PHY131H1F - Class 36


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Health Canada approves Pfizer-BioNTech COVID-19 vaccine

About 249,000 doses of the two-dose vaccine are expected to be on hand by year's end

John Paul Tasker · CBC News · Posted: Dec 09, 2020 10:54 AM ET | Last Updated: 18 minutes ago

The federal government has given the green light to the Pfizer-BioNTech's COVID-19 vaccine, a key step toward launching the largest inoculation campaign in Canada's history.

Health Canada announced the approval Wednesday after scientists finished a two-month review of the company's clinical trial data.

"The data provided supports favourably the efficacy of Pfizer-BioNTech COVID-19 vaccine as well as its safety," the department said in its report authorizing use of the vaccine in Canada for people over the age of 16.

Today:

Course Review

Liquid Nitrogen Demonstration

Final Bonus TeamUp Quiz

1

Final Assessment

- There will be a Final Assessment in this course on Thursday, Dec. 17.
- You will be able to find it on Quercus under a new module called "Final Assessment"
- The format will be a 30 minute multiple-choice test, followed by a 10 minute break, then a 35 minute 2-question written answer assignment to be submitted on crowdmark. Half of your final assessment mark will come from the multiple choice part, and the other half will come from the written answer part.
- The timing will be as follows (all Toronto time EST):
- 7:10-7:45pm, 10 Multiple Choice Questions. The window of availability is 35-minutes, but the timer is set for 30 minutes maximum.
- 7:45-7:55 break
- 7:55-8:30pm, 2 Written Answer Questions.

2

Final Assessment

- Thursday, Dec. 17, 7:55-8:30pm, 2 Written Answer Questions.
- You must follow the four-step problem solving strategy as given in Etkina and followed throughout this course, writing your answers out on the Answer Template Sheet or a reasonable facsimile.
- Each will be from one of the following five chapters:
- Ch. 5: Circular Motion
- Ch. 6: Impulse and Linear Momentum
- Ch. 9: Rotational Motion
- Ch. 10: Vibrational Motion
- Ch. 11: Mechanical Waves
- Each question will begin by stating the chapter, so you will know which of these five to use.

3

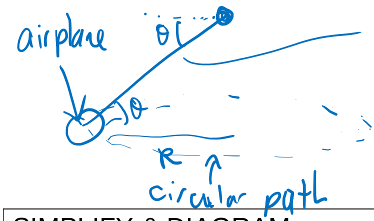
Ch. 5: Circular Motion Written Question Rubric

1. **Sketch and translate**
   - Sketch the situation, list and label known and unknown information.
   - Choose the system.
   - Identify the unknown that you need to find.
2. **Simplify and diagram**
   - State important assumptions and simplifications you can make – ie pointlike object, constant speed circular motion.
   - Draw a force diagram for the system, and a coordinate axis. You may want to label the direction of acceleration, or the radial direction toward the center of a circular path.
   - Force diagrams must include labeled forces with the "1 on 2" subscripts, where 2 is the system under consideration, and 1 is the various external objects providing the force.
3. **Represent mathematically**
   - Using your representation in Step 2, write down the important equations using Newton's second law.
   - You may drop the "1 on 2" subscripts for this step, if you wish.
   - Do not plug in numbers immediately.
4. **Solve and evaluate**
   - Rearrange the equations and solve for the unknown quantity.
   - Substitute known values for variables and include units.
   - Clearly indicate your final answer, using the appropriate number of significant digits.
   - You must evaluate your answer by comparing its magnitude with something else, or stating whether the sign, units, limiting cases are reasonable.

4

[Chapter 5] Suppose you have an airplane attached to the end of a 46-cm string, which makes a 25° angle relative to the horizontal while the airplane is flying. Find the period of the airplane's motion.

SKETCH & TRANSLATE.



$\theta = 25°$

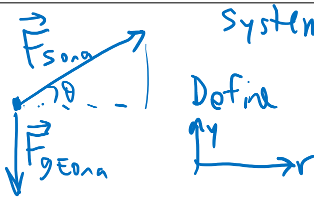
$L = 0.46\ m$

$R = L \cos\theta$

$R = 0.417 m$

$T = ?$ period

SIMPLIFY & DIAGRAM



System = airplane

Assume constant speed

$\boxed{v = \frac{2\pi R}{T}}$

$a_r = \frac{v^2}{R}$

REPRESENT MATHEMATICALLY

$$\Sigma F_y = 0 = F \sin\theta - mg$$

$$\Rightarrow F = \frac{mg}{\sin\theta} = \text{tension in string.}$$

$$a_r = \frac{v^2}{R} = \frac{\Sigma F_r}{m} = \frac{F\cos\theta}{m} = \frac{g\cos\theta}{\sin\theta}$$

$$v = \sqrt{\frac{R g \cos\theta}{\sin\theta}}$$

SOLVE & EVALUATE

$$v = \sqrt{\frac{0.417\,(9.8)\cdot \cos 25°}{\sin 25}}$$

$$v = 2.96\ m/s$$

$$T = \frac{2\pi R}{v} = \frac{2\pi(0.417)}{2.96}$$

$$\boxed{T = 0.88\ s}$$ similar to flying pig

5

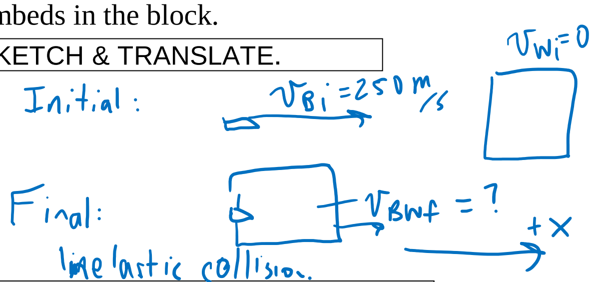
Ch. 6: Impulse and Linear Momentum Written Question Rubric

1. **Sketch and translate**
   - Sketch initial and final states, include appropriate coordinate axes.
   - Decide what is in your system.
   - List and label known and unknown information.
   - Identify the unknown that you need to find.
2. **Simplify and diagram**
   - State important assumptions and simplifications you can make.
   - State if there are any important external impulses exerted on the system.
   - Draw an impulse-momentum bar chart for the system for a chosen direction.
3. **Represent mathematically**
   - Use the bar chart from step 2 to apply the generalized impulse momentum principle along the chosen direction.
   - Each nonzero bar becomes a nonzero term in the equation.
   - Do not plug in numbers immediately.
4. **Solve and evaluate**
   - Rearrange the equations and solve for the unknown quantity.
   - Substitute known values for variables and include units.
   - Clearly indicate your final answer, using the appropriate number of significant digits.
   - You must evaluate your answer by comparing its magnitude with something else, or stating whether the sign, units, limiting cases are reasonable.

6

[Chapter 6] A 0.020 kg bullet traveling horizontally at 250 m/s embeds in a 1.0 kg block of wood resting on a table. Determine the speed of the bullet and wood block together immediately after the bullet embeds in the block.

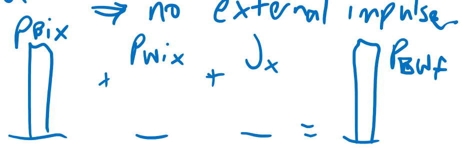
SKETCH & TRANSLATE.



SIMPLIFY & DIAGRAM

System = bullet + wood.

Assume no friction ⇒ no external impulse



REPRESENT MATHEMATICALLY

$$m_B v_{Bi} + 0 + 0 = (m_B + m_W) v_{Bf}$$

$$v_{BWf} = \frac{m_B}{m_B + m_W} v_{Bi}$$

SOLVE & EVALUATE

$$v_{BWf} = \frac{0.02}{0.02 + 1.0}(250)$$

$$\boxed{v_{BWf} = 4.9\ m/s}$$

A lot less than speed of bullet, since wood is a lot heavier.

7

Ch. 9: Rotational Motion Written Question Rubric

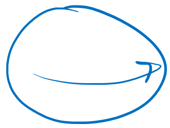
1. **Sketch and translate**
   - Sketch the situation, list and label known and unknown information.
   - Choose the system. Label the axis of rotation.
   - Identify the unknown that you need to find.
2. **Simplify and diagram**
   - State important assumptions and simplifications you can make
   - Draw an extended force diagram for the system, showing the direction of external forces as well as where on the object they are applied. Include coordinate axes and the axis of rotation. Label your definition of positive angular variables.
   - Force diagrams must include labeled forces with the "1 on 2" subscripts, where 2 is the system under consideration, and 1 is the various external objects providing the force.
3. **Represent mathematically**
   - Using your representation in Step 2, write down the important equations using Newton's second law and Newton's second law for rotation.
   - You may drop the "1 on 2" subscripts for this step, if you wish.
   - Do not plug in numbers immediately.
4. **Solve and evaluate**
   - Rearrange the equations and solve for the unknown quantity.
   - Substitute known values for variables and include units.
   - Clearly indicate your final answer, using the appropriate number of significant digits.
   - You must evaluate your answer by comparing its magnitude with something else, or stating whether the sign, units, limiting cases are reasonable.

8

[Chapter 9] Imagine that our Sun ran out of nuclear fuel and collapsed. What would its radius have to be in order for its period of rotation to be the same as the first discovered pulsar, PSR B1919+21 (1.34 s)? Conserve rotational momentum.

SKETCH & TRANSLATE.

Initial:



$R_i = 6.96\times10^8\,m$

$T_i = 25$ days

Final: o $R_f = ?$

$T_f = 1.34\,s$

System = Sun

SIMPLIFY & DIAGRAM

Assume no external torques on Sun. $\Rightarrow L_i = L_f$

$\boxed{\text{Assume Sun is solid sphere: } I = \frac{2}{5}mR^2}$ $L = I\omega$ = rotational momentum

m = constant.

REPRESENT MATHEMATICALLY

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

$L_i = L_f$

$I_i\omega_i = I_f\omega_f$

$I_i\left(\frac{\cancel{2\pi}}{T_i}\right) = I_f\left(\frac{\cancel{2\pi}}{T_f}\right)$

$\cancel{\frac{2}{5}m}\frac{R_i^2}{T_i} = \cancel{\frac{2}{5}m}\frac{R_f^2}{T_f}$

$R_f = R_i\sqrt{\frac{T_f}{T_i}}$

SOLVE & EVALUATE

$R_f = 6.96\times10^8\sqrt{\frac{1.34}{25\times24\times60\times60}}$

$R_f = 5.5\times10^5\,m$

$\boxed{R_f = 550\text{ km}}$

pretty small for a star

9

Ch. 10: Vibrational Motion Written Question Rubric

1. **Sketch and translate**
   - Sketch the situation, list and label known and unknown information.
   - Choose the system or systems of interest.
   - Identify the unknown that you need to find.
2. **Simplify and diagram**
   - State important assumptions and simplifications you can make – ie ideal spring, negligible friction.
   - Represent the process using force diagrams and/or bar charts as needed.
3. **Represent mathematically**
   - If necessary, use SHM kinematics equations to describe the motion.
   - If necessary, use force diagrams to apply Newton's second law to the problem, or work-energy principles if bar charts were used in step 2.
   - If necessary, use expressions for period of SHM for an object attached to a spring, or a pendulum.
   - Do not plug in numbers immediately.
4. **Solve and evaluate**
   - Rearrange the equations and solve for the unknown quantity.
   - Substitute known values for variables and include units.
   - Clearly indicate your final answer, using the appropriate number of significant digits.
   - You must evaluate your answer by comparing its magnitude with something else, or stating whether the sign, units, limiting cases are reasonable.

10

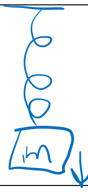
[Chapter 10] You attach a 1.6 kg object to a spring, pull it down to 0.13 m from the equilibrium position, and let it vibrate. You find that it takes 5.0 s for the object to complete 10.0 vibrations. What is the spring constant of the spring?

SKETCH & TRANSLATE.

$m = 1.6$ kg

$k = ?$

system = mass



$A = 0.13$ m

amplitude of SHM.

Period $T = \frac{5.0\text{ s}}{10} = 0.5$ s.

SIMPLIFY & DIAGRAM

Assume SHM, no dissipative forces

Period: $T = 2\pi\sqrt{\frac{m}{k}}$

REPRESENT MATHEMATICALLY

Solve for k:

$$\frac{T}{2\pi} = \sqrt{\frac{m}{k}}$$

$$\frac{T^2}{4\pi^2} = \frac{m}{k}$$

$$k = 4\pi^2 \frac{m}{T^2}$$

SOLVE & EVALUATE

$$k = \frac{4\pi^2 \cdot 1.6}{0.5^2} = \boxed{250\ N/m}$$

as m ↑, stiffer spring is needed.

strong spring

11

Ch. 11: Mechanical Waves Written Question Rubric

1. **Sketch and translate**
   - Sketch the situation, list and label known and unknown information.
   - Choose the system or systems of interest.
   - Identify the unknown that you need to find.
2. **Simplify and diagram**
   - State important assumptions and simplifications you can make.
   - Draw history graphs (y vs t) or snapshot graphs (y vs x) to represent the waves as necessary.
3. **Represent mathematically**
   - Represent the problem using mathematical relationships between physical quantities.
   - Do not plug in numbers immediately.
4. **Solve and evaluate**
   - Rearrange the equations and solve for the unknown quantity.
   - Substitute known values for variables and include units.
   - Clearly indicate your final answer, using the appropriate number of significant digits.
   - You must evaluate your answer by comparing its magnitude with something else, or stating whether the sign, units, limiting cases are reasonable.

12

[Chapter 11] A car horn vibrates at a frequency of 250 Hz. Determine the frequency a stationary observer hears as the car approaches her at a speed of 25 m/s.

SKETCH & TRANSLATE.

SIMPLIFY & DIAGRAM

Assume Doppler shift will cause freq. to increase slightly.

Use $v = 340$ m/s = wave speed, speed of sound.

REPRESENT MATHEMATICALLY

Use Eq. 11.15 for "toward"

use minus sign in denominator.

$$f_o = f_s\left(\frac{v}{v - v_s}\right)$$

SOLVE & EVALUATE

$$f_o = 250\left(\frac{340}{340-25}\right)$$

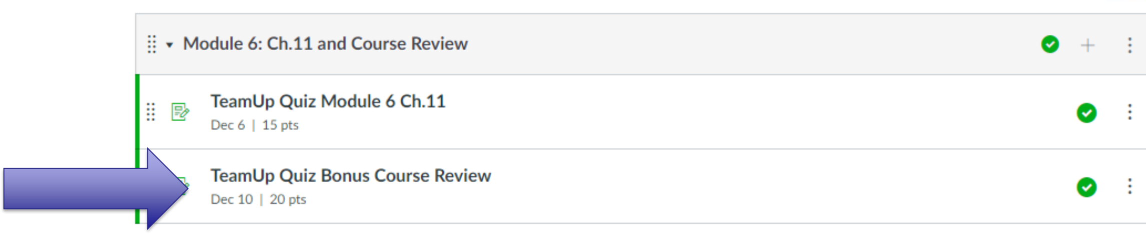
$$\boxed{f_o = 270 \text{ Hz}}$$

Makes sense, as it is a ~~tiny~~ little higher.

13

TeamUp Time!!

- Today you will be doing three multiple choice questions as a team of 2-4 students in your Practicals Pod.
- Your pod-team shares the mark!
- Right now you should open Microsoft Teams and someone (most recent Facilitator) should place a **video call** to all 3 or 4 members of your Pod-Chat.



14

Now: TeamUp! You have 15 minutes

- The first step is to decide who will be the TeamUp **Driver**
- All students must log-in to Quercus [You will now have three windows open: my zoom lecture, Microsoft Teams, and Quercus]

End is 11:50

- **Non-drivers**: Wait!
- **Driver**: Go to the TeamUp Quiz Bonus Course Review, click Go to Tool, then Create a Group. Let everyone in the Breakout Room know the session ID. Then WAIT – don't drive off alone!
- **Non-drivers**: Once you get the session ID, go to the TeamUp Quiz in this module, click Go to Tool, then Join Session and type the ID you were given.
- Once everyone in your room arrives in TeamUp, start going through the questions. Please **achieve consensus** before the driver submits.
- YOU MAY BEGIN! I'm going to go on mute for 15 minutes. Note: if your pod-mates are available on Microsoft Teams right now, go to the PHY131 Help Centre and I'll set up breakout rooms there. Zoom Meeting ID: 938 0964 2256, Passcode: 723874

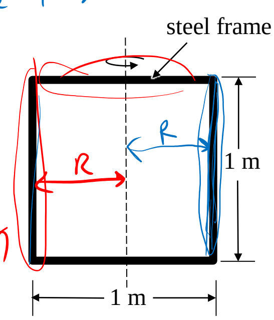
15

Question 1 Discussion

$\boxed{I = mR^2}$ for a particle

use this for sides

A steel square frame is 1 m x 1 m in size, and weighs a total of 4 kg. It can be thought of as 4 connected steel bars, each of mass 1 kg (one on top, one on the right, one on the bottom, and one on the left). If it is rotated around an axis which passes through its centre and which goes through its plane, what is its rotational inertia?



A. 0.1 kg m2
B. 0.7 kg m2
C. 1 kg m2
D. 2 kg m2

$I_{side} = mR^2$, $R = 0.5$

$= (1\ kg)(0.5)^2 = 0.25$

$I_{bottom} = I_{top} = \frac{1}{12} mL^2 = \frac{1}{12}(1 kg) 1^2 = 0.0833$

$I_{total} = 0.25 + 0.25 + 0.083 + 0.083 = 0.67\ kg\ m^2$

16

Question 2 Discussion

α = constant.

A stationary bike has a wheel that rotates while its axis of rotation does not move. The wheel has a rotational (angular) acceleration which is constant, and not zero. Which of the following statements is true for a point on the outermost part of the wheel?

$\boxed{a_t = R\alpha}$ = constant.

$\boxed{a_r = \frac{v^2}{R}}$ $v = \omega R$ is changing

A. The magnitudes of the tangential acceleration and radial acceleration are both constant, and not zero.

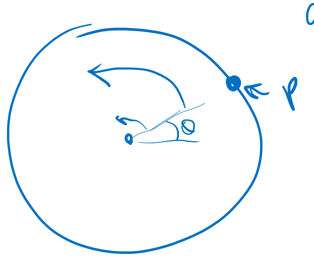
B. The magnitude of the tangential acceleration is changing with time, but the magnitude of the radial acceleration is constant.

C. The magnitude of the tangential acceleration is constant, but the magnitude of the radial acceleration is changing with time.

D. The magnitudes of the tangential acceleration and radial acceleration are both changing with time.

17

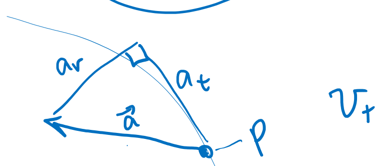
Wheel has angular acceleration α $\left[\frac{rad}{s^2}\right]$



$\omega = \omega_0 + \alpha t$ $\left[\frac{rad}{s}\right]$

$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$ [rad]

Point P at distance R from center has:



$v_t = \omega R$

a_t = tangential acceleration $\left[\frac{m}{s^2}\right] = R\alpha$

a_r = radial acc. $\left[m/s^2\right] = \frac{v_t^2}{R}$

acceleration $a = \sqrt{a_t^2 + a_r^2}$

$a_r = \frac{(\omega R)^2}{R} = \omega^2 R$

18

Question 3 Discussion

Earth's orbit around the sun has a semi-major axis of r = 1.5 × 10^8 m, and a period of T = 3.2 × 10^7 s. If a new planet was discovered in our Solar System, with an orbit whose period was T = 1.6 × 10^7 s, what would you expect would be the semimajor axis of this new planet's orbit?

Kepler's 3rd Law: $\frac{T^2}{r^3} = k$ Eq. 5.5 from pg. 137.

A. 0.19 x 10^8 m
B. 0.38 x 10^8 m
C. 0.75 x 10^8 m
D. 0.95 x 10^8 m

$$\frac{T_1^2}{r_1^3} = \frac{T_2^2}{r_2^3}$$

$$r_2 = r_1 \sqrt[3]{\left(\frac{T_2}{T_1}\right)^2} = 1.5\times10^8 \sqrt[3]{\left(\frac{1.6}{3.2}\right)^2}$$

$$r_2 = 0.95\times10^8 \text{ m}$$

Question 4 Discussion

$v_{avg} = \frac{\Delta d}{\Delta t}$

You walked half the distance to school at a speed of 1.0 m/s, and you ran second half of the distance at a speed of 4.0 m/s. What was your average speed?

A. 1.6 m/s
B. 2.0 m/s
C. 2.5 m/s
D. 3.0 m/s

$d/2$ $\quad$ $d/2$

$v_1 = 1.0$ m/s $\quad$ $v_2 = 4.0$ m/s.

$$v_{avg} = \frac{d}{t_1+t_2}$$

$$v_1 = \frac{d/2}{t_1} \Rightarrow t_1 = \frac{d}{2v_1}$$

$$v_2 = \frac{d/2}{t_2} \Rightarrow t_2 = \frac{d}{2v_2}$$

$$v_{avg} = \frac{\cancel{d}}{\cancel{d}/2v_1 + \cancel{d}/2v_2}$$

$$v_{avg} = \frac{1}{\frac{1}{2(1)} + \frac{1}{2(4)}} = \frac{1}{0.5 + 0.125} = 1.6 \text{ m/s}$$

[Ch. 7] When sketching Energy Bar charts.

If you use	Include this in system
$U_g = mgy$	Earth
$U_s = \frac{1}{2}kx^2$	spring
$\Delta U_{int} = \lvert f_k d \rvert$	surfaces that are sliding.

21

…it's been weird!

- I have really enjoyed all of my interactions with each of you throughout the semester.
- I installed the snapchat app on my phone a couple of days ago and chose jasonjbharlow as my name, but I still don't understand what's going on there. Perhaps I'm too old to figure it out?
- If you haven't done it, please check your utoronto email, respond to the course_evaluations email and evaluate me!
- Please email me (jharlow@physics.utoronto.ca) with any questions. Keep in touch! When COVID is over please stop by my office if you'd like – I'm in MP129E which is 60 St. George St. first floor North wing.

22