1. If a wheel is rotating at 3.0 rad/s, the time it takes to complete one revolution is about:

A) 0.33 s
B) 0.67 s
C) 1.0 s
D) 1.3 s
E) 2.1 s

$t = \frac{\theta}{\omega} = \frac{2\pi \text{ rad}}{3.0 \text{ rad/s}} \approx 2.1 \text{ s}$

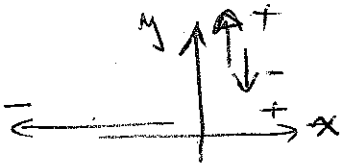
2. A wheel initially has an angular velocity of 12 rad/s but starts to slow down at t = 0 at a rate of 2.0 rad/s². From t = 0 till the time it stops it will have turned through:

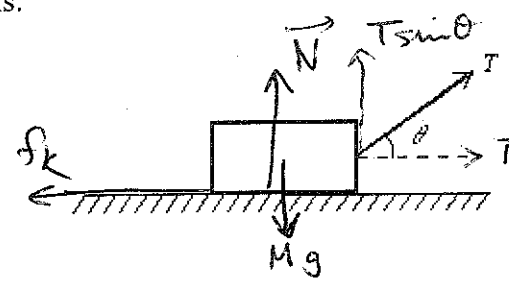
A) 40 rad
B) 108 rad
C) 24 rad
D) 18 rad
E) 36 rad

$\omega^2 = \omega_0^2 + 2\alpha\theta \Rightarrow \theta = \frac{12^2}{4} = 36 \text{ rad}$

$0 = (12)^2 + (2)(-2)\theta$

3. A block of mass 20 kg is pulled along a rough horizontal floor by an applied force $\vec{T}$ as shown. If θ = 30°, the coefficient of kinetic friction is 0.20 and the magnitude of $\vec{T}$ is 80 N, the acceleration of the block is:





A) 1.9 m/s²
B) 3.5 m/s²
C) 2.4 m/s²
D) 1.5 m/s²
E) 4.0 m/s²

$N + T\sin 30° - Mg = 0$

$\therefore N = Mg - T\sin 30°$

$= 156 \text{ N}$

$f_k = \mu_k N = (0.2)\,156$

$= 31.2 \text{ N}$

$T\cos 30° - f_k = (80)(0.866) - 31.2 = 38.3 \text{ N} = M a_x$

$\therefore a_x = \frac{38.3}{20} = 1.9 \text{ m/s}^2$

4. A car travels on a horizontal circular road of radius 40 m. If the maximum coefficient of static friction between the car's tires and the road is 0.50, what is the maximum speed such that the car does not skid (لا تنزلق)?

A) 11 m/s
B) 14 m/s
C) 8.4 m/s
D) the maximum speed cannot be determined unless we know the coefficient of kinetic friction
E) the maximum speed cannot be determined unless we know the coefficient of kinetic friction

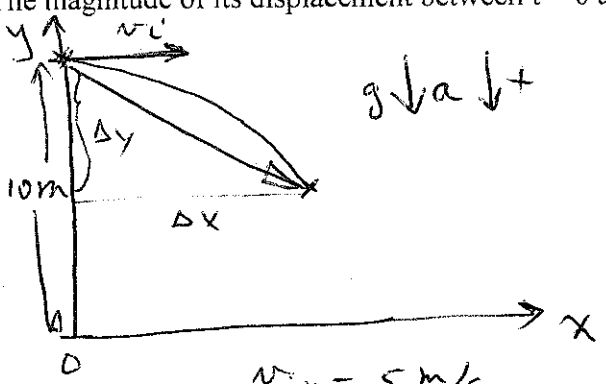
Centripetal force $= f_s = \frac{mv^2}{R}$ $\quad N = mg$

$f_{s\max} = \frac{m v_{\max}^2}{R}$ $\quad \therefore v_{\max}^2 = \frac{R f_{s\max}}{m} = \frac{R \mu_{s\max} mg}{m}$

$v_{\max} = \sqrt{R(\mu_{s\max})g} = 14 \text{ m/s}$

5. A stone is thrown at t = 0 from a height of 10 m. Its initial velocity is 5.0 m/s in the horizontal direction. The magnitude of its displacement between t = 0 and t = 1.0 s is

A) 5.0 m
B) 4.9 m
C) 9.9 m
D) 7.0 m
E) 3.0 m



g↓ a↓ +

$\Delta x = v_x \Delta t = (5.0 \text{ m/s})(1 \text{ s})$

$= 5 \text{ m}$

$\Delta y = (0)t + \frac{1}{2} g t^2$

$= \frac{1}{2}(9.8)(1)^2 = 4.9 \text{ m}$

$|\vec{d}| = \sqrt{5^2 + (4.9)^2}$

$= 7.0 \text{ m}$

$v_{ix} = 5 \text{ m/s}$

$v_{iy} = 0$

6. A child walks 24 m East with a constant speed of 2.2 m/s then turns and runs 74 m West with a constant speed of 4.0 m/s. Her average speed is:

A) 1.6 m/s
B) 3.3 m/s
C) 1.8 m/s
D) 1.7 m/s
E) 3.1 m/s

$\Delta t_1 = \frac{24}{2.2} = 10.9\ s$

$\Delta t_2 = \frac{74}{4.0} = 18.5\ s$

$\text{Av. speed} = \frac{\text{Total distance}}{\text{Total time}} = \frac{24+74}{10.9+18.5} = 3.3\ m/s$

7. The average velocity of the child in problem 6 is:

A) 1.7 m/s East
B) 1.7 m/s West
C) 3.3 m/s East
D) 3.3 m/s West
E) 1.9 m/s West

$\text{Av. velocity} = \frac{\text{Displacement}}{\text{total time}} = \frac{50\ m\ West}{10.9+18.5}$

$= 1.7\ m/s\ West$

8. A block is suspended معلقة from the ceiling السقف by a string حبل. The reaction to the force of gravity on the block is the force exerted by the:

A) string on the block
B) block on the string
C) block on the Earth
D) ceiling on the string
E) string on the ceiling

Force of gravity = Force from Earth on the block
= Action

Reaction = From from block on the Earth

9. A car moving with an initial velocity of 25 m/s north has a constant acceleration of 3 m/s^2 south starting at t = 0. At t = 6 seconds its velocity will be:

A) 5 m/s north
B) 5 m/s south
C) 10 m/s north
D) 7 m/s north
E) 7 m/s south

North = +ve

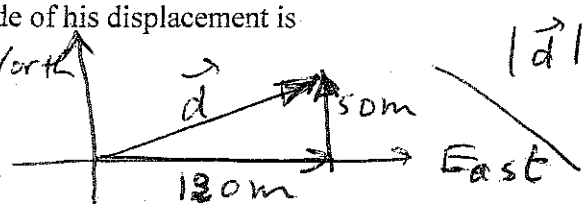
+ = North

$v = v_0 + at$

$= +25 + (-3\ m/s^2)\ 6 = +25 - 18 = +7\ m/s$

10. A man walks 120 m towards the East, then turns left and walks for 50 m towards the North. The magnitude of his displacement is

A) 130 m
B) 170 m
C) 70 m
D) 120 m
E) 50 m



$|\vec{d}| = \sqrt{120^2 + 50^2}$

$= 130\ m$

11. A speeding truck passes a stopped police car at t = 0. The police car starts chasing the truck at t = 1s with a constant acceleration of 5.0 m/s^2 and reaches the truck at t = 11 s. What is the speed of the truck in km/h (assume it remains constant)?

A) 90 km/h
B) 98 km/h
C) 180 km/h
D) 82 km/h
E) 76 km/h

Distance travelled by truck in 11s = (v truck)(11s)

" " " car in 10s = $\frac{1}{2} 5 (10)^2$

$\therefore (v_{truck})(11s) = \frac{1}{2}(5)(10)^2$

$\therefore v_{truck} = \frac{250}{11} = 22.727\ m/s * \frac{1\ km}{1000\ m} * \frac{3600\ s}{1\ h} = 82\ km/h$

12. A ball is thrown at t = 0 with a speed of 20 m/s at an angle of 45° above the horizontal. Its speed at t = 2.0 s is:

A) 0.4 m/s
B) 17 m/s
C) 8.7 m/s
D) 15 m/s
E) 13 m/s

$v_{ix} = v_{iy} = 20 \cos 45^\circ = 14.14 \text{ m/s}$

At $t = 2$ s: $v_x = v_{ix} = 14.14$ m/s ($a_x = 0$)

$v_y = v_{iy} - gt$

$= 14.4 - 19.6$

$= -5.46$ m/s

$v = \sqrt{(14.14)^2 + (-5.46)^2}$

$= 15.16$ m/s

13. Your mass is 70 kg and you push a 60 kg crate صندوق on a horizontal frictionless surface giving it an acceleration of 0.90 m/s^2 towards the East. The force exerted by the crate on you is:

A) 63 N towards the East
B) 63 N towards the West
C) 54 N towards the East
D) 54 N towards the West
E) 9.0 N towards the West

F(from you on crate) $= (m_{crate})\,\vec{a}$

$= (60 \text{ kg})(0.9 \text{ m/s}^2 \text{ East})$

$= 54$ N East $=$ Action

Reaction $= F$(from crate on you) $= 54$ N West

14. A transverse wave is given by $y(x, t) = (0.0500 \text{ m}) \cos[(0.0209 \text{ m}^{-1})\,x - (62.8 \text{ s}^{-1})\,t]$ where x is in meters and t is in seconds. Its wavelength is

A) 1800 m
B) 300 m
C) 43 m
D) 180 m
E) 150 m

$y = A \cos\left[2\pi\left(\frac{x}{\lambda} - \frac{t}{T}\right)\right]$

$\therefore 0.0209 \text{ m}^{-1} = \frac{2\pi}{\lambda}$

$\lambda = \frac{2\pi}{0.0209} = 300$ m

15. The frequency of the transverse wave in Problem 14 is:

A) 0.174 Hz
B) 62.8 Hz
C) 628 Hz
D) 314 Hz
E) 10 Hz

$62.8 \text{ s}^{-1} = \frac{2\pi}{T}$

$T = \frac{2\pi}{62.8} = 0.1$ s

$f = \frac{1}{T}$

$= 10$ Hz

16. If a wave has a wavelength of 20 cm and a period of 0.004 seconds then its speed is:

A) 50 m/s
B) 5000 m/s
C) 0.08 m/s
D) 0.0008 m/s
E) 8.0 m/s

$v = \lambda f$

$= \frac{\lambda}{T} = \frac{0.20 \text{ m}}{0.004 \text{ s}} = 50$ m/s

17. An electric fan مروحة is rotating at 10 revolutions per second. When the electricity is switched off it stops in 5.0 seconds. Assuming it slows down at a constant rate, how many revolutions does it make before stopping?

A) 50 revolutions
B) 75 revolutions
C) 25 revolutions
D) 13 revolutions
E) The number of revolutions cannot be determined without knowing the frictional forces that slow it down.

$\omega_0 = 10$ revolutions / s

$\omega_f = \omega_0 + \alpha t$

$0 = 10 + (\alpha)(5.0\,s)$

$\alpha = -2$ rev/s^2

$\omega_f^2 = \omega_0^2 + 2\alpha\,\Delta\theta$

$0 = (10)^2 + (2)(-2)\,\Delta\theta$

$\Delta\theta = 25$ revolutions

18. Two transverse waves are traveling in the same medium:

First wave: $y_1(x, t) = (0.0500\text{ m})\cos[(0.0209\text{m}^{-1})\,x - (32.8\text{ s}^{-1})\,t]$ and
Second wave: $y_2(x, t) = (0.0250\text{ m})\cos[(0.0418\text{m}^{-1})\,x - (65.6\text{ s}^{-1})\,t]$

which of the following statements is true about the rates at which these waves transmit energy?

A) The rate of the first wave is twice the rate of the second wave
B) The rate of the first wave is half the rate of the second wave
C) The rate of the first wave is 4 times the rate of the second wave
D) The rate of the first wave is ¼ the rate of the second wave
E) The rate of the first wave is the same as the rate of the second wave, since they are traveling in the same medium

$A_1 = 2A_2$ Energy $\propto A^2$

$\therefore$ wave 1 transmits at 4 times the rate of y_2

19. The total transverse displacement due to the two waves in problem 18 at the point x = 0 at the time t = 0 is:

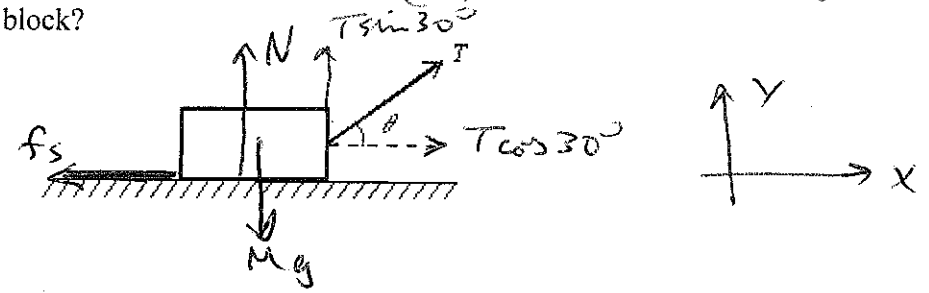
A) 0.0250 m
B) 0.0500 m
C) 0.0750 m
D) 0.0560 m
E) zero

$y_1(0,0) = (0.0500\text{ m})\cos 0 = 0.0500\text{ m}$

$y_2(0,0) = (0.0250\text{m})\cos 0 = 0.0250\text{ m}$

$y_{Total} = y_1 + y_2 = 0.0750\text{ m}$

20. A block of mass 20 kg on a rough horizontal floor is pulled to the right by an applied force $\vec{T}$ as shown. The block does not move. If T = 60 N and θ = 30°, find the force of friction f_s from the floor acting on the block?



A) f_s = 60N to the right
B) f_s = 60N to the left
C) f_s = 52N to the right
D) f_s = 52N to the left
E) f_s = 30N to the left

$a_x = 0$ (block does not move)

$\therefore T\cos 30° - f_s = m a_x = 0$

$\therefore f_s = T\cos 30° = (60)(0.866) = 52\text{N}$ to the left