Class	Register Number	Name

南洋女子中学校

NANYANG GIRLS' HIGH SCHOOL

End-Of-Year Examination 2020
Secondary Three

PHYSICS

Paper 3 (Advanced) **35 minutes**

Wednesday **14 October 2020** **13:00 – 13:35**

Calculators may be used

READ THESE INSTRUCTIONS FIRST

Do not open this booklet until you are told to do so.
Write your name, register number and class in the spaces at the top of this page and on any separate answer paper used.

INFORMATION FOR CANDIDATES
The intended number of marks is given in the brackets [ ] at the end of each question or part question. Answer ALL questions.

Take the acceleration due to gravity to be 10 m s^{-2} or gravitational field strength to be 10 N kg^{-1} unless told otherwise.

Examiner's Use	
Paper 3	
1	
2	
3	
4	
Total	
	20
	%

This document consists of **7** printed pages and 1 blank page.

Formulae Sheet

$$v = r\,\omega$$

$$a = \frac{v^2}{r}$$

$$F = \frac{Gm_1m_2}{r^2}$$

$$F\Delta t = mv - mu$$

Paper 3 (20 marks)

1 **(a)** A racing car moves in a circle of radius 20.0 m at a constant speed of 100 km/h. Determine the acceleration of the car.

acceleration = ……………………… [2]

(b) State the direction in which the acceleration is acting.

……………………………………………………………………………………… [1]

2 The International Space Station (ISS) orbits the Earth at an average height of 408 km.

(a) An astronaut weighs 678 N on the surface of the Earth, which has a radius of 6371 km. Calculate the gravitational force of attraction on the astronaut when he is on the ISS.

force of attraction on astronaut on ISS = ……………………… [2]

(b) Explain why the astronaut 'feels' weightless on the ISS.

………………………………………………………………………………………

……………………………………………………………………………………… [1]

3 In Fig. 3.1, a bullet of mass 50 g is travelling horizontally with a speed of 300 m s^{-1} when it strikes a stationary block of mass 3.0 kg. The bullet embeds itself in the block and the two move together along a smooth floor.

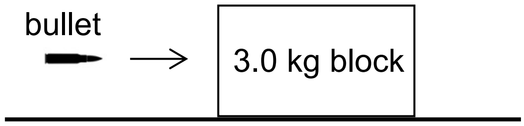

Fig. 3.1

(a) State the *Principle of Conservation of Momentum.*

....

.... [1]

(b) Calculate the velocity of the block immediately after the bullet comes to rest in the block.

velocity = ... [2]

(c) Given that the average force on the bullet as it slows down is 10 000 N, determine the time the bullet takes to come to rest in the block.

time to come to rest = ... [2]

(d) **(i)** Determine the total kinetic energy of the objects before and after the collision.

kinetic energy before collision = ……………………… [1]

kinetic energy after collision = ……………………… [1]

(ii) What does this information tell us about the nature of the collision?

…………………………………………………………………………… [1]

4 A tennis court is 11.89 m in length on either side of a net of height 0.98 m.
A tennis ball machine fires a tennis ball from an opening 0.50 m off the ground and 7.00 m behind the net shown in Fig. 4.1. The ball leaves the tennis ball machine at a speed of V at an angle 11° to the ground.

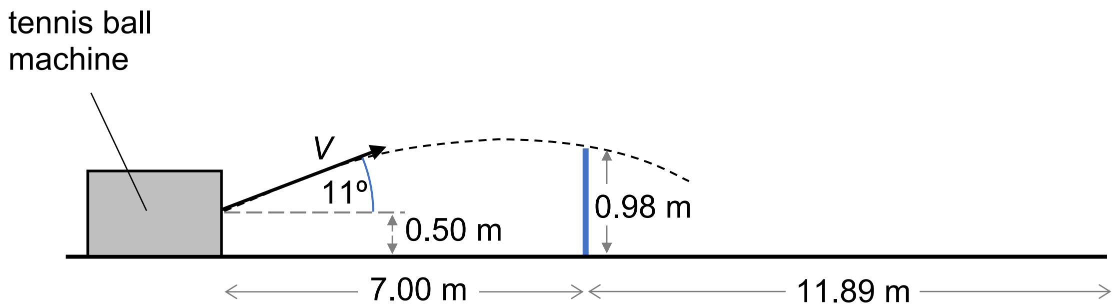

Fig. 4.1

(a) On its path from the tennis ball machine, the tennis ball just passes over the top of the net as shown by the dashed line.
Assuming that air resistance can be neglected, calculate the minimum speed V, that allows the tennis ball to just clear the net.

V = …………………… [4]

(b) The ball must land within the court (i.e. within 11.89 m of the net) in order for it to be considered a valid shot.

Calculate the distance from the net at which the tennis ball actually hits the ground.

distance from net = ……………………… [2]

End of Paper

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ANSWERS

1 **(a)**

100 km/h = 100 km/h × 1000m/1km × 1h/3600s = 27.8 m/s **{1}**

$a = v^2 / r$

$a = 27.8^2 / 20.0$

$a = 38.6$ m/s^2 **{1}**

(also accept a = 500 000 km/hr^2)

(b)

Towards the centre of the circle. **{1}**

2 **(a)**

$F = G\, m_1\, m_2 / r^2$

$F\, r^2 = G\, m_1\, m_2$

G, m_1 and m_2 are constants, thus

$F_{earth}\, r_{earth}{}^2 = F_{iss}\, r_{iss}{}^2$

$678 \times 6{,}371{,}000^2 = F_{iss} \times (6{,}371{,}000 + 408{,}000)^2$ **{1}**

$F_{iss} = 599$ N **{1}**

(b)

Both the astronaut and the ISS are in orbit and both constantly falling to the earth at the same rate. **{1}**

3 **(a)** It states that <u>total momentum of a system remains constant</u> if the resultant force (or <u>net force</u>) on the system <u>is zero</u>. **{1}**

(b) momentum before = mv = 0.050 × 300 = 15 kg m s^{-1}

momentum after bullet comes to rest = 3.050 × v = 15 **{1}**

v = 4.92 m/s **{1}**

(c) $F\Delta t = mv - mu$

for block,

$10\,000 \times \Delta t = 3.00 \times 4.92$ **{1}**

$\Delta t = 1.48$ ms **{1}**

(d) **(i)**

$KE_{before} = ½ m v^2 = ½ \times 0.050 \times 300^2 = 2250$ J **{1}**

$KE_{after} = ½ m v^2 = ½ \times 3.050 \times 4.92^2 = 36.9$ J **{1}**

(ii) The collision is an <u>inelastic collision</u>. **{1}**

4 **(a)**

$u_x = v_x = V\cos 11°$

$u_y = V\sin 11°$

Displacement in the horizontal direction given by:

$x = V\cos 11° \times t$ **{1}**

Displacement in the vertical direction given by:

$y = u_y t + ½at^2$

$y = V\sin 11° \times t + ½(-10)t^2$

$y = V\sin 11° \times t - 5t^2$ **{1}**

When the ball is just passing over the net,

$x = \underline{7.00 \text{ m}}$ & $y = (0.98-0.50) = \underline{0.48 \text{ m}}$ **{1}**

$7 = V\cos 11° \times t$

$0.48 = V\sin 11° \times t - 5t^2$

$0.48 = 7\sin 11°/\cos 11° - 5t^2$

$5t^2 = 0.88066$

$t = 0.420$ s

$V = 7/(0.420\cos 11°)$

$V = 16.98$ m/s **{1}**

(b)

The ball hits the ground when y = -0.50 m

$y = V\sin 11^\circ \times t - 5t^2$

$-0.50 = 16.98\sin 11^\circ \times t - 5t^2$

$0 = 0.50 + 3.24t - 5t^2$ **{1}**

t = -1.287 s (reject) or t = 0.7767 s

Horizontal distance travelled is thus given by

$x = 16.98\cos 11^\circ \times 0.7767$

x = 12.9 m

Thus, the ball hits the ground (12.9 – 7.00) 5.9 m from the net. **{1}**