2012 Biomedical Engineering Master Entrance Exam — Physics (依規定不可用計算機，計算複雜的題目請將計算過程，寫於答案後面)

單選題 (總共40題，每題2.5分，共100分，答錯倒扣 0.5分)

1 The coordinate of an object is given as a function of time by $x = 4t^2 - 3t^3$, where x is in meters and t is in seconds. Its average acceleration over the interval from t = 0 to t = 2 s is:
A. $-4 m/s^2$ B. $4 m/s^2$ C. $-10 m/s^2$ D. $10 m/s^2$ E. $-13 m/s^2$

2 An object with an initial velocity of 12 m/s west experiences a constant acceleration of 4 m/s^2 west for 3 seconds. During this time the object travels a distance of:
A. 12 m B. 24 m C. 36 m D. 54 m E. 144 m

3 A vector has a component of 10m in the +x direction, a component of 10m in the +y direction, and a component of 5m in the +z direction. The magnitude of this vector is:
A. zero B. 15m C. 20m D. 25m E. 225m

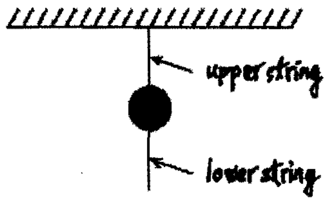
4 In a Young's double-slit experiment, light of wavelength 500nm illuminates two slits that are separated by 1 mm. The separation between adjacent bright fringes on a screen 5m from the slits is: A. 0.10 cm B. 0.25 cm C. 0.50 cm D. 1.0 cm E. none of the above

5 A jet plane in straight horizontal flight passes over your head. When it is directly above you, the sound seems to come from a point behind the plane in a direction 30° from the vertical. The speed of the plane is:
A. the same as the speed of sound B. half the speed of sound
C. three-fifths the speed of sound D. 0.866 times the speed of sound
E. twice the speed of sound

6 A stone is thrown outward from the top of a 59.4-m high cliff with an upward velocity component of 19.5m/s. How long is stone in the air?
A. 4.00 s B. 5.00 s C. 6.00 s D. 7.00 s E. 8.00 s

7 For a biological sample in a 1.0-m radius centrifuge to have a centripetal acceleration of 25g its speed must be:
A. 11m/s B. 16m/s C. 50m/s D. 122m/s E. 245m/s

8 A heavy ball is suspended as shown. A quick jerk on the lower string will break that string but a slow pull on the lower string will break the upper string. The first result occurs because:

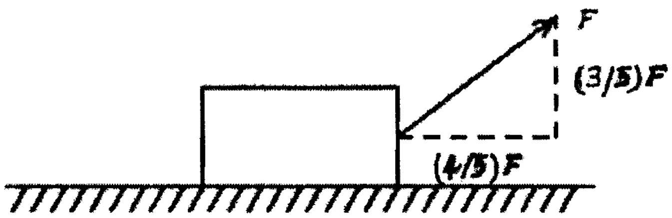


A. the force is too small to move the ball B. action and reaction is operating
C. the ball has inertia D. air friction holds the ball back E. the ball has too much energy

9 Radio waves of wavelength 300m have a frequency of:
A. 10^{-3} kHz B. 500 kHz C. 1MHz D. 9MHz E. 108 kHz

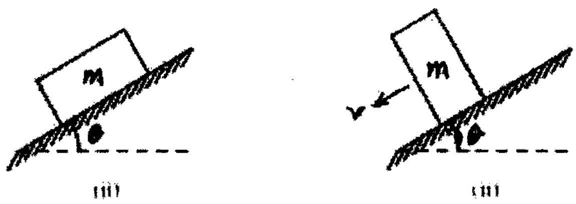
10 The speed of a 4.0-N hockey puck, sliding across a level ice surface, decreases at the rate of $0.61 m/s^2$. The coefficient of kinetic friction between the puck and ice is:
A. 0.062 B. 0.41 C. 0.62 D. 1.2 E. 9.8

11 A 400-N block is dragged along a horizontal surface by an applied force F as shown. The coefficient of kinetic friction is $\mu_k = 0.4$ and the block moves at constant velocity. The magnitude of F is :



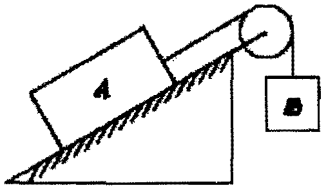
A. 100N B. 150N C. 200N D. 290N E. 400 N

12 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:



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 E. the force of gravity is more nearly down the plane in the second case

13 Block A, with a mass of 10 kg, rests on a 30° incline. The coefficient of kinetic friction is 0.20. The attached string is parallel to the incline and passes over a massless, frictionless pulley at the top. Block B, with a mass of 8.0 kg, is attached to the dangling end of the string. The acceleration of B is:

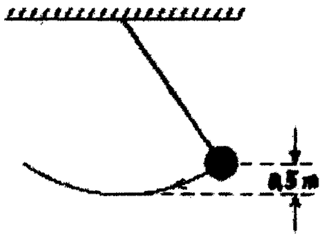


A. 0.69m/s^2, up the plane　B. 0.69m/s^2, down the plane　C. 2.6m/s^2, up the plane
D. 2.6m/s^2, down the plane　E. 0

14 An ideal spring is hung vertically from the ceiling. When a 2.0-kg mass hangs at rest from it the spring is extended 6.0 cm from its relaxed length. A downward external force is now applied to the mass to extend the spring an additional 10 cm. While the spring is being extended by the force, the work done by the spring is:
A. −3.6J　B. −3.3J　C. -3.4×10^{-5} J　D. 3.3J　E. 3.6J

15 A 5.0-kg cart is moving horizontally at 6.0m/s. In order to change its speed to 10.0m/s, the net work done on the cart must be:
A. 40 J　B. 90 J　C. 160 J　D. 400 J　E. 550 J

16 The long pendulum shown is drawn aside until the ball has risen 0.50 m. It is then given an initial speed of 3.0m/s. The speed of the ball at its lowest position is:



A. zero　B. 0.89m/s　C. 3.1m/s　D. 3.7m/s　E. 4.3m/s

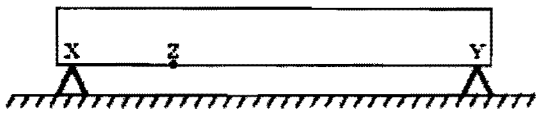
17 A 5-kg projectile is fired over level ground with a velocity of 200m/s at an angle of 25^0 above the horizontal. Just before it hits the ground its speed is 150m/s. Over the entire trip the change in the internal energy of the projectile and air is:
A. +19, 000 J　B. −19, 000 J　C. +44, 000 J　D. −44, 000 J　E. 0

18 Two boys, with masses of 40 kg and 60 kg, respectively, stand on a horizontal frictionless surface holding the ends of a light 10-m long rod. The boys pull themselves together along the rod. When they meet the 60-kg boy will have moved what distance?
A. 4m　B. 5m　C. 6m　D. 10m　E. need to know the forces they exert

19 A solid uniform sphere of radius R and mass M has a rotational inertia about a diameter that is given by (2/5)MR^2. A light string of length 3R is attached to the surface and used to suspend the sphere from the ceiling. Its rotational inertia about the point of attachment at the ceiling is:
A. (2/5)MR^2　B. 9MR^2　C. 16MR^2　D. (47/5)MR^2　E. (82/5)MR^2

20 A cylinder of radius R = 6.0 cm is on a rough horizontal surface. The coefficient of kinetic friction between the cylinder and the surface is 0.30 and the rotational inertia for rotation about the axis is given by $MR^2/2$, where M is its mass. Initially it is not rotating but its center of mass has a speed of 7.0m/s. After 2.0 s the speed of its center of mass and its angular velocity about its center of mass, respectively, are:
A. 1.1m/s, 0 B. 1.1m/s, 19 rad/s C. 1.1m/s, 98 rad/s D. 1.1m/s, 200 rad/s E. 5.9m/s, 98 rad/s

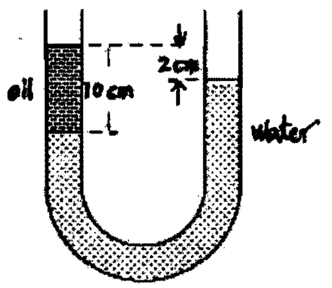
21 A uniform plank is supported by two equal 120-N forces at X and Y, as shown. The support at X is then moved to Z (half-way to the plank center). The supporting forces at Y and Z are



then:
A. FY = 240 N, FZ = 120N B. FY = 200 N, FZ = 40N C. FY = 40N, FZ = 200N
D. FY = 80N, FZ = 160N E. FY = 160 N, FZ = 80N

22 The mass of a hypothetical planet is 1/100 that of Earth and its radius is 1/4 that of Earth. If a person weighs 600N on Earth, what would he weigh on this planet?
A. 24N B. 48N C. 96N D. 192N E. 600N

23 The density of water is $1.0 g/cm^3$. The density of the oil in the left column of the U-tube



shown below is:
A. $0.20 g/cm^3$ B. $0.80 g/cm^3$ C. $1.0 g/cm^3$ D. $1.3 g/cm^3$ E. $5.0 g/cm^3$

24 The displacement of an object oscillating on a spring is given by $x(t) = x_m \cos(\omega t + \varphi)$. If the initial displacement is zero and the initial velocity is in the negative x direction, then the phase constant φ is:
A. 0 B. $\pi/2$ rad C. π rad D. $3\pi/2$ rad E. 2π rad

25 The displacement of a string carrying a traveling sinusoidal wave is given by

$$y(x, t) = y_m \sin(kx - \omega t - \varphi) .$$

At time t = 0 the point at x = 0 has a displacement of 0 and is moving in the positive y direction. The phase constant φ is: A. 45° B. 90° C. 135° D. 180° E. 270°

26 The sound intensity 5.0m from a point source is $0.50 W/m^2$. The power output of the source is: A. 39W B. 160W C. 266W D. 320W E. 390W

27 A Kelvin thermometer and a Fahrenheit thermometer both give the same reading for a certain sample. The corresponding Celsius temperature is:
A. 574^0 C B. 232^0 C C. 301^0 C D. 614^0 C E. 276^0 C

28 An ideal gas undergoes an isothermal process starting with a pressure of 2×10^5 Pa and a volume of 6 cm^3. Which of the following might be the pressure and volume of the final state?
A. 1×10^5 Pa and 10 cm^3 B. 3×10^5 Pa and 6 cm^3 C. 4×10^5 Pa and 4 cm^3
D. 6×10^5 Pa and 2 cm^3 E. 8×10^5 Pa and 2 cm^3

29 According to the second law of thermodynamics:
A. all heat engines have the same efficiency
B. all reversible heat engines have the same efficiency
C. the efficiency of any heat engine is independent of its working substance
D. the efficiency of a Carnot engine depends only on the temperatures of the two reservoirs E. all Carnot engines theoretically have 100% efficiency

30 Two identical conducting spheres A and B carry equal charge. They are separated by a distance much larger than their diameters. A third identical conducting sphere C is uncharged. Sphere C is first touched to A, then to B, and finally removed. As a result, the electrostatic force between A and B, which was originally F, becomes:
A. F/2 B. F/4 C. 3F/8 D. F/16 E. 0

31 A 200-N/C electric field is in the positive x direction. The force on an electron in this field is:
A. 200N in the positive x direction B. 200N in the negative x direction C. 3.2×10^{-17} N in the positive x direction D. 3.2×10^{-17} N in the negative x direction E. 0

32 A particle with charge 5.0-μC is placed at the corner of a cube. The total electric flux in $N \cdot m^2/C$ through all sides of the cube is:
A. 0 B. 7.1×10^4 C. 9.4×10^4 D. 1.4×10^5 E. 5.6×10^5

33 Two conducting spheres are far apart. The smaller sphere carries a total charge Q. The larger sphere has a radius that is twice that of the smaller and is neutral. After the two spheres are connected by a conducting wire, the charges on the smaller and larger spheres, respectively, are:
A. Q/2 and Q/2 B. Q/3 and 2Q/3 C. 2Q/3 and Q/3 D. zero and Q E. 2Q and –Q

34 A parallel-plate capacitor has a plate area of $0.2 m^2$ and a plate separation of 0.1mm. To obtain an electric field of 2.0×10^6 V/m between the plates, the magnitude of the charge on

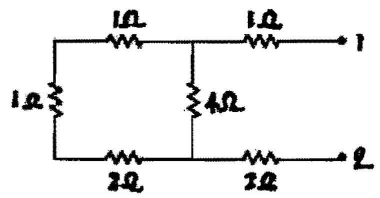
each plate should be:

A. 8.9×10^{-7} C B. 1.8×10^{-6} C C. 3.5×10^{-6} C D. 7.1×10^{-6} C E. 1.4×10^{-5} C

35 Copper contains 8.4×10^{28} free electrons/m3. A copper wire of cross-sectional area 7.4×10^{-7} m^2 carries a current of 1 A. The electron drift speed is approximately:

A. 3×10^8 m/s B. 10^3 m/s C. 1m/s D. 10^{-4} m/s E. 10^{-23} m/s

36 The equivalent resistance between points 1 and 2 of the circuit shown is:



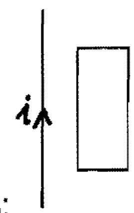
A. 3 Ω B. 4 Ω C. 5 Ω D. 6 Ω E. 7 Ω

37 A cyclotron operates with a given magnetic field and at a given frequency. If R denotes the radius of the final orbit, the final particle energy is proportional to:

A. 1/R B. R C. R^2 D. R^3 E. R^4

38 The magnetic field a distance 2 cm from a long straight current-carrying wire is 2.0×10^{-5} T. The current in the wire is: A. 0.16A B. 1.0A C. 2.0A D. 4.0A E. 25A

39 A long straight wire is in the plane of a rectangular conducting loop. The straight wire initially carries a constant current i in the direction shown. While the current i is being



shut off, the current in the rectangle is:

A. zero B. clockwise C. counterclockwise

D. clockwise in the left side and counterclockwise in the right side

E. counterclockwise in the left side and clockwise in the right side

40 A 150-g block on the end of a spring with a spring constant of 35N/m is pulled aside 25 cm and released from rest. In the electrical analog the maximum charge on the capacitor is 0.25 C. The maximum current in the LC circuit is:

A. 0.38A B. 0.025A C. 40A D. 2.3A E. 5.3A