PHYS 110 Midterm II 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

A $7kg$ mass travels at a speed of $5\frac{m}{s}$ along a line which makes an angle of $37°$ with $\hat{\imath}$ and $53°$ with $\hat{\jmath}$. A $6kg$ mass travels at $8\frac{m}{s}$ along a line which makes an angle of $120°$ with $\hat{\imath}$ and $150°$ with $\hat{\jmath}$.

The two masses collide. After the collision the $6kg$ mass has velocity $-4\frac{m}{s}\hat{\jmath}$.

2. What is the magnitude of the total momentum before the collision? In other words what is $|\vec{p}_{total}|$?

   (a) $13kg\frac{m}{s}$
   (b) *** $21kg\frac{m}{s}$
   (c) $35kg\frac{m}{s}$
   (d) $48kg\frac{m}{s}$
   (e) $83kg\frac{m}{s}$

3. What is the speed of the $7kg$ mass after the collision? In other words what is $|\vec{v}_{7,f}|$?

   (a) $0.0\frac{m}{s}$
   (b) $0.56\frac{m}{s}$
   (c) *** $0.75\frac{m}{s}$
   (d) $3.4\frac{m}{s}$
   (e) $5.3\frac{m}{s}$

4. What angle does $\vec{v}_7$ make with $\hat{\imath}$ after the collision?

   (a) *** $41°$
   (b) $49°$
   (c) $90°$
   (d) $131°$
   (e) $139°$

5. The collision took $0.1s$. What was the magnitude of the average force on the $6kg$ mass?

   (a) $53N$
   (b) $149N$
   (c) $241N$
   (d) *** $297N$
   (e) It cannot be determined.

A $50kg$ mass is at $\vec{r}_1 = 7m\hat{\jmath}$.
An object with mass $30kg$ and charge $8 \times 10^{-9}C$ is at $\vec{r}_2 = 4m\hat{\imath} + 4m\hat{\jmath}$.
A $5 \times 10^{-10}C$ charge is at $\vec{r}_3 = 4m\hat{\imath}$.

6. What is the force on the $30kg$ object due to the $50kg$ mass?

   (a) $\vec{F} = 3.2 \times 10^{-9}N\hat{\imath} + 2.4 \times 10^{-9}N\hat{\jmath}$
   (b) $\vec{F} = 3.2 \times 10^{-9}N\hat{\imath} - 2.4 \times 10^{-9}N\hat{\jmath}$
   (c) *** $\vec{F} = -3.2 \times 10^{-9}N\hat{\imath} + 2.4 \times 10^{-9}N\hat{\jmath}$
   (d) $\vec{F} = -3.2 \times 10^{-9}N\hat{\imath} - 2.4 \times 10^{-9}N\hat{\jmath}$
   (e) $\vec{F} = 4.0 \times 10^{-9}N\hat{\jmath}$

7. What is the magnitude of the net force on the object at $\vec{r}_2$ due to the mass and the charge?

   (a) $1.8 \times 10^{-9}N$
   (b) $2.6 \times 10^{-9}N$
   (c) $3.2 \times 10^{-9}N$
   (d) *** $5.6 \times 10^{-9}N$
   (e) $6.3 \times 10^{-9}N$

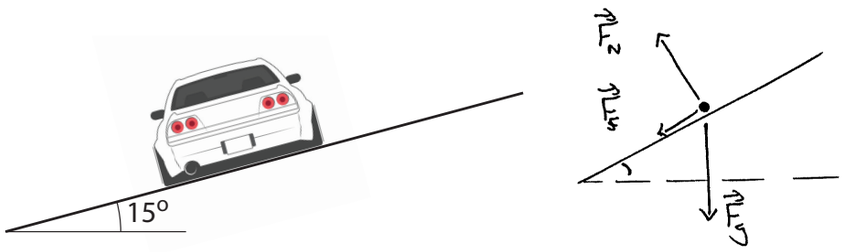
8. What angle does the net force on the object at $\vec{r}_2$ due to the mass and the charge make with $\hat{\imath}$?

   (a) $24°$
   (b) $55°$
   (c) $111°$
   (d) *** $125°$
   (e) $156°$

9. Suppose that the charge on the object at $\vec{r}_3$ was instead $-5 \times 10^{-10}C$. How would $\vec{F}_{net}$ change

   (a) Its magnitude would increase and the angle it makes with $\hat{\imath}$ would increase.
   (b) Its magnitude would increase and the angle it makes with $\hat{\imath}$ would decrease.
   (c) *** Its magnitude would decrease and the angle it makes with $\hat{\imath}$ would increase.
   (d) Its magnitude would decrease and the angle it makes with $\hat{\imath}$ would stay constant.
   (e) Its magnitude would decrease and the angle it makes with $\hat{\imath}$ would decrease.

A car of mass $1500kg$ travels in a circle of radius $50m$ at a speed of $20\frac{m}{s}$. It is on a track that is banked (sloped) towards the inside of the curve at an angle of $15°$ with the horizontal. The coefficient of static friction between the car and the slope is $\mu = 0.70$.



10. What is the magnitude of the net force on the car?

    (a) $0.27 \times 10^4 N$
    (b) $0.99 \times 10^4 N$
    (c) $1.03 \times 10^4 N$
    (d) *** $1.20 \times 10^4 N$
    (e) $1.47 \times 10^4 N$

11. The equation we obtain by considering the vertical component of Newton's second law is

$$0 = \frac{\left|\vec{F}_N\right|}{m}\cos 15 - \frac{\left|\vec{F}_f\right|}{m}\sin 15 - g \qquad (1)$$

    What equation do we obtain by considering the horizontal component of Newton's second law?

    (a) *** $-|\vec{a}| = -\frac{|\vec{F}_N|}{m}\sin 15 - \frac{|\vec{F}_f|}{m}\cos 15$
    (b) $-|\vec{a}| = -\frac{|\vec{F}_N|}{m}\sin 15 + \frac{|\vec{F}_f|}{m}\cos 15$
    (c) $-|\vec{a}| = \frac{|\vec{F}_N|}{m}\sin 15 - \frac{|\vec{F}_f|}{m}\cos 15$
    (d) $-|\vec{a}| = \frac{|\vec{F}_N|}{m}\sin 15 + \frac{|\vec{F}_f|}{m}\cos 15$
    (e) $-|\vec{a}| = -\frac{|\vec{F}_N|}{m}\cos 15 + \frac{|\vec{F}_f|}{m}\sin 15$

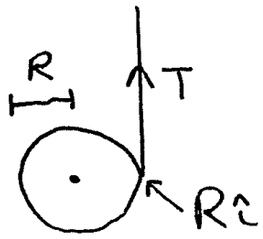
12. What is the magnitude of the friction force on the car?

    (a) *** $0.78 \times 10^4 N$
    (b) $0.95 \times 10^4 N$
    (c) $1.23 \times 10^4 N$
    (d) $1.73 \times 10^4 N$
    (e) $2.51 \times 10^4 N$

13. The car's speed $|\vec{v}|$ increases. What happens to the magnitudes of the normal and friction forces?

    (a) $\left|\vec{F}_N\right|$ decreases and $\left|\vec{F}_f\right|$ decreases.
    (b) $\left|\vec{F}_N\right|$ decreases and $\left|\vec{F}_f\right|$ increases.
    (c) $\left|\vec{F}_N\right|$ increases and $\left|\vec{F}_f\right|$ decreases.
    (d) $\left|\vec{F}_N\right|$ increases and $\left|\vec{F}_f\right|$ remains constant.
    (e) *** $\left|\vec{F}_N\right|$ increases and $\left|\vec{F}_f\right|$ increases.

A disk of mass $m = 5kg$, radius $R = 0.1m$, and moment of inertia $I = 0.02kgm^2$ is held with its center at the origin. A light and inextensible rope which is under tension T pulling upward (in the $\hat{k}$ direction) is wrapped around the disk and leaves contact with the disk at $R\hat{\imath}$.



The disk is released from rest.

14. What is the value of $\frac{d}{dt}\vec{L}$ for this disk measured around the center of disk at the moment described?

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

15. The equation from applying Newton's second law is $|\vec{a}| = g - \frac{T}{m}$, from applying that the rope does not slip is $R\frac{d^2\theta}{dt^2} = |\vec{a}|$, and from applying dynamics of angular momentum we find $RT = I\frac{d^2\theta}{dt^2}$. What is $|\vec{a}|$?

    (a) $\frac{I}{mR^2+I}g$
    (b) *** $\frac{mR^2}{mR^2+I}g$
    (c) $\frac{I}{|mR^2-I|}g$
    (d) $\frac{mR^2}{|mR^2-I|}g$
    (e) $\frac{mR^2+I}{mR^2I}g$

16. What is the tension in the rope?

    (a) *** $14N$
    (b) $20N$
    (c) $30N$
    (d) $35N$
    (e) $49N$

17. If the disk were more spread out, so that I was bigger while m and R stayed the same

    (a) T would decrease and $|\vec{a}|$ would decrease.
    (b) T would remain constant and $|\vec{a}|$ would decrease.
    (c) *** T would increase and $|\vec{a}|$ would decrease.
    (d) T would decrease and $|\vec{a}|$ would increase.
    (e) T would remain constant and $|\vec{a}|$ would increase.

A very thin object of mass $8kg$ is held between two springs and restricted to move on the x-axis. The spring to the object's left has an unstretched length of $0.2m$, a spring constant $k = 100\frac{N}{m}$, the left end is attached to the origin, and the right end attached to the object. The spring to the object's right has an unstretched length of $0.3m$, a spring constant of $k = 60\frac{N}{m}$, the left is attached to the object and the right end is attached to $0.4m\hat{\imath}$.

The object is at $0.15m\hat{\imath}$

18. What is the force on the object due to the spring to the left?

    (a) *** $5N\hat{\imath}$

    (b) $9N\hat{\imath}$

    (c) $12N\hat{\imath}$

    (d) $15N\hat{\imath}$

    (e) $18N\hat{\imath}$

19. What is the object's acceleration?

    (a) $-1.3\frac{m}{s}\hat{\imath}$

    (b) *** $-0.5\frac{m}{s}\hat{\imath}$ *This question was edited inconsistently during exam preparation; this is the closest value to the acceleration for the situation described.*

    (c) $1.8\frac{m}{s}\hat{\imath}$

    (d) $2.9\frac{m}{s}\hat{\imath}$

    (e) $4.1\frac{m}{s}\hat{\imath}$

A block of mass $3kg$ and charge $q = -2C$ is at $-2m\hat{\imath} + 3m\hat{\jmath}$ travelling at a velocity of $3\frac{m}{s}\hat{\imath} - 4\frac{m}{s}\hat{k}$ in a region where $\vec{B} = 5T\hat{\jmath}$

20. What is the magnitude of the block's angular momentum around the origin?

    (a) $17kg\frac{m^2}{s}$

    (b) $27kg\frac{m^2}{s}$

    (c) $34kg\frac{m^2}{s}$

    (d) *** $51kg\frac{m^2}{s}$

    (e) $54kg\frac{m^2}{s}$

21. What is the Lorentz force on the block?

    (a) $0N$

    (b) *** $-40N\hat{\imath} - 30N\hat{k}$

    (c) $-40N\hat{\imath} + 30N\hat{k}$

    (d) $40N\hat{\imath} - 30N\hat{k}$

    (e) $40N\hat{\imath} + 30N\hat{k}$

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End of Exam