Anderson Serangoon Junior College 2024 JC2 H1 Physics Preliminary Examination Mark Scheme

Paper 1 (30 marks)

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	A	B	D	C	B	C	A	B	D
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	A	B	A	A	C	C	A	C	A
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	C	A	D	A	B	D	D	B	D

1 **D**

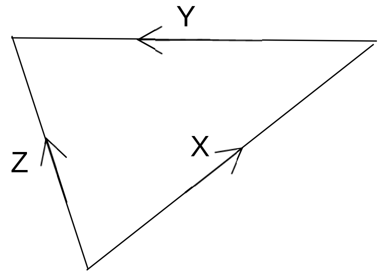
intensity $I = \dfrac{E}{At}$

units of $I = \dfrac{kg\ ms^{-2}\ m}{m^2\ s}$

$= kg\ s^{-3}$

2 **A**

Z = X + (–Y) as shown by the vector triangle below.



This is equivalent to option A.

3 **B**

Velocity is a vector; distance is a scalar

4 **D**

Taking downwards as positive,

$s = ut + \frac{1}{2}at^2$

$10.0 = 0 + \frac{1}{2}(9.81)t^2$

$t = 1.43$ s

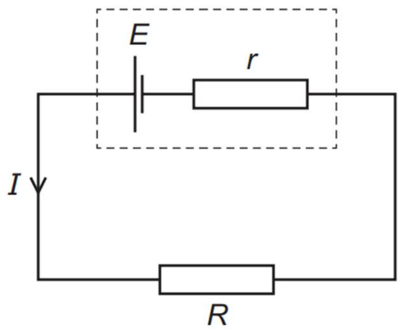
$v^2 = u^2 + 2as$

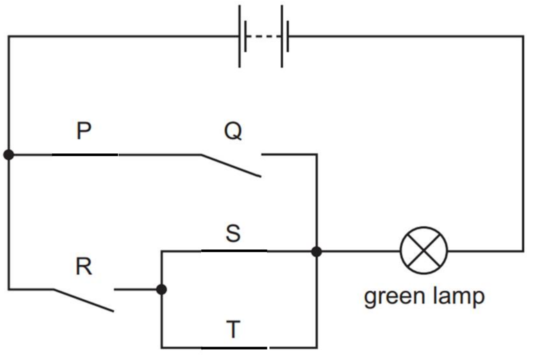
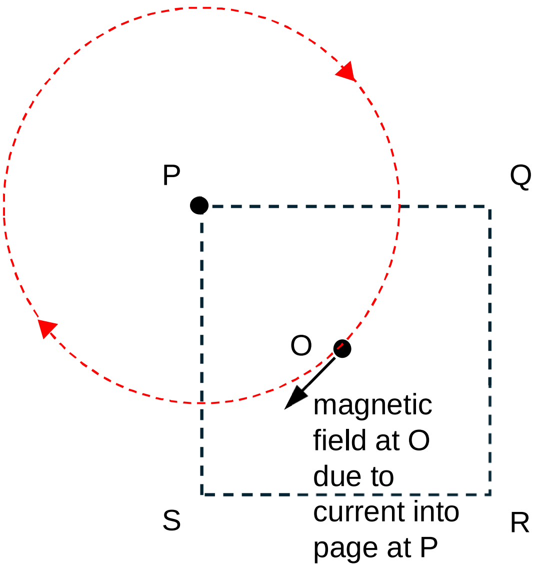
$v^2 = 0 + 2(9.81)(10.0)$

$v = 14.0$ m s^{-1}

5	**C** Constant speed up to t_1 means s increases at a constant rate, hence a straight line with positive gradient. As speed decreases at constant rate, distance travelled increases at a decreasing rate (decreasing gradient) and reaches a constant (zero gradient) when speed is zero.
6	**B** The vertical component of acceleration is the acceleration of free fall which is a constant in the absence of air resistance.
7	**C** Action-reaction must be of the same type. Weight is the gravitational force on the man due to the Earth.
8	**A** Consider the 2 masses as a system Weight of 2 kg mass – friction between 8 kg mass and plane = (mass of 2 masses) × a a = $\frac{2.0(9.81)-5.0}{8.0+2.0}$ = 1.5 m s^{-2}
9	**B** F_{net} = change in momentum / change in time = 0.2 (10.0 – (–20.0)) / 0.10 = 60 N
10	**D** Consider vertical equilibrium when there were three springs and weight W $3kx = W$ k = $\frac{W}{3x}$ Consider vertical equilibrium when there were two springs and weight 2W $2kx' = 2W$ $kx' = W$ $x' = \frac{W}{k} = \frac{W}{(\frac{W}{3x})} = 3x$
11	**C** Two equal and opposite parallel forces whose lines of action do not coincide.
12	**A** Weight must be vertical. The three forces form a closed triangle.
13	**B** total work done by man = Work done against friction + gain in GPE, since KE constant

	Work done against friction = total work done by man – gain in GPE = 1500 – mgh = 1500 – 5.0 x 9.81 x 12 = 911. 4 J Average friction = work done against friction / distance travelled along plane = 911.4 / ($\frac{12}{\sin 30°}$) = 37.9 ≈ 38 N
14	**A** By Conservation of Energy, loss in KE = Gain in GPE. ➔ ΔE = Δmgh = mgΔh Hence E varies linearly with height, i.e. a straight line. Since y is vertical displacement, at maximum height (largest y value) E = 0. Hence the answer is A.
15	**A** The centripetal acceleration at Singapore is: $a_S = r\omega^2 = r\left(\frac{2\pi}{T}\right)^2 = \left(6.4\times10^6\right)\left(\frac{2\pi}{24\times60\times60}\right)^2 = 3.4\times10^{-2}\ \text{m s}^{-2}$ The radius of rotation at Cambridge is $r\ \cos 52° = \left(6.4\times10^6\right)\cos 52° = 3.940\times10^6$ m Hence centripetal acceleration at Cambridge is: $a_C = r\omega^2 = r\left(\frac{2\pi}{T}\right)^2 = \left(3.94\times10^6\right)\left(\frac{2\pi}{24\times60\times60}\right)^2 = 2.1\times10^{-2}\ \text{m s}^{-2}$
16	**C** At the top of the circular path, centripetal force is directed vertically downwards and is provided by the sum of the weight and tension in the string. $mg + T = \frac{mv^2}{r}$ $T = \frac{mv^2}{r} - mg$
17	**C** Since a geostationary satellite is always vertically above a fixed point on the equator, it follows the Earth's rotation with the same period (24 hours) and hence the same angular velocity. Any points on the Earth rotates with the Earth about its axis with the same period, hence same angular velocity with the satellite. Answer A is wrong because the geostationary satellite must be above the equator and not any chosen fixed point. Answer B is wrong because linear speed = $r\omega$. The satellite has a larger radius of orbit than a point on the Earth's surface, it will have a larger linear speed (although its ω is the same as that of a point on the Earth's surface).

	Answer D is wrong because geostationary satellites follow the Earth's rotation from west to east, and not from the east to west.
18	**A** Resistance, $R = \frac{\rho l}{A}$. Since ρ is the same, R per unit length is inversely proportional to the cross-sectional area. The gradient of the graph $\frac{R}{d}$ is inversely proportional to the wire's cross-sectional area. Thus for the thinner sections, the gradient is steeper.
19	**C**  Initially, current 1.00 = E / (3.00 + r) ------ (1) When a second identical resistor is connected parallel to R, the effective resistance becomes 0.5R + r = 1.50 + r Hence 1.93 = E / (1.50 + r) ----- (2) Solve equation (1) and (2) simultaneously, E = 3.11 V and r = 0.113 Ω
20	**A** Let the current supplied by the e.m.f. source be I. Since Q and R are identical, current passing through each of these resistors is 0.5I, and the current passing through P is I. Power = I^2R, thus power dissipated in resistor P is 4 times current through Q and R. $P_P = 4P_Q = 4P_R$ Since $P_P + P_Q + P_R$ = 12 W $4P_R + P_R + P_R$ = 12 W P_R = 2 W
21	**D** When the variable resistor has resistance of 0 kΩ, current passes through it without passing through the 1.0 kΩ resistor in the other parallel branch i.e. short-circuit. Hence, the 12 V is entirely delivered across the 1.0 kΩ resistor with the voltmeter attached parallel to it. When the variable resistor has resistance of 1.0 kΩ, voltmeter reading = $\frac{1.0}{1.0+0.5} \times 12 = 8\,\text{V}$
22	**C** To light up the green lamp, current can either flow through PQ, RS or RT, which applies to all options except C.

	For option C, the circuit remains open (see below). 
23	**A** Since the thermistor's resistance decreases as its temperature increases, in accordance with the potential divider principle, the potential difference (p.d.) across it decreases with increasing temperature. The thermistor and the fixed resistor are in series thus their potential differences add up to 10 V. Therefore the p.d. across the fixed resistor increases as the p.d. across the thermistor decreases due to increase in temperature. When the p.d. across the fixed resistance exceeds the built-in p.d. of the diode (0.3 – 0.7 V) the diode becomes forward biased and current starts to flow downwards through the lamp to light it up. Option C is wrong as the diode is always in reverse bias hence the lamp will not light up as current will not flow through the diode even if the p.d. in the fixed resistor exceeds the diode's built-in potential difference.
24	**D** The magnetic field lines due to current in a conductor is made up of concentric circles centered about the conductor. The direction of the field can be found using the Right Hand Grip Rule. At O, the direction of the magnetic field is tangential to the circular field lines. For example, due to a current at P that is into the page, the direction of the magnetic field at O points towards S. Apply this to the options and D is the answer. 

25	**A** There is no force on the electron in the horizontal direction, hence it will have constant horizontal speed. The electric force on the electron is upwards, hence it will have a constant acceleration upwards.
26	**B** F on wire loop = $(0.020 \times 10^{-3}) \times 9.81 = 1.962 \times 10^{-4}$ Using $F = BIL$, $B = F/IL = 1.962 \times 10^{-4} / (3.0 \times 5.0 \times 10^{-2}) = 1.3 \times 10^{-3}$ T
27	**D** Alpha particles and gold nucleus are positively-charged, hence the alpha particles are repelled. The closer the distance of the approaching alpha particle to the gold nucleus, the larger is the deflective force hence option D is correct and B is wrong.
28	**D** Total mass of reactant is less than total mass of products, so energy has to be supplied for the reaction to take place. Energy supplied = $(1.0086 + 1.0097 - 2.0150)$ u $c^2 / (1.6 \times 10^{-19})$ = 3 MeV
29	**B** The proton number decreases by 2 during alpha decay, and increases by 1 during beta decay.
30	**D**