**Q1.**

Find the mass of a solid cylinder of copper with a radius of 5.00 cm and a height of 10.0 inches if the density of copper is 8.90 $g/cm^3$ (1 inch is equivalent to 2.54 cm).

A) 17.8 kg
B) 10.5 kg
C) 5.43 kg
D) 0.457 kg
E) 13.3 kg

**Ans:**

$$r = 5.00\ \text{cm} = 5 \times 10^{-2}\ \text{m}$$

$$h = (10.0\ \text{in})\left(2.54\ \frac{\text{cm}}{\text{in}}\right)\left(\frac{1\ \text{m}}{100\ \text{cm}}\right) = 0.254\ \text{m}$$

$$\rho = 8.90\left(\frac{\text{g}}{\text{cm}^3}\right)\left(\frac{10^2\ \text{cm}}{1\ \text{m}}\right)^3\left(\frac{1\ \text{kg}}{10^3\ \text{g}}\right)$$

$$= 8.90 \times 10^3\ \text{kg/m}^3$$

$$\therefore m = \rho\,\pi r^2 h = (8.90 \times 10^3)\left(\frac{22}{7}\right)(25 \times 10^{-4})\,(0.254) = 17.76 = 17.8\ \text{kg}$$

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Q2.

Suppose the speed of a wave on a string is given by $v = K\,\tau^m \mu^n$, where K is a dimensionless constant, $\tau$ is the tension in the string, and $\mu$ is the mass per unit length of the string. Find the values of *m* and *n*.

A) $m = +1/2$, $n = -1/2$
B) $m = +1/2$, $n = +1/2$
C) $m = -1/2$, $n = -1/2$
D) $m = +3/2$, $n = -3/2$
E) $m = +1/2$, $n = -3/2$

**Ans:**

$$[v] = [\tau^m][\mu^n]$$

$$LT^{-1} = (MLT^{-2})^m (ML^{-1})^n$$

$$LT^{-1} = M^m L^m T^{-2m} M^n L^{-n} = M^{m+n}\, L^{m-n} T^{-2m}$$

$$-2m = -1 \Rightarrow m = \frac{1}{2}$$

$$m + n = 0 \Rightarrow n = -m = -\frac{1}{2}$$

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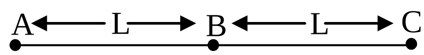
**Q3.**

A car driver maintains a speed of 20 km/hr for the first half of the distance to his destination. In order to have an average speed of 30 km/hr for the entire trip he has to maintain for the last half of the trip a speed of:

A) 60 km/hr
B) 40 km/hr
C) 50 km/hr
D) 45 km/hr
E) 35 km/hr

**Ans:**




$$(v_{avg})_{total} = \frac{2L}{t_{total}} = \frac{2L}{t_{AB}+L_{BC}} = \frac{2L}{\frac{L}{20}+\frac{L}{v_{avg}}}$$

$$30 = \frac{2}{\frac{1}{20}+\frac{1}{v}} \Longrightarrow 30\left(\frac{1}{20}+\frac{1}{v}\right) = 2$$

$$\therefore \frac{v+20}{20\,v} = \frac{1}{15} \Rightarrow 15\,v + 300 = 20\,v \Rightarrow 5v = 300 \Rightarrow v = 60\ km/hr$$

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**Q4.**

Sitting on the top of a building, you drop (release) a stone while you throw a second stone downward. Which curves in **Figure 1** give the velocity $v(t)$ for the dropped stone and the thrown stone, respectively?

A) Curves A and B.
B) Curves A and C.
C) Curves B and D.
D) Curves C and B.
E) Curves D and C.

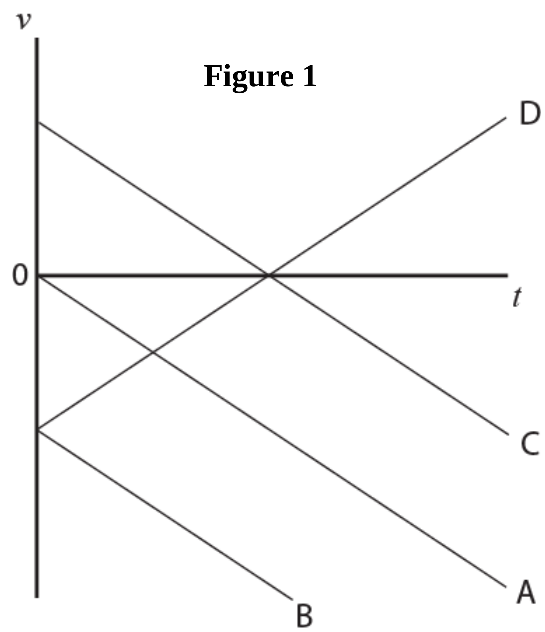



**Figure 1**

**Ans:**

**A**

**Q5.**

The velocity of a truck moving in a straight line is given by $v(t) = t^3 - t^2 - 2.0\,t$ where $v$ is in m/s and $t$ is in seconds. Find the velocity of the truck at the instant when its acceleration is 6.0 m/s$^2$.

A) 0
B) +8.0 m/s
C) −8.0 m/s
D) +4.0 m/s
E) −4.0 m/s

**Ans:**

$v\,(t) = t^3 - t^2 - 2t$

$a\,(t) = 3t^2 - 2t - 2 = 6$

$\therefore 3t^2 - 2t - 8 = 0$

$$t = \frac{+2 \pm \sqrt{4+96}}{6} = \frac{2 \pm \sqrt{100}}{6}\ ;\ t = 2s$$

$\therefore v(2) = 12 - 4 - 8 = 0$

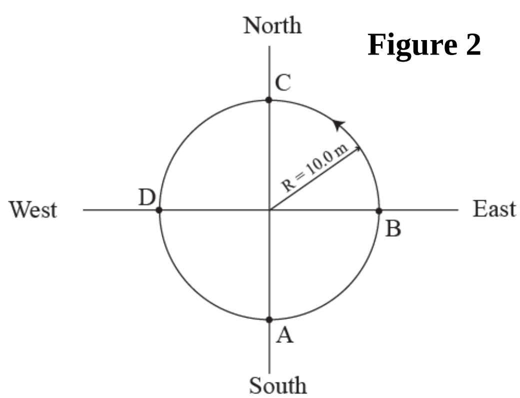
---

**Q6.**

An object is in a uniform circular motion in a horizontal circle of radius 10.0 m. If it completes 2.50 rotations in 10.0 s, starting at point A (**Figure 2**), find its **average velocity**.

A) 2.00 m/s toward North
B) 2.00 m/s toward South
C) 15.7 m/s toward East
D) 15.7 m/s toward West
E) 8.86 m/s toward West

**Figure 2**




**Ans:**

$\vec{D} = \overrightarrow{AC} = 20$ m North

$\vec{v} = 20/10 = 2.00$ m/s North

**Q7.**

Which of the following is a vector that is perpendicular to vector $\left(3\,\hat{i}+2\,\hat{k}\right)$?

A) $\left(2\,\hat{i}+\hat{j}-3\hat{k}\right)$
B) $\left(2\,\hat{i}+\hat{j}\right)$
C) $\left(\hat{j}-3\hat{k}\right)$
D) $\left(2\,\hat{i}+3\hat{k}\right)$
E) $\left(3\hat{k}\right)$

**Ans:**

**A**

---

**Q8.**

Vector $\vec{A}$ has a magnitude of 3.0 and makes an angle of $60^{o}$ with the positive *x*-axis. Vector $\vec{B}$ has *x* and *y* components of −2.0 and +4.5, respectively. Find the angle between the vectors $\left(3\,\vec{A}\times 2\,\vec{B}\right)$ and $\vec{B}$.

A) $90^{o}$
B) $45^{o}$
C) $66^{o}$
D) $24^{o}$
E) $0^{o}$

**Ans:**

vector $\left(3\vec{A}\times 2\vec{B}\right) \perp \vec{B}$

$\Rightarrow \theta = 90°$

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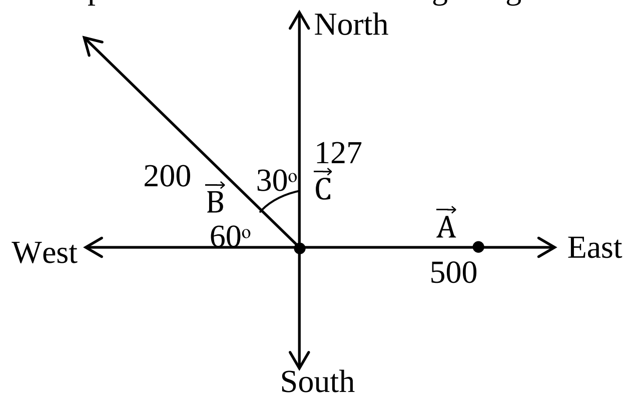
**Q9.**

An airplane starting from airport **A** flies 500 km east, then 200 km 30° west of north, and then 127 km north to arrive at airport **B**. The next day, another plane flies directly from **A** to **B** in a straight line. In what direction should the pilot travel in this direct flight? Ignore the effects of air.




A) 37° north of east
B) 50° north of west
C) northeast
D) north
E) northwest

**Ans:**

$\vec{A} = 500\,\hat{\imath}$

$\vec{B} = -200\cos 60°\ \hat{\imath} + 200\sin 60°\ \hat{\jmath}$

$\vec{C} = 127\,\hat{\jmath}$

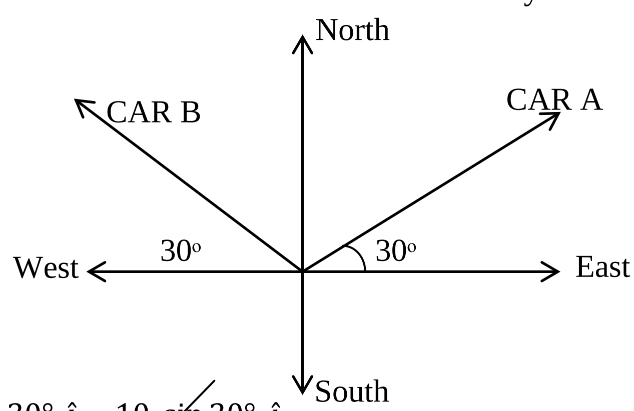
$\vec{R} = \vec{A} + \vec{B} + \vec{C} = 400\,\hat{\imath} + 300\,\hat{\jmath}$

$\theta_x = \cos^{-1}\frac{400}{500} = 36.87 \approx 37°$

---

**Q10.**

Car **A** is moving with a speed of 10.0 m/s in a direction 30.0° north of east. Car **B** is moving with a speed of 10.0 m/s in a direction 30.0° north of west. Find the velocity of car **A** relative to car **B**.




A) 17.3 m/s due east
B) 17.3 m/s due west
C) 10.0 m/s due north
D) 10.0 m/s due south
E) 13.7 m/s due north-west

**Ans:**

$\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$

$= 10\cos 30°\ \hat{\imath} + 10\sin 30°\ \hat{\jmath} + 10\cos 30°\ \hat{\imath} - 10\sin 30°\ \hat{\jmath}$

$= 20\cos 30°\ \hat{\imath} = 17.3\mathrm{m/s}\,\hat{\imath}$

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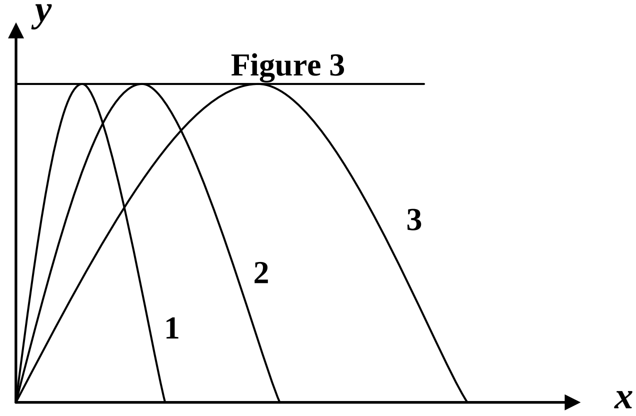
**Q11.**

**Figure 3** shows three paths for a soccer ball kicked from ground level. Rank the paths according to the time of flight, greatest first. Ignore the effects of air.

A) All tie
B) Path 1, Path 2, Path 3
C) Path 3, Path 2, Path 1
D) Path 2, Path 1, Path 3
E) Path 2, Path 3, Path 1



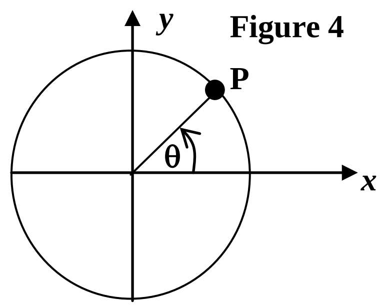

**Ans:**

**A**

Q12.

In **Figure 4** particle **P** is in a uniform circular motion, centered on the origin of an *xy* coordinate system. At what values of θ is the *y* component of the particle's acceleration greatest in magnitude?

A) $90^o$ and $270^o$
B) $0^o$ and $180^o$
C) $0^o$ and $90^o$
D) $90^o$ and $180^o$
E) $0^o$ and $270^o$




**Ans:**

**A**

**Q13.**

A particle is moved over an *xy* plane with acceleration components $a_x = 4.0$ m/s$^2$ and $a_y = -2.0$ m/s$^2$. Its initial velocity has components $v_{ox} = 8.0$ m/s and $v_{oy} = 12$ m/s. What is the speed of the particle when it reaches its greatest *y* coordinate?

A) 32 m/s
B) 12 m/s
C) 8.0 m/s
D) 16 m/s
E) 0

**Ans:**

$$v_{fy} = v_{0y} + a_y t$$

$$t = \frac{12}{2} = 6.0 \text{ s}$$

$$v_{fx} = v_{0x} + a_x t$$

$$= 8.0 + 24 = 32 \text{ m/s}$$

**Q14.**

A person measures the acceleration of an object and finds a value $+10\,\hat{i}$ m/s$^2$. Another person, moving at a constant velocity $\vec{v} = +5.0\,\hat{i}$ m/s with respect to the first one, makes an acceleration measurement on the same object at the same time. The value of the acceleration found by the second observer is

A) $+10\,\hat{i}$ m/s$^2$
B) $+15\,\hat{i}$ m/s$^2$
C) $+5.0\,\hat{i}$ m/s$^2$
D) $-10\,\hat{i}$ m/s$^2$
E) $-5.0\,\hat{i}$ m/s$^2$

**Ans:**

**A**

---

**Q15.**

A 4.80 kg object is accelerated upward by a cord of negligible mass. The maximum tension that the cord can take before breaking is 75.0 N. Find the maximum upward acceleration that can be given to the object.

A) 5.83 m/s$^2$
B) 9.81 m/s$^2$
C) 2.92 m/s$^2$
D) 16.0 m/s$^2$
E) 10.0 m/s$^2$

**Ans:**

$$\mathrm{T} - \mathrm{mg} = \mathrm{ma}$$

$$\mathrm{a} = \frac{\mathrm{T} - \mathrm{mg}}{\mathrm{m}}$$

$$= \frac{\mathrm{T}}{\mathrm{m}} - \mathrm{g}$$

$$= \frac{75}{4.8} - 9.8 = 15.625 = 9.8 = 5.83\ \mathrm{m/s^2}$$

---

**Q16.**

An 800 N person is standing on a scale inside an elevator at rest. Suddenly the elevator cable breaks and the elevator is in free fall. The weight of the person as indicated by the reading on the scale now is:

A) 0 N
B) 800 N
C) 1600 N
D) 400 N
E) 1000 N

**Ans:**

**A**

---

**Q17.**

A book is resting on a horizontal table. The reaction force to the weight of the book is

A) The force with which the book is pulling on Earth
B) The normal force from the table on the book
C) The support force from the floor on the table
D) The force with which the book is pushing on the table
E) The force with which the table is pushing on the floor

**Ans:**

**A**

---

**Q18.**

Friction and normal forces are always

A) Perpendicular to each other
B) Opposite to each other
C) Equal to each other
D) In the same direction
E) None of the others

**Ans:**

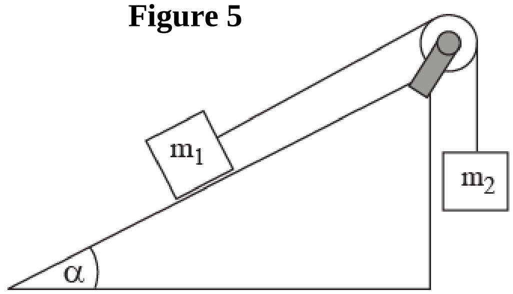
**A**

---

**Q19**.

A block with mass $m_1$ is placed on an inclined plane with slope angle $\alpha$ and is connected to a second hanging block with mass $m_2$ by a light cord passing over a massless and frictionless pulley (**Figure 5**). The coefficients of static and kinetic friction are $\mu_s$ and $\mu_k$ respectively. If the blocks are released from rest, for what range of values of $m_2$ will they **remain at rest?**

**Figure 5**




A. $m_1(\sin\alpha - \mu_s \cos\alpha) < m_2 < m_1(\sin\alpha + \mu_s \cos\alpha)$
B. $m_1(\sin\alpha - \mu_s \cos\alpha) < m_2 < m_1(\sin\alpha + \mu_k \cos\alpha)$
C. $m_1(\sin\alpha - \mu_k \cos\alpha) < m_2 < m_1(\sin\alpha + \mu_s \cos\alpha)$
D. $m_1(\sin\alpha - \mu_k \cos\alpha) < m_2 < m_1(\sin\alpha + \mu_k \cos\alpha)$
E. $m_1(\cos\alpha - \mu_s \sin\alpha) < m_2 < m_1(\cos\alpha + \mu_s \sin\alpha)$

**Ans:**

**A**

**Q20.**

What is the radial acceleration of the moon due to its motion around the earth? Assume the moon is moving around the earth in a circular orbit with a period of 28 days. Take the distance of the moon to the center of the earth to be of 3.85 x $10^5$ km.

A) 2.60 x $10^{-3}$ m/$s^2$
B) 2.60 x $10^{-6}$ m/$s^2$
C) 4.13 x $10^{-4}$ m/$s^2$
D) 4.13 x $10^{-7}$ m/$s^2$
E) 6.28 x $10^{+4}$ m/$s^2$

**Ans:**

$$a = \frac{v^2}{r} \qquad T = 28 \times 24 \times 3600 \text{ s}; \quad r = 385 \times 10^6 \text{ m}$$

$$a = \frac{\left(\frac{2\pi r}{T}\right)^2}{r}$$

$$= \frac{4\pi^2 r}{T^2}$$

$$= \frac{4\left(\frac{22}{7}\right)^2 \times 385 \times 10^6}{28 \times 24 \times 3600^{\,2}}$$

$$= \frac{15211.43 \times 10^6}{585252{,}8640 \times 10^4} = 0.002599 = 2.60 \times 10^{-3} \text{ m/s}^2$$