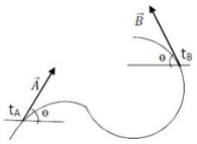
		Surname		Type
Group Number		Name		A
List Number		e-mail		
Student ID		Signature		

ATTENTION:Each question has only one correct answer and is worth one point. Be sure to fill in completely the circle that corresponds to your answer on the answer sheet. Use a pencil (not a pen). Only the answers on your answer sheet will be taken into account.

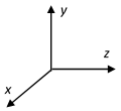
1. The position of a toy locomotive on a straight track along the x-axis is given by the equation $x(t) = t^3 - 6t^2 + 9t$, where x in meters and t is in seconds. When the path taken is the maksimum?
(a) $5s$ (b) $1s$ (c) $2s$ (d) *zero* (e) $4s$

2. An object travels along a path shown in the figure, with changing velocity as indicated by vectors $\overrightarrow{A}$ and $\overrightarrow{B}$ with the same magnitude.Which vector best represents the average acceleration of the object from time t_A to t_B?
(a) ↙ (b) ↘ (c) ⟵ (d) ⟶ (e) ↖

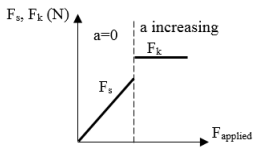


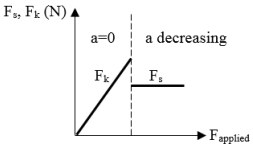
3. Which of the following is correct for the normal forces?
(a) its magnitude is always equal to the weight. (b) the value of the normal forces is different for static and kinetic frictions. (c) it is not determined if there is no friction. (d) the magnitude is higher than the weight if the surface is inclined. (e) it is always perpendicular to the surface.

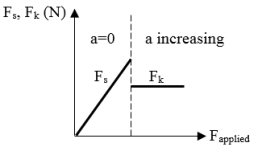
4. Which of the following is incorrect for the reference frame shown in figure. Here $\hat{i}$, $\hat{j}$, and $\hat{k}$ are the unit vectors for x, y, and z axis, respectively.
(a) $(\hat{j} \times \hat{i}) \bullet \hat{k} = +1$ (b) $(\hat{j} \times \hat{k}) \bullet \hat{i} = -1$ (c) $\hat{i} \times \hat{k} = \hat{j}$ (d) $(\hat{j} \times \hat{i}) \times \hat{k} = 0$ (e) $\hat{i} \times \hat{j} = \hat{k}$

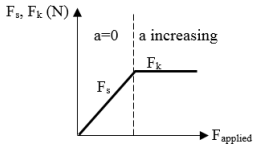


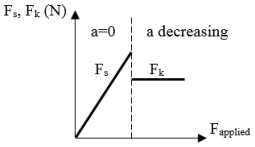
5. Which graph of the following is correct for F_s (static friction), and F_k (kinetic friction)?

(a)


(b)


(c)


(d)


(e)


6. If the air resistance is negligible, the sum of the potential and the kinetic energies of a freely falling body .....
(a) decreases (b) increases (c) is zero (d) first increases and then decreases (e) remains the same

7. Which of the following are correct?
1. Spring force is a conservative force.
2. Work done by a conservative force is always zero.
3. Frictional force is a conservative force for a closed orbit.
4. The work done by a conservative force for a closed orbit is zero.

(a) 1,2 and 4 (b) 2 and 4 (c) 1 and 4 (d) All are true (e) only 1

8. Which of the following statement is false?
(a) The total energy is preserved in the friction environment.
(b) Change in the potential energy equals to negative of the work done by a conservative force.
(c) Change in the potential energy equals to the work done by a conservative force.
(d) Change in the kinetic energy is equal to the work done.
(e) Mechanical energy is conserved in a frictionless environment.

9. Which of the following is wrong about the uniform circular motion?
(a) Angular speed is constant. (b) Magnitude of the velocity vector is constant. (c) None. (d) Acceleration vector is constant. (e) Angular frequency is constant.

10. An object is thrown with horizontal speed $v_0 = 10\,m/s$ from a height H. If the range of the object is also equal to H, which of the following is the time passing until the object hit the ground? (Take $g = 10\,m/s^2$.)
(a) $1\,s$ (b) $2\,s$ (c) $3\,s$ (d) $1/2\,s$ (e) $1/3\,s$

11. Assume that the air pressure is calculated with the formula $P = \alpha h^x g^y d^z$ where α is a dimensionless constant, P is the pressure, h is the height, g is the gravitational acceleration, and d is the density of the air; x, y, and z are also numerical constants. What is the value of x?
(a) 1 (b) 3 (c) 2 (d) 3/2 (e) 1/2

Questions 12-16

For $\overrightarrow{A}$ and $\overrightarrow{B}$ vectors given as $\overrightarrow{A} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ and $\overrightarrow{B} = -3\hat{i} - 4\hat{j} + \hat{k}$

12. Find a unit vector in the same direction with $\overrightarrow{B}$.
(a) $-3\hat{i} - 4\hat{j} + \hat{k}$ (b) $\frac{-3\hat{i}-4\hat{j}+\hat{k}}{\sqrt{8}}$ (c) $\frac{+3\hat{i}+4\hat{j}-\hat{k}}{\sqrt{8}}$ (d) $\frac{-3\hat{i}-4\hat{j}+\hat{k}}{\sqrt{26}}$ (e) $\frac{-3\hat{i}-4\hat{j}+\hat{k}}{2}$

13. Calculate $\overrightarrow{A} \bullet \overrightarrow{B}$?
(a) -14 (b) 4 (c) -12 (d) 10 (e) -16

14. Calculate $\overrightarrow{A} \times \overrightarrow{B}$?
(a) $14\hat{i} - 17\hat{j} - 10\hat{k}$ (b) $14\hat{i} - 13\hat{j} - 17\hat{k}$ (c) $13\hat{i} - 14\hat{j} - 17\hat{k}$ (d) $-13\hat{i} + 14\hat{j} - 17\hat{k}$ (e) $-13\hat{i} + 14\hat{j} + 17\hat{k}$

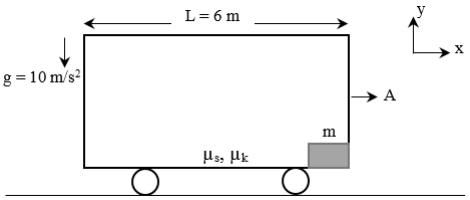
15. Find a unit vector, $\hat{c}$, which is perpendicular to the plane formed by $\overrightarrow{A}$ and $\overrightarrow{B}$ vectors.

(a) $\hat{c} = \pm\frac{14\hat{i}-13\hat{j}-17\hat{k}}{\sqrt{(13)^2+(-14)^2+(-17)^2}}$ (b) $\hat{c} = \pm\frac{13\hat{i}+14\hat{j}-17\hat{k}}{\sqrt{(13)^2+(-14)^2+(-17)^2}}$ (c) $\hat{c} = \pm\frac{14\hat{i}-17\hat{j}-10\hat{k}}{\sqrt{(13)^2+(-14)^2+(-17)^2}}$ (d) $\hat{c} = \pm\frac{13\hat{i}-14\hat{j}-17\hat{k}}{\sqrt{(13)^2+(-14)^2+(-17)^2}}$
(e) $-13\hat{i} + 14\hat{j} + 17\hat{k}$

16. Calculate the cosine of the angle between $\overrightarrow{A}$ and $\overrightarrow{B}$ vectors.
(a) $\frac{-14}{\sqrt{29}\cdot\sqrt{26}}$ (b) $\frac{10}{\sqrt{29}\cdot\sqrt{26}}$ (c) $\frac{-16}{\sqrt{29}\cdot\sqrt{26}}$ (d) $\frac{-4}{\sqrt{29}\cdot\sqrt{26}}$ (e) $\frac{-12}{\sqrt{29}\cdot\sqrt{26}}$

Questions 17-21

A truck of length $L = 6\ m$, initially at rest, starts moving with a constant acceleration A at $t = 0$. A block of mass $m = 2\ kg$ inside the truck is initially at rest and *barely touching* the front wall of the truck. The coefficient of static and kinetic frictions between the block and the truck are $\mu_s = 0.8$ and $\mu_k = 0.6$, respectively ($g = 10\ m/s^2$).



17. Which of the following is the minimum value of the A such that the block m starts sliding?
(a) $5\ m/s^2$ (b) $7\ m/s^2$ (c) $9\ m/s^2$ (d) $6\ m/s^2$ (e) $8\ m/s^2$

18. If $A = 9\ m/s^2$, which of the following is the acceleration vector of the block with respect to the truck?
(a) $2\hat{i}\ m/s^2$ (b) $3\hat{i}\ m/s^2$ (c) $-3\hat{i}\ m/s^2$ (d) $-2\hat{i}\ m/s^2$ (e) $-3/2\hat{i}\ m/s^2$

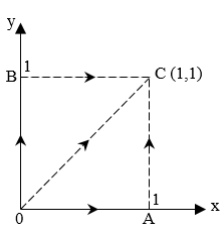
19. If $A = 6\ m/s^2$, which of the following is the magnitude of the friction force acting on the block?
(a) $10\ N$ (b) $12\ N$ (c) $8\ N$ (d) $14\ N$ (e) $16\ N$

20. If $A = 9\ m/s^2$, which of the following is the time required for the block to reach the back side of the truck?
(a) $2\ s$ (b) $3\ s$ (c) $\sqrt{3}\ s$ (d) $\sqrt{2}\ s$ (e) $1\ s$

21. If $A = 9\ m/s^2$, which of the following is the velocity vector of the block with respect to the ground when it reaches the back side?
(a) $12\hat{i}\ m/s$ (b) $-10\hat{i}\ m/s$ (c) $-8\hat{i}\ m/s$ (d) $10\hat{i}\ m/s$ (e) $8\hat{i}\ m/s$

Questions 22-25

A variable force acting on a particle of mass m moving in the xy-plane is given by $\vec{F}(x, y) = ax^2\hat{i} + by^2\hat{j}$ where a and b are constants. This particle moves from origin to point C with coordinates $(1, 1)$ through the three different paths: $O \to A \to C$, $O \to B \to C$, and $O \to C$.



22. Find the work done by $\vec{F}$ when the particle takes the path $O \to A \to C$, W_{OAC}=?
(a) $(2a + b)/3$ (b) $(a + 2b)/3$ (c) $(a - b)/3$ (d) $(2a - b)/3$ (e) $(a + b)/3$

23. Find the work done by $\vec{F}$ when the particle takes the path $O \to B \to C$, W_{OBC}=?
(a) $(a + b)/3$ (b) $(2a - b)/3$ (c) $(2a + b)/3$ (d) $(a + 2b)/3$ (e) $(a - b)/3$

24. Find the work done by $\vec{F}$ when the particle takes the path $O \to C$, W_{OC}=?
(a) $(a - b)/3$ (b) $(2a + b)/3$ (c) $(a + 2b)/3$ (d) $(a + b)/3$ (e) $(2a - b)/3$

25. Which of the followings are true?
1. This force can be a conservative force. **2.** This force can be a kind of frictional force. **3.** $W_{OACBO} = 0$.
4. $W_{OBCO} = b - a$.
(a) 2 (b) 1, 4 (c) 2, 4 (d) 1, 3 (e) 3, 4