



School of Indiana Alem Bank Branch Physics Department

Physics Model Exam for 2012 Batch of Grade 12 Natural Science Students in 2013 E.C

Direction:

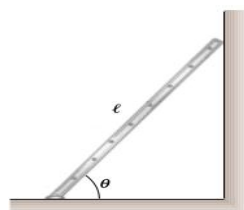
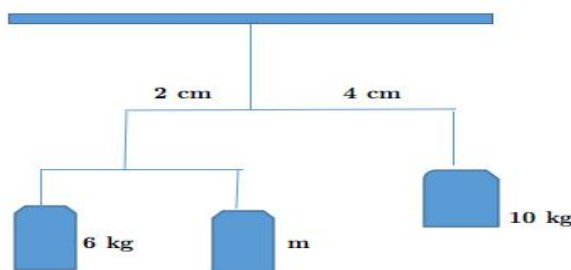
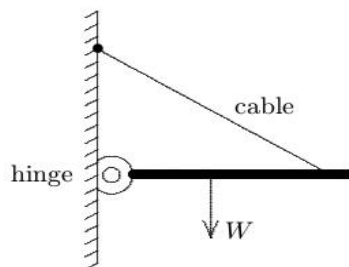
Time allowed: 2hrs

Choose the best answer from the given options and write the correct answer in the separate answer sheet

[Yekatit, 2013 E.C or February 2021]

- 1] A block attached to a spring oscillates in simple harmonic motion along the x axis. The limits of its motion are $x = 10$ cm and $x = 50$ cm and it goes from one of these extremes to the other in 0.25 s. Its amplitude and frequency are:
A] 40 cm, 2 Hz
B] 20 cm, 2 Hz
C] 20 cm, 4 Hz
D] 40 cm, 4 Hz
- 2] In simple harmonic motion, the magnitude of the acceleration is greatest when:
A] the displacement is zero
B] the speed is maximum
C] the displacement is maximum
D] the force is zero
- 3] A particle moves in simple harmonic motion according to $x = 2 \cos(50t)$, where x is in meters and t is in seconds. Its maximum velocity in m/s is:
A] $100 \sin(50t)$
B] 100
C] $100 \cos(50t)$
D] 200
- 4] A block attached to a spring undergoes simple harmonic motion on a horizontal frictionless surface. Its total energy is 50 J. When the displacement is half the amplitude, the kinetic energy is:
A] zero
B] 25 J
C] 12.5 J
D] 37.5 J
- 5] The temperature of n moles of an ideal monatomic gas is increased by ΔT at constant volume. The energy Q absorbed as heat, change ΔE_{int} in internal energy, and work W done by the environment are given by:
A] $Q = (5/2)nR\Delta T$, $\Delta E_{int} = 0$, $W = 0$
B] $Q = (3/2)nR\Delta T$, $\Delta E_{int} = (3/2)nR\Delta T$, $W = 0$
C] $Q = (3/2)nR\Delta T$, $\Delta E_{int} = (1/2)nR\Delta T$, $W = -nR\Delta T$
D] $Q = (5/2)nR\Delta T$, $\Delta E_{int} = (3/2)nR\Delta T$, $W = -nR\Delta T$
- 6] Suppose object C is in thermal equilibrium with object A and with object B. The zeroth law of thermodynamics states:
A] that C will always be in thermal equilibrium with both A and B
B] that C must transfer energy to both A and B
C] that A is in thermal equilibrium with B
D] that A cannot be in thermal equilibrium with B
- 7] The “triple point” of a substance is that point for which the temperature and pressure are such that:
A] only liquid and vapor are in equilibrium
B] only solid and vapor are in equilibrium
C] solid, liquid, and vapor are all in equilibrium
D] the temperature, pressure and density are all numerically equal
- 8] According to the first law of thermodynamics, applied to a gas, the increase in the internal energy during any process:
A] equals the heat input minus the work done on the gas
B] equals the heat input plus the work done on the gas
C] equals the work done on the gas minus the heat input
D] is independent of the heat input
- 9] The same energy Q enters four different substances as heat.
The temperature of 3 g of substance A increases by 10 K
The temperature of 4 g of substance B increases by 4 K
The temperature of 6 g of substance C increases by 15 K
The temperature of 8 g of substance D increases by 6 K
Which substance has the greatest specific heat?

- 10] Ten grams of ice at -20°C is to be changed to steam at 130°C . The specific heat of both ice and steam is $0.5 \text{ cal/g} \cdot ^{\circ}\text{C}$. The heat of fusion is 80 cal/g and the heat of vaporization is 540 cal/g . The entire process requires:
- A] 750 cal
B] 6950 cal
C] 1250 cal
D] 7450 cal
- 11] Water (density $= 1.0 \times 10^3 \text{ kg/m}^3$) flows through a horizontal tapered pipe. At the wide end its speed is 4.0 m/s . The difference in pressure between the two ends is $4.5 \times 10^3 \text{ Pa}$. The speed of the water at the narrow end is:
- A] 2.6 m/s
B] 4.0 m/s
C] 3.4 m/s
D] 5.0 m/s
- 12] A boat floating in fresh water displaces $16,000 \text{ N}$ of water. How many newtons of saltwater would it displace if it floats in saltwater of specific gravity 1.17?
- A] 14,500
B] 16,000
C] 17,600
D] 284
- 13] Gases may be distinguished from other forms of matter by their:
- A] lack of color
B] inability to form free surfaces
C] small atomic weights
D] ability to flow
- 14] A horizontal beam of weight W is supported by a hinge and cable as shown. The force exerted on the beam by the hinge has a vertical component that must be:
- A] nonzero and up
B] nonzero and down
C] zero
D] equal to W
- 15] A uniform plank is 6.0 m long and weighs 80 N . It is balanced on a sawhorse at its center. An additional 160 N weight is now placed on the left end of the plank. To keep the plank balanced, it must be moved what distance to the left?
- A] 6.0 m
B] 1.5 m
C] 2.0 m
D] 1.0 m
- 16] A mobile is constructed of light rods, light strings, and beach souvenirs, as shown in the Figure below. Determine the mass m of the object.
- A] 20 kg
B] 26 kg
C] 14 kg
D] 12 kg
- 17] A uniform ladder of length l rests against a smooth, vertical wall (see Fig. below). If the mass of the ladder is m and the coefficient of static friction between the ladder and the ground is μ_s , find the minimum angle $\theta_{\min}$ at which the ladder does not slip.
- A] $\theta_{\min} = \tan^{-1}(1/2\mu_s)$
B] $\theta_{\min} = \sin^{-1}(1/2\mu_s)$
C] $\theta_{\min} = \tan^{-1}(2\mu_s)$
D] $\theta_{\min} = \sin^{-1}(2\mu_s)$
- 18] If the sum of three equal force vectors is equal to zero, the angle between any of two vectors is:
- A] 30°
B] 60°
C] 90°
D] 120°



- 19] Find the unit vector along the direction of the sum of two vectors $\vec{A}$ and $\vec{B}$ lying in the xy plane and given by: $\vec{A} = (2\hat{i} - 2\hat{j})$ m and $\vec{B} = (2\hat{i} + 4\hat{j})$ m
- A] $(4\hat{i} - 2\hat{j})$ m
B] $(4\hat{i} + 2\hat{j})$ m
C] $(4\hat{i} - 2\hat{j})/\sqrt{20}$ m
D] $(4\hat{i} + 2\hat{j})/\sqrt{20}$ m
- 20] Let $\vec{A} = 2\hat{i} + 6\hat{j} - 3\hat{k}$ and $\vec{B} = 4\hat{i} + 2\hat{j} + \hat{k}$. The projection of vector $\vec{A}$ onto $\vec{B}$ is:
- A] 17
B] $17/\sqrt{21}$
C] $17/7$
D] 21
- 21] Which one of the following framework for writing up reports describe what your graphs show?
- A] Error
B] Analysis
C] Results
D] Method
- 22] If you perform the subtraction on $1.002 - 0.998$, the result has:
- A] three significant figures
B] two significant figures
C] one significant figure
D] four significant figures
- 23] Which of the following statement is correct about errors in measurement?
- A] Experimental error is the same as a mistake.
B] Errors occur in every scientific investigation.
C] Errors make measured values same as accepted value.
D] Errors can be avoided by using modern measuring instruments.
- 24] A 3 kg object is moving in a plane, with its x and y coordinates given by $x = t + 1$ and $y = t^3 + 2$, where x and y are in meters and t is in seconds. Find the magnitude of the net force acting on this object at $t = 2$ s.
- A] 12 N
B] 32 N
C] 24 N
D] 48 N
- 25] A 1000 kg car moving on a flat, horizontal road negotiates a curve as shown in Fig. 1. If the radius of the curve is 200 m and the coefficient of static friction between the tires and dry pavement is 0.5, find the maximum speed the car can have and still make the turn successfully.

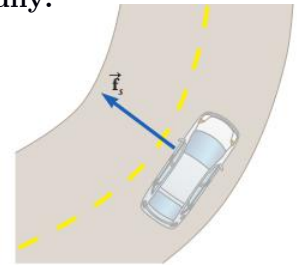


Fig. 1

- 26] A block is given an initial velocity of 10 m/s up a frictionless incline of angle $\theta = 30.0^\circ$ (Fig.2). How far up the incline does the block slide before coming to rest?

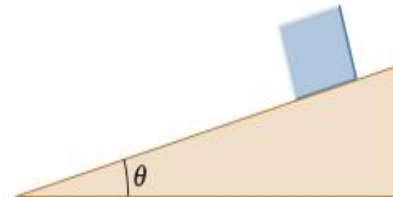


Fig. 2

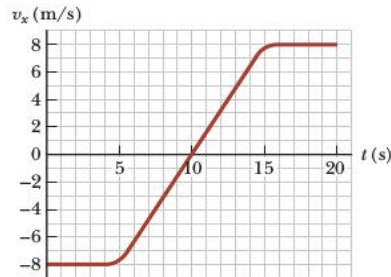
- 27] Three forces acting on an object are given by $\mathbf{F}_1 = (20 \mathbf{i} - 10 \mathbf{j}) \text{ N}$, and $\mathbf{F}_2 = (5 \mathbf{i} + 20 \mathbf{j}) \text{ N}$, and $\mathbf{F}_3 = (-25 \mathbf{i} - 5 \mathbf{j}) \text{ N}$. The mass of an object is 2.5 kg. If the object is initially at rest, what is its speed after 10 s?
- A] 20 m/s
B] 30 m/s
C] 25 m/s
D] 35 m/s

28] An object moves along the x axis according to the equation $x = 3t^2 - 12t + 3$, where x is in meters and t is in seconds. At what time is the object at rest?

- A] 2 s
B] 3 s
C] 5 s
D] 4 s

29] A velocity–time graph for an object moving along the x axis is shown in Figure 3. Determine the average acceleration of the object in the time interval $t = 5\text{ s}$ to $t = 10\text{ s}$ in m/s^2 .

- A] -8
B] 8
C] -4
D] 4



30] Starting at time $t = 0$, an object moves along a straight line. Its coordinate in meters is given by $x(t) = 75t - t^3$, where t is in seconds. When it momentarily stops its acceleration in m/s^2 is:

- A] - 30
B] 30
C] - 40
D] 40

31] A uniform sphere of radius R rotates with an angular velocity ω about a diameter with an angular momentum of magnitude L. Under the action of internal forces the sphere collapses to a uniform sphere of radius $R/4$. The magnitude of its new angular velocity is:

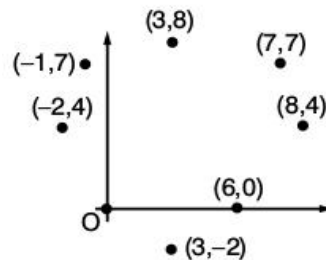
- A] $\omega/4$
B] $\omega/16$
C] 4ω
D] 16ω

32] A skater is spinning with an angular velocity 6 rad/s. The skater has her arms close to her body. Her moment of inertia is 2 kg m^2 . She puts her arms out and her angular velocity decreases to 3 rad/s. What is her moment of inertia now?

- A] 2 kg m^2
B] 4 kg m^2
C] 6 kg m^2
D] 8 kg m^2

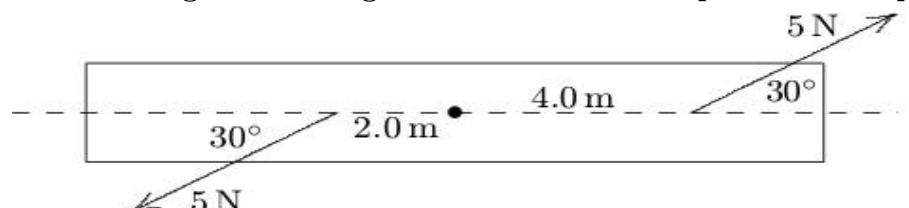
33] Work out the position of the centre of mass for the following system. Each point has a mass of 0.5 kg.

- A] (0.5, 1.0)
B] (1.0, 0.5)
C] (3.4, 4.0)
D] (4.0, 3.4)

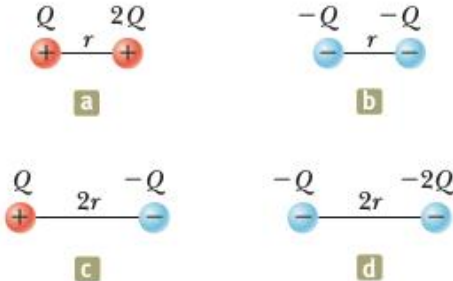


34] A rod is pivoted about its center. A 5-N force is applied 4 m from the pivot and another 5-N force is applied 2 m from the pivot, as shown in Fig. 1. The magnitude of the total torque about the pivot (in $\text{N} \cdot \text{m}$) is:

- A] 5
B] 15
C] 26
D] 8.7



- 35] The magnitude of the acceleration of a point on a spinning wheel is increased by a factor of 4 if:
- A] the magnitudes of the angular velocity and the angular acceleration are each multiplied by a factor of 4
 - B] the magnitudes of the angular velocity and the angular acceleration are each multiplied by a factor of 2
 - C] the magnitude of the angular velocity is multiplied by a factor of 2 and the angular acceleration is not changed
 - D] the magnitude of the angular velocity is multiplied by a factor of 2 and the magnitude of the angular acceleration is multiplied by a factor of 4
- 36] A force $\mathbf{F} = (6 \hat{i} - 2 \hat{j}) \text{ N}$ acts on a particle that undergoes a displacement $\mathbf{r} = (3 \hat{i} + \hat{j}) \text{ m}$. Find the work done by the force on the particle.
- A] - 16
 - B] 16
 - C] - 18
 - D] 18
- 37] A 0.5 kg particle has a speed of 2 m/s at point A and kinetic energy of 7.5 J at point B. What is the total work done on the particle as it moves from A to B?
- A] 8.5 J
 - B] 7.5 J
 - C] 6.5 J
 - D] 5.5 J
- 38] A 800 N Marine in basic training climbs a 10 m vertical rope at a constant speed in 5 s. What is his power output?
- A] 800 J
 - B] 400 J
 - C] 1600 J
 - D] 3200 J
- 39] A 40 kg box initially at rest is pushed 5 m along a rough, horizontal floor with a constant applied horizontal force of 130 N. If the coefficient of friction between box and floor is 0.3, find the net work done?
- A] 10 J
 - B] 40 J
 - C] 50 J
 - D] 80 J
- 40] An object of mass 3 kg, moving with an initial velocity of $5 \hat{i} \text{ m/s}$, collides with and sticks to an object of mass 2 kg with an initial velocity of $-5 \hat{j} \text{ m/s}$. Find the final velocity of the composite object.
- A] $15 \hat{i} - 10 \hat{j}$
 - B] $5 \hat{i} + 20 \hat{j}$
 - C] $3 \hat{i} - 2 \hat{j}$
 - D] $5 \hat{i} + 6 \hat{j}$
- 41] If two light waves are coherent:
- A] their amplitudes are the same
 - B] their frequencies are the same
 - C] their wavelengths are the same
 - D] their phase difference is constant
- 42] In the equation $\sin \theta = \lambda/a$ for single-slit diffraction, θ is:
- A] the angle to the first minimum
 - B] the angle to the second maximum
 - C] the phase angle between the extreme rays
 - D. $N\pi$ where N is an integer

- 43] When a soap bubble is in air, it exhibits different colors under sunlight. The absence of a particular color in a region is due to:
- double refraction
 - straight line propagation of light
 - destructive interference of light of that color in that region
 - constructive interference of light of that color in that region
- 44] Two separate coherent sources produce waves whose wavelengths are 0.1m. Which statement is correct about points that are 3.2m away from one source?
- Constructive interference occurs if the points are 3.0m from the other source.
 - Constructive interference occurs if the points are 3.05m from the other source.
 - Constructive interference occurs if the points are 2.95m from the other source.
 - Destructive interference occurs if the points are 3.2m from the other source.
- 45] Consider a wave passing through a single slit. What happens to the width of the central maximum of its diffraction pattern as the slit is made half as wide?
- It becomes one-fourth as wide.
 - Its width does not change.
 - It becomes one-half as wide.
 - It becomes twice as wide.
- 46] Rank the potential energies of the four systems of particles shown in Figure shown below from largest to smallest. Include equalities if appropriate.
- $U = \frac{2KQ^2}{r}$
 - $U = \frac{KQ^2}{r}$
 - $U = -\frac{KQ^2}{2r}$
 - $U = \frac{KQ^2}{r}$
- 
- 47] The electric potential at $x = 3.00$ m is 120 V, and the electric potential at $x = 5.00$ m is 190 V. What is the x component of the electric field in this region, assuming the field is uniform?
- 2140 N/C
 - 235.0 N/C
 - 35.0 N/C
 - 75.0 N/C
- 48] A proton is released from rest at the origin in a uniform electric field in the positive x direction with magnitude 850 N/C. What is the change in the electric potential energy of the proton-field system when the proton travels to $x = 2.50$ m?
- 3.40×10^{-16} J
 - 2.50×10^{-16} J
 - 23.40×10^{-16} J
 - 22.50×10^{-16} J
- 49] An electron in an x-ray machine is accelerated through a potential difference of 1.00×10^4 V before it hits the target. What is the kinetic energy of the electron in electron volts?
- 1.00×10^4 eV
 - 1.60×10^{-22} eV
 - 1.60×10^{-15} eV
 - 6.25×10^{22} eV
- 50] A parallel-plate capacitor is connected to a battery. What happens to the stored energy if the plate separation is doubled while the capacitor remains connected to the battery?
- It is doubled.
 - It decreases by a factor of 4.
 - It decreases by a factor of 2.
 - It increases by a factor of 4.