RVHS JC2 H2 Physics Preliminary Examinations Paper 2 Mark Scheme

1 **(a)** error that does not have a fixed magnitude or direction — B1

or

error that scattered around the true value.

or equivalent statement

(b) **(i)** $13\cos 35^o = 10.6 \text{ or } 11$ m s^{-1} — B1

(ii) $v_{max} = 13 \times 1.1\cos 34^o = 11.9$ m s^{-1} — B1
or
$v_{min} = 13 \times 0.9\cos 36^o = 9.47$ m s^{-1}

uncertainty = $11.9 - 10.6 \approx \pm$ 1 m s^{-1} — B1
or $10.6 - 9.47$ or $\frac{11.9-9.47}{2}$

(11 ± 1) m s^{-1} — B1
uncertainty given to 1 sf <u>and</u> value given to the same precision as uncertainty

2 **(a)** No net force — B1
No net torque/moment about any point — B1

(b) **(i)** Downwards weight from centre of block
Force by ball at upper left hand corner of block, follows direction of velocity of ball.
Upwards normal reaction force at A (equal length to weight) — B1 for both

Frictional force acting at A to the left — B1

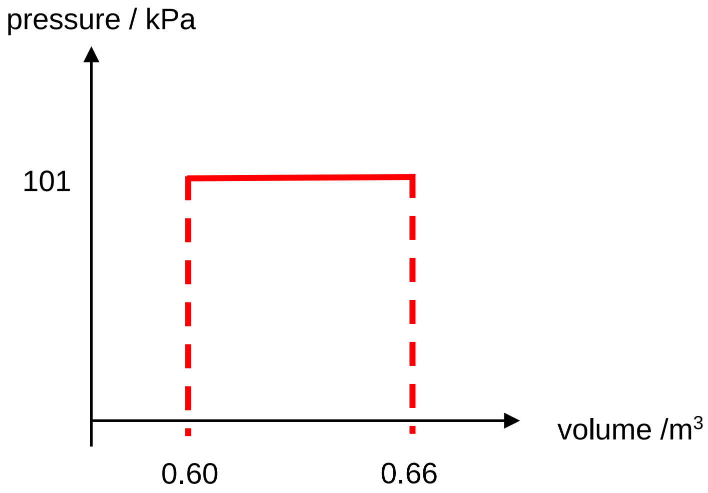
(ii) Taking pivot about A, clockwise moments by force from ball = anticlockwise moments by weight. — C1

9.0 × F = 300/1000 × 9.81 × 5.0 — M1
F = 1.64 N — A1

3 **(a)** **(i)** When the gas is heated, <u>the molecules gains kinetic energy (or speed)</u>, leading to a <u>larger change in momentum per collision with the container per unit time</u>. This leads to a <u>larger force</u> on the walls of container and piston. — B1

This leads to an <u>increase in pressure</u> in the container. To keep the pressure constant, the piston moves up that leads to an <u>increase in volume</u> of gas until the <u>rate of change of momentum</u> of gas molecules with the walls of the container <u>decreases to the original level</u>. — B1

(ii) B2



$$\frac{0.60}{28+273.15}=\frac{V_2}{57+273.15}$$
$$V_2=0.66\text{ m}^3$$

1 mark for correct graph
1 mark for correct showing correct values on both axes

(iii) Energy from heater = (24)(15)(60) = 21600 J

Using $\Delta U = Q + W$,

Q = – 7000 + 21600 = 14600 J — B1
W = 101000(0.66 – 0.60) = 6060 J — C1

ΔU = 14600 – 6060 = 8540 J — A1

Accept slight variation in values if using raw values from (ii)
Max of 1 mark if students using alternative methods

(b) **(i)** Using $pV=\frac{1}{3}Nm\langle c^2\rangle$ and $pV=NkT$,

$$\frac{2}{3}N\left(\frac{1}{2}m\langle c^2\rangle\right)=NkT$$ B1

$$E=\frac{1}{2}m\langle c^2\rangle=\frac{3}{2}kT$$

(ii) Using $\frac{1}{2}m\langle c^2\rangle=\frac{3}{2}kT$, $k=\frac{R}{N_A}$ and $M=N_Am$

$$c_{rms}=\sqrt{\langle c^2\rangle}=\sqrt{\frac{3kT}{m}}=\sqrt{\frac{3RT}{M}}=\sqrt{\frac{3(8.31)(57+273.15)}{4.0\times10^{-3}}}=1.43\times10^3\text{ m s}^{-1}$$ C1 A1

4 **(a)** A **<u>progressive</u>** wave is a wave in which **<u>energy is carried from one point to another</u>** by means of vibrations or oscillations within the wave. Particles within the wave are <u>not transported</u> along the wave. B1

(b) **(i)** λ = 0.40 m since distance between P and Q is 1.5 wavelength. C1

$v = f\lambda = 0.40 \times 850 = 340$ m s^{-1} A1

(ii) Intensity of sound at man $I = \frac{P}{A} = \frac{1500}{4\pi(80.0)^2}$ C1

$= 0.01865$ W m^{-2} C1

Power intercepted by man = I × A = 0.01865 × 2.1 × 10^{-3} A1
= 3.9 × 10^{-5} W

5 **(a)** Destructive interference is when <u>two waves arrive at the same point anti-phase</u> (phase difference of π / 3π etc rad) they superpose to produce a <u>resultant wave with minimum (or zero) amplitude or a minimum is produced.</u> B1 B1

(b) **(i)** $\lambda = \frac{v}{f}$

$\lambda = \frac{v}{f} = \frac{330}{1780} = 0.185m$ A1

(ii) $S_1D = \sqrt{12^2 + 4^2}$ = 12.649 m

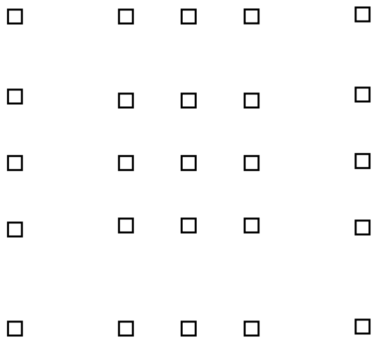
Path difference
= 12.649 – 12
$= \frac{0.649}{0.18539}\lambda$ C1
$= 3.5\lambda$ A1

(iii) The path difference of 3.5λ would lead to a phase difference of π rad. Since sound from both speakers have a phase difference of π rad, this would mean that there is no net phase difference at D. B1

Constructive interference of sound waves will take place and loud sound will be heard at D. B1

(c) **(i)** d sinθ = nλ
Since sin θ cannot be greater than 1
For max order, sin θ < 1
n λ / d <1
n < 2.7
C1
Since n must be an integer, and cannot exceed 2.7, the max order =**<u>2</u>** A1

(ii)



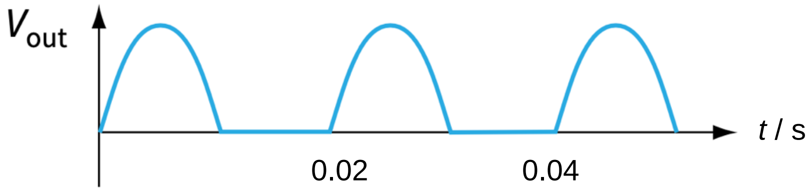
1 mark for correct shape grid of spots 5x5 B1
1 mark for 2nd order dots are further apart than 1st order dots B1

(iii) The new light source has shorter wavelength. Using d sinθ = nλ, the diffracted angle for each wave will be smaller.

Hence, more bright spots can be seen on the screen and the closer spacing between spots. B1

6 **(a)** **(i)** $100\pi = 2\pi f$, so frequency $f = 50$ Hz. B1
So period T= 1/50 = 0.020 s

(ii)



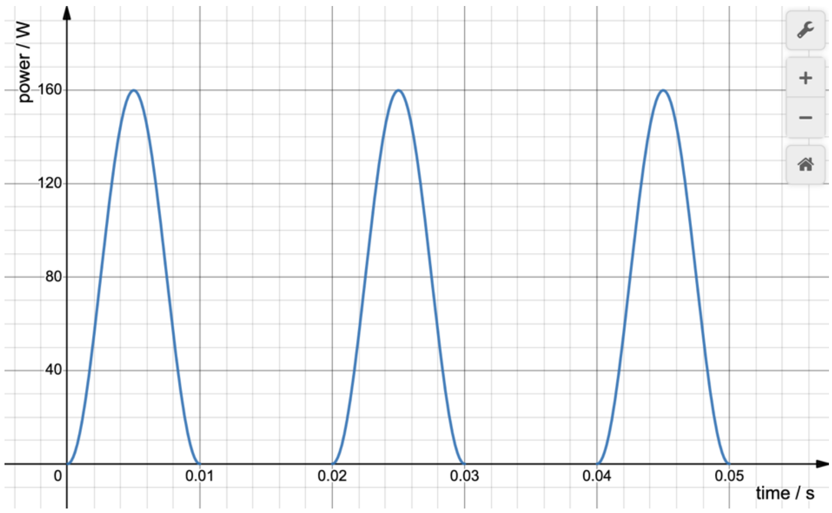
1 mark for shape B1
1 mark for labelling of period B1

(b) **(i)** mean power = $\frac{v_{rms}^2}{640} = 40$ B1

For half-rectified voltage, mean square voltage = $\frac{V_0^2}{4}$ C1

Hence $\frac{V_0^2}{4} = 640 \times 40$, giving $V_0 = 320$ V A1

(ii)



1 mark for shape B1
1 mark for labelling of peak power at 160 W B1

7 (a) (i) photons and electrons undergo a <u>one-to-one</u> interaction. B1

(ii) photons could have interacted with electrons below surface; energy is used to take electron to the surface. B1

or

some electrons are more tightly bound to nuclei than others

(iii) 1. $\phi = -E_{max}$ when $\frac{1}{\lambda} = 0$ (use of the x-intercept) B1

Allow range $(3.8 \pm 0.2) \times 10^{-19}$ J

(allow use of substitution)

2. Use of gradient $= \frac{1}{hc}$ C1

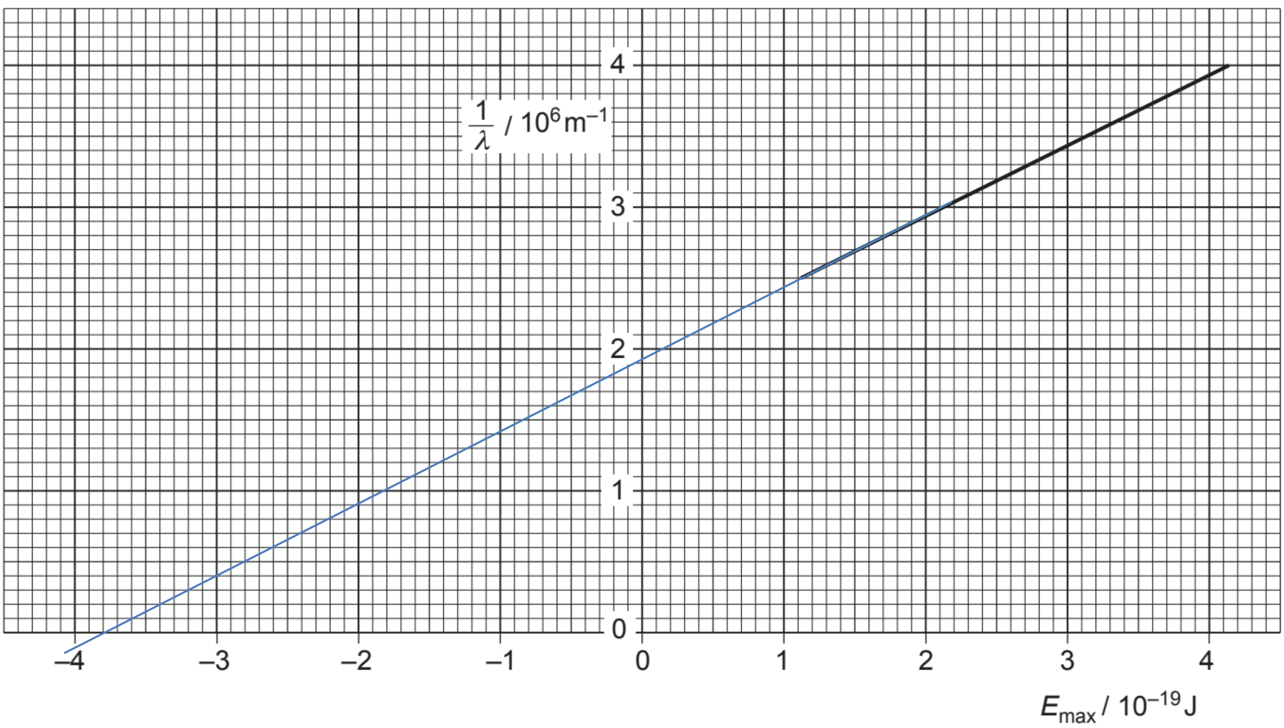
Allow range of gradient $(4.8 - 5.2) \times 10^{24}$ B1

Allow range of *h* $(6.4 - 6.9) \times 10^{-34}$ J s

alternative

(allow use of substitution of points) C1

Allow range of *h* $(6.4 - 6.9) \times 10^{-34}$ J s A1



(iv) increase intensity only increases the rate / number per unit time of the emitted electrons B1

E_{max} depends on frequency of photons and work function of metal only. B1

Hence, no change.

(b) **(i)** energy difference $\Delta E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{663\times10^{-19}} = 3.0\times10^{-19}$ M1

So energy levels associated with the transition is between n = 2 and n = 3 B1

Since dark line is observed, n = 2 to n = 3 A1

(ii)
$$21.8\times1 = 21.8$$
$$5.4\times2^2 = 21.6$$
$$2.4\times3^2 = 21.6$$

1 mark for working to find constant B2

1 mark for comparing the any pair of values

8 **(a)** **(i)** Similarity: B1

Both nuclear reactions produce energy

or

Both produces products that are more stable/higher binding energy per nucleon.

Difference: B1

Nuclear fusion combines two lighter nuclei into a heavier nuclei while nuclear fission splits a heavier nuclei into two lighter nuclei of similar sizes.

Nuclear fission produces radioactive waste while nuclear fusion does not.

(ii) The process is able to use the energy produced to keep itself going without any external help/guidance. B1

(iii) It does not produce any radioactive waste/ produces very little short-lived radioactive wastes. B1

It produces more energy per unit mass compared to nuclear fission.

Nuclear fusion reactors will not melt down compared to nuclear fission reactors.

The raw ingredients required for fusion is more readily available compared than that for fission.

(b) **(i)** High amount of kinetic energy required for the positively charged nuclei to B1

overcome the Coulombic/electrostatic repulsion B1

(ii) To increase the probability of collision between the nuclei B1

(c) **(i)** 4 m_H – (m_{He} + 2 m_e)

= 4(1.007825) – (4.002604 + 2(0.000549))u M1

= 4.58(1) × 10^{-29} kg. A1

(ii) $E = \Delta mc^2$

= (4.581 × 10^{-29})(3.00 × 10^{8})^2

= 4.123 × 10^{-12} J (/ 1.60 × 10^{-19})

= 25.8 MeV A1

(iii) Percentage loss in mass
= (4 × 1.007825 – (4.002604 + 2(0.000549) / (4 × 1.007825)
=0.006846
=0.6846% A1

(iv) Loss in mass $M = M_{core} \times 0.006846 = 0.10 \times M_{Sun} \times 0.006846$ C1

$$3.8 \times 10^{26} = \frac{(0.10 \times M_{Sun} \times 0.006846)(3.00 \times 10^{8})^{2}}{t}$$ C1

$t = 3.243 \times 10^{17}$ s A1

=10.3 billion years

(d) **(i)**
- Inverted asymmetrical U-shaped curve with right side lower in height. B1
- Max B.E per nucleon is between 8.0 to 9.5 MeV B1
- Corresponding nucleon number is between 55 - 65 B1

(ii) Iron has a very high binding energy per nucleon. M1

When iron is fused, the products are less stable/lower BE per nucleon and there is no net energy released in the reaction. A1

(iii) They are produced via explosions which provide energies for these elements to be fused together. B1