UNIVERSITY OF BUEA
COLLEGE OF TECHNOLOGY
ENTRANCE EXAMINATION INTO FIRST YEAR OF BTECH PROGRAM

PAPER TITLE: PHYSICS
DATE: 25/09/19 **TIME:** 12.00 – 15.00
TIME ALLOWED: 3 HOURS **COEFFICIENT:** 4

SECTION 1, 1hr 30min

INSTRUCTIONS: Answer all questions in this section. Write down only the letter that corresponds to the best answer to each question. Each question carries two marks.

1. A projection lens is employed to produce 2.4m x 3.2m pictures from 3cm x 4cm slides on a screen that is 25cm from the lens. Compute its focal length.
   (A) 29cm (B) 30cm (C) 31cm (D) 32cm
2. An astronomical telescope with an objective lens of focal length +80cm is focused on the moon. By how much must the eyepiece be moved to focus the telescope on an object 40m distant?
   (A) 1.6cm (B) 1.5cm (C) 1.4cm (D) 1.7cm
3. What must be the focal length of a third thin lens placed in close contact with two thin lenses of 1.6cm and -23cm focal length, to produce a lens with -12cm focal length?
   (A) 8cm (B) 8.3cm (C) 9.5cm (D) 9.8cm
4. What is the critical angle when light passes from glass (n = 1.5) into air.
   (A) 41.5° (B) 41° (C) 42° (D) 41.8°
5. A pool of water (n = 4/3) is 60cm deep. Find its apparent depth when viewed vertically through air.
   (A) 35cm (B) 45cm (C) 40cm (D) 30cm
6. The critical angle for light passing from rock salt into air is 40.5°. the index of refraction of rock salt is
   (A) 1.54 (B) 1.55 (C) 1.56 (D) 1.57
7. How far should an object be formed a concave spherical mirror of radius 36cm to form a real image on – ninth its size?
   (A) 0.17m (B) 0.18m (C) 0.19m (D) 0.16m
8. Two plane mirrors make an angle of 90° with each other. A point like luminous object is placed between them. How many imaged are formed?
   (A) 1 (B) 2 (C) 3 (D) 4
9. Two long parallel wires are 4cm apart and carry currents 2A and 6A in the same direction. Calculate the force between the wires per meter of wire length.
   (A) 6×10^{-5}N/m, attraction (B) 5×10^{-5}, attraction (C) 10×10^{-5}N/m (D) 4×10^{-5}N/m, attractio
10. An air – core solenoid 50cm long has 4000 loops wound round on it. Compute B in its interior when a current of 0.25A exists in the winding.
    (A) 3mT (B) 2.5mT (C) 3mT (D) 4Mt
11. Compute the flux density in air at a point 6cm from a long straight wire carrying a current of 15A
    (A) 20μT (B) 25μT (C) 30μT (D) 35Mt
12. Compute the value of B in air at a point 5cm from a long straight wire carrying a current of 15A
    (A) 4×10^{-5}T (B) 5×10^{-5}T (C) 6×10^{-5}T (D) 7×10^{-5} T
13. Calculate the speed of ions that pass un deflected through crossed E and B fields for which e = 7.7Kv/m.
    (A) 45km/sec (B) 40km/sec (C) 50km/sec (D) 55km/sec

14. An ion (q = +2e) enters a magnetic field of 1.2wb/m^2 at a velocity of 2.5 x 10^5m/s perpendicular field. Determine the force on the ion.

(A) 9.6 x 10^{-6}N (B) 9.6 x 10^{-12}N (C) 9.6 x 10^{-3}N (D) 9.6 x 10^{-}

15. What is the direction of the force, due to the earth's magnetic field, on a wire carrying current ver downward?

(A) Horizontally towards west (B) horizontally towards north (C) horizontally towards south (D) horizontally towards east

16. How many 160Ω resistors (in parallel0 are required to carry 5A on a 100v line?

(A) 4 (B) 6 (C) 8 (D) 1

17. What resistance must be placed in parallel with 20Ω to make the combined resistance of 15Ω.

(A) 60Ω (B) 70Ω (C) 50Ω (D) 40Ω

18. Compute the equivalent resistance of 4Ω and 8Ω in series and parallel combined.

(A) 10Ω (B) 12Ω (C) 14Ω (D) 16Ω

19. A metal rod is 2m long and 8mm in diameter. Calculate its resistance if the resistivity of the metal is 1.76 x 10^{-8}Ω/m.

(A) 6 x 10^{-6}Ω (B) 7 x 10^{-6}Ω (C) 7 x 10^{-4}Ω (D) 8 x 10^{-4}Ω

20. What is the potential drop across an electric hot plate that draws 5A. when its hot resistance is 24Ω?

(A) 120v (B) 115v (C) 100v (D) 96v

21. In nuclear fission, a uranium nucleus combines with a neutron. becomes unstable. and splits into Ce and Zr plus two neutrons. The change in the mass of the interacting parts is 0.211 amu. How much energy is released in this reaction? (Note: c^2 = 931.5 MeV/amu)

A. 98 MeV B. 130 MeV C. 157 MeV D. 197 MeV

22. Mercury has specific gravity of 13.6. The column of mercury in the barometer below has a height h = 76 cm. If a similar barometer were made with water, what would be the approximate height h of the column of water?

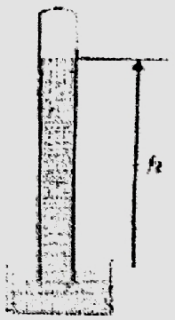

Fig Q22

A. 5.6 cm B. 76 cm C. 154 cm D. 1034 cm

23. An ideal fluid with pressure P flows through a horizontal pipe with radius r. I.F the radius of the pipe is increased by a factor of 2, which of the following most likely gives the new pressure?

A. P B. $4P$ C. $16P$ D. The new pressure cannot be determined

24. All of the Following would increase the volume flow rate of a fluid being pumped through a pipe EXCEPT:

A. increasing the pressure difference between the ends of the pipe.
B. decreasing the fluid viscosity.
C. increasing the length of the pipe.
D. increasing the pipe radius.

25. Water in moist soil rises through capillary action. The intermolecular forces between water molecules are:

A. weaker than the intermolecular forces between water and soil molecules.
B. equal to the intermolecular forces between water and soil molecules.
C. stronger than the intermolecular forces between water and soil molecules.
D. The comparative strength between the intermolecular forces cannot be determined with the information given.

26. The Young's modulus for bone is $9 \times 10^9 N/m^2$. What is the percent change in length of a tibia with a cross sectional area of 6 cm^2, if it experiences a compressive force of 5.4×10^3 N?

A. 0.001% B. 0.1% C. 1% D. 10%

27. The bulk modulus for a substance would be most important to a researcher who is testing material that will be:

A. used in high tension cables. B. submerged deep in the ocean.
C. subjected to high temperatures. D. transported at great speeds.

28. If an ocean wave hits a particular beach once every 4 seconds, and the wave peaks are 12 meters apart, with what velocity are the waves coming into shore?

A. 3 ms^{-1} B. 4 ms^{-1} C. 12 ms^{-1} D. 48 ms^{-1}

29. Waves generally travel faster in solids than in gases because:

A. The density of solids is generally greater than the density of gases.
B. The density of gases is generally greater than the density of solids.
C. Solids are less compressible than gases.
D. Gases are less compressible than solids.

30. If the intensity of a sound is doubled, the decibel level will increase by:

A. less than 10dB. B. exactly 10 dB. C. more than 10 dB. D. exactly 20 dB.

31. How many wavelengths are shown between the dotted lines in the wave form below?

A. 1 B. 2 C. 3 D. 4

Fig Q31

32. If a guitar string is 0.5 m long, what is the wavelength of its third harmonic?

A. 0.25 m B. 1m C. 0.5 m D. 1m 0.33 m

33. Two violinists are playing together, slightly out of tune. If one violinist produces a frequency of 883 Hz and the other produces a frequency of 879 Hz, beats would be heard with a frequency of:

A. 2Hz. B. 4Hz. C. 881 Hz. D. 1762 Hz.

34. In order for two sound waves to have an audible beat frequency, the two waves must be:

A. in phase. B. out of phase. C. close in frequency. D. of the same wavelength.

35. All of the following are examples of harmonic motion EXCEPT:

A. a pendulum moving back and forth
B. a skydiver falling through the atmosphere.
C. a car moving around a circular track.
D. a string vibrating on a musical instrument.

36. Two charged metal plates are placed one meter apart creating a constant electric field between them. A one coulomb charged particle is placed in the space between them. The particle experiences a force of 100N due to the electric field. What is the potential difference between the plates?

A. 1V B. 10V C. 1000V D. 100V

37. The electric field for two point charges A and B is shown below. Which of the following is true?

A. Both charges are positive.
B. Both charges are negative.
C. The charges have opposite charges.
D. The charges can not be determined.

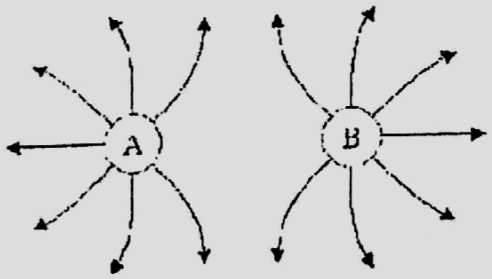

Fig Q37

38. Each resistor in the circuit below has a resistance of 2 Ω. The battery is a 12 volt battery. What is the current across resistor B?

A. 1 A B. 2A
C. 3A D. 4A

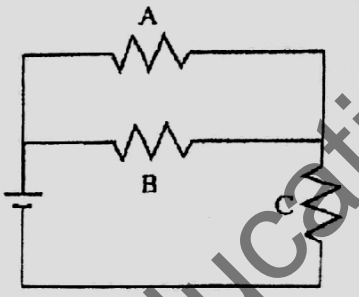

Fig Q38

39. What is the energy required to operate a 60 W light bulb for 1 minute?

A. 1 J B. 60J C. 360J D. 3600 J

40. The magnetic field created by a long straight current carrying wire:
A. decreases in strength proportionally with the distance from the wire.
B. decreases in strength with the square of the distance from the wire.
C. increases in strength proportionally with the distance from the wire.
D. increases in strength with the square of the distance from the wire.

41. A charged particle moves horizontally through a magnetic field which points directly upward. The force on the particle due to the magnetic field is:
A. perpendicular to the magnetic field and parallel to the velocity of the particle.
B. parallel to the magnetic field and perpendicular to the velocity of the particle.
C. perpendicular to the magnetic field and perpendicular to the velocity of the particle.
D. parallel to the magnetic field and parallel to the velocity of the particle.

42. A particle of mass m is fired into a magnetic field of strength B at a speed v. The particle travels in a circular path inside the field with a radius r. Which of the following expressions gives the magnitude of the charge on the particle?

A. $\frac{vB}{mr}$ B. $\frac{mv}{Br}$ C. $\frac{mr}{v^2B}$ D. $\frac{mv^2}{Br}$

43. If a light on a dimmer switch is gradually turned down, it will generally show a red glow at the moment before it is turned off. This is because red light:
A. has less energy than light of any other color.
B. moves more quickly through air than light of any other color.
C. has more energy than light of any other color.
D. moves more slowly through air than light of any other color.

44. When an object is 10 cm from a certain converging lens, the image is magnified by a factor of 1.5. What is the distance of the image?

A. 3.3 cm B. 6.6 cm C. 10 cm D. 15 cm

4

45. An invetled image is created 5 ill in front of a mirror. Which of the following could be true about the mirror and the object?

A. The mirror is convex with less than a 5 ill focal distance.
B. The mirror is concave with less than a 5 ill focal distance.
C. The mirror is convex with more than a 5 m focal distance.
D. The mirror is concave with more than a 5 ill focal distance.

SECTION 2: (1hr 30min):

Answer any three (03) questions of your choice in this section

Q1a. A ball of mass 0.5kg moving with speed 10m/s strikes an identical stationary ball. After impact, they continue with speed v and (v+5) m/s respectively along the same line.

i) The value of v **(5 marks)**
ii) The loss in kinetic energy after the impact. **(6 marks)**

Q1b. Two crates, one with mass 4.0kg and the other with mass 6.0kg, sit on the frictionless surface of a frozen pond, connected by a light rope (Fig. Q1b). A woman wearing golf shoes (so she can get traction on the ice) pulls horizontally on the 6.0kg crate with a force ***F*** that gives the crate an acceleration of 2.5 ms^{-2}.

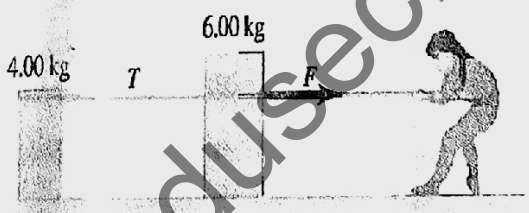

Figure Q1b.

(i) What is the acceleration of the 4.0kg crate? **(2 marks)**

(ii) Draw a free-body diagram for the 4.0kg crate. Use that diagram and Newton's second law to find the tension ***T*** in the rope that connects the two crates. **(3 marks)**

(iii) Draw a free-body diagram for the 6.0kg crate. What is the direction of the net force on the 6.0kg crate? Which is larger in magnitude, force ***T*** or force ***F***? **(3 marks)**

(iv) Use part (iii) and Newton's second law to calculate the magnitude of the force ***F***.**(2 marks)**

1c. A light rope is attached to a block with mass 4.0 kg that rests on a frictionless, horizontal surface. The horizontal rope passes over a frictionless, massless pulley, and a block with mass *m* is suspended from the other end. When the blocks are released, the tension in the rope is 10.0 N.

(i) Draw two free-body diagrams, one for the 4.0kg block and one for the block with mass *m*. **(4 marks)**

5

(ii) What is the acceleration of either block? **(2 marks)**

(iii) Find the mass m of the hanging block. **(2 marks)**

(iv) How does the tension compare to the weight of the hanging block?**(2 marks)**

Q2a. A luggage handler pulls a 20.0kg suitcase op a ramp inclined at 25.0° above the horizontal by a force magnitude 140 N that acts parallel to the ramp. The coefficient of kinetic friction between the ramp and incline is $\mu_k = 0.30$. If the suitcase travels 3.80 m along the ramp, calculate

(i) the work done on the suitcase by the force F: **(3 marks)**

(ii) the work done on the suitcase by the gravitational force; **(3 marks)**

(iii) the work done on the suitcase by the normal force; **(2 marks)**

(iv) the work done on the suitcase by the friction force; **(3 marks)**

(v) the total work done on the suitcase. **(3 marks)**

(vi) If the speed of the suitcase is zero at the bottom of the ramp, what is its speed after it has traveled 3.80 along the ramp?**(3 marks)**

Q2b. A uniform ladder 5.0 m long rests against a frictionless, vertical wall with its lower end 3.0 m from th wall. The ladder weighs 160 N. The coefficient of static friction between the foot of the ladder and the ground 0.40. A man weighing 740 N climbs slowly up the ladder. Start by drawing a free-body diagram of the ladder.

(i) What is the maximum frictional force that the ground can exert on the ladder at its lower end? **(3 marks)**

(ii) What is the actual frictional force when the man has climbed 1.0 m along the ladder? **(3 marks)**

(iii) How far along the ladder can the man climb before the ladder starts to slip?**(3 marks)**

Q2c. A uniform, 255N rod that is 2.0 m long carries a 225N weight at its right end and an unknown weight W toward the left end (Fig. Q2c). When W is placed 50.0 cm from the left end of the rod, the system just balance horizontally when the fulcrum is located 75.0 cm from the right end.

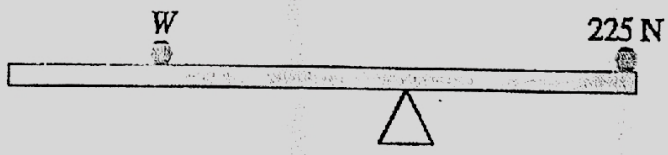

Figure Q2c.

(i) Find W. **(2 marks)**

(ii) If W is now moved 25.0 cm to the right, how far and in what direction must the fulcrum be moved to restor balance?**(3 marks)**

Q3a. A stone is projected vertically upwards from ground level with a speed of 30m/s. Find

i) The time taken to return to the ground? **(3 marks)**
ii) The maximum height reached. **(3 marks)**
iii) The time the stone was more than 40m above the ground. **(2 marks)**

(ii) What is the acceleration of either block? **(2 marks)**

(iii) Find the mass m of the hanging block. **(2 marks)**

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(i) What is the maximum frictional force that the ground can exert on the ladder at its lower end? **(3 marks)**

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Q2c. A uniform, 255N rod that is 2.0 m long carries a 225N weight at its right end and an unknown weight W toward the left end (Fig. Q2c). When W is placed 50.0 cm from the left end of the rod, the system just balance horizontally when the fulcrum is located 75.0 cm from the right end.

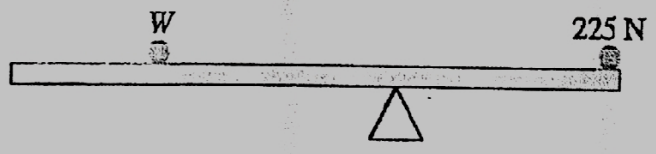

Figure Q2c.

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Q3a. A stone is projected vertically upwards from ground level with a speed of 30m/s. Find

i) The time taken to return to the ground? **(3 marks)**
ii) The maximum height reached. **(3 marks)**
iii) The time the stone was more than 40m above the ground. **(2 marks)**

Q3b. Three forces $\begin{pmatrix}3\\6\end{pmatrix}N, \begin{pmatrix}5\\4\end{pmatrix}N$ *and* $\begin{pmatrix}-4\\2\end{pmatrix}N$ act together on a mass of 5kg.

i) Calculate the magnitude of the acceleration and show that it is perpendicular to $\begin{pmatrix}3\\-1\end{pmatrix}N$. **(3 marks)**

ii) A fourth force $\vec{P} = \begin{pmatrix}2s\\-5s\end{pmatrix}N$ is now added. Find The new acceleration of the mass in terms of s. **(3 marks)**

iii) The magnitude of $\vec{P}$ if this acceleration is parallel to the x-axis. **(4 marks)**

Q3c. Two particles A and B of masses 2kg and mkg respectively are moving towards each other with speed 5m/s and 3m/s respectively. After collision they coalesce and move with a common speed of 2m/s. Find

i) The value of m **(3 marks)**
ii) The magnitude of the impulse experienced by A. **(3 marks)**
iii) The loss in kinematics energy after impact. **(3 marks)**

Q4a. (i) Two protons in a molecule are separated by 3.80×10^{-10}m. Find the electric force exerted by one proton onthe other. **(3 marks)**

(ii) How does the magnitude of this force compare to the magnitude of the gravitational force between the two protons? **(3 marks)**

(iii)What must be the charge-to-mass ratio of a particle if the magnitude of the gravitational force between two of these particles equals the magnitude of electric force between them?**(3 marks)**

Q4b. Three capacitors are connected to a battery as shown in Figure Q4b.

Their capacitances are $C_1 = 3C$, $C_2 = C$, and $C_3 = 5C$.

(i) What is the equivalent capacitance of this set of capacitors? **(2 marks)**

(ii) State the ranking of the capacitors according to the charge they store, from largest to smallest. **(2 marks)**

(iii) Rank the capacitors according to the potential differences across them, from largest to smallest.**(2 marks)**

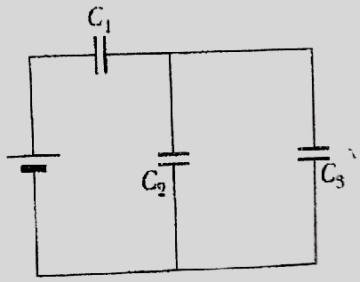

Figure Q4b

(iv) If C_3 is increased, what happens to the charge stored by each of the capacitors?**(3 marks)**

Q4c. (i) Find the equivalent resistance between points *a* and *b* in Figure Q4c. **(3 marks)**

(ii) A potential difference of 34.0 V is applied between points *a* and *b*. Calculate the current in each resistor. **(6 marks)**

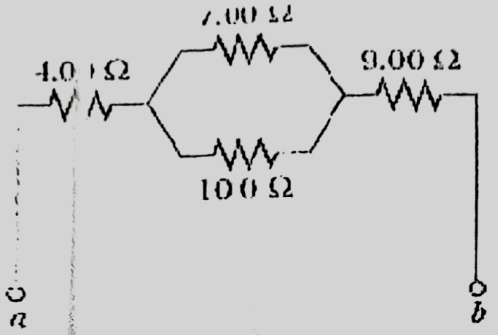

Figure Q4c

Q4d. A series RL circuit with L =3.0H and a series RC circuit with C =3.0μF have equal time constants. If the two circuits contain the same resistance R,

(i) what is the value of R and **(2 marks)**

(ii) what is the time constant?**(2 marks)**

Q5a. Light of wavelength 700 nm is incident on the face of a fused quartz prism at an angle of 75.0° (with respect to the normal to the surface). The apex angle of the prism is 60.0°.Use the value of n as 1.458 and calculate the angle

(i) of refraction at this first surface. **(2 marks)**

(ii) of incidence at the second surface. **(3 marks)**

(iii) of refraction at the second surface. **(2 marks)**

Q5b. (i)A converging lens has a focal length of 20.0 cm. Locate the image for object distances of 40.0 cm, and 10.0 cm. For each case, state whether the image is real or virtual and upright or inverted. Find the magnification in each case. **(6, 6 marks)**

(ii) The wavelength of red helium–neon laser light in air is632.8 nm. What is its frequency, wavelength in glass that has an index of refraction of 1.50? **(2, 2 marks)**

(iii) A person sees clearly when he wears eyeglasses that have a power of −4.0 diopters and sit 2.0 cm in front of hiseyes. If the person wants to switch to contact lenses, which are placed directly on the eyes, what lens power should be prescribed? **(2 marks)**

Q5c. A laser used to weld detached retinas emits light with a wavelength of 652 nrn in pulses that are 20.0 ms in duration. The average power during each pulse is 0.600 W.

(i) How much energy is in each pulse in joules? In electron volts? **(2 marks)**

(ii) What is the energy of one photon in joules? In electron volts? **(2 marks)**

(iii) How many photons are in each pulse? **(2 marks)**