SPH 4U

Name: ANSWER

WINTER 2019

SPH 4U UNIT # 1 TEST – DYNAMICS

Knowledge & Understanding / 10 Application / 27 Thinking & Inquiry / 12

Multiple Choice (1 mark each, total 10 Knowledge & Understanding Marks)

1. Which of the following is a scalar quantity?

   a. the velocity of a projectile
   b. the northward acceleration of a car along a test track
   c. the instantaneous velocity of a parachutist in free fall
   d. the displacement of a hiker from her base station
   e. the measured distance between Toronto and Fenelon Falls

2. A race car completes exactly 10 laps around an oval track. Which of the following pairs of quantities concerning its motion would both have values of zero?

   a. displacement, average velocity
   b. average speed, average acceleration
   c. distance, average speed
   d. average speed, average velocity
   e. displacement, average speed

3. An object sits at rest on a ramp. As the angle of incline of the ramp increases, the object suddenly begins to slide. Which of the following explanations best accounts for the object's motion?

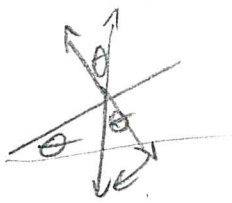
   a. The coefficient of friction has decreased
   b. The force of gravity acting on the object has increased
   c. The component of gravity along the ramp has increased
   d. The friction has decreased while the normal force has remained unchanged
   e. The normal force has increased

4. Two masses, A and B, hang on opposite ends of a rope suspended over a pulley. The mass of A is greater than the mass of B. If $\vec{F}_{TA}$ represents the force of tension exerted by the rope on mass A and $\vec{F}_{TB}$ represent the force of tension exerted by the rope on mass B, then which of the following statements concerning the forces of tension is true?

   a. $|\vec{F}_{TA}| > |\vec{F}_{TB}|$
   b. $|\vec{F}_{TA}| < |\vec{F}_{TB}|$
   c. $|\vec{F}_{TA}| \geq |\vec{F}_{TB}|$
   d. $|\vec{F}_{TA}| \leq |\vec{F}_{TB}|$
   e. $|\vec{F}_{TA}| = |\vec{F}_{TB}|$

5. A skier of mass *m* slides down a slope that makes an incline of θ with the horizontal. Which expression describes the component of the force of gravity **perpendicular** to the slope?

   a. *mg*
   b. *mgsinθ*
   c. *mgcosθ*
   d. *mgtanθ*
   e. None of the above



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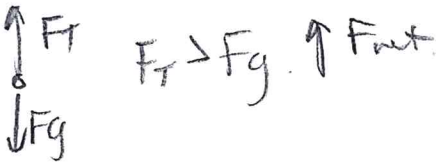
6. An object is pushed horizontally at a constant velocity. What can correctly be said about the forces acting on the object?

a. The force(s) acting forward is/are greater than the force(s) acting backward.
b. The sum of all forces has a value directed forward.
c. The sum of all forces is zero.
d. The forces acting on the object can be said to be "unbalanced".
e. Newton's second law best summarizes the effect of the forces acting on the object.

7. The upwards tension in a cable supporting a beam at a construction site is less than the force of gravity acting on the beam. The beam may be:

a. Travelling up or down with non-uniform velocity
b. Travelling up with increasing velocity
c. Travelling down with decreasing velocity
d. All of the above
e. None of the above



8. For an object traveling with "uniform circular motion", its acceleration is

a. zero because the speed is constant
b. directed tangent to the circle
c. directed toward the centre of the circle
d. changing in magnitude depending on its position in the circle
e. directed outward from the centre of the circle

9. An object is travelling in a circular path, with frequency, *f*. If the frequency is doubled, the centripetal force will be

a. Doubled
b. Halved
c. Multiplied by a factor of 4
d. Unchanged
e. None of the above

$F_c = m 4\pi^2 r f^2$

$F_c = m 4\pi^2 r (2f)^2$

$F_c = 4 (m 4\pi^2 r f^2)$

10. What provides the centripetal force for a car moving around in a circle on a banked curve covered with very slippery ice (HINT: the force of friction is essentially zero)?

a. The friction between the tires and the banked curve
b. The horizontal component of the normal force
c. The vertical component of the normal force
d. The force of gravity on the car
e. None of the above

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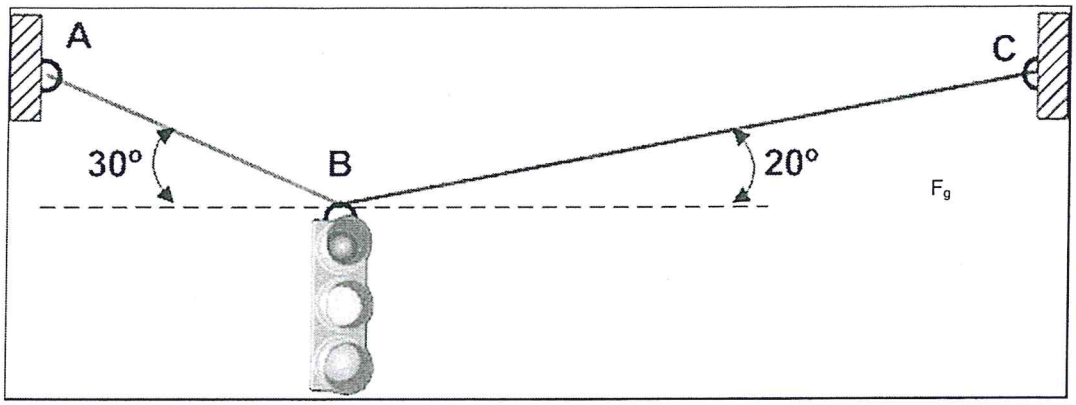
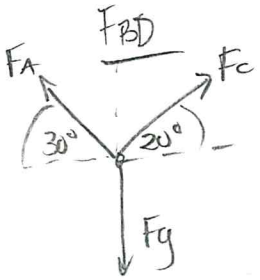
Problems (27 Application Marks)
Answer in the space provided.

1. Determine the mass of the object shown in the diagram below, if cable A has a tension of 650 N and cable C has a tension of 950 N. The system is in static equilibrium. ~~17~~ 16 marks)



FBD



$F_A = 650N$
$F_C = 950N$ (1)
$F_{net} = 0N$

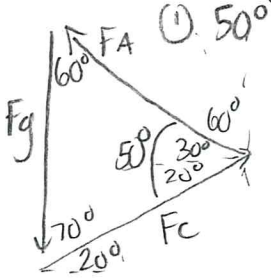
$c^2 = a^2 + b^2 - 2ab\cos C$ (1)

$F_g^2 = F_A^2 + F_C^2 - 2F_AF_C\cos 50°$

$(mg)^2 = F_A^2 + F_C^2 - 2F_AF_C\cos 50°$ (1)

$$m = \sqrt{\frac{F_A^2 + F_C^2 - 2F_AF_C\cos 50°}{g^2}}$$

(1) Diagram (1) 50°



$$m = \sqrt{\frac{(650N)^2 + (950N)^2 + 2(650N)(950N)\cos 50°}{(9.8\,N/kg)^2}}$$

$m = 148.5331127\,kg$

$M = 150\,kg$ or $1.5 \times 10^2\,kg$ (1)

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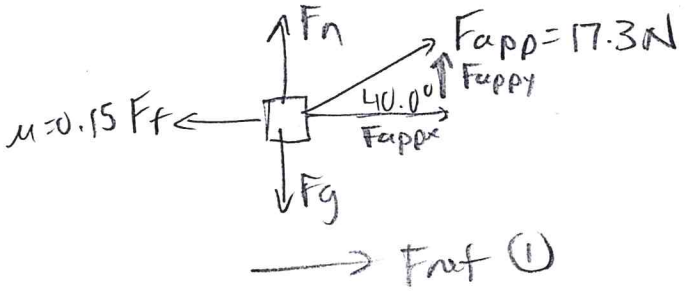
2. A boy pulls a wagon, on a flat surface, with a force of 17.3 N on the handle. The coefficient of friction between the wheels and the road is 0.15. The handle makes an angle of 40.0° with the horizontal. If the wagon has a mass of 1.5 kg, find the acceleration. (~~10~~ 12 marks)



$m = 1.5\,kg$

$\rightarrow F_{net}$ (1)

$F_{net_y} = 0N$ (1)

$F_n + F_{appy} = F_g$ (1)

$F_n = F_g - F_{appy}$

$F_n = mg - F_{app}\sin\theta$ (1) (1)

$F_{net_x} = F_{appx} - F_f$ (1)

$ma = F_{app}\cos\theta - \mu F_n$ (1) (1)

$ma = F_{app}\cos\theta - \mu(mg - F_{app}\sin\theta)$ (1)

$a = \dfrac{F_{app}\cos\theta - \mu mg + \mu F_{app}\sin\theta}{m}$

$a = \dfrac{(17.3N)\cos 40.0° - (0.15)(1.5kg)(9.8N/kg) + (0.15)((17.3N)\sin 40.0°)}{1.5\,kg}$

$a = 8.477068475\ m/s^2$

$a = 8.5\ m/s^2$ (1)

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3. An object of mass 2.50 x 10^2 kg is whirled around in a vertical circle of radius 3.5 m with a period of 0.867 s. Calculate the maximum and minimum tension in the string and clearly state where these occur. (10 marks)

$m = 2.50 \times 10^2 \text{ kg}$

$r = 3.5 \text{ m}$

$T = 0.867 \text{ s}$

Top – F_T min (1)

$\downarrow F_g$ $\downarrow F_c$ (1)

$\downarrow F_T$

$F_c = F_g + F_T$ (1)

$F_T = F_c - F_g$

(1) (1)

$F_T = \frac{m4\pi^2 r}{T^2} - mg$

$F_T = \frac{(2.50 \times 10^2 \text{ kg})(4)\pi^2(3.5 \text{ m})}{(0.867 \text{ s})^2} - (2.50 \times 10^2 \text{ kg})(9.8 \text{ N/kg})$

$F_T = 43504.66397 \text{ N}$

$F_{T_{min}} = 4.4 \times 10^4 \text{ N}$ (1)

44000 N

Bottom – F_T max (1)

$\uparrow F_T$ $\uparrow F_c$ (1)

$\downarrow F_g$

$F_c = F_T - F_g$ (1)

$F_T = F_c + F_g$

$F_T = \frac{m4\pi^2 r}{T^2} + mg$

$F_T = \frac{(2.50 \times 10^2 \text{ kg})4\pi^2(3.5 \text{ m})}{(0.867 \text{ s})^2} + (250 \text{ kg})(9.8)$

$F_T = 48404.66397 \text{ N}$

$F_{T_{max}} = 4.8 \times 10^4 \text{ N}$ (1)

48000 N

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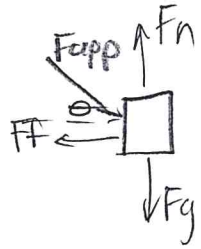
Making Connections (12 Thinking & Inquiry Marks)
Answer on the paper provided.

1. You need to move a piece of furniture across a level floor. The furniture is too heavy for you to lift. The coefficient of kinetic friction between the piece of furniture and the floor is 0.20. Prove which is the better approach – pushing downward at an angle of θ between the horizontal, or pushing upward with an angle of θ between the horizontal. (4 marks)

Pushing Downward

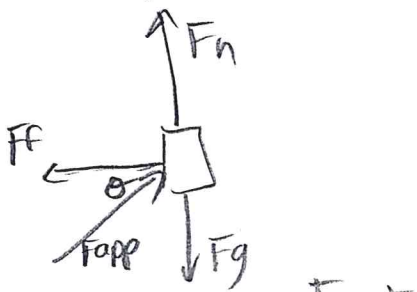


→ Fnet.

$F_{nety} = ON = F_n - F_g - F_{appy}$

$F_n = F_g + F_{appy}$

Pushing Upward



→ Fnet

$F_{nety} = ON = F_n + F_{appy} - F_g$

$F_n = F_g - F_{appy}$

I.

Fappx is the same in both scenarios; therefore, the only difference in the net force is caused by the force of friction.

$F_f = \mu F_n$

∴ the easier scenario will have a lower Fn. The pushing upward scenario has a lower Fn, ∴ it will be easier to push upward.

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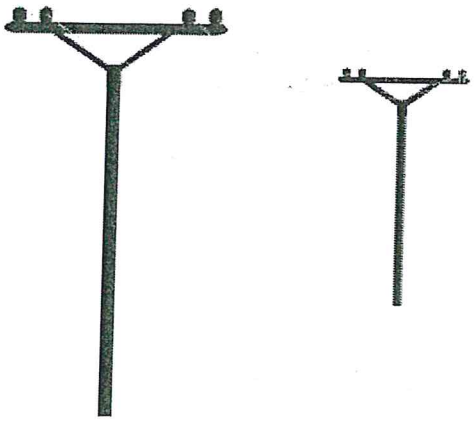
2. Electricity or telephone line installers purposely allow lines to sag or droop, especially in areas where freezing rain and ice build-up are frequent. Using concepts from this unit, explain why. (4 marks)

Less F_T in wires means it can hold a greater mass of ice & snow before breaking.



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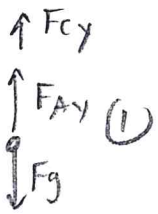
3. Explain what the centrifugal force really is and provide one example of where it is used in society. (4 marks)

Explanation (3)

Where (1)

Application #1, Version 2



(1)

$F_{net\,y} = 0N$ (1)

$F_{Ay} + F_{cy} = F_g$ (1)

$mg = F_A \sin\theta_A + F_c \sin\theta_c$ (1) (1) (1)

$$m = \frac{F_A \sin\theta_A + F_c \sin\theta_c}{g}$$

$$m = \frac{(650N)\sin 30° + (950N)\sin 20°}{9.8\,N/kg}$$

$m = 66.3182792\,kg$

$m = 66\,kg$ (1)