SURNAME:_____ INITIALS:_____

STUDENT NUMBER:_____

UNIVERSITY of JOHANNESBURG

Department of Physics

PHY2EB1

Physics 1A2E

Paper C 2022

	Student's mark	Questions' mark
Q1		20
Q2		21
Q3		16
Q4		23
Q5		20
Total		**100**

Date:

Examiner: Mr L Nyadzani

Moderator: Mr P Molefe

Time: 150 Minutes

Pencils and cell-phones are not allowed.
Answer all the questions.
This paper consists of 18 pages including the extra space pages.

Leave any calculations in numbers if you don't have a calculator.
Insert units in the calculations and answer all questions (please do not write in pencil!).

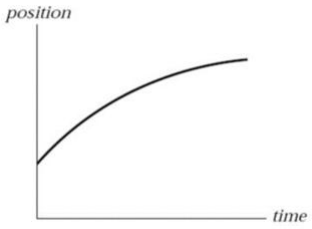
Where necessary, explain what you are doing in derivations.

IF YOU DO NOT UNDERSTAND ANY OF THE LANGUAGE USED, ASK!!!
Cell phones must be switched off in the test venue.
MORE SPACE ON PAGE 17 AND 18.

Question 1 [20]

(Select the best answer(s) for every question, and circle on the answer sheet provided.)

1.1 A train car moves along a long straight track. The graph shows the position as a function of time for this train. The graph shows that the train [2]



A) speeds up all the time.

B) slows down all the time.

C) speeds up part of the time and slows down part of the time.

D) moves at a constant velocity.

1.2 You are throwing a ball straight up in the air. At the highest point, the ball's [2]

A) velocity and acceleration are zero.

B) velocity is non-zero but its acceleration is zero.

C) acceleration is non-zero, but its velocity is zero.

D) velocity and acceleration are both non-zero.

1.3 In a perfectly ELASTIC collision between two perfectly rigid objects [2]

A) the momentum of each object is conserved.

B) the kinetic energy of each object is conserved.

C) the momentum of the system is conserved but the kinetic energy of the system is not conserved.

D) both the momentum and the kinetic energy of the system are conserved.

1.4 Which has greater inertia: 1 kg of feathers or 1 kg of lead? [2]

A) Feathers

B) Lead

C) Neither, they are both zero.

D) Neither, they both are the same.

1.5 An air track cart initially at rest is put in motion when a compressed spring is released and pushes the cart. In the frame of reference of Earth, the velocity-versus-time graph of the cart is shown here. In a frame moving at constant speed relative to Earth, the cart's change in the following quantities can have any value: [2]

A) Velocity

B) Momentum

C) Kinetic energy

D) None of the above

1.6 Knowing all the forces exerted on an object gives you direct information about which aspect of the object's motion? [2]

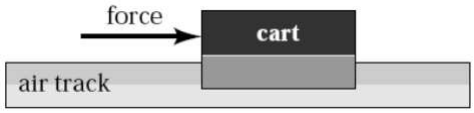
A) Its displacement

B) Its energy

C) Its momentum

D) Its acceleration

1.7 A constant force is exerted for a short time interval on a cart that is initially at rest on an air track. This force gives the cart a certain final speed. Suppose we repeat the experiment but, instead of starting from rest, the cart is already moving with constant speed in the direction of the force at the moment we begin to apply the force. After we exert the same constant force for the same short time interval, the increase in the cart's speed [2]



A) is equal to two times its initial speed.

B) is equal to the square of its initial speed.

C) is equal to four times its initial speed.

D) is the same as when it started from rest.

1.8 A passenger in a speeding train drops a peanut. **Which is greater?** [2]

A) The magnitude of the acceleration of the peanut as measured by the passenger.

B) The magnitude of the acceleration of the peanut as measured by a person standing next to the track.

C) Neither, the accelerations are the same to both observers.

D) The magnitude of the acceleration of the peanut as measured by a person standing at the back of the train.

1.9 Which fundamental interaction exerts the most control (a) in chemical processes and (b) in biological processes? [2]

A) Gravitational in both

B) Gravitational, electromagnetic respectively

C) Electromagnetic in both

D) Electromagnetic, gravitational respectively

1.10 Is vector addition commutative? Is vector subtraction commutative? [2]

A) Yes, yes

B) Yes, no

C) No, yes

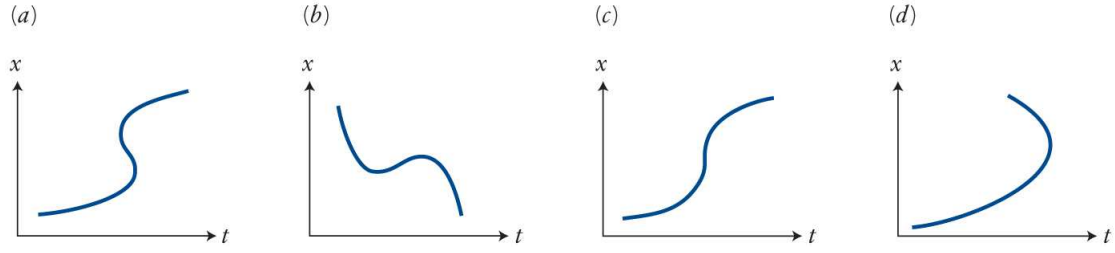
D) No, no

Question 2 [21]

2.1 Briefly describe the scientific method and what it involves. [4]

2.2 What does the phrase arrow of time mean? [2]

2.3 One or more of the graphs in the figure represent an impossible motion. Identify which ones and explain why the motion is not possible. [3]



2.4 Draw a motion diagram for an object that initially has a negative x component of velocity but has a positive x component of acceleration. [3]

2.5 You walk 3.2 km to the supermarket and then back home. What is your distance traveled? What is your displacement? [2]

2.6 A cart starts at position $x = -2.073$ m and travels along the x axis with a constant x component of velocity of -4.02 m/s. What is the position of the cart after 0.103 s? [3]

2.7 Take the first and second time derivatives of x_f, [4]

$$x_f = v_i t + \frac{1}{2} a_x t^2$$

What do you notice?

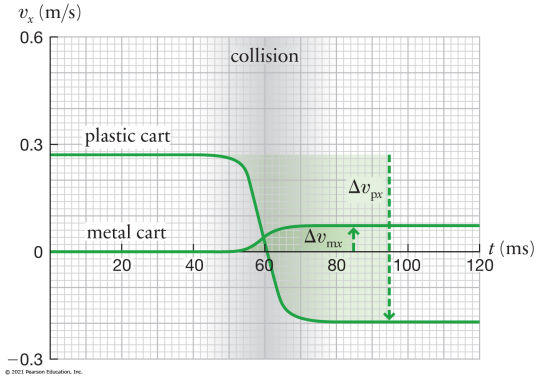
Question 3 [16]

3.1 What is the key difference between an extensive quantity and an intensive quantity? [2]

3.2 Describe several ways of minimizing friction between a surface and an object moving on that surface. Is it possible for a surface to be completely frictionless? [3]

3.3 A 3.00 kg particle has a velocity of $(4.0\,i - 2.0\,j)$ m/s. Calculate its x and y components of momentum and the magnitude of its total momentum. [4]

3.4 The figure shows the $v_x(t)$ curves for two carts, A and B, that collide on a low-friction track. What is the ratio of their inertias? [4]



3.5 You and a friend are bowling. She rolls her 4.5-kg ball at 10 m/s; you roll your ball at 8.0 m/s. What inertia must your ball have if its momentum is to be the same as hers? [3]

Question 4 [23]

4.1 A pickup truck has several empty soda cans loose in the bed. Why do the cans roll forward in the bed when the truck slows down? [2]

4.2 An object of inertia m_1 moving at v_{1i} collides elastically with an object of inertia m_2 initially at rest. Show that the following solution for the final velocities of the two objects after the collision conserve kinetic energy **and explain your steps in detail.** [5]

$$v_{1f} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) v_{1i}$$

$$v_{2f} = \left(\frac{2m_1}{m_1 + m_2}\right) v_{1i}$$

4.3 What are the Galilean transformation equations $t_B = t_A = t$ and $\vec{r}_{\mathrm{Be}} = \vec{r}_{\mathrm{Ae}} - \vec{v}_{\mathrm{AB}} t_{\mathrm{e}}$ used for? [2]

4.4 Someone says to you, "Momentum isn't a conserved quantity! All I have to do is change to a different inertial reference frame and the momentum of the system I'm looking at is different from what it was in my first reference frame." How should you respond? [2]

4.5 You place a 0.10-kg sonic ranger on a low-friction track in front of a 0.50-kg cart to measure the cart's velocity in the Earth reference frame, which turns out to be $+(1.0\ \mathrm{m/s})i$. You are distracted, the cart hits the ranger in a totally inelastic collision, and the two objects then move forward together. A friend is running toward the cart with a velocity of $-(3.0\ \mathrm{m/s})i$ with her sonic ranger on and pointed at the cart.

(i) What is the momentum of the cart, with the ranger stuck to it, in your friend's reference frame? [4]

(ii) What velocity does her sonic ranger measure for the cart after the collision?. [3]

4.6 Two objects A and B having inertias $m_a = m/2$ and $m_b = m$ are moving with velocities $v_a = v$ and $v_b = v/3$. Calculate the velocities of the two objects in the zero-momentum frame of reference. [5]

Question 5 [20]

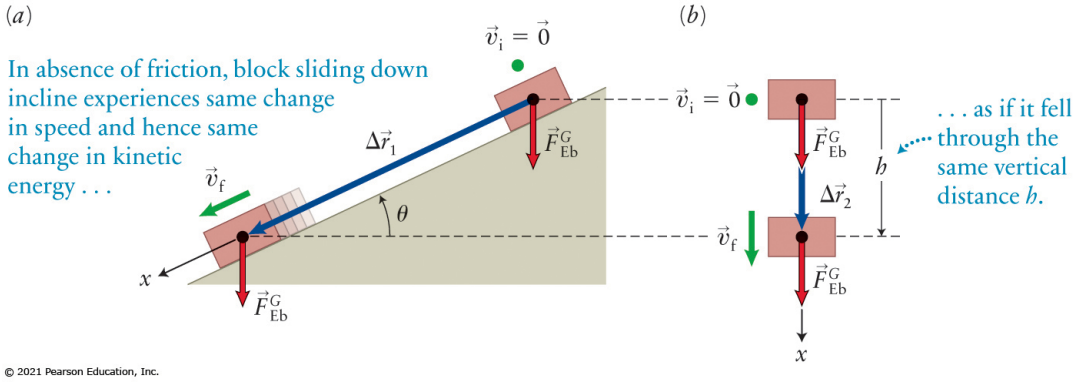
5.1 Give an example of an interaction that converts kinetic energy to thermal energy. [1]

5.2 A woman stands in an elevator that is accelerating upward. Draw a free-body diagram for her. [2]

5.3 A person is sitting on a stool in an elevator. The forces exerted on the stool are a downward force of magnitude 60 N exerted by Earth, a downward force of magnitude 780 N exerted by the person, and an upward force of magnitude 850 N exerted by the elevator floor. If the inertia of the stool is 5.0 kg, with the aid of the diagram calculate the acceleration of the elevator? [5]

5.4 What is the relationship between work and force? [2]

5.5 Consider a block sliding down an incline as shown (ignore friction). The x component of the force of gravity is what causes the block to accelerate. Show that the work done on the block is equal to the final kinetic energy of the block. [6]



5.6 If you try to pound a nail into a board with a 2.5-kg rubber mallet, you will have less luck than if you use a 0.8-kg steel hammer. **Explain why is the case**. [2]

5.7 A ball is thrown at an angle of 40° to the horizontal at a speed of 35 m/s. Write the ball's velocity in terms of rectangular unit vectors. [2]

END OF QUESTIONS

EXTRA SPACE

EXTRA SPACE