**Translational & Circular Motion Review**

**Task A:** Complete a mind map on A4 paper, adding detail from points 1), 2) & 3) below and pages 35 to 58 from your course book, by reviewing the relevant **theory** section (purple boxes).

1. **KNOW THE EQUATIONS: ie symbols and situations where used**



**Note: Equations for Centre: **

|  |  |  |  |
| --- | --- | --- | --- |
| Equation |  | Symbol’s **complete** name And SI unit | Situation where equation is most commonly used (or notes about this equation).  |
|  | FNET | Net Force (N) | 1. Newton’s 2nd Law: Net (resultant or total) force proportional to acc. Also F and a are in same direction. |
| m | Mass (kg) |
| a | Acceleration (ms-2) |
| **Translational Motion** | ρ | Momentum (kgms-1) | 2. For 1D type problems: remember opposite direction means NEGATIVE.For 2D type problems: need TRIAGLE for conservation of momentum And for negative velocity (or subtraction) must draw arrow 180° (backwards) |
| v | Velocity (ms-1) |
|  | Δρ | Impulse (kgms-1) | 3. Alternative unit for kgms-1 (Ns). Force used to change momentum (and speed) for impacts, crashes or collisions. Can be paired with F=ma or W=Fd.Also: any Δ = final quantity – initial quantity |
| F | Average force (N) |
| Δt | Time of contact (s) |
|  | ΔEP | Change in gravitational potential energy (J) | 4. can be paired with and maybe  for energy conservation (assumes no friction or energy-loss)Used to find elastic vs inelastic collisions (no energy loss vs energy loss) |
| g | Gravity (acceleration) (ms-2) |
| h | Height (m) |
|  | W | Work (change in energy) (J) | 5. Can be used in most “change in energy” situations. Average Force must be PARALLEL to distance moved. Work = “energy lost” for “stopping on carpet” problems |
| d | Distance (m) |
|  | EK(LIN) | Kinetic Energy (linear) (J) | 6. see #4 above |
| v | Velocity (ms-1) |

|  |  |  |  |
| --- | --- | --- | --- |
| **Circular** **Motion** | FG | Gravitational Force (N) | 7. Used for finding weight of space-station or astronaut (NOT ZERO!).Common mistake: not including height above earth into r or converting km into m OR not including radius of Earth, planet or moon into r.Could be paired with  with mass in orbit cancelling out.Or can be paired with F = mg to find gravity at any height or on any planet. |
| G | Universal Grav Const (N m2 kg-2) |
| M | Parent Mass (planet) (kg) |
| m | Other Mass (orbiting) (kg) |
| r | Radius of Orbit (distance between mass centres) (m) |
|  | FC | Centripetal Force (N) | 8. Can be paired with F = ma or  for satellite situations.F towards centre of circle (as well as acc). |
| m | Spinning Mass (kg) |
| v | Tangential Velocity (linear) (ms-1) |
| r | Radius of Orbit (m) |

1. **Be familiar with the NCEA standard: i.e. what COULD be on the exam:**
* Centre of mass (1 and 2 dimensions).
* Conservation of momentum and impulse (2 dimensions only).
* Velocity & acceleration of, and resultant force on, objects moving in a circle under the influence of 2 or more forces: eg banked corners, vertical circles, etc
* Newton’s Law of gravitation, Satellite motion.
1. **Know the MEANINGS of these key-words or common terms**
2. center of gravity
3. center of mass
4. translational motion
5. momentum
6. impulse
7. conservation of momentum
8. components
9. elastic collision
10. inelastic collision
11. gravitational potential energy
12. kinetic energy
13. work
14. conservation of energy
15. equilibrium
16. free body force diagram
17. circular motion
18. friction
19. tension
20. weight
21. weightless
22. negative g’s
23. centripetal force
24. centripetal acceleration
25. conical pendulum
26. banked corner
27. Newton’s law of gravitation
28. satellite motion

**TASK B: Be familiar with the COMMON DIAGRAMS and GRAPHS:**

(and know the details, labels, possible equations and *explanations* that accompany them)

EXPLAIN AND UNDERSTANDING PHYSICS DIAGRAMS MAKES FOR EXCELLENT REVISION!

 Look at each diagram and calculate all possible values and describe EACH situation (A,B,C etc).

* Finding the Centre of mass

Before

 After

Vector Diagram

2

A

B

C

1

A

B

C

* Conservation of momentum and impulse (2 dimensions) only

Look at each diagram and calculate all possible values and describe EACH situation.

A

B

C

D

3

* Conservation of momentum and impulse (2 dimensions) only

A

B

4

C

D

* objects moving in a circle under the influence of 2 or more forces only

5

A

B

C

D

* banked corners
* vertical circle motion

A

B

C

D

E

7

A

B

C

E

D

6

**TASK C: Practice NCEA Translational Motion application based questions**

**QUESTION ONE: Bumper-Trolleys**

|  |  |
| --- | --- |
| While studying collisions in physics class, Stuart and Julia observed the following collision with very low friction trolleys. Each trolley was the same as the others and they stuck together and moved together after the collision, as shown.Mass of one trolley = 5.00 x 102 gVelocity = 22 cms-1Two trolleys stacked verticallyVelocity = 0 ms-1d = 132 cm**Before the collision** |  |

|  |  |
| --- | --- |
| (a) Show that the position of the Centre of Mass (COM) of the trolleys at the instant shown before the collision is 44cm from the centre of the two stacked trolleys.(b) Show that the momentum of the COM ***before*** the collision is 0.11kgms-1.  Explain your reasoning for this answer. | Trolleys stuck together, move with a combined velocity**After the collision** |

(c) What is the momentum of the COM after the collision?

(d) If the trolleys stick together in the collision, calculate the velocity of the COM after the collision. Present your answer to an appropriate number of significant figures.

Mass of small oil drop = 2g

Velocity = 10 cms-1

Mass of large oil drop = 5g

Velocity = 3 cms-1

|  |  |
| --- | --- |
| In another lesson, Stuart watched a video that showed two streams of oil drops colliding at right angles and sticking together. This is represented in the diagram to the right. After sticking together the combined oil drop moved off in the direction shown. |  |

(e) Show that the momentum of the large oil drop is 1.5 x 10-4 kgms-1 and of the small one is 2.0 x 10-4 kgms-1.

(f) His teacher drew a triangle to represent the vector diagram of the situation. Put arrows for directions and labels on the vectors appropriate for this situation.

(g) By using the vector diagram and calculation, determine the velocity of the centre of mass of the combined oil drop.

View from above

**QUESTION TWO: Hover-Discs**

Terry is playing with a hover-disc on a smooth floor. Hover-discs are small battery powered discs that have a fan and float on a cushion of air. They have a rubber bumper and a mass of 225g. Terry pushes a disc so it collides with a wall at a right angle.

The disc comes in at a speed of 0.53 ms and rebounds at a speed of 0.47 ms.

 The collision lasts 0.12s.

(a) Is this collision elastic or inelastic? Explain your answer.

1. Explain why the disc’s momentum is not conserved during the collision.
2. Calculate the change in the disc’s momentum during the collision.
3. Calculate the size and direction of the average force the wall exerts on the disc.
4. Determine the size and direction of the average force the disc exerts on the wall.
5. Terry now pushes the disc so it hits the wall at 0.40ms-1 and bounces off at 0.40ms-1 as shown below.

300

300

Draw a vector diagram and use it to calculate the size of the change in velocity. Show the direction of the change in velocity.

1. Terry now pushes the disc at 0.50 ms so it collides with a second, identical, stationary disc and rebounds as shown below. Using a vector diagram or otherwise, calculate the velocity of the second disc after the collision.

0.50 ms-1

0.31 ms-1

350

You **may** wish to use the cosine rule a2 = b2 + c2 - 2bc cosA

**QUESTION THREE: Air-Hockey**

Before collision

1.8 ms-1

1

2

After collision

130o

1

2

1.1 ms-1

A metal disc of mass 65g is moving at 1.8 ms-1 across a frictionless table. It hits another metal disc of the same mass which is stationary. After the collision the first disc moves off at 1.1 ms-1 as shown in the diagram. The second disc moves away from it at right angles as shown.

(a) Calculate the **velocity** of the second disc after the collision.

(b) Show whether the collision is elastic or not.

**NCEA Gravitational application based question**

Venus

**P**

Spacecraft

Mass of Earth = 5.98 x 1024kg

Radius of the earth = 6.37 x 106 m

Universal Gravitational Constant = 6.67 x 10-11 Nm2kg-2

 Acceleration due to Gravity = 9.81 ms-2

**DATA:**

Mass of Venus = 5.41 x 1024 kg

Mass of the spacecraft = 4.32 x104 kg

**QUESTION FOUR:** Space Travel

During a space exploration a spacecraft flies past the planet Venus. The diagram above shows the path taken by the spacecraft as it flies past the planet. Use the data given below to answer the following questions.

(a) The point P is 6.682 x 106 m above the centre of the planet Venus.

Show that the size of the gravitational force acting on the spacecraft at the instant when it is at P is 3.49 x 105 N.

(b) State the direction of the force experienced by the spacecraft when it is at the point P.

(c) Calculate the orbital speed of the spacecraft at the point P. State your answer to the correct number of significant figures.

**NCEA Circular Motion application based questions**

Acceleration due to Gravity = 9.81 ms-2

|  |  |
| --- | --- |
| **QUESTION FIVE:** Year 13 Cross-Country SkiingJasmine is a cross country skier. On the expedition the group takes a large, icy, banked left hand curve as shown below. The curve has a radius of 7.93 m and her mass, with backpack, is 82.3 kg. 1. On the diagram draw and label the forces acting on Jasmine as she makes this turn with constant speed. (Assume there is no sideways friction between the skis and the surface of the snow)
 |  |

|  |  |
| --- | --- |
| (b) Explain why it is possible for Jasmine to travel around the banked curve despite the fact that friction is not present.(c) By resolving the forces, calculate the snow’s force on Jasmine.(d) Show that the horizontal component of the snow’s reaction force on Jasmine is 1300 N.(e) Calculate the speed at which Jasmine should take this turn. Give your answer to the correct number of significant figures. |  |

(f) Explain (using a diagram if you wish) what would happen to Jasmine if she were to take this turn too slowly?



**QUESTION SIX:** Hammer Throw

Julia competes in the sport of hammer throwing, as shown in the photo alongside. Julia swings a steel ball on the end of a chain around in a circle then lets it go. A women’s hammer is usually 118cm long from the end of the chain to the ball and has a mass of 4.00kg.

At one point in the ball’s swing, it is travelling in a horizontal circle as shown in the diagram below (diagram not to scale):

1.18m

Stick figure view of Julia

Hammer ball, mass 4.00kg

 = 70º

(a) Explain why a net force must be acting on the Hammer ball?

(b) Show that the acceleration due to gravity on the hammer ball, caused by the attraction of the earth, is 9.83ms-2.

(c) The triangle below represents the vector arrangement of the two forces acting on the ball and also shows the net force. Identify and label these three forces on the vector diagram, then calculate the speed of the ball as it rotates.

 = 70º