Tampines Meridian Junior College
2023 JC2 H2 Physics Preliminary Examination Paper 2
Suggested Solution

1 **(a)**

$$S_y = u_y t + \frac{1}{2}at^2$$

$$-1.0 = u_y(0.80) + \frac{1}{2}(-9.81)(0.80)^2$$ [M1- correct S_y and a values]

$$u_y = 2.674$$

$$= 2.67 \text{ m s}^{-1}$$ [A0]

(b)

$$\frac{u_y}{u_x} = \tan(10°)$$

$$u_x = \frac{2.67}{\tan(10°)}$$ [M1]

$$= 15.1 \text{ m s}^{-1}$$ [A1]

(c)

$$S_x = u_x t$$

$$S_x = (15.1)(0.80) = 12.1 \text{ m}$$ [C1- for calculating best value]

$$\frac{\Delta S_x}{S_x} = \frac{\Delta u_x}{u_x} + \frac{\Delta t}{t}$$

$$= \frac{5.0}{100} + \frac{0.08}{0.80} = 0.15$$ [C1: correct substitution]

$$\Delta S_x = 0.15(S_x) = 1.8 \text{ m}$$

$$S_x \pm \Delta S_x = 12 \pm 2 \text{ m}$$ [A1]

(d) **(i)** Air resistance acts in the same direction/ downward as the weight of ski jumper. [B1]

Hence, the vertical acceleration of the ski jumper is greater than that of free fall or net force is downwards. [B1]

Air resistance decreases with decreasing speed. Hence magnitude of vertical acceleration decreases. [B1]

At highest point, vertical acceleration is *g or* free fall (as there is no resistance). [B1]

Maximum 3 marks for any of points stated above.

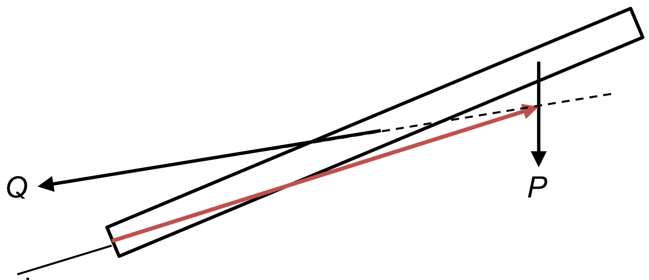
(ii) This position increases her surface area to generate upwards lift force.
The more the lift, the more time she stays on the flight and thus, the further she will travel. [B1]
Or:
This position decreases her exposed surface area horizontally (or more streamlined/ reduce the air resistance). Hence, she can travel more horizontally.

Or:
This position will lower her CG such that there is a counter moment to the moment created by air resistance.

2 **(a)** **(i)** The resultant force in any direction is zero. [B1]

The resultant torque about any point/axis is zero. [B1]

(ii)



[B1] arrow from base of spine and correctly going through the point of intersections of all the forces.

(iii) Taking the base of the spine as the pivot,

$$Q\sin 12°(0.40) = P\sin 70°(0.65)$$ [M1]

$$\frac{Q}{P} = \frac{\sin 70°(0.65)}{\sin 12°(0.40)}$$

$$= 7.3$$

[A1]

(b) **(i)** Vertical direction: F_{net} = 0 as the suitcase did not move in the vertical direction.

$$T_y + N = W$$

$$30\sin 20° + N = 11(9.81)$$ [M1]

$$N = 97.6 \text{ N}$$ [A1]

(ii) The resultant force acting on the body is proportional to the rate of change of its momentum, and the change takes place in the direction of the resultant force. [B1]

(iii) Horizontal direction: F_{net} = *ma* as the suitcase accelerated horizontally.

$$T_x - f = ma$$

$$30\cos 20° - 8.5 = 11a$$ [M1]

$$a = 1.79 \text{ m s}^{-2}$$ [A1]

3 **(a)** Rate of change of angular displacement [B1]

(b) **(i)** By conservation of energy,
Loss in Ep = Gain in Ek

$mgh = \frac{1}{2}mv^2 - 0$ [C1]

$m(9.81)(4.5+5.5) = \frac{1}{2}mv^2$ [M1]

$v = 14 \text{ m s}^{-1}$ [A0]

Do not accept use of kinematics equation.

(ii) $\omega = \frac{v}{r} = \frac{14}{4.5}$

$= 3.1 \text{ rad s}^{-1}$ [B1]

(iii) (Tension – weight) provides for the centripetal force. [B1]

$F_{net} = ma$

$T - mg = m\frac{v^2}{r}$

$T - (65)(9.81) = (65)\left(\frac{14^2}{4.5}\right)$ [C1]

$T = 3469 = 3470 \text{ N}$ [A1]

(iv) <u>Parabolic</u> path with initial horizontal velocity [B1]

4 **(a)** **(i)** $V_{out} = 0.040 \times 80 = 3.2\text{V}$ [M1]
potential at A= 0-3.2V=-3.2V[A1]

(ii) $V_x = 8.0 - 3.2 = 4.8V$ [C1]

$\text{R}_x = \frac{4.8}{0.040} = 120\Omega$[A1]

(b) **(i)** $R_{out} = \frac{100 \times 80}{100 + 80} = 44.44\Omega$ [C1]

$\text{V}_{out} = \frac{R_{out}}{R_{total}} \times 8.0$

$= \frac{44.44}{44.44 + 120} \times 8.0$ [C1]

$= 2.16 \text{ V}$ [A1]

(ii) When temperature gets hotter, resistance across the thermistor decreases [M1]

and hence effective/combined resistance across AB decreases. By applying potential divider rule, potential difference across BC increases [M1] which will turn on the fan.

Thus, fan should be connected across BC [A1]

5 **(a)** **(i)** The magnetic flux density of a magnetic field is defined as the force per unit current per unit length (of conductor) acting on a straight current-carrying conductor placed at right angles to the magnetic field [B1].

(ii) Current in clockwise direction through wire [A1]

(iii) $B = \mu_o nI = 4\pi \times 10^{-7} \times \frac{50}{0.30} \times 2.0 = 4.189 \times 10^{-4}$ T [A1]

(iv) $F = Bqv$

$= (4.189 \times 10^{-4})(1.6 \times 10^{-19})(10)$ [C1]

$= 6.7 \times 10^{-22}$ N [A1]

(v) The magnetic force is acting perpendicular to the direction of travel/ velocity of the electron [M1] and this will only affect direction of velocity and not its magnitude [A1]

Alternative answer:
The magnetic force is acting perpendicular to travel/ velocity of the electron [M1] and therefore no (net) work done [A1] on the electron, resulting in no change in kinetic energy

(b) **(i)** No net force acting on electron,

Magnetic force= Electric force [C1]

qE= Bqv

E= Bv = 4.19 x 10^{-3} Vm^{-1} [A1]

(ii) Downwards vertical arrow labelled E [B1]

6 **(a)** α : protons decrease by 2, neutron decrease by 2 [B1]
β : protons increase by 1, neutron decrease by 1 [B1]
γ: no change to number of protons and neutrons [B1]

(b) γ has no charge, so does not experience magnetic force [B1]. So its path should be undeflected [B1]

α and β have opposite charges, so should experience magnetic forces in opposite directions [B1]. So their paths should curve in opposite directions [B1]

(c) **(i)** Mass is converted [B1] into kinetic energies of nickel-60 nucleus and β particle (also energy of neutrino) as well as electromagnetic energy (photon energy) of the γ radiation [B1]

(ii) Energy released
= (mass loss) c^2
= (59.9338 – 59.9308 – 5.4348 x 10^{-4}) (1.66 x 10^{-27}) (3.00 x 10^8)^2 [C1]
= 3.67 x 10^{-13} J [C1]
= 2.29 MeV [A1]

7 **(a)** **(i)** Sound cannot be polarised [B1] as it is longitudinal [B1].

(ii) The particles are more tightly packed in solid steel [B1] than in air. Hence it is faster for energy to be transferred between particles.

(iii) I is inversely proportional to square of r. $I \propto \frac{1}{r^2}$ [B1]

iv.1

$$10\lg\frac{I_X}{\left(1.0\times10^{-12}\right)}=120$$

$I_X = 1.0$ W m^{-1} [B1]

$$20\lg\frac{p_X}{\left(20\times10^{-6}\right)}=120$$

$p_X = 20$ Pa [B1]

iv.2 Estimated area of an eardrum = 1 cm^2 = 10^{-4} m^2 [B1]

(accepted area between 2 x 10^{-5} m^2 to 2 x 10^{-4} m^2; based on circular area between diameter of 0.5 cm to 1.5 cm)

iv.3 $F = PA$

$= 20\left(10^{-4}\right)$ [C1]

$= 2.0\times10^{-3}$ N [A1]

(b) **(i)** To avoid causing noise disturbances to people living on land. [B1]

OR

As no human lives on the ocean, no one will be affected by the noise disturbance. [B1]

(ii) Any of the following (or other sensible suggestions): [B1]

Minimise the drag force at high speed as air is thinner at high altitude.

Minimal obstacle / traffic at high altitude so that it can travel at high speed without obstructions.

Minimise intensity of noise at sea level.

(ii) Speed = (1.4)(295) = 413 m s^{-1} [B1]

(c) **(i)** Resonance [B1]

(ii) Wavelength

= 2(0.91 – 0.54) [C1]

= 0.74 m [A1]

(iii) Speed of sound = fλ

= (480)(0.74) [C1]

= 355 m s^{-1} [A1]

(iv) $v = 331\sqrt{\frac{22+273}{273}}$ [M1]

$= 344$ m s^{-1} [A1]