PHYS 110 Midterm I answers – Spring 2022

Note that the exam *you* had may have had questions in a different order, and may have had answers to questions in a different order. Any material posted that refers to 'your' answers have had the answers rearranged so they correspond to this version of the exam.

1. This is test version 'A'. Put 'A' as the answer to this question.

   (a) A
   (b) B
   (c) C
   (d) D
   (e) E

Consider the following three vectors:

$$\begin{aligned} \vec{A} &= 2.0\hat{\imath} + 4.0\hat{\jmath} \\ \vec{B} &= 1.0\hat{\imath} + 3.0\hat{k} \\ \vec{C} &= 2.0\hat{\jmath} + 2.0\hat{k} \end{aligned} \tag{1}$$

2. What is $\left|\vec{A} - 2\vec{B}\right|$?

   (a) 3.16
   (b) 4.47
   (c) *** 7.21
   (d) 8.25
   (e) 10.79

3. What is $\vec{A} \times \vec{B}$?

   (a) $2\hat{\imath}$
   (b) $3\hat{\imath} + 4\hat{\jmath} + 3\hat{k}$
   (c) $4\hat{\imath} - 6\hat{\jmath} + 2\hat{k}$
   (d) $8\hat{\imath} - 4\hat{\jmath} + 4\hat{k}$
   (e) *** $12\hat{\imath} - 6\hat{\jmath} - 4\hat{k}$

4. What is $\left(\vec{B} - \vec{C}\right) \cdot \vec{A}$.

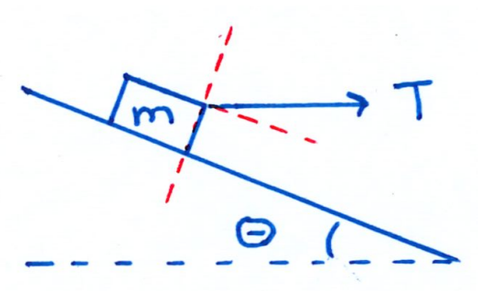
   (a) -10
   (b) *** -6
   (c) 2
   (d) 8
   (e) 10

5. What is the angle between $\vec{B}$ and $\vec{C}$?

   (a) 8.4°
   (b) 20°
   (c) 42°
   (d) *** 48°
   (e) 70°

A box of mass m sits on a rough slope with which it has a coefficient of static friction μ. It is subject to a force of magnitude T which pulls horizontally to the right. The slope makes an angle of θ with the horizontal.

This is shown in the diagram below.



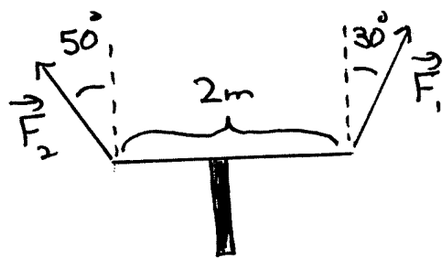
6. As T increases what happens to the magnitudes of the normal and friction forces?
   (a) $\left|\vec{F}_f\right|$ increases and $\left|\vec{F}_n\right|$ increases
   (b) $\left|\vec{F}_f\right|$ decreases and $\left|\vec{F}_n\right|$ increases
   (c) *** $\left|\vec{F}_f\right|$ increases and $\left|\vec{F}_n\right|$ decreases
   (d) $\left|\vec{F}_f\right|$ decreases and $\left|\vec{F}_n\right|$ decreases
   (e) $\left|\vec{F}_f\right|$ is constant and $\left|\vec{F}_n\right|$ increases

7. Suppose that $m = 10kg$, $\theta = 20°$, and $T = 35N$. What is the magnitude of the normal force?
   (a) $63N$
   (b) *** $80N$
   (c) $86N$
   (d) $92N$
   (e) $98N$

8. Suppose that $m = 10kg$, $\theta = 20°$, and $T = 35N$. What is the magnitude of the friction force?
   (a) $33N$
   (b) $48N$
   (c) *** $66N$
   (d) $79N$
   (e) $98N$

9. Suppose that $m = 10kg$, $\theta = 20°$, and $T = 35N$. What angle does the net force the ground exerts, $\vec{F}_f + \vec{F}_N$, make with the direction straight up ($\hat{k}$)?
   (a) *** $20°$
   (b) $40°$
   (c) $45°$
   (d) $50°$
   (e) $70°$

A uniform bar of length $L = 2m$ and mass $25kg$ rests horizontally on a pillar at its center. The right end of the bar is attached to a rope which exerts force $\vec{F}_1$ up and to the right making an angle of 30° with the vertical. The left end of the bar is attached to a rope which pulls with force $\vec{F}_2$ up and to the left making an angle of 50° with the vertical.



10. If the magnitude of $\vec{F}_1$ were an unknown value T, which of the following expressions would represent the magnitude and direction of the torque produced by $\vec{F}_1$ about the center of the bar?

    (a) (1m T 0.50) out of the page
    (b) *** (1m T 0.87) out of the page
    (c) (1m T) out of the page
    (d) (1m T 0.50) into the page
    (e) (1m T 0.87) into the page

11. The magnitude of $\vec{F}_1$ is T. What is the magnitude of $\vec{F}_2$?

    (a) $0.65T$
    (b) $0.78T$
    (c) $0.92T$
    (d) $1.13T$
    (e) *** $1.35T$

12. What is the x-component of the friction force the pillar exerts on the bar?

    (a) $-0.87\left|\vec{F}_1\right| + 0.64\left|\vec{F}_2\right|$
    (b) $-0.87\left|\vec{F}_1\right| + 0.77\left|\vec{F}_2\right|$
    (c) $-0.50\left|\vec{F}_1\right| + 0.64\left|\vec{F}_2\right|$
    (d) *** $-0.50\left|\vec{F}_1\right| + 0.77\left|\vec{F}_2\right|$
    (e) $-0.64\left|\vec{F}_1\right| + 0.87\left|\vec{F}_2\right|$

13. If $T = 40N$, what is the minimum value of μ needed for equilibrium?

    (a) $\mu = 0.09$
    (b) *** $\mu = 0.12$
    (c) $\mu = 0.17$
    (d) $\mu = 0.21$
    (e) $\mu = 0.25$

At time $t = 1s$ a particle is at $1m\hat{\imath} - 3m\hat{\jmath}$. At this moment its speed is $5\frac{m}{s}$ in a direction which makes an angle of 53° with $\hat{\imath}$ and 37° with $\hat{\jmath}$. It undergoes constant acceleration $\vec{a} = 2\frac{m}{s^2}\hat{\imath} - 2\frac{m}{s^2}\hat{\jmath}$.

14. What is $\vec{r}(4s)$?

    (a) *** $19m\hat{\imath}$
    (b) $22m\hat{\imath} - 3m\hat{\jmath}$
    (c) $28m\hat{\imath} - 9m\hat{\jmath}$
    (d) $29m\hat{\imath} - 3m\hat{\jmath}$
    (e) $45m\hat{\imath} - 19m\hat{\jmath}$

15. What is the speed of the particle at $t = 4.0s$?

    (a) *** $9.2\frac{m}{s}$
    (b) $10.4\frac{m}{s}$
    (c) $11.7\frac{m}{s}$
    (d) $17.0\frac{m}{s}$
    (e) $22.5\frac{m}{s}$

16. At the time $t = 4.0s$ what angle does the velocity $\vec{v}$ make with $\hat{\jmath}$?

    (a) *** 103°
    (b) 107°
    (c) 110°
    (d) 118°
    (e) 122°

17. What is the second time after $t = 1s$ when the y-component of $\vec{r}$ is $-2m$?

    (a) $1.3s$
    (b) $1.6s$
    (c) $3.0s$
    (d) $4.4s$
    (e) *** $4.7s$

A particle's position as a function of time is given by

$$\vec{r}(t) \quad = \quad 3m \sin\left(2s^{-1}t\right)\hat{\imath} - 3m\cos\left(2s^{-1}t\right)\hat{\jmath} + \left(4\frac{\mathrm{m}}{\mathrm{s}}t\right)\hat{k}$$

18. What is the particle's speed at $t = 1.57s$?

    (a) $4.0\frac{m}{s}$
    (b) $5.3\frac{m}{s}$
    (c) $6.0\frac{m}{s}$
    (d) *** $7.2\frac{m}{s}$
    (e) $8.7\frac{m}{s}$

19. What angle does the particle's velocity make with the z-axis (with $\hat{k}$) at $t = 1.57s$?

    (a) $0°$
    (b) $34°$
    (c) *** $56°$
    (d) $90°$
    (e) $124°$

20. What is the magnitude of the particle's acceleration at $t = 1.57s$?

    (a) $0\frac{m}{s^2}$
    (b) $3\frac{m}{s^2}$
    (c) $6\frac{m}{s^2}$
    (d) *** $12\frac{m}{s^2}$
    (e) $24\frac{m}{s^2}$

21. What is the unit vector in the direction of the acceleration at $t = 1.57s$?

    (a) $\hat{\imath}$
    (b) $\hat{\jmath}$
    (c) $\hat{k}$
    (d) $-\hat{\imath}$
    (e) *** $-\hat{\jmath}$

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End of Exam