistor made from a metal oxide has a resistance of 1.5 Ω. The resistor is in the form of a cylinder of length 2.2×10^{-2} m and radius 1.2×10^{-3} m. Calculate the resistivity of the metal oxide. [2 marks]

(d) A 500 Ω resistor, an uncharged 1.50 μF capacitor, and a 6.16 V emf are connected in series.

i. What is the initial current? [2 marks]
ii. What is the RC time constant? [2 marks]
iii. What is the current after one time constant? [4 marks]
iv. What is the voltage on the capacitor after one time constant? [3 marks]

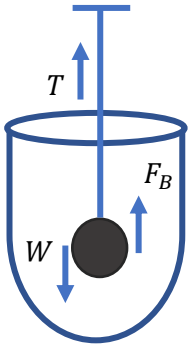
(e) ECG monitor must have an RC time constant less than 1.0 μs to be able to measure variations in voltage over small time intervals. If the resistance of the circuit (due mostly to that of the patient's chest) is 1.0 kΩ, what is the maximum capacitance of the circuit? [4 marks]

Q.4 (25 Marks)

Answer each of the following questions.

(a) State Archimedes' principle and the State the law of floatation. [3 marks]

(b) A ball bearing of mass 180 g is hung on a thread in oil of density 800 kg/m^3 as shown below. Calculate the tension in the string if the density of the ball bearing is 8000 kg/m^3. [8 marks]



(c) A jet plane flying at 600 m/s experiences an acceleration of 4.0 g when pulling out of a circular dive. What is the radius of the curved path in which the plane is flying? [4 marks]

(d) A liquid of density 1.17 × 10^3 kg/m^3 flows steadily through a pipe of varying diameter and height. At location 1 along the pipe the flow speed is 9.47 m/s and the pipe diameter is 1.11 cm. At location 2 the pipe diameter is 1.77 cm. At location 1 the pipe is 9.45 m higher than it is at location 2. Ignoring viscosity, calculate the difference between the fluid pressure at location 2 and the fluid pressure at location 1. [10 marks]

Q.5 (25 Marks)

Answer each of the following questions.

(a) A ray of light is travelling from glass to air. The angle of incidence in the glass is 30^0 and angle of refraction in air is 60^0. What is the refractive index of glass w.r.t air? [3 marks]

(b) A water tank appears to be 4 m deep when viewed from the top. If the refractive index of water is 4/3, what is the actual depth of the tank? [5 marks]

(c) A boy 1.80 m tall stands in front of a plane mirror. What is the minimum height of the mirror, and how high must its lower edge be above the floor for the person to be able to see his whole body? The boy's eyes are 6.0 cm below the top of the head. [5 marks]

(d) Define critical angle and total internal reflection with diagram. [6 marks]

(e) A beam of light is incident from air on the surface of a liquid. If the angle of incidence is 30^0 and the angle of refraction is 22^0, find the critical angle for the liquid when surrounded by air. [6 marks]

Q.6 (25 Marks)

Answer each of the following questions.

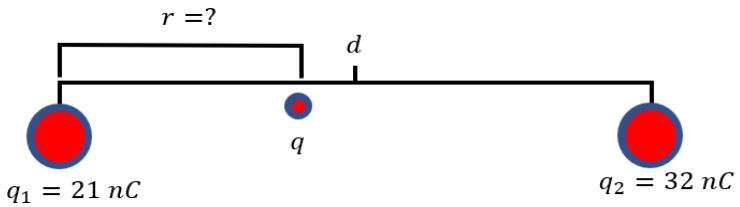
(a) A hollow metal sphere with a diameter of 10 cm has a net charge of 4 μC distributed uniformly across its surface. What is the magnitude of the field a distance 2.0 m from the center of the sphere? [4 marks]

(b) Two infinite parallel conducting sheets each have positive charge density σ. What is the magnitude and direction of the electric field to the right sheet? [4 marks]

(c) A proton moves in a straight line for a distance of 5 m. Along this path, the electric field is uniform with a value of $2 \times 10^7 V/m$. Find the potential difference created by the movement. [4 marks]

(d) A negative charge of magnitude 9.0 nC is placed in a uniform electric field of $3 \times 10^4\ N/C$, directed upwards. If the charge is moved 1.0 m upwards, how much work is done on the charge by the electric field in this process? [4 marks]

(e) Two positive point charges of q_1 and q_2 are place at a distance 1000 μm away from each other, as shown below. If a positive test charge, q, is placed in between, at what distance away from q_1 will this test charge experience zero net force? [9 marks]



All answers must be written in the Answer Sheet