Name (print)_____ Student No._____ Section_____

Phys 1003A13: Tutorial Test 2 Solutions

Multiple Choice Problems

Circle the correct answer on the sheet. All problems are worth 1 mark.

1 What is the tangential velocity of a particle at the surface of the planet Venus, on the equator, due to the rotation about the axis? You may assume that Venus is a perfect sphere with a radius of 6050 km, and the length of the day on Venus is 2.80×10^3 hours. (A day lasts a long time on Venus!)

(A) 3.77 m/s (B) 4.63m/s (C) 5.96 m/s (D) 6.61 m/s (E) 7.52 m/s

We can calculate the angular speed from the period:

$$\omega = \frac{2\pi}{T}$$

The tangential velocity of a particle on the surface then becomes:

$$v = r\omega = \frac{2\pi r}{T}$$

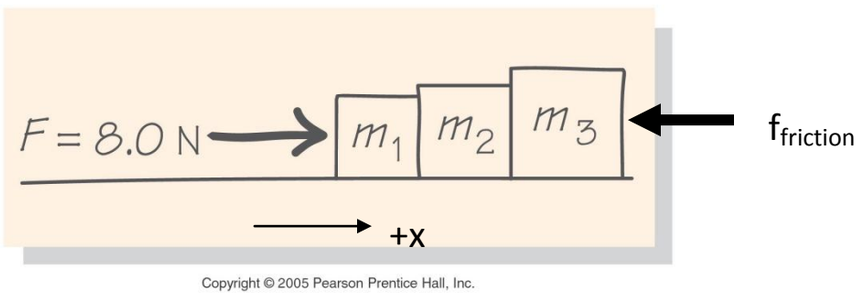
The period of the rotation of the earth about the axis is 24 hours (to a first approximation!). Convert this into seconds, to do the calculation. Convert the radius to metres.

$$v = \frac{2\pi r}{T} = \frac{2\pi(6050\times10^3\,\text{m})}{2.80\times10^3\times60\text{min}\times60\text{s}} = 3.77\ \text{m/s}$$

Answer (A)

2 The diagram shows three boxes, with a total mass of 17 kg, sliding along with a velocity of +2.0 m/s and an acceleration of -0.23 m/s^2. The friction force, opposing motion is:

(A) +12 N (B) +8.0 N (C) 0 N (D) -8.0 N (E) -12 N



The friction force always opposes motion, so it must be in the negative x direction. The net force in the x direction is given by Newton's Second Law:

$$F_{net,x} = F - f_{friction} = ma_x$$

$$f_{friction} = F - ma_x = 8.0N - (17kg)(-0.23\,\text{m/s}^2) = 11.91\,\text{N} = 12\,\text{N to 2 s.f.}$$

The friction vector must have a negative sign on it, as it opposes motion. Answer (E)

3 A 3000-kg pickup truck pulls a 1200-kg boat on a trailer, travelling at +23 m/s, the driver is breaking, and so they are accelerating together at -0.41 m/s. What is the force exerted by the truck and trailer on the road?

(A) +950 N (B) -950 N (C) + 1700 N (D) -1700 N (E) +2100N

The vehicle is braking, so the acceleration is negative, and the force exerted on the truck and trailer must also be negative. By Newton's Third law, the force exerted by the truck and trailer on the road is equal and opposite, so it is in the positive direction.

We can calculate the magnitude and direction of the force exerted on the truck and trailer using Newton's 2nd Law

$$\vec{F}_{net} = m\vec{a} = (4200\ \text{kg})(-0.41\,\text{m/s}^2) = -1722\,\text{N}$$

Hence the force exerted by the truck and trailer on the road is

$$\vec{F} = +1700\,\text{N to 2 s.f}$$ Answer (C)

4 A gear-wheel is rotating at 1400 rpm (revolutions per minute). What is the angular speed in radians/s?

(A) 95 rad/s (B) 100 rad/s (C) 110 rad/s (D) 120 rad/s (E) 150 rad/s

1 revolution is 2π radians, so the conversion is:

$$1400\ \text{rpm} = 1400 \times 2\pi \times \left(\frac{1\,\text{minute}}{60\,\text{s}}\right) = 150\ \text{rad/s}$$ Answer (E)

5 A ball is thrown into the air and performs projectile motion. You may assume that there is no air resistance. Which one of the following statements is CORRECT?

(a) There is always a single solution for the horizontal range, which depends on the launch angle θ.

(b) When the ball reaches the top of the trajectory, the acceleration is zero.

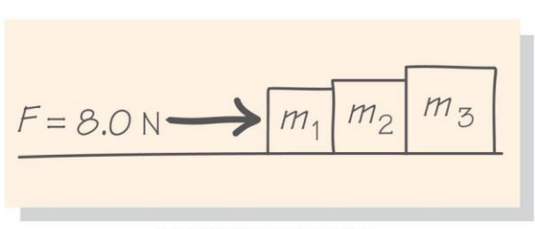
(c) When the ball reaches the top of the trajectory, the velocity is zero.

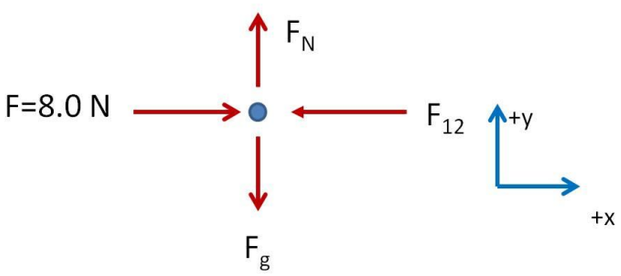
(d) The ball has a constant y-component of velocity, which depends on the launch angle θ.

(e) The ball has a constant x-component of velocity, which depends on the launch angle θ

Written Problems

1 Draw a free body diagram of the forces acting on mass m1 pictured in the diagram, as it slides along a frictionless surface (5 marks)





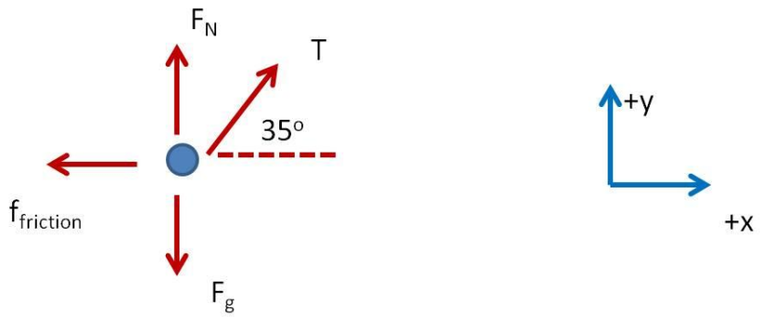
Must have a coordinate system defined to get the 5th mark!

2 A sled of mass M kg, is being pulled across a horizontal ice surface with an acceleration of +0.10 m/s^2, using a rope which is tilted at 35^o with respect to the horizontal and has a tension of 44 N. The friction force operating is a constant 3.0 N. (10 marks)

(a) Draw a free body diagram of the forces acting on the sled.

(b) Calculate the mass M of the sled

(c) If the sled starts from rest, how far does it move in 5.0 seconds?



(b) Use Newton's Second Law to determine the net force, and hence net acceleration of the block. In this case, there will be no acceleration in the y direction, as it doesn't leave the ice, and there is a known acceleration in the x direction.

$$\vec{F}_{net} = \vec{F}_N + \vec{F}_g + \vec{T} + \vec{f}_{friction} = M\vec{a}$$

$$F_{net,x} = T\cos\theta - f_{friction} = Ma_x$$

$$F_{net,y} = T\sin\theta + F_N - Mg = 0$$

We use the x-component equation to calculate the answer to (b)

$$F_{net,x} = T\cos\theta - f_{friction} = Ma_x$$

$$\frac{(44\text{ N})\cos 35^o - 3.0N}{+0.10\text{ m/s}^2} = M$$

$$M = 330kg$$

The acceleration vector is in the positive x direction.

(c) Use $\vec{x} = \vec{x}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$;

In this case we set the origin as x =0 at t = 0

$$\vec{x} = \vec{x}_0 + \vec{v}_0 t + \frac{1}{2}\vec{a}t^2;$$

$$\vec{x} = 0 + 0 + \frac{1}{2}(0.10\text{ m/s}^2)(5s)^2$$

$$\vec{x} = 0.125\text{ m} = 0.13\text{ m to 2 s.f.}$$