# THE 1ST OXFORD-THE DAILY STAR NATIONAL PHYSICS OLYMPIAD
DHAKA
FRIDAY, APRIL 29, 2011

PLEASE READ THE FOLLOWING INSTRUCTIONS:

1.   Please write your student code and school name on the box provided in the answer script.

2.   The examination consists of two rounds and the stipulate time for each round is one hour.

3.   In the **First Round** there are *30 MCQ* & *25 one word questions*.

4.   Each MCQ carries [1] mark and one word question carries [2] marks.

5.   Use the **Answer Sheets** provided is to fill in your answers. Numerical results should be given in 2 decimal places. *Do not forget to state the units.*

6.   No rough sheet will be provided. All the working should be done in the space provided on the question paper.

7.   You may use the calculator to solve the problems.

8.   Turn over the page *only* when you are instructed to do so.

9.   This question Paper consists of 9 printed pages and I blank page.

1. A glass tank contains some water. The length QR and the width RS of the tank are known. What other distance needs to be measured in order to be able to calculate the volume of the water?
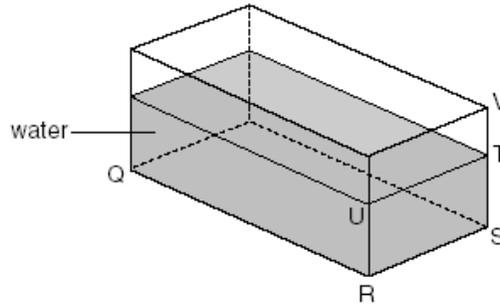
   A. ST
   B. SV
   C. TU
   D. TV

2. As a rocket is accelerating vertically upward at 9.8 m/s² near Earth's surface, it releases a projectile. Immediately after release the acceleration (in m/s²) of the projectile is:
   A. 9.8 down
   B. 0
   C. 9.8 up
   D. 9.6 up

3. A person holds a glass beaker in one hand and fills it quickly with hot water. It takes several seconds before his hand starts to feel the heat. Why is there this delay?
   A. Glass is a poor conductor of heat.
   B. Glass is a good conductor of heat.
   C. Water is a poor conductor of heat.
   D. Water is a good conductor of heat.

4. A student connects two lamps in the circuit shown. Which switches must he close to light both lamps?
   A. 1 and 2
   B. 1, 2 and 3
   C. 1 and 3
   D. 2 and 3
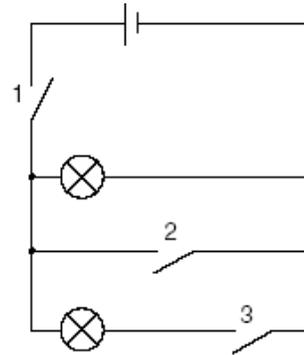
5. A sphere with a radius of 1.7 cm has a volume of:
   A. 2.1×10^{-5} m³
   B. 9.1×10^{-4} m³
   C. 3.6×10^{-3} m³
   D. 0.11 m³

6. The average speed of a moving object during a given interval of time is always:
   A. the magnitude of its average velocity over the interval
   B. the distance covered during the time interval divided by the time interval
   C. one-half its speed at the end of the interval
   D. its acceleration multiplied by the time interval

7.   What is the source of the energy converted by a hydro-electric power station?
     A. hot rocks
     B. falling water
     C. oil
     D. waves

8.   A block is first placed on its long side and then on its short side on the same inclined plane, as shown. The block slides down the plane on its short side but remains at rest on its long side. A possible explanation is:

(ii)   (ii)
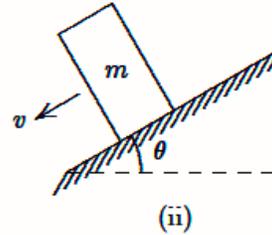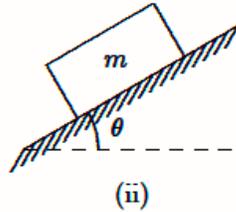
     A. the short side is smoother
     B. the frictional force is less because the contact area is less
     C. the center of gravity is higher in the second case
     D. the normal force is less in the second case

9.   An ice skater is in a fast spin with her arms held tightly to her body. When she extends her arms, which of the following statements is *not* true?
     A. She increases her moment of inertia.
     B. She decreases her angular speed.
     C. Her moment of inertia remains constant.
     D. Her total angular momentum remains constant.

10. The center of mass of the system consisting of Earth, the Sun, and the planet Mars is:
     A. closer to Earth than to either of the other bodies
     B. closer to the Sun than to either of the other bodies
     C. closer to Mars than to either of the other bodies
     D. at the geometric center of the triangle formed by the three bodies

11. The higher the frequency of a wave
     A. the smaller its speed.
     B. the shorter its wavelength.
     C. the greater its amplitude.
     D. the longer its period.

12. At a height of 10 km (33000 ft) above sea level, atmospheric pressure is about 210 mm of mercury. What is the resultant normal force on a 600 cm^2 window of an airplane flying at this height? Assume the pressure inside the plane is 760 mm of mercury. The density of mercury is 13 600 kg/m^3.
     A. 6.1 kN
     B. 4.4 x 10^3 kN
     C. 1.2 x 10^3 kN
     D. 4.4 kN

13. The speed of sound is 340m/s. A plane flies horizontally at an altitude of 10, 000m and a speed of 400m/s. When an observer on the ground hears the sonic boom the horizontal distance from the point on its path directly above the observer to the plane is:
A. 5800m
B. 6200m
C. 8400m
D. 12, 000m

14. An atom of lithium contains three protons and three electrons. The nucleon number (mass number) of the atom is 7. How many neutrons are there in the atom?
A. 3   B. 4   C. 7   D. 10

15. The speed of waves in a stretched string depends upon which one of the following?
A. The tension in the string
B. The amplitude of the waves
C. The wavelength of the waves
D. The gravitational field strength

16. An electron is traveling horizontally east in Earth's magnetic field. What is the direction of the magnetic force on the particle?
A. Up   B. Down   C. West   D. Zero

17. A rock is swung on the end of a rope in a horizontal circle at constant speed. The rope breaks. Immediately after the rope breaks, the ball will
A. fall straight down to the ground.
B. move inward toward the center of the circle.
C. move outward normal to the circle from the point the rope broke.
D. move outward tangent to the circle from the point the rope broke.

18. Which of the following effects could *not* be observed for sound waves in air?
A. interference
B. refraction
C. polarization
D. diffraction

19. An object 7.0 cm high is placed 15 cm from a convex spherical mirror of radius 45 cm. Describe its image.
A. virtual, erect, 9.0 cm behind mirror, 4.2 cm high
B. virtual, erect, 45.0 cm behind mirror, 4.2 cm high
C. virtual, erect, 9.0 cm behind mirror, 0.6 cm high
D. virtual, inverted, 9.0 cm behind mirror, 4.2 cm high

20. The speed of light in a certain glass is 1.91×10^{8} m/s. What is the refractive index of the glass?
A. 1.57   B. 0.64   C. 1.09   D. 4.9

21.   Two isotopes of an element have
       A. the same number of nucleons in their nuclei.
       B. the same number of protons as well as neutrons.
       C. the same number of protons but a different number of neutrons.
       D. a different number of protons but the same number of neutrons.

22.   The wave-particle duality theory is the first to give an adequate explanation of which of the
       following facts about the hydrogen atom?
       A. Why more than one possible orbit exists for the electron.
       B. Why only certain energies are possible for the orbiting electron.
       C. Why more than one momentum is possible for the orbiting electron.
       D. None of these are correct.

23.   A bimetallic strip made from brass and iron is used as a thermostat. When the strip is heated,
       the brass expands more than the iron.
       Which shape will the strip become?
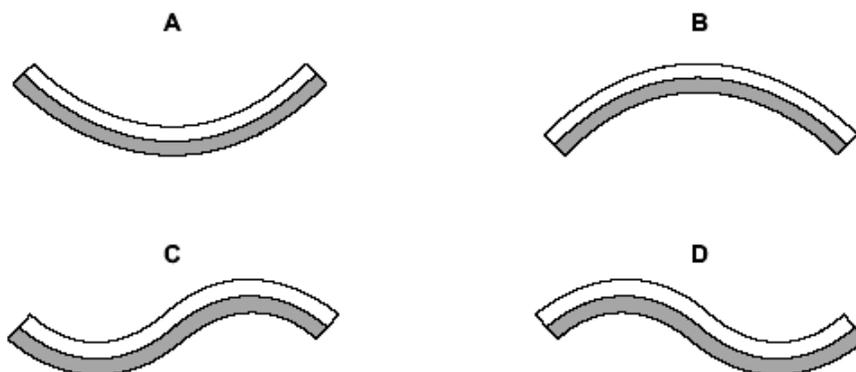
24.   A hospital needs to sterilize medical equipment. Which electromagnetic waves could be used?
       A. infra-red
       B. microwaves
       C. radio waves
       D. ultraviolet

25.   Which properties make materials suitable for use as a core in an electromagnet?
       A. difficult to magnetize and easy to demagnetize
       B. difficult to magnetize and retains magnetic strength
       C. easy to magnetize and retains magnetic strength
       D. easy to magnetize and easy to demagnetize

26.   We desire to measure the current through and the voltage across a resistor connected in a
       circuit. How should an ammeter and a voltmeter be connected to the resistor?
       A. Both are connected in parallel with the resistor.
       B. Both are connected in series with the resistor.
       C. The ammeter is connected in series and the voltmeter is connected in parallel with the
           resistor.
       D. The ammeter is connected in parallel and the voltmeter is connected in series with the
   resistor.

27.   A student tests the circuit of a press-button telephone with a lamp and a battery. Which single switch can be pressed to make the lamp light?

A. 0
B. 1
C. 5
D. 6
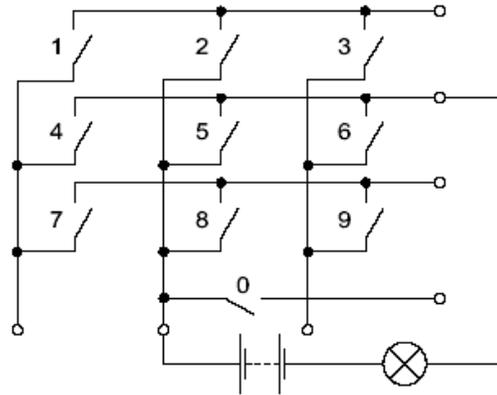
28.   A magnet is pushed slowly into a coil and there is a current in the coil in the direction shown. The magnet is then pulled out quickly from the same end of the coil.
What happens to the direction and the size of the current?

	Direction	Size
A	reversed	decreased
B	reversed	increased
C	unchanged	decreased
D	unchanged	increased
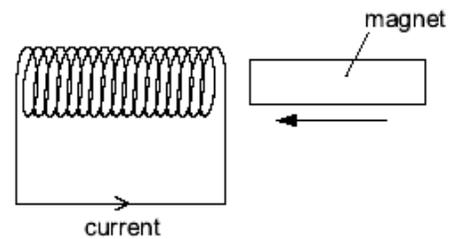
29.   The diagram shows a d.c. motor. Why is a split-ring commutator used?
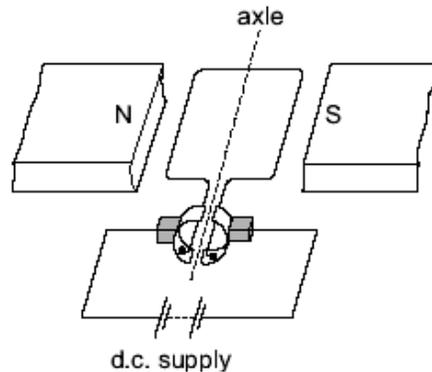
A. to change the current direction in the coil as the coil passes the horizontal position
B. to change the current direction in the coil as the coil passes the vertical position
C. to change the current direction in the d.c. supply as the coil passes the horizontal position
D. to change the current direction in the d.c. supply as the coil passes the vertical position

30.   Which row is correct for fission and for fusion?

|	fission of a nucleus	fusion
A	produces larger nuclei	is the energy source of a star
B	produces larger nuclei	is used to release energy in a power station
C	produces smaller nuclei	is the energy source of a star
D	produces smaller nuclei	is used to release energy in a power station

ONE WORD QUESTIONS

1.   An auto travels at the rate of 25 km/h for 4.0 minutes, then at 50 km/h for 8.0 minutes and finally at 20 km/h for 2.0 minutes. Find (a) the total distance covered in km and (b) the average speed for the complete trip in m/s.

2.   A bottle dropped from a balloon reaches the ground in 20 s. Determine the height of the balloon if (a) it was at rest in the air and (b) it was ascending with a speed of 50 m/s when the bottle was dropped.

3.   When a nucleus of Uranium-235 absorbs a neutron, nuclear fission occurs. In a typical reaction the total mass decreases by 3×10^{-28} kg. Given that the speed of light c is 3×10^{8} m / s, approximately how much energy is released?

4.   A measuring cylinder containing some water stands on a scale pan. A solid ball is lowered into the water. The water level rises from the 30 cm3 mark to the 40 cm3 mark. The scale reading increases from 100 g to 180 g. What is the density of the material of the ball?
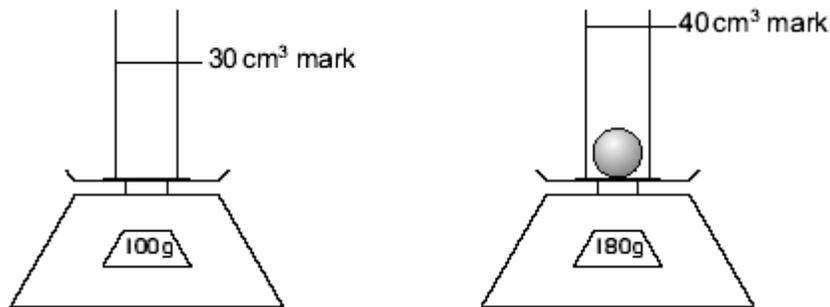

5.   The half-life of a radioactive substance is 5 hours. A sample is tested and found to contain 0.48g of the substance. How much of the substance was present in the sample 20 hours before the sample was tested?

6.   A tunnel has a length of 50 km. A car takes 20 min to travel between the two ends of the tunnel. What is the average speed of the car?

7.   Compute the power output of a machine that lifts a 500-kg crate through a height of 20.0 m in a time of 60.0 s.

8.   A large open tank of non-viscous liquid springs a leak 4.5 m below the top of the liquid. What is the theoretical velocity of outflow from the hole? If the area of the hole is 0.25cm^2, how much liquid would escape in exactly 1 minute?

9.	A pendulum is timed as it swings back and forth. The clock is started when the bob is at the left end of its swing. When the bob returns to the left end for the 90th return, the clock reads 60.0s. (a) What is the period of vibration? (b) What is the frequency of vibration?

10.	A proton ($q = e$, $m_p = 1.67 \times 10^{-27}$ kg) is accelerated from rest through a potential difference of 1.0 MV. What is the final speed?

11.	Three resistors, of 8.0 Ω, 12 Ω, and 24 Ω, are in parallel, and a current of 20 A is drawn by the combination. Determine (a) the potential difference across the combination and (b) the current through each resistance.

12.	A capacitor with air between its plates has capacitance of 3.0µF. What is its capacitance when wax of dielectric constant 2.8 is placed between the plates?

13.	The half-life of carbon-14 is 5.7×10^3 years. What fraction of a sample of ^{14}C will remain unchanged after a period of five half-lives?

14.	The mass of Mars is approximately 0.1 times the mass of Earth and its diameter is approximately 0.5 times that of Earth. What is the approximate gravitational field strength on the surface of Mars?

15.	In a given time interval 1200 J of energy is extracted from a refrigerator cabinet and 1800 J of energy ejected to the outside. The coefficient of performance of the refrigerator is

16.	A ball of mass 2 kg travelling at 8ms–1 strikes a ball of mass 4 kg travelling at 2ms–1. Both balls are moving along the same straight line as shown. After collision, both balls move at the same velocity v. What is the magnitude of the velocity v?
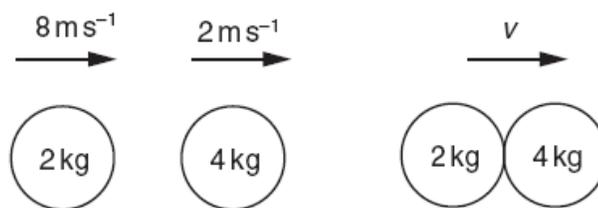

17.	A motorist travelling at 10ms–1 can bring his car to rest in a distance of 10 m. If he had been travelling at 30ms^{-1}, in what distance could he bring the car to rest using the same braking force?

18.	The current in a component is reduced uniformly from 100 mA to 20 mA over a period of 8.0 s. What is the charge that flows during this time?

19. The diagram shows an arrangement of four resistors.
   What is the resistance between X and Y?
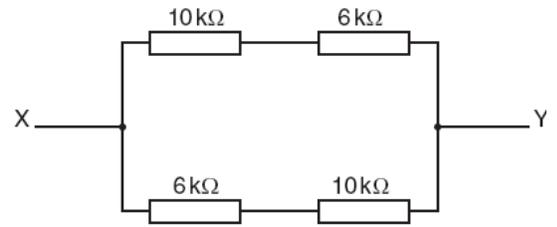
20. Two forces, each of 10 N, act at a point P as shown in the diagram. The angle between the
     directions of the forces is 120°.What is the magnitude of the resultant force?
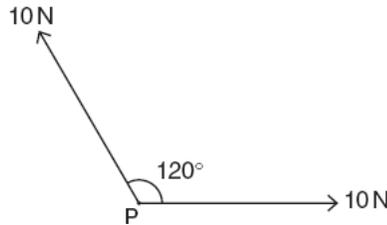
21. An Olympic athlete of mass 80 kg competes in a 100 m race. What is the best estimate of his
     mean kinetic energy during the race?

22. A semi-circular block is made from a plastic. A ray of light passes through it at the angles
     shown. To two decimal places, what is the refractive index of the plastic?
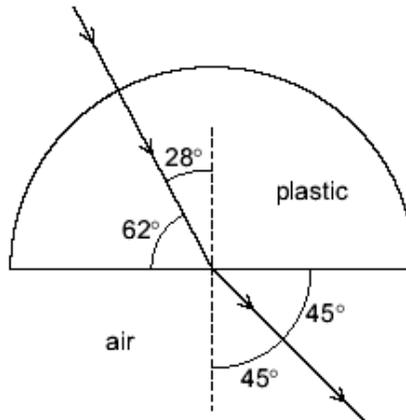
23. A concrete cube of side 0.50 m and uniform density 2.0 x 10⁹ kg m¯³ is lifted 3.0 m vertically
     by a crane. What is the change in potential energy of the cube?

24. A rigid uniform bar of length 2.4 m is pivoted horizontally at its mid-point. Weights are hung
     from two points of the bar as shown in the diagram. To maintain horizontal equilibrium, a
     couple is applied to the bar. What is the torque and direction of this couple?
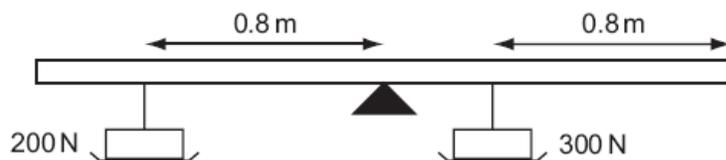
25. The average person can hear sound waves ranging in frequency from about 20 Hz to 20 kHz.
     Determine the wavelengths at these limits, taking the speed of sound to be 340 m/s.